Fuzzy Delphi for Marine Space Stakeholder Framework Development: An Analytical Literature Review

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SUMMARY

This paper presents an analytical literature review on Fuzzy Delphi Method (FDM) and Marine Space Stakeholder Issues (MSSI) of papers published between 2000 and 2013. In this review were divided into two leading groups. The main group comprise of publications which proposed some models/method to develop Marine Space Stakeholder Framework. Then the followed by Fuzzy Delphi Method used in Stakeholder Framework. Finally, all the publications were analysed using comparable method in order to distinguish the research gaps and their future directions. This study found that FDM has a great potential to be applied in Marine Space Stakeholder Issues (MSSI) for developing the Marine Space Stakeholder Framework. This approach is emphasised on the importance of Marine Space Stakeholder framework goals on each of the strategy capabilities to satisfy with the fuzzy numbers. It takes into considerations on both goals known as tangible and intangible goals which dealing with the selection problem. Thus, the adequate ability of nature opinions of the marine space stakeholders can be measured and accessed, indeed an appropriate framework will be useful for the stakeholder's guidance.

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1. INTRODUCTION

The responsibility of marine area management and administrations particularly to facilitate the stakeholder effective engagement in economic perspective, social and environmental, needs participation from the rest of the world. The responsibility includes; the marine space administrations, marine governing property rights, and the use of marine and maritime. However, those activities are usually governed by various aspects which regard to the roles and responsibilities of each stakeholder as the stakeholder engagement gives a significant impact as it able to affect the success of sustainable marine space environment (Liu, Ballinger, Jaleel, Wu, & Lin, 2012).

In the early discussions on the analyses of Marine Space administrations emerged during 2004s which posed the three major issues, namely; technical, legal and stakeholders (Assessment et al., 2010; Binns, Rajabifard, Collier, & Williamson, 2003; Choon & Seng, 2013; Elisa, Michael, Tarrant, 2014; Maguire, Potts, & Fletcher, 2012; Ng'ang'a, Sutherland, Cockburn, & Nichols, 2004).

The technical issue such as vertical datum, the high water mark as a jurisdictional limit and loose and overlapping jurisdictions amongst various government agencies merely able to be resolved by implementing new technology such as GPS, satellite imagery and geographic information system which greatly improved access to data collection while the legislation problem can be improved by introducing new policy instruments to the marine space area. However, the implementation and the improvement of the technical and legislation issues involve the stakeholder and an authorise individual who have interest on the marine spaces which includes various sections of the government agencies. The relationship between all stakeholders together with the technical and legislation implementation could achieve many economic goals, social, politic, and environment blocked (Nichols, S., Monahan, D., & Sutherland, 2000).

There are various techniques have been used to resolve the stakeholder issue and yet the solution is usually applicable to that particular study area. Thus, this literature study is aimed to identify an identical case of study with regard to the use of FDM in solving the stakeholder issue of the marine space area.

2. STAKEHOLDER

Stakeholder can be defined as A person with an interest or concern in something, especially a business (Oxford Dictionary, 2014). However, in broad terms, stakeholder can be defined as an individual or a group of people that have common characteristic of interest, who looking forward for the system or organization success. In marine spaces, the stakeholder can be divided into three categories; known as national, state and local organizations in sustainable with various department and agencies which including government, private and education organizations (Tarmidi et al., 2014) and each of the category that has jurisdiction in the marine environment is able to create their own marine manage areas or spaces. Marine manage areas, in the widest sense, are geographic areas that been designed to protect or manage resources within the marine environment. In Malaysia, the creating agency could be a federal, state, territorial, tribal, or local government and an independent agency, or a regional entity with resource authority, such as a port management council. Table 1 shows some samples of the Malaysia Marine Space stakeholder with 15 categories of marine space activities, 14 ministries and more than 30 department/units are responsible for the management of the marine space activities.
What interesting in this data that there is visible from multiple stakeholders under various ministries. Therefore clarity is needed in the stakeholder administrative management of the marine environment. In Malaysia, there are various stakeholders and activities in the marine environment such as in land development, coastal activities, agriculture, tourism related activities, native title or indigenous issues, marine parks or protected area, aquaculture, oil and gas exploration, shipping the international boat or local, waste management from industry, cable and pipelines for the water supply or electricity and heritage area such as shipwreck. There are many different activities occurring the ocean surface as shown in Figure 1

Table 1: The Malaysia Marine Space Institutional/Stakeholder Structure

No	Category	Ministry	Department/Agencies	Division/Council
1	Port	Ministry of Transport, Prime Minister's Department, Ministry of International Trade and Industry	Johor Port Autority, Bintulu Port Autority ,Klang Port Authority, Kuantan Port Autority, Kemaman Port Autority, Penang Port Comission, Maritime Institute of Malaysia	National Shipping Council
2	Shipping		Marine Department of Malaysia, Maritime Institute of Malaysia	Malaysian National Shipper's Council
3	Light House		Marine Department of Malaysia	
4	Non Living Resources	Ministry of Science and Technology	Department of Standard Malaysia (STANDARD MALAYSIA), National Oceanographic Directorate (NOD), Malaysia Remote Sensing Agency (ARSM), Malaysia Meteorological Department	National Oil Spill Control Committee
		Prime Minister's Department	Economic Planning Unit , Maritime Institute of Malaysia	National Petroleum Advisory Council
5	Living Resources/Fisheries	Ministry of Agriculture and Agro-Based Industry	Department of Fisheries Fisheries Development Authority of Malaysia (LKIM) Maritime Institute of Malaysia	National Advisory Council for Marine Park and Marine Reserve
		Prime Minister's Department, Ministry of Transport		
6	Natural Resources	Ministry of Natural Resources and Environment,	National Hydraulic Research Institute Research Institute of Malaysia (NAHRIM), Department of Survey and Mapping Malaysia, Department of Director General of Lands and Mines, Department of Irrigation and Drainage Minerals and Geoscience Department , Maritime Institute of Malaysia	
7	Forestry/Wildlife	Prime Minister's Department, Ministry of Transpot	Department of Marine Park Malaysia, Department of Environment, Forestry Department Peninsular Malaysia, Forest Research Institute Malaysia, Department of Wildlife and National Park Department of Biosafety, Maritime Institute of Malaysia	
8	Jurisdiction	Ministry of Defence, Prime Minister's Department, Ministry of Transpot	Royal Malaysia Navy, Hydrographic National Center, Maritime Institute of Malaysia	
9	Enforcement	Ministry of Home Affairs	Royal Malaysian Police	Marine Unit
		Prime Minister's Department	Maritime Enforcement and Coordinating Centre Malaysia Maritime Enforcement Agency	
10	Tourism	Ministry of Culture, Arts and Tourism, Prime Minister's Department, Ministry of Transport	Malaysia Tourism Board, Maritime Institute of Malaysia	
11	Heritage and Antiquity			
12	Telecommunication	Ministry of Communication and Multimedia		
13	Dispute Settlement		Attorney General's Chamber	Advisory and International Division
		Ministry of Foreign Affairs	Economic Division Policy and Planning Division	Maritime Affairs Units
14	Educations	Ministry of Education		Universiti Teknologi Malaysia (UTM), Universiti Malaya(UM), Universiti Malaysia Terengganu(UMT), Universiti Putra Malaysia(UPM), Universiti Kebangsaan Malaysia (UKM), Universiti Teknologi MARA(UITM), Politeknik Ungku Omar(PUO)
15	Trade and Service	Ministry of Finance	Internal Tax Division	Secretariat for Cabinet Committee on Trade and Service

Modify: After Abdul Hamid Saharudin (Saharuddin, 2001)

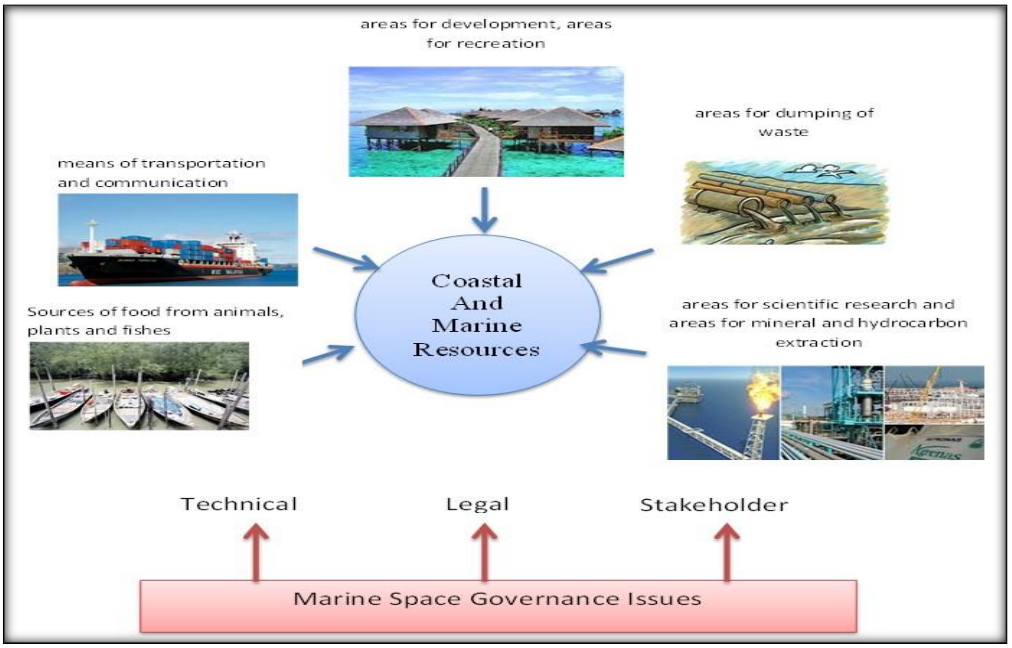


Figure 1: Competing Demand for Malaysia Coastal and Marine Recourses with Marine space Governance Issues

Ten years later, Freeman, Wicks & Parmar, (2004) reported that the stakeholder theory is based on the assumption that values comprise a part of doing business and asks managers to express the shared sense of the value created. The stakeholder theory is based on two queries. Firstly is what the purpose of the firm is and secondly is, what responsibility management has to stakeholders. These queries assist administrators to verbalise the shared sense of value created, in other words, what creates outstanding performance and guides administrators to state how they want to do business, especially around which relationships they want to and need to establish with stakeholders.

Jones and Wicks (1999) as well as Mainardes et al., (2011) raised several concerns about the important principles of the stakeholder theory. They highlighted that the organisation has relationships with many stakeholders that affect and are affected by its decisions, the descriptions of these relationships is occupying on processes and outcomes for the organisation and its stakeholders, the intrinsic value have interests of all legitimate stakeholders, and the managerial decision-making are focused.

Consequently, according to Mainardes et. al. (2011), the management must engage in identifying stakeholders and develop processes of identifying and interpreting stakeholder needs and interests. As an outcome of this process relationships can then be constructed where the entire process is planned around the organisation's objectives. Hence the goal of this paper is to find out the recent method that been used in managing stakeholder problem as showed at table 2 and proposed the well-known method but new in marine space governance.

Table 2: A brief description of reviewed paper on method used in stakeholder research

Year	Author	Journal	Title	Method
2010	Monica R. Geist (Geist, 2010)	Evaluation and Program Planning journal	Using the Delphi method to engage stakeholders: A comparison of two studies	The Delphi method
2012	Vincent Luyet , Rodolphe Schlaepfer , Marc B. Parlangea, Alexandre Buttler (Luyet, Schlaepfer, Parlange, & Buttler, 2012)	Journal of Environmental Management	A framework to implement Stakeholder participation in environmental projects	Literature Review and case study
2008	Emma L. Tompkinsa,,1, Roger Fewa,c, Katrina Browna (Tompkins, Few, & Brown, 2008)	Journal of Environmental Management	Scenario-based stakeholder engagement: Incorporating stakeholders preferences into coastal planning for climate change	Case Study
2013	Majeed Pooyandeh*, Danielle J. Marceau(Pooyandeh & Marceau, 2013)	Journal of Environmental Management	A spatial web/agent-based model to support stakeholders' negotiation regarding land development	Case Study
2010	Emma Ter Mors*, Mieneke W.H. Weenig, Naomi Ellemers, Dancker D.L. Daamen(Ter Mors, Weenig, Ellemers, & Daamen, 2010)	Journal of Environmental Psychology	Effective communication about complex environmental issues: Perceived quality of information about carbon dioxide capture and storage (CCS) depends on stakeholder collaboration	Quantitative

2012	Wen-Hong Liu, Rhoda C. Ballinger, Azmath Jaleel, Chin-Cheng Wu, Kun-Lung Lin(Liu, Ballinger, Jaleel, Wu, & Lin, 2012)	Ocean & Coastal Management	Comparative analysis of institutional and legal basis of marine and coastal management in the East Asian region	Qualitative
2012	Vincent Luyet, Rodolphe Schlaepfer,Marc B. Parlange, Alexandre Buttler (Luyet et al., 2012)	Journal of Environmental Management	A framework to implement Stakeholder participation in environmental projects Vincent	Qualitative, quantitative and case study
2013	Majeed Pooyandeh, Danielle J. Marceau (Pooyandeh & Marceau, 2013)	Journal of Environmental Management	A spatial web/agent-based model to support stakeholders' negotiation regarding land development	spatial web/agent-based modeling system, fuzzy Analytic Hierarchy Process and case study
2014	Helena Ranängen, Thomas Zobel(Ranängen & Zobel, 2014)	Journal of Cleaner Production	Exploring the path from management systems to stakeholder management in the Swedish mining industry	Case study
2010	Emma Ter Mors*, Mieneke W.H. Weenig, Naomi Ellemers, Dancker D.L. Daamen Leiden(Ter Mors et al., 2010)	Journal of Environmental Psychology	Effective communication about complex environmental issues: Perceived quality of information about carbon dioxide capture and storage (CCS) depends on stakeholder collaboration	Quantitative
2014	V.M.Waligo ,J. Clarke and R. Hawkins (V.M. Waligo, Clarke, & Hawkins, 2014)	Journal of Business Research	The 'Leadership–Stakeholder Involvement Capacity' nexus in stakeholder management	Case study
2013	Victoria M. Waligoa,, Jackie Clarke, Rebecca Hawkins(Victoria M. Waligo, Clarke, & Hawkins, 2013)	Tourism Management	Implementing sustainable tourism: A multi-stakeholder involvement management framework	Case study
2014	Xuan-Quynh Le , Van-Hieu Vub, Luc Hensc, Bas Van Heur (Le, Vu, Hens, & Van Heur, 2014)	Journal of Cleaner Production	Stakeholder perceptions and involvement in the implementation of EMS in ports in Vietnam and Cambodia	Qualitative and Quantitative
2014	Stephanie Missonier, and Sabrina Loufrani-Fedida (Missonier & Loufrani-Fedida, 2014)	International Journal of Project Management	Stakeholder analysis and engagement in projects: From stakeholder relational perspective to stakeholder relational ontology	Qualitative longitudinal study
2012	Heidi M. Nutters and Patricia Pinto da Silva (Nutters & Pinto da Silva, 2012a)	Ocean & Coastal Management	Fishery stakeholder engagement and marine spatial planning: Lessons from the Rhode Island Ocean SAMP and the Massachusetts Ocean Management Plan	Qualitative

2014	Judith van Leeuwen, Jesper Raakjaer, Luc van Hoof, Jan van Tatenhove , Ronán Long and Kristen Ounanian (van Leeuwen et al., 2014)	Marine Policy	Implementing the Marine Strategy Framework Directive: A policy perspective on regulatory, institutional and stakeholder impediments to effective implementation	Qualitative

It is apparent from this table that most researchers used qualitative and quantitative methods in their studies then, followed by case study methodology. Literature review studies seen by the authors of the study were randomly selected research papers in stakeholders issues where it started from 2010 to 2014 in 10 refereed journals. However, there are also studies that seen by the authors of marine space stakeholders. Their study has chosen qualitative method (Liu et al., 2012; Nutters & Pinto da Silva, 2012b; van Leeuwen et al., 2014).
In recent years there has been growing awareness of the importance of stakeholder relationship analysis related to the marine space governance focussing the need for a structured and consistent approach to the definition, maintenance and management of the marine space administrations. Several authors (Akter & Simonovic, 2005; Gray et al., 2014; Ishikawa et al., 1993; Pooyandeh & Marceau, 2013; van Vliet, Kok, & Veldkamp, 2010) have already proclaimed the potential value of the Fuzzy Delphi method to analyse stakeholder in a future setting.

The authors argued that in uncertain environments it is necessary to analysed how stakeholder can impact marine space governance. The Fuzzy Delphi technique are summarized using FDMs, such as avoiding the distortion of expert opinions, clearly expressing the semantic structure of selected options, and the consideration of fuzzy nature during the survey process (Chang, Hsu, & Chang, 2011; Mohd Ridhuan Mohd Jamil, Saedah Siraj, Zaharah Hussin, Nurulrabihah Mat Noh, 2014). There-by, this method overcomes drawbacks of traditional group discussions, such as the stakeholder identification issues, stakeholder engagement and managing stakeholder data (Binns et al., 2003; Hoefnagel, de Vos, & Buisman, 2013; Plasman, 2008; Suzanne Bass et al., 2006),and produces answers quicker and more accurately than individual on the average (Ishikawa, Akira, 1993; Ma, Shao, Ma, & Ye, 2011; Mohd Ridhuan Mohd Jamil, Saedah Siraj, Zaharah Hussin, Nurulrabihah Mat Noh, 2014). Therefore this paper tries to see the current practise/model of using Fuzzy Delphi Method Therefore; this paper tries to look at the current practice / model of using FDM for obtaining consensus from experts in a particular issue and to prove this method is also suitable for developing framework for marine space stakeholder management.

3. MARINE SPACE STAKEHOLDER ISSUES (MSSI)

The successful application of Marine Space Governance to resolve conflicts in coastal regions depends on the level of stakeholder involvement, data availability and the existing knowledge. Practical problems in governance namely; first how identify who the stakeholders are; second; how to engage them effectively; and third how to manage their input, including keeping the dialogue going over time (M. Sutherland & Nichols, 2006).

Author list three possibilities category marine space stakeholders, namely local, regional, and national level. The stakeholder thinking into multiple disciplines, stakeholders are predominantly defined solely by their generic economic function—to consume, invest, supply, and so on (Crane & Ruebottom, 2012). The central idea of this research is that current stakeholder involvement approaches for large-scale marine space governance are inadequate, and that effective stakeholder involvement in the representation, design and management of complex administration systems an essential part of marine space governance decision-making. The emphasis on "effective" refers to the fact that not all stakeholder involvement results in improved decision-making. Why is there so much resistance and hesitation when it comes to stakeholder involvement, if its intrinsic merits are broadly accepted? One possible answer is that many of the current approach to stakeholder involvement is inadequate and either fails at producing agreements, or fail at creating consensus between stakeholder.

In recent years, there has been an increasing amount of literature on issues in marine space administration and marine space governance. More recent studies have confirmed that practical problems in marine space governance include such as how identify who the stakeholders are, how to engage them effectively and how to manage stakeholder input, including keeping the dialogue going over time (Hillman, 2010; Luyet et al., 2012; Matos & Silvestre, 2013; Sutherland & Nichols, 2006). M. Sutherland & Nichols (2006) summarized this as defining the governance process in terms of liaising, listening, learning, and leading. More importantly to consider is too often agencies responsible for programs and projects focus only on the last step. One of the greatest limitations in most marine programs and projects is having a narrow approach to stakeholder participation. This is often driven by issues such as: time constraints, lack of knowledge, single issue focus, or governmental silos. It is particularly true in coastal region were there may be jurisdictional uncertainty, overlaps, and gaps (Boateng, 2006; Elisa, Michael, Tarrant, 2014; Sutherland & Nichols, 2006). Despite its importance, the identification of stakeholders, including the identification of their needs and expectations, is poorly achieved in marine space stakeholder management projects. There is essential for establishing effective relationships and collaboration between them after identification of stakeholder. Again, effective relationship is not just "this is what we are going to do for you" (Ng'ang'a et al., 2004; M. Sutherland & Nichols, 2006). Once input is obtained, consensus building strategies are required to establish priorities and identify appropriate solutions here called as managing stakeholder input based on the priority. Normally the priorities are different at the local, regional, and national level.

There are many marine space stakeholders and a main function of governance is to improve the communication and collaboration among them. Most of the literature on the marine space issues focused mainly on the technical issues. In addition to these, systematic studies on the marine space stakeholder issues are still needed for better understanding of marine space governance. There is a need to create a framework for marine space stakeholder management in order to provide a foundation from which governance issues, including the global focus on sustainable development, can be addressed. In order to address this, marine space stakeholder management framework were carried out by Author. Therefore Author goes to detailed information related current practice or models were used in stakeholder research and it will be elaborated in the next topic.

4. LITERATURE REVIEW ON CURRENT PRACTICE/MODEL

Fuzzy Delphi Method introduced by Murray, Pipino and Gigch in 1985 and reviewed by Kaufman and Gupta by 1988 (Ahmad, Muhidin, Wasli, Salihin, & Mohd, 2014; Guru et al., 2014; Hsu, Lee, & Kreng, 2010; Ma, Shao, Ma, & Ye, 2011; Mohd Ridhuan Mohd Jamil, Saedah Siraj, Zaharah Hussin, Nurulrabihah Mat Noh, 2014; Mohd Ridzuan Mohd Jamil, Zaharah Hussin, Nurul Rabihah Mohd Noh, 2013). Fuzzy Delphi Method is a combination of fuzzy set numbering or fuzzy set theory with traditional Delphi Method (Lin, 2013) to overcome the weakness of the existing Delphi Method (Chang, Hsu, & Chang, 2011).

Lotfi Zadeh in 1965 a great researcher and also recognized as an expert mathematician was introducing the fuzzy set numbering or fuzzy set theory Fuzzy. His serve as an extension of the classical set theory, where each element in a set is evaluated on the basis of a set of binary (‘yes” or “no”) responses. Fuzzy set theory also permits the gradual assessment of each element in a set, and the value contained in this fuzzy set is from 0 to 1 or in the unit interval (0,1).

Therefor combinations of Delphi Method and fuzzy set number call as fuzzy Delphi is known as an effective measurement tool because it is seen as being able to solve problems with the particular study’s imprecision and uncertainties. Fuzzy Delphi Method is able to process the ambiguity in relation to the forecasting item and the information content of the respondents and Fuzzy Delphi also can explained by individual characteristics of the participants (Chang, P.T., Huang, LC., & Lin, 2000). The series of the Fuzzy Delphi Method also knew as the good method in obtain the consensusus of expert as showed in Table 1.

Through this narrative review, Tables 3 through 9 provide summary information for each of the studies reviewed. Because many (if not most) researchers currently focused on a getting experts consensus in their type of research (e.g., consensus in teching, management, design), we organize the tables around those types. The tables present information about each study, by focusing to the key result of using Fuzzy Delphi Method. Authors hope is that readers may benefit from the literature of using the Fuzzy Delphi Method in getting consensus from various perspectives.

From this point of view, author’s confidence in the existing strengths with Fuzzy Delphi Method in reaching the consensus, therefor the author has made a model/ FDM framework for the development of a framework for marine space stakeholder management.

. **Table 3**: Most relevant literature on Fuzzy Delphi Method in obtains the Consensus of Experts.

Year	Author	Journal	Title	Key Result
2013	Chiahsu Lin (Lin, 2013)	International Journal of Clothing Science and Technology	Application of fuzzy Delphi method (FDM) and fuzzy analytic hierarchy process (FAHP) to criteria weights for fashion design scheme evaluation	• The first stage is to use the fuzzy Delphi method (FDM) by fashion design experts of academia and industries for fashion design evaluation criteria. • The second stage is based on the use of a fuzzy analytic hierarchy process (FAHP) to find the criteria weight. Finally, an empirical example is used to illustrate the procedure of obtaining the criteria weights for the evaluation of a fashion design scheme.
2011	Dimitris Damigos and Fotis Anyfantis (Damigos & Anyfantis, 2011)	Landscape and Urban Planning	The value of view through the eyes of real estate experts: A Fuzzy Delphi Approach	• Fuzzy Delphi method was employed in order to estimate the effect of view on housing prices in the broader area of Athens, the Greek capital. • Towards this direction, four principal issues were considered for various forms of natural and man-made features with respect to: (a) the effect on property value (positive or negative), (b) the attractiveness or disattractiveness of different views, (c) the influence of distance and (d) the price alteration
2011	Pao-Long Changa, Chiung-Wen Hsub, Po-Chien Chang (Chang et al., 2011)	International Journal of Hydrogen	Fuzzy Delphi method for evaluating hydrogen production technologies	• The linguistic scores are then converted into fuzzy numbers, and a consensus of the decision makers' opinions on weights and ratings is mathematically derived using fuzzy Delphi methodology.

2014	Farzad Tahriri, Maryam Mousavi Siamak Hozhabri Haghighi, Siti Zawiah Md Dawal (Tahriri, Mousavi, Hozhabri Haghighi, & Zawiah Md Dawal, 2014)	Journal of Industrial Engineering International	The application of fuzzy Delphi and fuzzy inference system in supplier ranking and selection	• Fuzzy Delphi method used to defining aspects and criteria for hierarchical structure. • Fuzzy Delphi method to adjust the consensus condition
2014	Ying Wang a, Gi-Tae Yeo a,n, Adolf K.Y. Ng (Wang, Yeo, & Ng, 2014)	Transport Policy	Choosing optimal bunkering ports for liner shipping companies: A hybrid Fuzzy-Delphi–TOPSIS approach	• Fuzzy-Delphi–TOPSIS is a methodology combining the Fuzzy Delphi and Fuzzy TOPSIS methods for optimal decision making strategies. • Fuzzy has four advantages: (1) to decrease the times of questionnaire surveys, (2) to avoid distorting individual expert opinions, (3) to clearly express the semantic structure of predicted items, and (4) to consider the fuzzy nature during the interview process
2012	Okan Durua, Emrah Bulut, and Shigeru Yoshida	Expert Systems with Applications	A fuzzy extended DELPHI method for adjustment of statistical time series prediction: An empirical study on dry bulk freight market case	• The Fuzzy Delphi based adjustment procedure is investigated in a dry bulk shipping example, and the results are promising. • One critical conclusion is that the consensus of the group was ensured successfully since a reduction on variance is gained. • Fuzzy Delphi based study provided superior predictions, as compared with the statistical benchmark results. In fact, statistical approach could not success over no-change strategy, but proposed method improved its accuracy by expert aided design.

2010	Yu-Lung Hsua, Cheng-Haw Lee a, and V.B. Kreng (Hsu et al., 2010)	Expert Systems with Applications	The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection	• Fuzzy Delphi Method used to establish a hierarchical framework by reached a general consensus among experts.
2013	Nurulrabihah Mat Noh, Saedah Siraj, Mohd Ridhuan Mohd Jamil, Zaharah Husin and Ahmad Arifin Sapar(Noh, Siraj, & Ridhuan, 2013)	The Online Journal of Distance Education and e-Learning	Design Of Guidelines On The Learning Psychology In The Use Of Facebook As A Medium For Teaching & Learning In Secondary School	• Fuzzy Delphi Method in getting consensus from the experts.
2008	Azizollah Jafari, Mehdi Jafarian, Abalfazl Zareei and Farzad Zaerpour	Journal of Uncertain Systems	Using Fuzzy Delphi Method in Maintenance Strategy Selection Problem	• Fuzzy Delphi method is applied for the assessment of the importance of each goal and capability of each maintenance strategy, considering the expert's opinion.

5. CONCEPTUAL MODEL OF PROPOSED METHOD

In order to effectively address the problems related to marine space stakeholder in this region, it is necessary to notice the marine space governance issues. Authors used Qualitative method to identify issues related to the administration of the marine environment. However, to the best of author's knowledge, no report has been found so far using Fuzzy Delphi Method confirm and put priority on Marine space governance issues. This paper will discuss on Fuzzy Delphi Method.

Fuzzy Delphi has seven steps that must be followed in order to study the empirical studies considered. The process of Fuzzy Delphi Method and Organization of the fuzzy Delphi Method of the research framework is illustrated as follows:

5.1 Phase of Fuzzy Delphi Method

Phase 1: Forming questions for the fuzzy Delphi questionnaire was based on literature review, expert interviews, focus group and adapt and adopt technique. Questionnaire script creation process is similar to the construction of the questionnaire usual script. Likert scale used in the questionnaire and it is based on the requirements of the research questions required that according to what is to be measured by the researchers as CONSENT level, level STAGE and level of INTEREST. The instruments will be used in this study depends on the purpose of each phase as described in the framework of the research design. In Phase I, authors will use the interview and focus group approach to collect data to develop the

constructs and items in the instrument development process. Research interview can be defined as conversations between two parties that are relevant to the study, and focused on a specific content is determined as the objective description, prediction or explanation to systematically (Sang, 2010).

Phase 2: Assuming that the number of experts K invited to determine the importance of the evaluation criteria for the variables to be measured by using linguistic variables. Among the methods that can be done is like running a seminar or workshop and invited scientific experts involved, meet face to face against each expert and spread online like through email experts identified in the surveyed areas (Mohd Ridhuan Mohd Jamil, Saedah Siraj, Zaharah Hussin, Nurulrabihah Mat Noh, 2014) .
There are two different opinions about the appropriate number of experts who were 10 to 15 people (Adler, M.& Ziglio, 1996), while Jones and Twiss (1978) was proposed a total of 10 to 50 experts. For this study the researchers selected 30 experts which were identified in advance based on the literature review. A Fuzzy Delphi panel is a group of experts who have a view to share on a specific topic. This sharing leads to consensus through a number of structured rounds of a research process. In this research, experts can be either policy makers, academician and as all are seen to have expert views on marine space stakeholder management based on their own perspectives.

The experts for this study were selected with care with the specific goal in mind to ensure heterogeneity in terms of the role they play in the marine space administration or environment. Experts were thus selected to be representative of the agencies performing on marine space environment. Care was taken to include experts from all marine space environments in the Malaysia namely the Higher Education Sector, Public sector and the Private sector.

Phase 3: Converting to all linguistic variables into triangular fuzzy numbers. Assume the fuzzy numbers fuzzy r_{ij} is variable for each of the criteria for expert K for i = 1, ..., m, j = 1, ..., n, k = 1, ..., k and $r_{ij} = 1 / K (r^1_{ij} \pm r^2_{ij} \pm r^K_{ij})$. Likert scale examples that will be used in this study are as follows:

Tier	Likert Scale	Fuzzy Scale		
Strongly Agree	5	0.60	0.80	1.00
Agree	4	0.40	0.60	0.80
Neither Agree nor Disagree	3	0.20	0.40	0.60
Disagree	2	0.00	0.20	0.40
Strongly Disagree	1	0.00	0.00	0.20

Phase 4: Threshold value (d) will be calculated after the data converted into fuzzy scale. This threshold value is calculated based on the formula set forth below (Chen, 2000).

$$d(\tilde{m},\tilde{n}) = \sqrt{\frac{1}{3}\left[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2\right]}.$$

Phase 5: Determination of the first condition of Fuzzy Delphi if the distance between the average of the data evaluation specialists is less than or equal to the threshold, (d) = 0.2, then all the experts considered to have reached a consensus Chu & Hwang, 2008).

Phase 6: If among experts m x n, the percentage achieving group consensus is more or equal to the value of 75% (Chu & Hwang, 2008; Murry & Hammons, 1995), indicating that the consensus of the expert group has also been observed. The next step can be executed. Otherwise, a second round fuzzy delphi method needs to be done.

Phase 7: Fuzzy assessment for calculating the aggregate score and determine the position of each item as follows (Chang et al., 2011):

$$\widetilde{A} = \begin{bmatrix} \widetilde{A}_1 \\ \widetilde{A}_2 \\ : \\ : \\ \widetilde{A}_m \end{bmatrix} \text{ where } \widetilde{A} = r_{i1} \times w_1 + r_{i2} \times w_2 + \ldots\ldots\ldots\ldots r_{in} \times w_n$$

$i = 1, 2, \ldots\ldots\ldots, m$

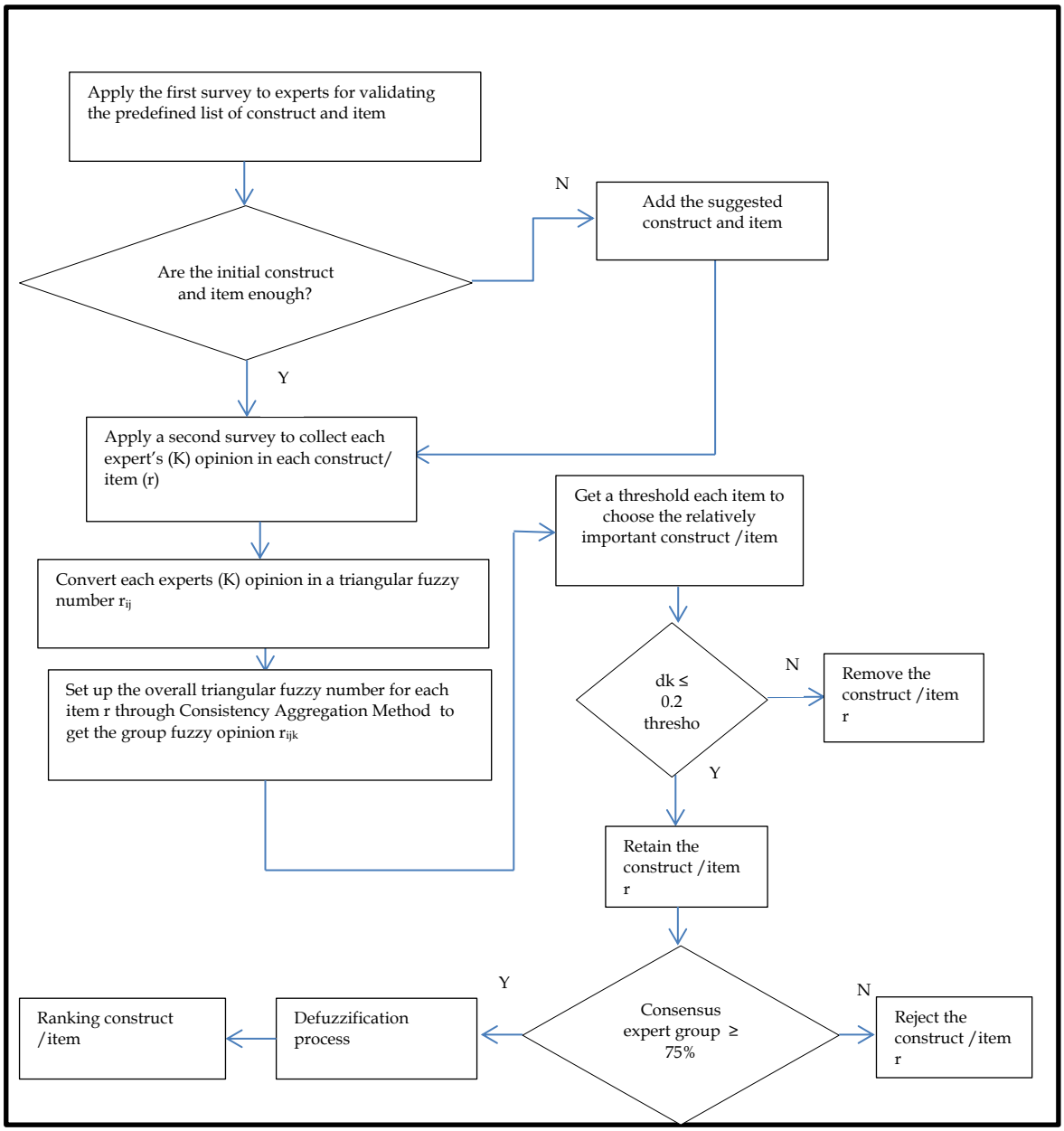
Calculation and determination of fuzzy evaluation is using the formula $\mathbf{A_{max} = 1/4\ (m_1 + 2m_2 + m_3)}$

5.2 Organization Model of the fuzzy Delphi Method

Figure 2 exhibits the organization of fuzzy delphi method for marine space stakeholder analysis. So the model is built, first considering applying the first survey to experts for validating the predefined list of contract and item of marine space governance issues. Then convert each experts (K) opinion in a triangular fuzzy number rij. After that set up the overall triangular fuzzy number for each item r through Consistency Aggregation Method to get the group fuzzy opinion rijk. Get a threshold each item to choose the relatively important constructs/item. If the finding shows that the finding are suited to first rules with threshold score (d) ≤ 0.2 then retain the contract/item r. Second rules in fuzzy delphi where's percentage consensus of expert more than 75% expert agreed. Finally is the defuzzification process for ranking the constructs/item.

Defuzzification of the average fuzzy adjustment stretches a crisp adjustment, which is applied to statistical outcomes to produce the final results of the Fuzzy Delphi Method. There have been several studies in the literature reporting the Fuzzy Delphi adjustment approach enables us to reduce data uncertainty and to group the data into linguistic terms this method also

judgmentally adjusted statistical forecasts are concluded from implementing the defuzzified adjustments (Chang, P.T., Huang, LC., & Lin, 2000; Duru, Bulut, & Yoshida, 2012; Hsu et al., 2010; Zadeh, 1965).



r = Construct/item for marine space stakeholder

Figure 2: Organization Model of the fuzzy Delphi Method for Marine Space Stakeholder Analysis (Modify: Sánchez-lezama & Cavazos-arroyo, 2014)

5. DISCUSSION

In this paper a review of 11 randomly selected papers on stakeholder issues and the role of management on stakeholders is performed. The reviewed papers are classified according to the years in which they published. The selected papers are appearing from 2010 to 2014. The papers are classified according to the used research methodology. The classification is shown in figure 3. As can be seen from figure 2 that, the Case study type research methodology is highly applied in as many 8 papers, followed by Qualitative type research methodology (5 papers), Quantitative (4 papers).

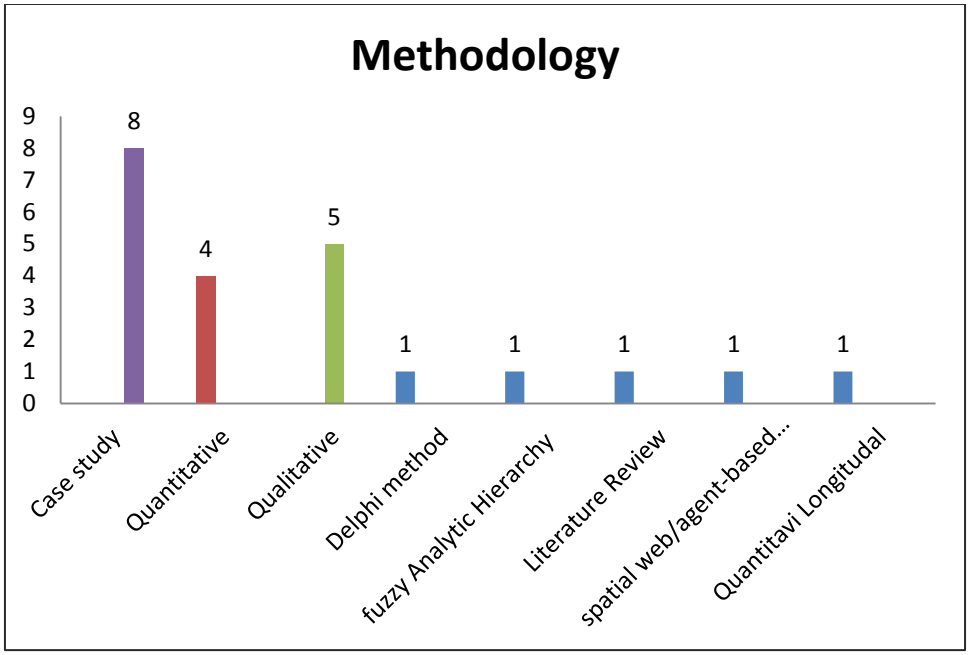


Figure 3: Methodology wise classification of papers

Among the plausible explanations for these findings is that Fuzzy Delphi studies were conducted for a minimum number of rounds, without a formal criterion for consensus. Therefore, when authors conclude, as most did, that the results of the study reflect the consensus opinion, it would seem that the achievement of consensus within a Fuzzy Delphi study is implicit to be an integral part of the technique, as has been suggested in the literature (Chang, P.T., Huang, LC., & Lin, 2000; Fasanghari & Montazer, 2008; Glumac, Han, Smeets, & Schaefer, 2009; Jafari, Jafarian, Zareei, & Zaerpour, 2008). The fact that consensus was an important agenda to developed a framework for marine space stakeholder management. Despite the fact that consensus may be the expected outcome of the fuzzy delphi method, authors believe that there is a distinctness in Fuzzy Delphi Method so o had decided to use it.

These findings enhance our understanding of Fuzzy Delphi Method, is a versatile research tool that researchers can employ at various points in their research. Use of the Fuzzy Delphi method for issue identification/prioritization can be valuable in the early stages and end, particularly in selecting the topic and defining the research questions and also the final confirmation of findings.

To analyse how stakeholder can impact marine space governance an issue on identification/prioritization is an important stage of analysing. Our finding revealed that Fuzzy Delphi Method is the best method on this matter.

6. CONCLUSION

After analysis of the randomly selected research publications, it is quite evident that no study has been found in the marine space stakeholder context used fuzzy delphi methodology to developed marine space governance framework by focussing on stakeholder issues. Although there is consistent with findings by Author, we found that Fuzzy Delphi is the ideal method in obtain consensus. In the studied papers a balance between empirical study type papers and conceptual study type papers has been observed. The result of using the fuzzy Delphi method in obtaining consensus for developing framework for marine space stakeholder management e will presented in Authors next paper. In conclusion, Authors also encourages researchers to consider integrating this method in their personal repertoire of research methods so that it is available to them to use as needed to accomplish their research objectives.

REFERENCES

Adler, M.& Ziglio, E. (1996). *Gazing into the oracle: the Delphi method and its application t o social policy and public health.* London: Jessica Kingsley.

Ahmad, Z., Muhidin, M., Wasli, P., Salihin, M., & Mohd, H. (2014). Fuzzy Delphi Analysis for Future Environmental Education Using Interactive Animation, *2014*(February).

Boateng, I. (2006). Institutional Frameworks in the Administration of Coast Institutionalal and Marine Space in Africa. In *Administering Marine Spaces: International Issues. Frederiksberg: The International Federation of Surveyors (publication No. 36).*

Chang, P.-L., Hsu, C.-W., & Chang, P.-C. (2011). Fuzzy Delphi method for evaluating hydrogen production technologies. *International Journal of Hydrogen Energy*, *36*(21), 14172–14179. doi:10.1016/j.ijhydene.2011.05.045

Chang, P.T., Huang, LC., & Lin, H. J. (2000). The fuzzy delphi method via fuzzy statistic and membership function fitting and an application to the human resources. *Fuzzy Sets and Systems, 112(3),* 511–520.

Chu, H. C., & Hwang, G. J. (2008). A Delphi-based approach to developing expert systems with the cooperation of multiple experts. *Expert Systems with Applications*, *34*, 2826–2840. doi:10.1016/j.eswa.2007.05.034

Crane, A., & Ruebottom, T. (2012). Stakeholder Theory and Social Identity: Rethinking Stakeholder Identification. *Journal of Business Ethics*, *102*(S1), 77–87. doi:10.1007/s10551-011-1191-4

Damigos, D., & Anyfantis, F. (2011). The value of view through the eyes of real estate experts: A Fuzzy Delphi Approach. *Landscape and Urban Planning*, *101*(2), 171–178. doi:10.1016/j.landurbplan.2011.02.009

Duru, O., Bulut, E., & Yoshida, S. (2012). A fuzzy extended DELPHI method for adjustment of statistical time series prediction: An empirical study on dry bulk freight market case. *Expert Systems with Applications*, *39*(1), 840–848. doi:10.1016/j.eswa.2011.07.082
Elisa, Michael, Tarrant, M. F. (2014). 2014 Marine Spatial Planning in San, (March).

Fasanghari, M., & Montazer, G. A. (2008). A Stock Portfolio Selection Method through Fuzzy Delphi, 615–623.

Geist, M. R. (2010). Using the Delphi method to engage stakeholders: a comparison of two studies. *Evaluation and Program Planning*, *33*(2), 147–54. doi:10.1016/j.evalprogplan.2009.06.006

Glumac, B., Han, Q., Smeets, J., & Schaefer, W. (2009). Rethinking Brownfield redevelopment features : applying Fuzzy Delphi, 1–11.

Guru, K., Pengurusan, T., Dan, P., Ridhuan, M., Jamil, M., & Azeez, M. I. K. (2014). Jurnal kepimpinan pendidikan |, 77–88.

Hillman, A. M. Y. J. (2010). SHAREHOLDER VALUE , STAKEHOLDER AND SOCIAL ISSUES : WHAT ' S MANAGEMENT , *22*(2), 125–139.

Hsu, Y.-L., Lee, C.-H., & Kreng, V. B. (2010). The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection. *Expert Systems with Applications*, *37*(1), 419–425. doi:10.1016/j.eswa.2009.05.068

Jafari, A., Jafarian, M., Zareei, A., & Zaerpour, F. (2008). Using Fuzzy Delphi Method in Maintenance Strategy Selection Problem. *Journal of Uncertain Systems*, *2*(4), 289–298.

Le, X.-Q., Vu, V.-H., Hens, L., & Van Heur, B. (2014). Stakeholder perceptions and involvement in the implementation of EMS in ports in Vietnam and Cambodia. *Journal of Cleaner Production*, *64*, 173–193. doi:10.1016/j.jclepro.2013.07.032

Lin, C. (2013). Application of fuzzy Delphi method (FDM) and fuzzy analytic hierarchy process (FAHP) to criteria weights for fashion design scheme evaluation. *International Journal of Clothing Science and Technology*, *25*(3), 171–183. doi:10.1108/09556221311300192

Liu, W.-H., Ballinger, R. C., Jaleel, A., Wu, C.-C., & Lin, K.-L. (2012). Comparative analysis of institutional and legal basis of marine and coastal management in the East Asian region. *Ocean & Coastal Management*, *62*, 43–53. doi:10.1016/j.ocecoaman.2012.01.005

Luyet, V., Schlaepfer, R., Parlange, M. B., & Buttler, A. (2012). A framework to implement Stakeholder participation in environmental projects. *Journal of Environmental Management*, *111*, 213–9. doi:10.1016/j.jenvman.2012.06.026

Ma, Z., Shao, C., Ma, S., & Ye, Z. (2011). Constructing road safety performance indicators using Fuzzy Delphi Method and Grey Delphi Method. *Expert Systems with Applications*, *38*(3), 1509–1514. doi:10.1016/j.eswa.2010.07.062

Matos, S., & Silvestre, B. S. (2013). Managing stakeholder relations when developing sustainable business models: the case of the Brazilian energy sector. *Journal of Cleaner Production*, *45*, 61–73. doi:10.1016/j.jclepro.2012.04.023

Missonier, S., & Loufrani-Fedida, S. (2014). Stakeholder analysis and engagement in projects: From stakeholder relational perspective to stakeholder relational ontology. *International Journal of Project Management*, *32*(7), 1108–1122. doi:10.1016/j.ijproman.2014.02.010

Mohd Ridhuan Mohd Jamil, Saedah Siraj, Zaharah Hussin, Nurulrabihah Mat Noh, A. A. S. (2014). *Pengenalan Asas Kaedah FUZZY DELPHI Dalam Penyelidikan Rekabentuk Pembangunan*. (M. I. Agency, Ed.)*The Online Journal of Islamic Education* (Cetakan Pe., Vol. 2). Monosh Technologies.

Mohd Ridzuan Mohd Jamil, Zaharah Hussin, Nurul Rabihah Mohd Noh, ahmad A. S. and N. A. (2013). Applications of Fuzzy Delphi Method in Educational Research. In D. D. and Z. H.

Siraj, Saedah, Norlidah Alias (Ed.), *Design and Developmental Research - Emergent Trends in Educational Research* (pp. 85–92). Malaysia: Pearson Malaysia Sdn Bhd
.

Murry, J. W., & Hammons, J. O. (1995). Delphi: A Versatile Methodology for Conducting Qualitative Research. *Review of Higher Education*, *18*, 423–36. Retrieved from http://search.proquest.com.myaccess.library.utoronto.ca/pao/docview/1308044902/abstract?accountid=14771

Noh, N. M., Siraj, S., & Ridhuan, M. (2013). Design Of Guidelines On The Learning Psychology In The Use Of Facebook As A Medium For Teaching & Learning In Secondary School Faculty of of Malaya Languages and of Malaya, *2*(4), 103–111.

Nutters, H. M., & Pinto da Silva, P. (2012a). Fishery stakeholder engagement and marine spatial planning: Lessons from the Rhode Island Ocean SAMP and the Massachusetts Ocean Management Plan. *Ocean & Coastal Management*, *67*, 9–18. doi:10.1016/j.ocecoaman.2012.05.020

Nutters, H. M., & Pinto da Silva, P. (2012b). Fishery stakeholder engagement and marine spatial planning: Lessons from the Rhode Island Ocean SAMP and the Massachusetts Ocean Management Plan. *Ocean & Coastal Management*, *67*, 9–18. doi:10.1016/j.ocecoaman.2012.05.020

Pooyandeh, M., & Marceau, D. J. (2013). A spatial web/agent-based model to support stakeholders' negotiation regarding land development. *Journal of Environmental Management*, *129*, 309–23. doi:10.1016/j.jenvman.2013.07.028

Ranängen, H., & Zobel, T. (2014). Exploring the path from management systems to stakeholder management in the Swedish mining industry. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2014.04.025

Saharuddin, A. H. (2001). National ocean policy—new opportunities for Malaysian ocean development. *Marine Policy*, *25*(6), 427–436. doi:10.1016/S0308-597X(01)00027-6

Sánchez-lezama, A. P., & Cavazos-arroyo, J. (2014). Applying the Fuzzy Delphi Method for determining socio-ecological factors that influence adherence to mammography screening in rural areas of Mexico Aproximación Fuzzy Delphi para determinar los factores socioecológicos que influyen en la adherencia a la , *30*(2), 245–258.

Sang, M. S. (2010). *Penyelidikan dalam Pendidikan - Perancangan dan Pelaksanaan Penyelidikan Tindakan.* Kuala Lumpur: Penerbitan Multimedia Sdn. Bhd.
Sutherland, M., & Nichols, S. (2006). Administering Marine Spaces : International Issues. In *FIG PUBLICATION NO 36*.

Tahriri, F., Mousavi, M., Hozhabri Haghighi, S., & Zawiah Md Dawal, S. (2014). The application of fuzzy Delphi and fuzzy inference system in supplier ranking and selection. *Journal of Industrial Engineering International*, *10*(3), 66. doi:10.1007/s40092-014-0066-6

Ter Mors, E., Weenig, M. W. H., Ellemers, N., & Daamen, D. D. L. (2010). Effective communication about complex environmental issues: Perceived quality of information about carbon dioxide capture and storage (CCS) depends on stakeholder collaboration. *Journal of Environmental Psychology*, *30*(4), 347–357. doi:10.1016/j.jenvp.2010.06.001

Tompkins, E. L., Few, R., & Brown, K. (2008). Scenario-based stakeholder engagement: incorporating stakeholders preferences into coastal planning for climate change. *Journal of Environmental Management*, *88*(4), 1580–92. doi:10.1016/j.jenvman.2007.07.025

Van Leeuwen, J., Raakjaer, J., van Hoof, L., van Tatenhove, J., Long, R., & Ounanian, K. (2014). Implementing the Marine Strategy Framework Directive: A policy perspective on regulatory, institutional and stakeholder impediments to effective implementation. *Marine Policy*, 1–6. doi:10.1016/j.marpol.2014.03.004

Waligo, V. M., Clarke, J., & Hawkins, R. (2013). Implementing sustainable tourism: A multi-stakeholder involvement management framework. *Tourism Management*, *36*, 342–353. doi:10.1016/j.tourman.2012.10.008

Waligo, V. M., Clarke, J., & Hawkins, R. (2014). The "Leadership–Stakeholder Involvement Capacity" nexus in stakeholder management. *Journal of Business Research*, *67*(7), 1342–1352. doi:10.1016/j.jbusres.2013.08.019

Wang, Y., Yeo, G.-T., & Ng, A. K. Y. (2014). Choosing optimal bunkering ports for liner shipping companies: A hybrid Fuzzy-Delphi–TOPSIS approach. *Transport Policy*, *35*, 358–365. doi:10.1016/j.tranpol.2014.04.009

Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, *8*, 338–353.

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