Assessment of MPA management: Using Analytic Hierarchy Process to analyze stakeholder preferences for performance indicators in Nha Trang Bay MPA, Vietnam

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Nguyen Hai Anh

Contents

Tables and Figures

Abbreviations

AIG	Alternative Income Generation
AHP	Analytic Hierarchy Process
CBA	Cost Benefit Analysis
CI	Consistency Index
CR	Consistency Ratio
DEFRA	Department for Environment, Food and Rural Affairs
EIMR	Egadi Islands Marine Reserve
EVALSED	Evaluating Socio Economic Development
GIS	Geographical Information System
HMMPA	Hon Mun Marine Protected Area
HCA	Hierarchical clustering analysis
IUCN	International Union for Conservation of Nature
MAUT	Multi-attribute Utility Function
MCA	Multi-criteria Analysis
MCDM	Multi-criteria Decision-making
MPAs	Marine Protected Areas
NOAA	US National Oceanic and Atmospheric Administration
NTB-MPA	Nha Trang Bay Marine Protected Area
NTU	Nha Trang University
ONEB	Office of the National Environment Board (Thailand)
RI	Random Consistency Index
SAS	Statistical Analysis Software
sp.	Species
SPSS	Statistical Package for Social Sciences
UNEP	United Nations Environment Programme
U.S	United States of America
US$	United States Dollars
VNIO	The National Institute of Oceanography
VND	Vietnam Dong
WB	World Bank
WCPA-Marine	World Commission for Protected Areas-Marine
WWF	World Wide Fund for Nature

Abstract

The establishment of the Nha Trang Bay Marine Protected Area (NTB-MPA) in the Southern coastal of Central Vietnam in 2002 focused on two main purposes: to reserve and manage the biodiversity environment within the MPA areas; and, to enhance the local communities' life-conditions by providing the alternative livelihoods. To assess the efficiency of an MPA management process, it needs the understandings in what extent and how the perception from stakeholders about the goals of the MPA establishment and management process was. Much has regarded such perceptions with the complication. This study provides an example in analyzing the stakeholders' opinions of the MPA goals through the performance indicators by applying Analytic Hierarchy Process (AHP). The options from stakeholders were investigated by the mean of a pairwise comparison survey. The results show that by all stakeholders, there was a little homogeneity in weighting the priority of the NTB-MPA objectives in improving the local communities' livelihood. The objectives of the NTB-MPA management process in preserving the biological resources receive the quite similar opinions from all stakeholders in ranking their priority. The other conclusion is about the failures in enforcing the regulation of "*banning trawlers in the water within and around NTB-MPA*" together with the great requirements for enhancing the available sources of information about the MPA. The major challenge for NTB-MPA management process was the possible conflicts between the groups of stakeholders, which were more popular than those among individuals from each separate group of stakeholders regarded as within-conflicts. Especially, the within-conflicts appear mostly amongst 2 key stakeholders: fishermen and local households.

Key words: AHP, Multi-criteria analysis, Stakeholder, Performance indicator, NTB-MPA.

1. Introduction

1.1. Background

Marine protected areas (MPAs) provide an example of integrated approach to the management of coastal and marine areas. To determine the success of plans for an MPA in term of management, it is essential to find out appropriate definitions of management objective (Ward and Kelly, 2009). Claudet et al. (2006) also showed that monitoring operations in an MPA area to determine if objectives are met is essential to the MPA success. In achieving the objectives, it requires the use of indicators (a measurable quantity for evaluating objectives), reference points (benchmark values), and performance measures for each MPA (Sainsbury and Sumaila, 2003). Hence, the identification of performance indicators is to preferred management objectives and future interventions. Up to now, many studies have measured about biological and ecological influences in local waters within and around MPA; for example, the rapidly increased application of bioeconomic model in MPA management (Sumaila and Charles 2002; Grafton *et al*. 2005b). However, not only biological and ecological aspects, but an MPA also involves its objectives in socioeconomic and management performance (Himes 2007b). Christie et al. (2003) and Mascia et al. (2003) pointed out that without or with a little of research in term of society on MPAs, two unfortunate conditions will occur. The first is the incomplete understanding about how the most effective utilization of this popular management tool could be reached at and the other about omissions of feasible measurement of human responses to MPAs from the scientific literature. The avoidance of the last negative impact seems to be so necessary to the management process of MPAs because of the important role of local residents around and within an MPA area or its vicinities. Such responds should come from all people, who are related to an MPA or contribute to the out come of an MPA; and, called as stakeholders.

Stakeholders are considered as the factor making the MPA management more successful. Pomeroy et al. (2005) stated that to manage MPAs effectively, it requires continuous feedback of information to achieve objectives. Obtaining such information requires a periodic and comprehensive assessment of the natural and social processes occurring within and outside the boundaries of MPAs. As such, there is an increasing interest in the development and use of an adequately comprehensive set of indicators that measure the socio-economic, biophysical, and institutional (governance) outputs and outcomes from the process associated with MPA management (Pomeroy et al., 2005). Thus, the variety of stakeholder interests and needs for performance indicators calls into question the typical notion in achieving the MPA “success”. According to Pomeroy (2005), different stakeholder groups and coastal communities might additionally use completed evaluation results to see how far their interests have been taken into account and addressed in the management of an MPA. He also said that the lack of information

and data about the status and nature of conditions (including threats) operating within or around MPAs is one of the most serious cause on restricting the effective management of MPAs. For this, an increasing tendency in using indicators measuring the socio-economic, biophysical, and institutional (governance) outputs and outcomes from the operations relevant to MPAs management was rather obvious.

The remarkable efforts to identify the indicators for the performance evaluation of coastal resources management were done by some organizations and institutions such as the International Union for Conservation of Nature (IUCN), the World Bank (WB), the Intergovernmental Oceanographic Commission, and the US National Oceanic and Atmospheric Administration (NOAA) (Ward et al., 2001). Actually, there are perceivable changes in using the tools and instruments to evaluate the performance of coastal resources management. According to Himes (2007b), although many semi-quantitatively evaluating analyses[1] on stakeholder in MPAs management have been conducted, to define concise criteria for the efficient management of MPAs, a more intensive multi-criteria analysis (MCA) could be used. All approaches of MCA are to vary criteria explicitly and to construct the preferences of group or individuals amongst their alternative during the process of implementing objectives (Department for Communities and Local Government, 2009). Thus, multi-criteria optimization techniques are used to small groups of solutions; and among such approaches, the analytic hierarchy process (AHP) is likely to be the most popular approach in finding out which solution in the group is the most preferred at iteration (James et al., 1992).

In Vietnam, the pilot project of Nha Trang Bay Marine Protected Area (NTB-MPA) has been seen as a model for collaborative MPA management in Vietnam (Yen and Adrien, 2002). Together with its objective to manage and protect effectively the biodiversity status in the MPA area, the project also implemented the other objectives in enabling local island communities to improve their livelihoods. Thus, the stakeholders in the MPA play an important role during the implementation of this project. Since the establishment of NTB-MPA, some studies have researched the value of coral reef and influence factor on it (Long and Hoang, 2008; Nam et al., 2005), economic valuation (Nam and Son, 2001a), willingness to pay from tourism (Lindsey and Holmes, 2002), about livelihood for one kind of stakeholders to safeguard (O'Callaghan, 2004) or from aquaculture (Tung, 2002) as well as studies on several certain kinds of stakeholders; for instance, tourists (Nam and Son, 2001b), or aquaculturemen, local residents and mangers (Lan, 2009). Actually, it is lack of a completed study on overall main groups of stakeholders and their

[1] Semi-quantitatively evaluating analyses or semi quantitative methods here could be seen as the indirect way to evaluate the status of the quantity or amount of one substance (specifically in fisheries, substance may be the ecological status, biomass, biodiversity and so on) in the past or at present basing on other factors (in fisheries, the others are probably the comprehensive marine life and habitat surveys of any location, the amount of fish caught, the cover of coral reef for instance), in the case of shortening of a quantitative result. (source for examples of semi quantitative methods: http://www.nhatrangbaympa.vnn.vn/intro/03Coralsandmarine_en.htm)

attitudes on the MPA. More than that, along with the shortcoming of financial supports, the lack of information and data on current status of biodiversity, socioeconomic, etc. creates the reduction in studying the efficiency of management in NTB-MPA. Basing on a small survey which is involved in Alternative Income Generation (AIG) project supporting to assess the socioeconomic status of NTB-MPA (Thu, 2005b), the opinions from main households toward the implementation and efficiencies of NTB-MPA have been surveyed; however, it only focused on the investigation of foundation conditions in term of socioeconomic and gave the sketchy overviews about the local people's ideas. For these, this study can probably be considered as the first contribution on evaluation of all main groups of stakeholders living inside NTB-MPA areas and in its vicinities, who bring their perceptions on NTB-MPA as the main tool for managing the coastal and marine areas. In this research, the overall judgments of stakeholders with regard to the objectives of the implementation of NTB-MPA for 3 main issues including biology, socioeconomic and management will be analyzed in more detailed and explicit.

Moreover, it has revealed the lack of data and information since the temporary cease of the NTB-MPA project because of the withdrawing of sponsors and the shortening of fund (reported by NTA-MPA Authority 2009). This leads to the case of challenge in assessing the management efficiency from NTB-MPA by the traditional quantitative analysis or semi quantitative methods. However, the AHP method is considered a tool that does not completely require the overall historical data to assess the multi criteria objective systems (Davies, 2001). Therefore, this study can be regarded as the potential and feasible way to assess the success of a specific MPA in Vietnam in the case of limited historical information or data. De facto, up to now in Vietnam, AHP method as one common type in MCA has hardly appeared in studies of fisheries management; and specifically, not in evaluation of overall aspects of MPAs. So, the purpose of this research is becoming the pilot using of AHP in assessing the NTB-MPA management efficiency. We assumed the hypothesis that *all major objectives of NTB-MPA establishment can be found in preferences of all groups of stakeholders. On the other hand, the various preferences can be expected to occur mainly in the group of local households who should be the key factor of the management process for this MPA*. This study aims at giving for the managers of NTB-MPA input with regard to improving the effectiveness of the management process by (1) identifying the main focus of different stakeholders; (2) finding out where the potential conflicts will appear and, (3) enabling them to revise their strategies of management process.

Hence, the overall preferences from fishermen, local households, aquaculturemen, researchers, managers, tourists are collected in order to study the topic "***Assessment of MPA management: Using the Analytic Hierarchy Process to analyze stakeholder preferences for performance indicators in Nha Trang Bay MPA, Vietnam***".

1.2. Objectives of Study

The overall objective of this study is to assess the success of the NTB-MPA in term of management. Specific objectives were; as follows:

- To define performance indicators that the stakeholders expected most in NTB-MPA area.
- To investigate the management efficiency of NTB-MPA via the stakeholders viewpoints.
- To determine and suggest the most feasible and potential alternatives of management strategies via performance indicators to managers of NTB-MPA in improving the efficiency of this MPA by fulfilling the stakeholders' needs and interests.

The aim of this study is to answer several relevant practical questions below:

- How many objectives of the implementation of NTB-MPA could be suitable?
- Do the most important performance indicators of NTB-MPA would differ in various stakeholders with dissimilar knowledge and perceptions?
- If so, how much such differences would be?

Data used in this thesis is primary data that was surveyed in 6 fishing communities of NTB-MPA (Tri Nguyen, Bich Dam, Vung Ngan, Hon Mot, Hon Mun, Dam Bay) and 2 fishing communes (Vinh Luong, Vinh Truong). A convenience sample of 120 questionnaires was collected in 2010. The preferences from all groups of stakeholders for performance indicators of NTB-MPA are performed by the AHP; and, the hierarchy clustering process is also used to analyze the similar preferences by gathering them into one cluster. The analysis of stakeholder preferences was done by Expert Choice 11.0, the SPSS 16.0 was used to describe the view on the clustering analysis; meanwhile, Excel was applied to see the standard deviation and to test the results by ANOVA and T-test.

In the next chapter, the theoretical framework is proposed. Then, in Chapter3, the collection for the primary data is described and we also mention about how to define the performance indicators and how to analyze data from survey. Chapter 4 is the demonstration of results from the analysis. After that, it is giving some discussions from those results. Finally, Chapter 5 will provide several conclusions.

2. Theoretical framework

2.1 Marine Protected Areas

2.1.1. Definition of Marine Protected Area (MPA)

To conserve and restore the high-value species and/or habitats, basically marine reserves are established (Kelleher, 1996; Dayton et al., 2000). Marine protected areas (MPAs) have been used as the efficient tool to manage the fisheries resource since over 40 years ago. Up to 2005, the number of MPAs was estimated about 4600 in over the world (Wood, 2008). MPAs were suggested by IUCN (1999) in the definition quoted; as follows:

> *"Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment*" (Pomeroy, 2004)

IUCN at the World Conservation Congress in October 2008 expressed the new official definition for the term "protected area":

> *"A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values"* (IUCN, 2008).

In these definitions, each types of protected areas such as terrestrial, freshwater, coastal, and marine had a certain possibility to be created as one kind of protected areas relevant to natural conditions in each case. An important topic for economists dealing with the conservation of ecosystems is the analysis of management tools, such as MPAs. Economists started to study MPAs mostly focused on the role of MPAs on fisheries management (Sanchirico, 2000).

2.1.2. The potential benefits of MPAs

Basing on the main role of MPAs that are to reserve resource and habitat, the benefit from MPAs could be seen as the results won from the implication of MPAs. In theory, MPAs have been regarded as the tool to increase the catch under certain conditions. Ward et al. (2001) took in consideration that in the case of the sanctuary providing a greater rate of recruitment, stocks then could suffer a higher level of fishing mortality. Meanwhile, Pezzey et al. (2000) and Sanchirico and Wilen (2001) demonstrated, in theoretical models with density-dependent growth, that in some cases, the aggregate harvest in the exploited area is raised together with the increasing of the abundance of population caused by reserves. For this, it is expected that MPAs will be used as the potential way to improve productivity to recover stocks from the exploited level. A number of

authors are, however, skeptical about a possible increase in catches due to the implementation of an MPA (Schmidt, 1997; Hatcher, 1998; Shipp, 2002; Willis et al., 2003).

The other benefit from MPAs can be seen as the decreasing the changing in the population and catch. By making fish stocks less vulnerable to overfishing, the MPA should provide about stability in catches (e.g. García-Charton and Pérez-Ruzafa, 1999). Conrad (1999) confirmed that reserves could limit the variation of the population. Indeed, the variation in the catch for a given size of the resource may be reduced by reserves (Sladek Nowlis and Roberts, 1998; Mangel, 2000 and Hannesson, 2002). MPAs could result in declined variations in aggregate catch levels (Lauck et al., 1998) or an increase in the long-run total catch.

MPAs also give insurance against stock collapse; especially in the case of lacking of accuracy in stock assessment. Clark (1996) said that MPAs act as the boundary to face with uncertainty if the measurement about population stocks is wrong and harvest rate less than the controllable level. Ward et al. (2001) pointed out that stock recovery after a collapse or severe decline would seemingly be more likely and rapid.

On the other hand, improving fisheries management is considered as the other positive impacts from MPAs. According to Babcock (2005), in the case of effective implementations, spatial management tools can broadly improve fishery management (Sainsbury et al., 1997). Hilborn et al. (2004) said that one of potential values of marine reserves for the protection is the improvement in fisheries management. By the monitoring which is the most regular activities of MPAs mangers, the abundance of population could be overseen and forecasted for controlling variations of stocks (e.g. Bohnsack, 1996; Lauck et al., 1998) that are importantly impacting on the long-run management of fisheries resources (Pomeroy et al., 2004). More than that, the implementation of MPAs can be seen as an application of the precautionary principle against the various sources of uncertainty in the management of marine resources (Alban et al., 2008; Dayton et al., 2000); for example, uncertainties occurs from the natural variability of ecosystems, from the human activities on these ecosystems (e.g. Lauck et al., 1998; Mangel, 2000), and the socioeconomic system (Sumaila, 2002).

Other benefits could be remarked such as: increasing consumer surplus (Flaaten and Mjølhus, 2006) that in stabilizing or increasing fish populations within their enclosures, MPAs could produce a similar function outside the protected area if the significant spillover effect is available (Sanchirico, 2002); increasing employment and improving livelihoods of coastal communities from tourism following the creation of MPAs (Ward et al., 2001); providing the stable and unchangeable area for scientific activities and education (Sanchirico, 2002) that the best basis for understanding the larger range of impacts on fishing may be supplied by closed areas, which are specifically

appropriate during the time new fisheries are developed along with highly uncertain sustainable exploitation rates of newly exploited species leading to the tendentious risk of over-fishing (Hilborn et al., 2004); and so on.

2.1.3. The costs and problems with MPAs

The implications of MPAs in an area not only results in the benefits, but also involves the cost or loss; for instance, decreasing in catch, at least in the short term, due to the limitation in the fishing ground. The establishment of an MPA is seemingly making a spatial reallocation of fishing effort (Sanchirico et al., 2002). New fisheries conflicts maybe appear caused by transfers of fishing effort (Bohnsack, 1996) and result in a reduction of the socioeconomic benefits of MPAs (Holland, 2000). Reducing the amount of fishable waters may lead to increased conflicts between users of the resource, such as allocation disputes (i.e. between fisheries and aquaculture). This may result in local communities reluctant in supporting MPA projects (Emerton, 1999; Dobrzynski and Nicholson, 2000). Generally, costs are directly caused by the shortening in fishable waters and the resulting displacement of fishing effort (Sanchirico, 2000). For these, the reallocation should be concerned during the deployment of marine reserves.

MPAs may lead to the increase in variable costs associated with the choice of the fishing locations (Sanchirico, 2000). After a no-take zone has been established, fishers are likely to improve their effort in the area which is left open to fishing; if this shift is uncontrolled, it might remove the expected benefits from the MPA as regards fishing mortality (Alban et al., 2008). The costs, which are created by space transfers of effort, will change together with the modification of the dependency degree of fishers on a specific fishing zone (Holland, 2002; Sumaila, 2002).

Management costs are possibly increased because of the operation of MPAs and the need for additional monitoring and enforcement (Sanchirico et al., 2002). There are the different opinions in discussing about the management cost of MPAs with some authors supporting for reducing this cost (e.g. Armstrong et al., 2001; Carter, 2003); meanwhile, the others giving the opposite view (Parrish, 1999; Sanchirico et al., 2002). Sanchirico et al. (2002) said that the expected biological benefits can not be achieved if monitoring and enforcement would not be executed or done with a little effort so that it requires a cost of management for such activities. The literature reviewing from Alban (2008) for economic analysis of MPAs mentioned that in doing survey of 83 MPAs in over the world to measure the running cost of MPAs, Balmford et al. (2004) demonstrated that annual running costs per unit area were higher in smaller MPAs; especially in developed nations. Another thing is that the total annual running cost per unit area of a fully protected MPA was often greater. De facto, it

reveals the increasing pressure for the implementation of marine reserves in areas with high degree of industrial fishing activity, where remote sensing and closed areas could potentially reduce management costs. There is however very few existing reserves in fisheries where one could expect reduced management costs; in highly industrialized fisheries with satellite monitoring, for instance. Though MPAs are often considered as a preferred option in terms of ease in management, there are few published estimates of the costs in setting up MPAs and/or costs in monitoring and enforcement for the effectively implication of MPAs (Hoagland et al., 1995).

Recently, many MPAs sites have been also used for tourism and recreational activity of which the development may also have some negative impacts such as an uncontrolled increase in tourism or a lower quality of environment, even though it has some potential benefits to local communities and ecosystem. According to Alban (2008), such an increase of tourism may lead to a lower quality of environment and there is evidence to prove that mass tourism has negative environmental consequences (e.g. Davis et al., 1995; Shaalan, 2005). The behaviour of animals may be also altered by imposing stress on them because of marine mammal watching (Duffus and Dearden, 1993; Mazaudier and Michaud, 2000). Several studies have mentioned the coral reef degradation in the area have been caused by tourism (ONEB, 1993; Thailand Department of Fisheries, 1999). As the considerations from Roman (2007), there are various kinds of impacts on environment stemmed from coral reef tourism; for example, pollution (e.g., sewage, litter, sedimentation, sunscreens), resource depletion created by tourist demand (e.g., for seafood or souvenirs), clearing of mangroves to develop tourism infrastructure, human disturbance of organisms, tour boat anchoring, and trampling on corals (Orams, 1999; UNEP, 2003). Orams (1999) declared that unmanaged tourism often destroys coral reefs and other natural resources. Moreover, the marginalization of artisanal fisheries by other forms of resource utilization such as dive tourism may create the conflicts (Christie, 2004).

2.2 Effectiveness from MPAs

Pomeroy et al., (2006) said that the implementation of most MPAs often involves in biological, socioeconomic and governance goals and objectives. Sustaining or protecting marine resources, protecting biological diversity, protecting individual species, protecting habitat, and so on could be seen as biological objectives. It is often considered socioeconomic goals as the food security, livelihoods, and non-monetary benefits to society, as well as maximizing compatibility between management and local culture. Meanwhile, governance goals include creating an effective and legal structures and strategies for management, the effectiveness of stakeholder participation

and representation, the compliance by resource users with the management, and controlling and limiting conflicts among resource users. Hence, in fact, each MPA also have its own effectiveness in such aspects as below.

2.2.1. In term of biology

Ward et al (2001) demonstrated the scientific evidences for three effects from MPAs including "reserve effect," a "spillover effect," and an "export effect". While mentioning about the role of MPAs in managing the fisheries resource in Australia, Ward (2001) said that the "reserve effect", also called as a "stability effect", takes place within an MPA causing greater spawning, settlement, and more larval and juvenile survival; lower fish mortality; and the higher value of mean age, density, biomass, and reproductive potential. The "spillover effect" occurs between inside and outside of an MPA leading the increase in local fish density and local fish catches (Paul, 2005). This effect is caused by a net movement of juvenile and adult individuals out of sanctuaries. The dispersal characteristics of the populations existing in the reserve exercise an influence in the amount and range of the spillover (Sanchirico et al., 2002). Together with juvenile and adult movement, if larvae from the closed area expand to the open areas, "spillover effect" will occur (Hastings and Botsford, 1999; Pezzey et al., 2000). By the net outward movement of larvae, the "export effect" or "larva export" increases regional recruitment and increases regional catch. Russ and Alcala (1996) in doing case-study in a marine reserve in the Philippines provided some confirmation of the assumption that there was a transfer effect of adult fish from the reserve to the fishing zone. Recreational fishing is also understood as a sample to show the benefits of MPAs for fishing. Thus, the economic value in the area outside of an MPA will be gained more by the spillover and export effects.

2.2.2. In social term

The effects of MPAs in social term have been recognized in four main dimensions of poverty including wealth, health, political empowerment, and education by some present researches (Pomeroy et al., 2006). For wealth, the shifts in various ways among social groups to access and use resource would be encouraged. By the understanding of local marine resource use patterns, the available impacts on income and livelihood patterns and cultural traditions because of management strategies is simply determined (Alban et al., 2008). Pomeroy et al., (2006) stated that these shifts often connect to the changes from extractive activities (e.g. fishing) to non-extractive activities (e.g. ecotourism) and/or local resource users moving to exclude "outsiders" (users from outside the

immediate community) from accessing nearby marine resources. However, there have been few studies about the other social effects from MPAs on health, political empowerment, and education. De facto, it is expected that the impacts from such kinds of social effectiveness might be fairly similar to the shifts above (Pomeroy et al., 2006). It seems that there are only educational effects received most concerns; for example, in NTA-MPA in Vietnam, during the project from 2001 to 2005, many educational programs to guide local residents to the other careers such as culture of chicken, goat, pig or seaweed and so on (Thu and Doan, 2005a). Hence, FAO (2009) also mentioned that "*failure to take the social and economic context into account in the design and implementation of an MPA can seriously reduce levels of support and compliance with the regulations, and therefore the effectiveness of the MPA*".

2.2.3. In economic term

The economic effects may be easily and simple understood as example as the shift sources of income on local residents, livelihoods, food security as well as the change in fish caught etc. All participants in fisheries within and around an MPA could perceive benefits from its establishment (Sumaila and Armstrong, 2006). However, according to Pomeroy et al., (2006), the distributive economic effects from marine reserve maybe vary among both consumptive and non-consumptive users. He also said that the result from implementing an MPA is the increase in income, food security and materials assess though it may lead to the shift among resource use patterns or livelihood plans. The positive impacts of an MPA in term of economic should be indicated by the increasing in material style of life items inside the local community households (Alban et al., 2008). For the amount of fish caught, in short-run the implementation of an MPA seems to make such amount reduce because of closed off areas (Sanchirico, 2000); however, the increase could be seen in long-run by decreasing variations in aggregate catch levels (Lauck et al., 1998). Besides, Holland (2000) said that the establishment of an MPA would create the changes in the payoffs to different fishing groups. Another economic effect from MPAs was demonstrated by Sanchirico et al., (2002): "*MPAs can also increase the market value of a fishery by changing the composition of the Catch*". He suggested that revenues would increase in case the switching to a more valuable form of product (frozen to fresh product, for instance) and the changes in catch composition from smaller to larger fish are combined. Grafton et al., (2004) mentioned that even though in the case of optimal harvesting, resource rents could be still increased due to the high level of resilience toward negative shock created by marine reserves. In generally, by its protection to resources, an MPA might create a potential for the economical sectors, which indirectly connected to fishing, receiving economic

returns (Sanchirico, 2002). One example for economic effects of MPAs is that more jobs, income, and tax revenues for the local community would be carried out in the case of an MPA attracting new visitors into its areas (Grafton et al., 2004).

2.2.4. In term of policy or regulation

Effects in term of policy or regulations have been proved to be few unclear and vary amongst different MPAs. In assessing the success of Co-Management in the Gladden Spit and Silk Cayes Marine Reserve in southern Belize, Gray (2008) said that after marine reserves were implemented fisheries laws and restrict incursions from outsider fishermen had been likely to be better enforced in comparison with prior to this establishment due to patrolling the reserve, issuing warnings and arresting illegal fishers occasionally. In practice, most of MPAs have its specific regulations or laws enforced by its authority or the government to forbid particular fishing; for instance, in NTB-MPA in Vietnam, trawler fishing is restricted in core and buffer zones (Ngoc et al., 2009). According to Suuronen et al., (2010), some MPAs in Baltic sea have driven the ‘‘summer ban’’ (early June to late August in 1995) to prohibit targeted cod harvests and an area closure ‘‘box closure’’ enforced for all fishing activities from mid May to the end of August in 1997 for all fishing activities (ICES, 1999; Hinrichsen et al., 2009; Kraus et al., 2009). In general, such enforcements in term of regulation or law would create the shift in catch and effort distributions from area to area or from season to season (Suuronen et al., 2010; ICES, 2004).

2.3 Performance indicators for MPAs

Pomeroy et al. (2004) defined an indicator as a unit of information that allows us to document variation in specific attributes of the MPAs and to determine an indirectly measurable or uneasily feasible aspect such as effectiveness. An indicator may be associated to a qualitative or quantitative variable that can be produced from field surveys or from models, and that can be directly connected to a management objective or a research question (Ferraris et al., 2005). In other word, it is possibly concerned an indicator as the understanding of a small piece of information telling us something about a complex system (Raakj, 2007). In fact, the relevance of an indicator proves the connection between the indicator and the effect supposed to indicate. The effectiveness of an indicator collects the perception of statistical power, precision, variability, sensitiveness and the fact that there are reference values or thresholds against which the indicator can be tested (Pelletier, 2005). Hence, it is able to prove whether or not the goals and objectives of your MPA are being achieved via evidences stemmed from a range of such indicators; but not alone of each indicator because of inefficient proof

(Pomeroy et al., 2004). In accessing the success of the Egadi Islands Marine Reserve (EIMR), Himes (2007b) mentioned that performance indicators are a measure of performance of an MPA. He also said that sometimes conflicts amongst different stakeholders will occur and stakeholders mostly define the performance indicators similar to the resources and threats to resources identified previously.

Launched in 2000, the International MPA Management Effectiveness Initiative, a joint effort of the World Commission for Protected Areas-Marine (WCPA-Marine) and the World Wide Fund for Nature (WWF) developed and introduced a guidebook (Pomeroy, 2005) to evaluate MPA management effectiveness by biophysical, socio-economic, and governance indicators. In identifying the community-bases indicators to assess the effects of MPAs, Pelletier (2005) said that the range of management objective should be relevant to the provision of indicators in integrated coastal management (Russ and Alcala, 1996). According to Himes (2007b), there are four categories of defined performance indicators for accessing the MPAs success involving: biological or environmental, social, economic, and management. "Biological or environmental" categories are designed to determine the ecosystem or environmental integrity and to monitor the status of environmental health[2]. "Biological or environmental" indicators are also designed to protect and repopulate environment (protecting habitats as well as increasing fish biomass) (Himes, 2007a). Thus, such indicators mainly focus on outcomes from MPAs applications.

Pomeroy et al. (2004) said that the "socio-economic" indicators focus on obtaining from social and economic goals and objectives to access the overall value of the MPA. Socio-economic considerations often include food security, livelihood opportunities, monetary and non-monetary benefits, equitable distribution of benefits, compatibility with local culture, and environmental awareness and knowledge. However, in evaluating the MPAs performance, it is sometimes ignored the socioeconomic indicators mostly (Pelletier et al, 2005). It is likely that together with knowledge about the socio-economic context of stakeholders involved with and/or influenced by the MPA (individuals, households, groups, communities, and organizations), it is practicable and feasible to assess, predict and manage MPAs (Pomeroy et al., 2004).

"Economic" indicators are regarded as the improvement and achievement in term of economic that may be gained from the MPA. Himes (2007a) gave some examples of economic indicators including the increase in economic development, community benefits economically from MPA or tourism increases. Provision of indicators addressing the range of management objectives is needed for integrated coastal management (Belfiore, 2003).

[2] Wikipedia: Bioindicator, accessing in Dec 2009: http://en.wikipedia.org/wiki/Bioindicator

The category "management" or "governance" is intended to include an increase in the two most cited performance indicators specifically relevant to management: management efficiency and availability of information regarding the MPA to locals and tourists, for instance. "Management" indicators are to deal with interaction amongst human and fish as the large information system (Ian and Donald, 1998). As the suggestions from Himes (2007a), the management and tourism is better organized, and change regulations can be seen as such management category. Pomeroy et al. (2004) in their guidebook for evaluating MPAs stated that among the 16 governance indicators, several ones determine stakeholder participation of which a distinct aspect is measured by each indicator in MPA management.

2.4 Local stakeholder groups in MPAs

Many authors discussing the importance of the role that stakeholders play in achieving successful MPAs conclude that to gain the success of management, it requires stakeholders' attitudes towards MPAs and associated regulations (Dahl, 1997; Himes, 2007a; White et al., 2000). Although the term "stakeholders" is popularly used in the management literature, its accurate definition has been not given. Himes (2007b) suggested the viewpoints for determining stakeholders in an MPA area is that "*anyone who is invested into the outcome of management actions or decisions related to MPA*". According to National Oceanic and Atmospheric Administration (2004), another simple definition was expressed by the National Research Council in U.S is that in term of MPA, it is considered stakeholders as anyone who has an interest in or whom the implementation of a protected area affected to. In U.S fishery management for instance, the stakeholders include commercial and recreational fishing interests, scientists, environmental organizations, and local, state, and national government agencies (Sanchirico et al., 2002; Ward and Kelly, 2009). By this definition, several examples of stakeholders and their characteristics could be seen in the table 2.1.

To assess whether an MPA could obtain its management objectives or not, the level of compliance from local resource users, who bear most of the costs of an MPA should be taken in consideration (Rudd et al., 2001). Among stakeholders group, it is likely to be that fishermen will be the most important key for managers to decide where to site reserves and how to mange it (Sanchirico et al., 2002). He also declared that how fishermen respond to the management objectives of MPAs will have an influence in their effectiveness; along with the presence of external threats: nutrient pollution and meteorological disturbances, for instance. In analyzing the equity issues among the stakeholders, Holland (2000) said that such issues in the process can easily arise because of the disproportioned affection from MPAs on user groups. Hence, it is suggested that resource

managers have to consider the identification of all stakeholders as the first step; to involve them at each stage of the decision making process; and, should engage them in setting goals for MPAs and in taking responsibility for achieving the goals.

Table 2.1: Examples of stakeholder group in MPA
(Adapted from source: http://www.nmfs.vt.edu/case_studies/mpa/mpa_stakeholders.php)

Group of Stakeholders	Related to MPA
Commercial fishermen	Often specially licensed, this group makes their life at sea
Recreational fishermen	This group is fishers but not occupationally; sometimes requires their catch for sustenance and compete for similar species as the commercial vessel[1]
Local households	Households within the local communities in the close vicinity of the MPA area[2]
Local landowners	People who live on the land adjacent to an MPA and gain economic and personal benefit from its well-being
Occupational users of an area (i.e. dive operators, tour guides)	Tour guides earn benefits from preservation of pristine habitat, with ecosystem health being a main tourist draw.
Tourists	Tourists gain personal benefit from visiting protected areas; this benefit can be assessed by proxies such as their travel cost or by opinion ("Contingent Valuation") surveys
Government agencies or managers	Government agencies sometimes behave as a separate stakeholder group. Managers who are responsible for the development and implementation of management plans[1]
Students and universities	Both students and professors can gain knowledge and understanding from the study of MPAs
Conservationists	This groups concerned about the environmental impacts of fishing[1]
Non-profits and NGOs	These groups work along with local organizations and agencies to protect habitat across the world by providing solutions to local problems.

1: Pascoe et al., (2009)
2: Thu (2005b); Yen and Adrien (2002)

Dobrzynski and Nicholson (2001), in defining who the stakeholders are, also agreed about the importance that needs to reach consensus on management objectives, location and design, and use of MPAs. By such ways, scientific endeavours could be created by values and beliefs of local resource users.

The definition of participation in management process is demonstrated by Grimble and Chan (1995); as follows: "groups of people with common objectives and sets of interests with regard to the resource in question and the environment". In general, the central components of such process should be the high levels of public participation and the most factors of the outcomes from these successful operations must be the key stakeholders (Brody, 2003; Duram and Brown, 1999) in fisheries management, such key group is often fishers or local households. The participation from groups will increase both understanding and support for marine protection as well as the limitation of potential conflicts (Cocklin, et al., 1998; Salm et al., 2000). In other words, such participation also creates legitimacy; almost complete compliance could be the results formed by the legitimate process (Sutinen and Kuperan 1999). Pomeroy (1995) said that with the participation of stakeholders involved in the initial process of management, it would lead to the reduction of conflicts, the better implementation and the more efficient resource management. More than those, the designation and regulation-making activities could be supported and enforced more effectively by the active contributions from stakeholders (Brody et al., 2003; Cocklinet al., 1998; Gilman 1997; Salm et al., 2000). However, along with its benefits, the participation also contains some negative impacts such as delays in the decision-making process, the greater expenditure and/or fewer consensuses (National Oceanic and Atmospheric Administration, 2004). In the management process of MPAs, stakeholder supports or participations will give the best opportunity for designing and establishing an MPA by a "bottom-up" approach (Brody, 1998; Russ and Alcala, 1999; Suman et al., 1999). Sanchirico et al., (2002) stated that the process of fishery policy from recommendations to implementation should include studies of national stakeholder opinions with regard to effects of MPAs.

Nevertheless, each group of stakeholders expresses their various attitudes on the implementation and management process of MPAs due to their uses of their resource using, culture, family as well as community traditions, beliefs, expectations about the future, environmental knowledge, and so on (Pomeroy et al., 2006). For fishermen including both of commercial and artisanal ones most impacted by MPA designations (Mangi and Auste, 2008), Pomeroy et al., (2006) illuminated that they will be likely to be against the implementation and management of MPAs; because of their overview on the past management measures, their opposition and skepticism

towards managers and policy makers, and their rights of resources as well as accessing on reallocation. In response to MPAs establishment and management, fisheries scientists principally focused on the biological status of fish stocks; meanwhile, the other groups who pay attention to the fishing activities, the fish marketing and the environmental sometimes make a conflict against the management directions (Mardle et al., 2004). Indeed, Sesabo et al., (2006) said that various rural households often showed their different own views, needs, and attitudes towards coastal resources and management initiatives. Besides, according to Infield (1988), wealthier rural households with more resources of land, materials and labour often concentrated on conservation rather than poor ones, who mostly depended on natural resource-based activity for their survival (Ruttan and Mulder, 1999). In considering the tourist perception of recreational environment and management in the marine protected area of Torre Guaceto, south of Italy, Petrosillo et al., (2007) provided a result that the valuation of tourists in term of conservation was fairly low. He also said that most of tourists concerned in the context of spatial perceptions (for instance, how patterns of natural resources are distributed across the landscape); instead of the temporal ones.

2.5 Theory of Multi-criteria analysis

Appeared in the 1960s as a decision-making tool, multi-criteria analysis (MCA) during the last 30 years has undergone a remarkable development (Belton and Stewart, 2002). MCA provided a structured approach that has been used to find out overall preferences amongst alternative options in which several objectives are executed. In MCA, desirable objectives are specified with corresponding attributes or indicators. The practical measurement of indicators requires not only monetary terms, but often quantitative analysis (through scoring, ranking and weighting) in a wide range of qualitative impact categories and criteria as well. MCA allows criteria not easily demonstrated to be included in quantitative measures in the analysis (van Huylenbroeck & Coppens, 1995). In other word, MCA provides techniques for comparing and ranking different outcomes, meanwhile a variety of indicators are used. With these techniques, as EVALSED (2009) mentioned, in a complex situation it took some criteria into account simultaneously. The method is established to help decision-makers reflecting the opinions of the actors that are concerned into a prospective or retrospective framework to aggregate the different options. The decision-makers in the process should be the main part of this approach. A comparative assessment of alternative projects or heterogeneous measures will be designed. Thus, the results are often directly used to give operational advices or recommendations to future activities. According to EVALSED (2009), multi-

criteria evaluation is designed with a view to producing a single synthetic conclusion at the end of the evaluation.

Although different objectives in term of both monetary and non-monetary may exercise their influences on policy decisions recognized (DEFRA, 2003), it is likely that there is a fairly obvious similar of MCA to evaluation approaches such as cost benefit analysis (CBA). However, the criteria measured in term of monetary as those in benefit cost analysis are not required in MCA (Prato, 2003). While efficiency criteria are the major targets which CBA only considers, MCA measures multi criteria that help limit some of the ethical, theoretical and practical weakness of CBA (Prato, 1999) In MCA method, economic costs and benefits will be side by side accomplished and improved with various environmental and social indicators (DEFRA, 2003). The easy and simple way to combine heterogeneous information seems to be the strength of MCA. De facto, MCA has been widely applied in term of economic to assess the environmental impacts (Villa et al., 2002), food security (Haettenschwiler, 1994), forest management (Kangas and Kuusipalo, 1993), environmental management (Penttinen, 1994), natural areas (Xu et al., 1995) and so on. In the field of MPA management, Brown et al. (2001) in hypothesizing the stakeholders' options in Egadi Islands MPA said that there were concerns of multiple management criteria and objectives on a regular basis and the strengthening of the argument for the use of MCA in applying multi-criteria decision-making (MCDM) techniques in protected area management and evaluation. Villa et al., (2002) also used the spatial multi-criteria analysis to develop the zoning plan for the Asinara Island National Marine Reserve in Italy. In Vietnam, limited MCA have also been used to support the application of Geographical Information System (GIS) in identifying high potential areas for marine conservation in Phu Quoc MPA (Vinh, 2008).

2.5.1. Analytic hierarchy process (AHP)

According to Himes (2007b), one of the most common applied methods of MCA and preference elicitation methods is the AHP. Introduced by Saaty (1977), AHP is a general tool in evaluating preferences and importance of a variety of criteria; and also is a methodology to compare complex performance criteria amongst various groups. In a diversification of application areas to assess stakeholders' preferences based on the conception of paired comparison, the AHP has been applied as the main tool (Saaty and Vargas, 2004).

AHP has its strength in organizing tangible and intangible factors in a systematic way and in providing a structured yet relatively simple solution to the decision making problems (Skibniewski and Chao, 1992). As the statements from Forman and Gass (2001), there was ample evidence that

basing on its power and simplicity, AHP has a widespread acceptance and usage in the United States as well as throughout the world. In summarizing the application of AHP in various areas, they said that AHP included three primary functions: structuring complexity, measurement, and synthesis; that's why AHP is such a general methodology with such a wide variety of applications, not just choice problems. However, AHP is rarely used in isolation; but along with, or in support of other methodologies; specially combined with utility theory (Dyer, 1990). A wide range of applications for AHP included transport study, technological choice, resource allocation and organization planning (Saaty and Vargas, 1991).

There are several advantages of using AHP to assess the success of MPAs and to manage fisheries resources. Firstly, a complete decision-making framework for the analysis of appropriate fishery management problems may be stemmed from the AHP applications (DiNardoet al. 1989). Secondly, improving the understanding of how respondents trade-off non-quantifiable attributes which exhibit only subtle differences is often considered as the primary reason for the use of AHP method (Duke and Aull-Hyde, 2002). Another advantage from using AHP in evaluating complex performance criteria often requires an easier way to obtain input data (Vargas, 1982; Khurgin and Polyakov, 1986; Triantaphyllou and Mann, 1990). Last but not least, according to Duke and Aull-Hyde (2002), in supposing the existence of an underlying utility foundation in the AHP, Zahedi (1987) proved that the process of selecting alternatives is consistent along with maximizing a respondent's uni-attribute utility function or a respondent's multi-attribute utility function (MAUT). Besides, even though no identical alternatives are considered, the results of arbitrary rankings are still achieved by the original AHP (Dyer, 1990). Hence, the results of the AHP on a measure of the decision maker are relative.

However, there are some issues related to the application of the AHP listed by Robins (1999; 2003) such as: vendors get improperly penalized, inaccurateness in the ratio scale; inconsistencies can be generated because of an artifact of its calculations that have nothing to do with consistency of judgment; and, rank reversal. Among the shortcomings of the AHP method, it has been most criticized about the problem of rank reserve occurring because of the addition of an alternative identical to one of the already existing alternatives (Triantaphyllou and Mann, 1994). This issue would lead to the dissimilar results between the application of original and revised AHP. To solve this problem, Belton and Gear (1983) proposed the revised AHP called as the variant of the original AHP. In this proposal, each column of the AHP decision matrix should be divided by the maximum entry of that column. Triantaphyllou and Mann (1994) said that it was likely to get a better result

from using the revised AHP than the original. For this, the revised AHP as one way to reduce the rank reversal in AHP is discussed in the present investigations.

In practice, even though AHP has been used in various areas of study, in fisheries management, its applications are limited and most focus on a specific target group such as aquaculturemen, fishermen an so on. For example, in evaluating social acceptability of marine aquaculture from aquaculturemen in five Scottish coastal areas; specifically salmon farmers, Whitmarsh and Palmieri (2009) concluded that for the future of salmon culture industry, public opinions may be seen as the function of the weights people have with regard to the positive effects from the industry expansion (i.e. job creation) because of the opposition to environmental degradation. They warned about conflicts among the stakeholders over which preferences aquaculture policies should be taken into account. They also gave a discussion to explain the different attitudes in various geographical areas due to some dissimilar particular conditions such as employment rate. Another example was described in the study by Pascoe et al., (2009) on stakeholders' attitudes about commonwealth managed fisheries in Australia. In this survey, each most specific concern is connected with each group such as: industry with increasing industry profits, conservation with limiting the environmental damage from fisheries and social scientists are most concerned with minimizing externalities; however, there is no evidence to prove that there was the single issue writing all groups. Mardle et al., (2004) when studying the management objective importance in UK Fisheries of the English Channel stated that in determining the most appropriate strategies for fisheries management, the importance of objectives should be delivered in the process. They also suggested the use of the AHP framework as the potential assistance for the policy making process. The study using AHP analysis by Himes (2007b) can be seen as the pilot on the research field of MPAs. In his research, virtually all stakeholder groups are included: local residents, artisanal fishers, researchers, EIMR managers, and tourists. Himes (2007b) suggests the AHP framework as an aid for decision-making and evaluation of MPA management and considered it as an innovation for studying MPA management due to the integration of both quantitative and qualitative criteria into the analysis of an MPA management (Mardle et al., 2004). In this specific MPA (EIRM), several issues were raised including: the necessity for local awareness and investment; the heterogeneous attitudes for the prioritization of performance indicators, though similar individuals (conservation or tourism, for instance) with their own opinions or interests were also revealed by the cluster analysis.

On the other hand, in reformulating the AHP methodologies in a linear vector space, Zahir (1999) also suggested for the solution to avoid this rank reversal problem by considering the

decisions in a homogeneous group instead of focusing only on individuals'. Together with framework of the conventional theory of the AHP, he mentioned that it should concern the normalization in the AHP via more than one-dimension. The subjects of group decisions and the derivation of group preferences from individual preference have been received much more interests (Saaty, 1990). Zahir (1999) said that it might synthesize the individual preferences into a group preference which becomes homogenous. De facto, to be homogeneous groups is likely not to be an urgent requirement and it may be solved by the clustering method. According to Zahir (1999), various papers had discussed about clustered group decisions.

2.6 Cluster analysis

In most of studied fields, AHP could provide good results without bias because of the assumption that the group, of which each individual had been surveyed, would be homogenous. In fisheries, however, such assumption would be not fair in case the appearance of the variation in opinions from interest groups. Moreover, there is still a certain specific group with a homogenous opinion amongst the groups of diverse attitudes. To deal with these problems, cluster analysis is regarded as the best tool to investigate the coherency among the interviewed individuals as well as the specific association between the groups (Mardle et al., 2004). He also suggested the application of hierarchical cluster analysis to search for the sets of clusters.

In literature, it is defined a "cluster" simply as a *"close group of things"* (according to *The Cambridge Advanced Learner Dictionary*, 2008). Used by Tryon (1939), the term of cluster analysis is an important technique that contains a number of different algorithms and groups similar (or related) objects according to some respective categories (Anderberg, 1973; Fayyad and Uthurusammy, 1996; Dunham, 2003; Friedman et al., 2007). De facto, the greater the similarity (or homogeneity) within a group and the greater the difference between groups are, the better or more distinct the clustering is. Cluster analysis can simply discover structures in data without explaining why they exist[3]. Hsu (2007) mentioned that the cluster analysis method has been applied in a wide variety of research problems such as psychiatry, archeology, disease classification, document retrieval, image processing, market segmentation, scene analysis, and web access pattern analysis. In general, the cluster analysis would be greatly utilizable whenever the classification of a "mountain" of information into manageable meaningful piles is required. Thus, in grouping similar responses from database which are based on several variables, Cluster Analysis seems to be used quite popularly and efficiently.

[3] cited in http://www.statsoft.com/TEXTBOOK/stcluan.html

Hierarchical clustering analysis (HCA) is one of various ways to form and considered as the most straightforward methods. According to Himes (2007b), Zahir (1999) recommended to use the analysis of group clusters based on collected AHP data of which the assumption was raised for the same group with the a similar preference. In HCA, to determine a method, two important choices are feasible including the type of similarity measure between objects and/or groups, and the linkage technique (Bratchell, 1989). The goal of HCA is finding out the underlying structure of objects based on an iterative process that associates (agglomerative methods) or dissociates (divisive methods) object by object (Steinbach et al., 2003). If all objects have been processed, HCA would be ceased. Almeida et al. (2007) said that for N objects, along with the divisive methods the process of HCA involves N−1 clustering steps.

In measuring the similar preference among individuals in a group, Euclidean (or squared Euclidean) distances are likely to be the most popularly chosen type of distance (Abonyi & Balázs, 2007). It is simply seen Euclidean distances as the geometric distance in the multidimensional space. Another note from such distances is that primary data is usually used instead of standardized secondary one. There are some obvious advantages from application of this kind of measurement for distances such as effects from the addition of new objects, which may be outliers, to the analysis will not occur during the procession of accounts for the distance between any two objects. However, the differences in scale amongst the dimensions to measure distances may greatly impacts negatively on the results of distances measurement[4].

A "*Dendrogram*" or "*Horizontal Hierarchical Tree Plot*" is the most commonly used method to summarize the hierarchical clustering results (even though "skyline plots" are existent in SAS[5] that is not suggested for classification procedures). *Dendrogram* shows us the relationships of cluster and sub-cluster as well as how way the clusters were merged (agglomerative view) or split (divisive view). Except for the links between objects, the clustering topology and object labels could be showed by dendrogram. Branches are created by dendrogram meet at nodes that are drawn at the similarity value where fusion of the branches occurs. The furcating of branches from any node can be switched without ever affecting the information content (Abonyi and Balázs, 2007). An example can be seen in figure 2.1 (in the top, the inter-pattern distances can be seen in a form of dissimilarity matrix; in the bottom, ordered similarity data is arranged into a dendrogram by SPSS).

[4] More references can be seen in assessing: http://www.statsoft.com/textbook/cluster-analysis/?button=1

[5] Statistical Analysis Software (SAS) can be used in hierarchical clustering of multivariate data or distance data; disjoint clustering of large data sets; nonparametric clustering with hypothesis tests for the number of clusters (see more in http://www.sas.com/technologies/analytics/statistics/stat/index.html#section=1)

Inter-pattern Distances

	Biomass	*Banning trawler*	*Employment*	*Fish caught*	*Management efficiency*	*Information*
Fishermen 1	0.355	0.039	0.191	0.193	0.041	0.18
Fishermen 2	0.123	0.033	0.419	0.202	0.028	0.196
Fishermen 3	0.137	0.035	0.243	0.147	0.034	0.405
Fishermen 4	0.249	0.065	0.079	0.451	0.046	0.11
Fishermen 5	0.329	0.031	0.166	0.191	0.032	0.249

Proximity Matrix

Case	Euclidean Distance				
	Fishermen 1	Fishermen 2	Fishermen 3	Fishermen 4	Fishermen 5
Fishermen 1	0	3.382	3.105	3.259	1.539
Fishermen 2	3.382	0	2.538	4.99	2.883
Fishermen 3	3.105	2.538	0	4.849	2.426
Fishermen 4	3.259	4.99	4.849	0	4.108
Fishermen 5	1.539	2.883	2.426	4.108	0

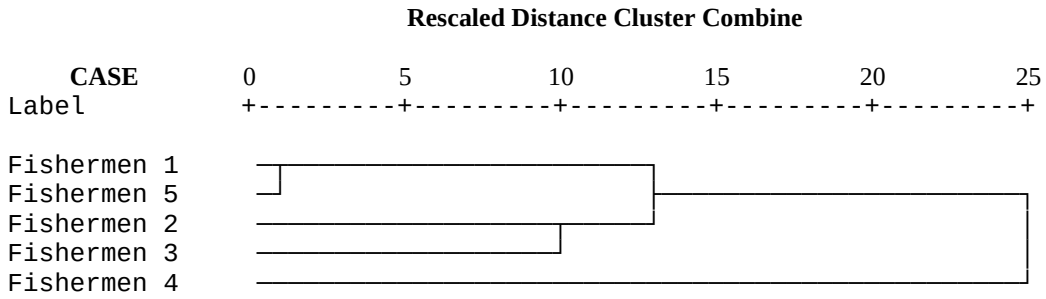


Figure 2.1: Dendrogram building
(Based on Abonyi and Balázs, 2007)

2.7 Study sites

Nha Trang Bay Marine Protected Area (NTB-MPA) encompasses 160 km^2 of shore waters and nine islands; one large island, Hon Tre, and several small islands (Hon Mun, Hon Mot, Hon Tam, Hon Mieu, Hon Mat, Hon Cau and Hon Vung). The surrounding waters with approximate

coordinates $12^0$09'-$12^0$17'N and $109^0$13'-$109^0$23'E, and lies offshore from Nha Trang City, Khanh Hoa province, on the coast of central south Viet Nam (Yen & Adrien, 2002). The distance between the mainland ranges and the furthermost community (Bich Dam) from several kilometers to about 10 kilometers and to Tri Nguyen - the closest islands - is about 2 kilometers (Ngoc, 2009). The Temporary Regulations mentioned three main zones: core, buffer and transition one in which fishing activities are strictly forbidden in the core zones (Tung, 2002 and Thu, 2005b).

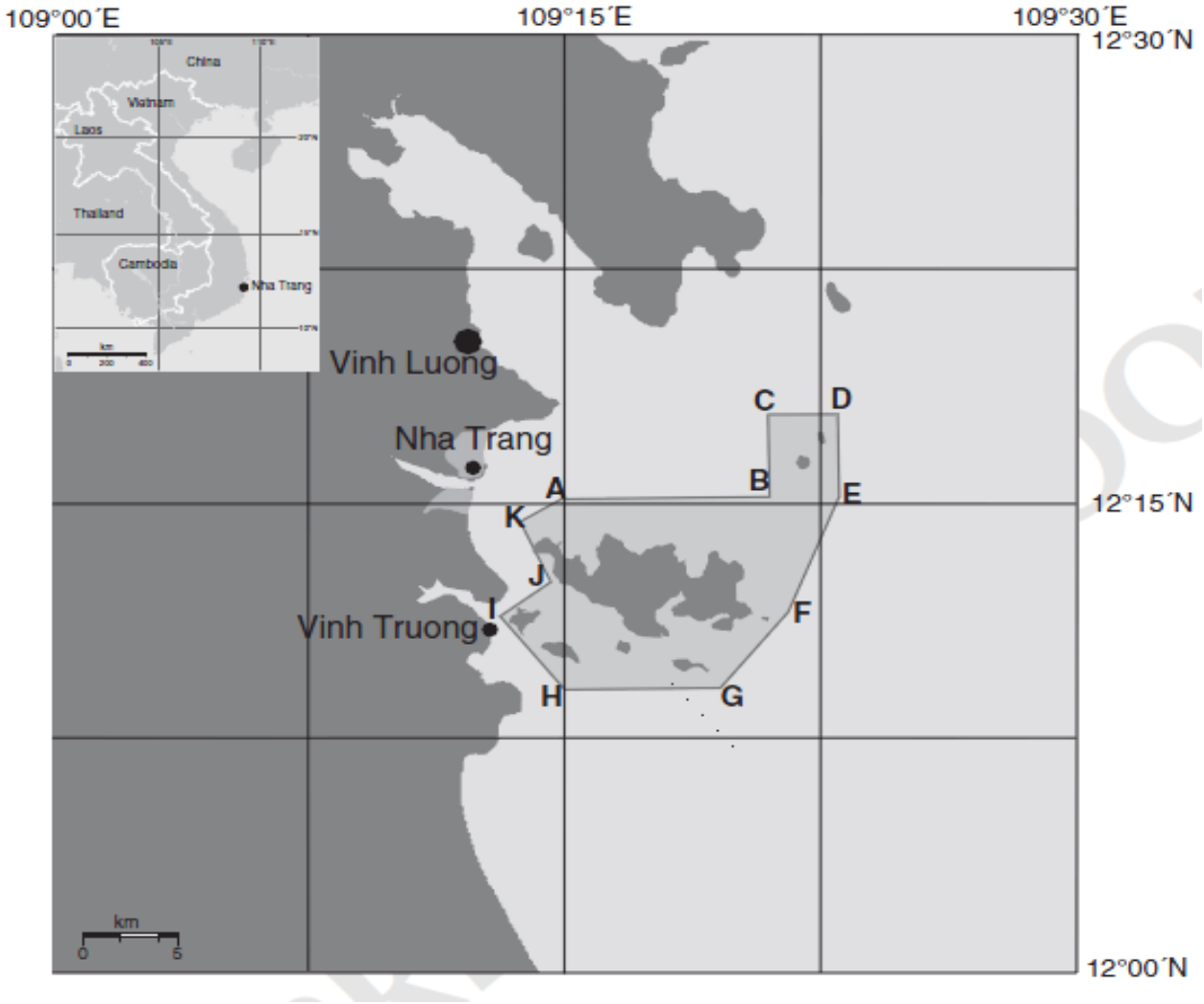


Figure 2.2: Map of the Nha Trang Bay MPA locations and boundaries
(*Source: Maps cited from Ngoc et al., 2009*)

General Characteristics of the MPA

The population in NTB-MPA in 2005 was about 5,300 with over 1000 households (Thu, 2005b). Up to 2005, the increasing of the population in comparison with that in 2002 was of 14.83% together with the equal distribution of males and females among most of local people (Yen and Adrien, 2002). According to Thu (2005b), most of residents in the MPA live in 5 predominantly

fishing communities (Tri Nguyen, Bich Dam, Vung Ngan, Hon Mot, Dam Bay). In their report in 2002, Yen and Adrien (2002) stated that nearly 80% of the local household heads are fishermen; however, this percentage decreased to 76% in 2005 (Thu, 2005). For this, it is likely that fishing is the major economic activity in such 5 communities. Together with the decreasing of choosing fishing as the main career, there was however a more local people, who took part into the aquaculture activity; specially raising lobster because of its huge benefits, as the number of cage increased by 204% from 1675 in 2001 to 5096 in 2005. For fishing fleet, the new built boats occupied 11.9% of total boats during the Project's implementation from 2002 to 2005.

In considering to the biodiversity in NTB-MPA from 2002 to 2005, as Ngoc et al., (2009) mentioned, an initial survey of the area reported that 350 species of coral, 250 species of fish, 122 species of crustaceans, 112 species of mollusks, 69 species of seaweed and 27 species of echinoderms was available and accountable in 2002 (Tuan, 2002). After a survey by Hon Mun Authority (Thu, 2005c), it indicated about a little change in corals and declines in fish and invertebrate abundances and increases in macro-algae. For coral reef, there was a permanence of species richness and abundance in overall (highest in Hon Tre with nearly 160 sp. in species richness and 250 sp. in species abundance), although within individual sites the changes were substantial. It reported about 7 additional species in 2005 (Thu, 2005c). For fish, he also reported that overall fish abundance was temporally declined (from 140 to 60 for selected taxonomic groups at 8 sites in 4 locations of NTB-MPA). There was only an increasing difference in abundance of the small fishes (< 10 cm total length) in 2002; but, for the larger fishes, the change was low (Thu, 2005c). Thu (2005c) informed about the overall decline of species richness (highest from 70 to 35 around Hon Tre). For invertebrates, it was likely to be a little change in both of species richness (10 sp. in 2005) and abundance (15 sp. in 2005). For macro-algae, there were the increase from 2002 to 2005 in species richness (5 to 10 sp.) and abundance (7 to 17 sp.) at significance $P < 0.05$.

During the implementation of NTB-MPA, the quality of living conditions for local residents had been improved. It is declared that the average monthly income per capita within the MPA increased from 478,000VND (US$30.2) in 2001 to 698,200VND (US$ 44.1) in 2004 (Thu, 2005c). However, the education level of the adults was only at basic (the largest portion of the adults is of level Grade I, knowing how to read and write).

For tourism industry, Nha Trang Bay has been peaceful destination for both domestic tourists and international ones. According to Michael and Tu (2004), annually around 660,000 visitors have been to Nha Trang and most of them (600,000 persons) are domestic visitors. Together with benefits from tourism activities such as improving the Khanh Hoa tourism industry, bringing profit to the

MPA Authority, tourism has made several negative impacts on the MPA: pollution to environment because of garbage, destroying coral reef since the diving operations takes place within the area of coral reef, and some other causes (Nam et al., 2005).

In terms of policies to manage the MPA, the top down management system had been used to manage NTB-MPA (Hon Mun MPA Newsletter No.1, 2002; Nguyen, 2009). A Temporary Regulation and Zoning Scheme was published and performed on 11 March 2002 by the People's Committee of Khanh Hoa Province (Ngoc, 2009). This regulation focused on the protection for marine biodiversity and the zones for using and extracting the marine resources. According to Ngoc et al., (2009), in 2005 there were some changes in regulations for the management of NTB-MPA such as some sites (i.e. island Hon Noc) in core zones had been replaced by the others (i.e. the northeastern Hon Tre and the southern corner of this island); together with the publication of banned zones for trawler fishing operations (core zones and buffer zones) and limited zones (transition zones). After four years of the project of the MPA from 2001 to 2005, Hon Mun MPA (HMMPA) had been renamed to Nha Trang Bay MPA (Dung, 2007).

De facto, it seemed that after 4 years of establishment of the MPA, the destructive fishing such as dynamic, poison fishing almost disappeared (Thu, 2005d). However, the existence of trawl nets was still available outside of the core area of the MPA at deeper areas (from Hon Dun to Hon Ngoai, at the depth of more than 50m).

In a survey carried out by the HMMPA project in 2005 to assess the opinion of local residents to the implementation of NTB-MPA, it reported that a high percentage of the community (more than 67%) agreed with the positive effects on the quality of their coral reefs, fish density and water quality, meanwhile nearly half of people surveyed realized about the improvement of the awareness of local people on the environmental roles, the appropriate environmental protection measures, and activities to create economic development. In this survey, 36% of interviewed households said that there was an enhancement of biodiversity through the Project. However, there were a few critics on uncontrolled aquaculture, illegal fishing, waste disposal and over-fishing are still existed (Thu, 2005b).

3. Materials and Methodology

3.1 Research design

3.1.1 Analytic hierarchy process (AHP)

To evaluate preferences and importance of a variety of criteria as well as to compare complex performance indicators amongst various groups of stakeholders, Himes (2007b) suggested using AHP as the main methodology.

Table 3.1: The fundamental scale of pairwise comparison for AHP preferences
(Source: based on Saaty, 2008)

Intensity of Importance	Definition	Explanation
1	Equal importance	Two decision elements (e.g., indicators) contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Respondents slightly prefer one decision element to another
4	Moderate plus	
5	Strong importance	Respondents strongly favour one decision element over another
6	Strong plus	
7	Very strong or demonstrated importance	A decision element is preferred very strongly over another
8	Very, very strong	
9	Extreme importance	A decision element is favoured over another at the highest possible order of affirmation
Reciprocals of above	If decision element *i* has one of the above non-zero numbers assigned to it when compared with decision element *j*, then *j* has the reciprocal value when compared with *i*	A reasonable option and/or assumption

In using the AHP framework adapted from Saaty (1977), he demonstrated four main steps: (1) establish a hierarchy of performance indicators which involves the goal or achievement of the

decision at top and then the objectives from the intermediate level to the lowest level (sometime such lowest level could be the alternatives or sub-objectives or sub-criteria depended on the intermediate) (Saaty, 2008); (2) through a pair-wise comparison survey, collect data related to the preferences of individuals for each indicator; (3) analyze individuals' responses of priority by constructing a set of pairwise comparison matrices (Saaty, 2008); and (4) aggregate the relative weights of decision elements to derive a set of ratings for each indicator (Leung et al., 1998; Mardle et al., 2004). For all distinct pairs of sub-criteria under criteria, a single rating from the finite set {1/9, 1/8,…, 1, 2,…, 8, 9} is assigned corresponding to the verbal expressions in table 3.1.

3.1.2 Definition of the Performance Indicators and Stakeholders (Step 1)

The performance indicators for stakeholders' preferences were defined based on the goals and objectives of NTB-MPA project, which mainly focus on reserving biodiversity environment as well as improving the livelihoods of local island communities together with other stakeholders to protect and manage NTB-MPA effectively[6]. Thus, biological indicators and socioeconomic indicators would be seen as the main goals to achieve the success of NTB-MPA along with the support from the management indicators. Each of these indicators would be further explained by six sub-criteria described in figure 3.1.

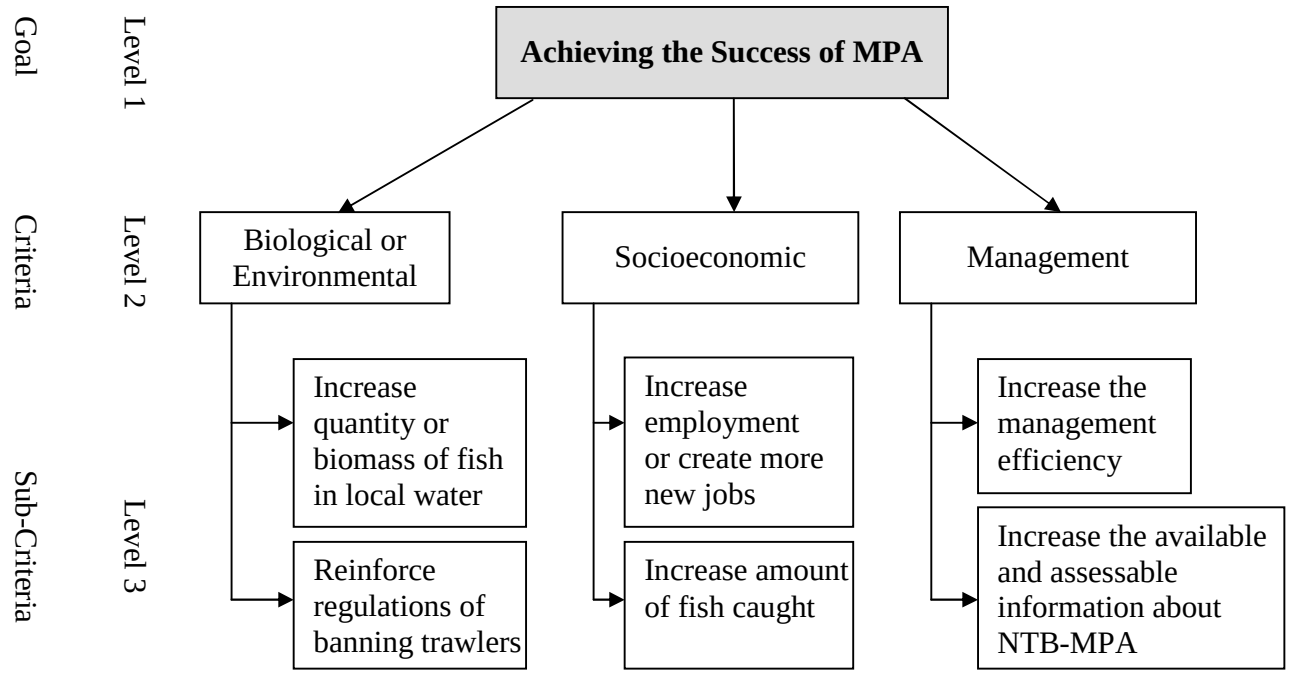


Figure 3.1: Key performance indicators defined by NTB-MPA stakeholder groups

[6] Source: *http://www.nhatrangbaympa.vnn.vn/intro/01nhatrangbay_en.htm*

There were two sub-criteria for demonstrating each main category concentrating on the cited performance indicators which stakeholders put their preferences into previously. The "biological or environmental" criteria expressed the need to gain more fishing biomass based on the environmental protection plans and the requirement to protect environment by decreasing or forbidding fishing by trawlers in the water of NTB-MPA (i.e. Ngoc et al. (2009) mentioned the "Temporary Regulation and Zoning Scheme for the NTB-MPA" in 2002 that banning trawling activities in core zones and buffer zones, and limited them in the transition zone). The category of "socio-economic" indicators were mostly designed to represent the improvement in the economic situation due to increasing the amount of fish caught; and, to express the benefit of local communities from the NTB-MPA objectives to develop local communities that is keeping a balance and increasing employment or creating more new jobs (such benefits towards local communities had been considered as the main purposes of NTB-MPA project; see Yen & Adrien, 2002)). The "management" indicators are likely to be related to particular cited performance indicators in management: increasing management efficiency and making the information and understanding about NTB-MPA more available and approachable to local residents, visitors such as tourists as well as scientists or researchers, who see the NTB-MPA project as the pilot during the process of implementation of MPA management in Vietnam (Yen & Adrien, 2002).

Table 3.2: The description of the performance indicators used in the AHP hierarchy

Indicator	Description	Explanation
C1	Increase quantity or biomass of fish in local water	The available number of fish around and within NTB-MPA areas is higher
C2	Reinforce regulations of banning trawlers	This regulations is used to limit the activities of trawlers insides NTB-MPA to avoid the damage of sea bottom and habitats and so on
C3	Increase employment or create more new jobs	It focuses on the activities of livelihood operations to improve the living standard for local residents
C4	Increase amount of fish caught	It means there are more fish harvested for sale
C5	Increase the management efficiency	E.g. The better organization from NTB-MPA authorities, sign buoys, patrolling and so on
C6	Increase the available and assessable and available information about NTB-MPA	Publications and information of the activities, regulations, prohibited areas within and/or around NTB-MPA to all stakeholders monthly or yearly, for instance

Yen and Adrien (2002) identified 2 major groups of stakeholders for NTB-MPA in the socio-economic survey for MPA establishment: negative stakeholders who are related directly to environmental issues (i.e. the villagers themselves, villagers from outside the MPA area, tourist boats, and aquaculture farmers) and positive ones who have responsibilities relative to NTB-MPA (for instance authorities and institutions). In this study, 6 groups of stakeholders were used to investigate the preferences for the performance indicators of NTB-MPA: fishermen, local households, aquaculturemen, researchers, managers, and tourists. The stakeholders that are directly related to the level of success and efficiency of operations of NTB-MPA are interviewed using a random sample.

3.1.3 Data collection (Step 2)

Basing on the theory of choosing appropriate sample size in survey design (Bartlett et al, 2001), the questionnaires were designed with the Acceptable Margin of Error[7] of 0.03 and Alpha Level[8] of 0.05 to interview face-to-face 120 people in 6 groups: 60 local households, 27 fishermen, 15 aquaculturemen, 5 researchers, 5 managers, and 8 tourists. The survey was done by random selection from February to March in 2010 in 6 main local communities including Tri Nguyen, Bich Dam, Vung Ngan, Hon Mot, Hon Mun, Dam Bay {these communities have mostly been surveyed and reported by scientists and managers since the NTB-MPA implementation in 2001; see Yen & Adrien (2002) and Thu (2005a; 2005b)} inside NTB-MPA and in 2 main fishing communes: Vinh Luong, Vinh Truong, where vessels often operate in the buffer and vicinities in NTB-MPA (Ngoc, 2009). The largest portion of questionnaires for local households, fishermen, aquaculturemen and tourists was asked most in Tri Nguyen, where the number of population and households is highest (reported from Hon Mun Authorities, 2009) and in 5 other communities. The other part of questionnaires for fishermen was done in Vinh Luong, Vinh Truong. The last questionnaires were

[7] Acceptable Margin of Error (frequently regarded as the "radius" (or half the width) of a Confidence Interval) statistically expresses the amount of random sampling error in the results from a survey. The Acceptable Margin of Error implies the reliability of an estimate
- ✓Wikipedia: **margin of error**, accessing in March 2010: http://en.wikipedia.org/wiki/Margin_of_error
- ✓http://www.surveysystem.com/sscalc.htm#one

[8] Alpha Levels (or α) is often called as the chosen significance level. In practice, the significance level or Alpha Level is usually accepted at 0.05. The definition of significance level (Alpha Level) at 0.05 means that there is a probability (P) or chance of 5% of being wrong for our conclusion; or, Statistical significance is set at the 95% confidence level ($P < 0.05$), (Zar, 1984; Potter, 1994). The greater significance level for social study, the confidence level is gradually chosen at 95%; meanwhile, 99% of the level is accepted in the field of medicine. See more in some sources below:
- ✓Wikipedia: **Confidence interval**, accessing in March 2010: http://en.wikipedia.org/wiki/Confidence_interval#cite_note-2
- ✓http://www.idrc.ca/en/ev-56462-201-1-DO_TOPIC.html

http://www.surveysystem.com/signif.htm

responded to by tourists in Hon Mun; and, by researchers and managers in Nha Trang University, NTB-MPA Authority, and The National Institute of Oceanography (VNIO) in Nha Trang city, Khanh Hoa province, Vietnam in February and March 2010. With an attempt, we made interview an equal number of men and women.

In practice, local households and most of fishermen were interviewed face to face at their home in the 5 islands except for Hon Mun Island and in the communes of Vinh Truong and Vinh Luong; and, some fishermen were asked on their fishing vessels. For tourists, the samples were collected at the Hon Mun Island where NTB-MPA centre house locates; meanwhile, aquaculturemen were asked at their culture cages. . On the other hand, managers were interviewed at their office by handling out directly the questionnaires to them. The last group of stakeholders as researchers was surveyed via email mainly; except for one who was interviewed face by face at home. The random selection for the survey which mainly focused on the variation between male and female, was done well in the group of tourists, local households, managers and researchers by the attempt to survey the equivalent numbers of male and female interviewees; however, it was impossible to carry out this random on the groups of fishermen and aquaculturemen who were often male. On the other hand, the random for the differences of the income level, of ages, of occupation, of educational level and so on were not used in this study.

The questionnaire was translated into the local languages - Vietnamese. The purpose of the questionnaire was to determine according to stakeholders what aspect and objective of NTB-MPA management should be improved to gain more success. For this, the respondents were asked to show their preferences for each criterion over the other; for instance: “to gain the high biomass indicator, which criterion do you like more or equally: increase the quantity of fish in the local water of NTB-MPA or reinforce the regulations of banning trawlers inside the area of NTB-MPA?” and “if you prefer a certain criteria to the other, how much would you like rather than?”. Their response was arranged into 9 scales of preference from “*equal preference*” (the first scale) to “*extreme preference*” (the ninth one). Then, the results from interviewing survey were put in groups and categories to be solved by the general AHP analysis to investigate the potential performance indicators.

3.1.4 The analysis of performance indicators priority preferences (Steps 3 and 4)

The objects or criteria are denoted by A_1,..., A_n. For each respondent, the pairwise comparisons may be represented by a pairwise comparison reciprocal matrix (A) of judgments as follows:

$$\mathbf{A} = \begin{array}{c} \\ \text{A1} \\ \text{A2} \\ \dots \\ \text{A}_n \end{array} \begin{array}{c} \begin{array}{cccc} \text{A1} & \text{A2} & \dots & \text{A}_n \end{array} \\ \begin{pmatrix} 1 & \frac{a_1}{a_2} & \dots & \frac{a_1}{a_n} \\ \frac{a_2}{a_1} & 1 & \dots & \frac{a_2}{a_n} \\ \dots & \dots & 1 & \dots \\ \frac{a_n}{a_1} & \frac{a_n}{a_2} & \dots & 1 \end{pmatrix} \end{array} \quad (1)$$

where a_i is the relative numerical preference (from 1 to 9) for performance indicator *i*. Then, for each of the defined alternatives from the pairwise comparison reciprocal matrix, relative priorities were stemmed by solving (Saaty, 1977; Himes, 2007b)

$$\sum_{j=1}^{n} a_{ij} w_i = \lambda_{\max} w_j \qquad with \qquad \forall_i \left(a_{ij} = \frac{1}{a_{ji}},\ and\ a_{ij} > 0 \right) \quad (2)$$

where *a* is an individual element of the preference matrix, *i* and *j* indicate the *i*th and *j*th indicators, λ_{max} is the largest eigenvalue, and the normalization for the priority weights (*w*) are appropriately solved by

$$\sum_{i=1}^{n} w_i = 1 \quad (3)$$

The positive reciprocal matrix (A) and the set of equations (2) are solved using the eigenvector method. The solution is normalized in this case as shown in equation (3). The maximum eigenvalue, λ_{max}, (Saaty, 1977) can now be determined by

$$\lambda_{\max} = \sum_{i,j=1}^{n} w_{ij} \frac{a_j}{a_i} \quad or \quad \lambda_{\max} = \sum_{j=1}^{n} w_{ij} a_{ji} \quad (4)$$

After all the pairwise comparisons have made, the consistency index (CI) for the n × n comparison matrix is determined by using the eigenvalue λ_{max} expressed in equation (4). The quantity $\lambda_{max} - n$ counts the degree of inconsistency within the n × n matrix A. Mathematically (Himes, 2007b),

$$CI = \frac{\lambda_{\max} - n}{n-1} \quad (5)$$

Saaty (1977) proved that $\lambda_{max} \geq n$, which enables AHP to test the degree of inconsistency in a respondent's ratings. The matrix A is considered to be consistent when $w_i = a_{ij} w_j$ and its principal eigenvalue is equal to *n* (i.e., the dimension of A). Conversely, the matrix A is regarded to be

inconsistent if only if $\lambda_{max} > n$. The variance of the error inherent in estimating a_{ij} (a quantitative measure of each respondent's judgment concerning the importance of objective *i* over objective *j*) may then be shown to equal $(\lambda_{max} - n)/(n-1)$ (Mardle and Pascoe, 1999; Wattage and Mardle, 2005).

An indication of a respondent's consistency can be determined and compared to an indicative consistency produced from randomly developed matrices. Judgment consistency can be checked by taking the consistency ratio (CR) of CI [CI is conditional on equation (5)].From this, a consistency ratio (CR) for an individual can be produced, measured by

$$CR = \frac{(\lambda_{\max} - n)}{(n-1)} * \frac{1}{RI} \quad or \quad CR = \frac{CI}{RI} \qquad (6)$$

Where the variance of the error is divided by an average, consistency index derived from the random consistency index[9] (RI) described in table 3.3. Perfect consistency occurs when λ_{max} equals *n* (CR = 0); hence, the closer λ_{max} is to *n*, the better the consistency. Himes (2007) said that CR values of less than 10% are demanded; however, many authors have agreements with values up to 20% in post analysis (Mardle and Pascoe, 1999). If one a pair-wise comparison reciprocal matrix has CR over than 20%, it will be unsuitable for use in the analysis due to the respondent's high inconsistency in responses to the pair-wise comparisons in the questionnaire. In this case, judgments should be reviewed and improved so that respondents should be asked to revise their pairwise comparison ratings.

Table 3.3: The average consistencies of random index (RI values)
(Source: Berrittella et al., 2007)

Size	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

3.1.5 Coherence measurement

Through a vector-based approach, Zahir (1999b) suggested a measure for group coherence in which such coherence can be earned by measuring the angles between vectors. He assumed that V^i and V^j are unit vectors pointing in an n-dimensional Euclidean space. The aggregate preference vectors or the grand preference vectors **V** (Zahir, 1999a) are defined; specifically,

$$V^T = [V_i, \ldots, V_n]$$

[9] The random consistency index (RI) represents the consistency of a randomly generated pairwise comparison matrix calculated from a sample of 500 (Saaty, 2000) based on the AHP scale in table 3.1

V is same to a radial vector pointing to a specific direction, implying the orientation of the human mind in the alternative space, which is spanned by corresponding basis vectors. We would interpret $(V_i)^2$ is the relative priority of alternative i (Zahir, 1999a) such that

$$\left(V_i\right)^2 = w_i \quad or \quad V_i = \sqrt{w_i} \qquad (7)$$

The elements w_i and V_i are the same vectors normalized in two different ways and related to each other.

The coherence "ρ" of cluster C (including more than one member in it) or the homogeneous group (Zahir, 1999b) is calculated by

$$\rho = \left\langle V^i * V^j \right\rangle = \left\langle \left(V^i\right)^T \left(V^j\right) \right\rangle \quad \text{With } (i, j = 1,\ldots, N; \text{ and, } i \neq j) \qquad (8)$$

Where $V^j, V^i \in C^\rho$, * implies scalar product and < > expresses averages, respectively. The superscript T implies the transpose of each vector (i.e., a column matrix).

According to Himes (2007b), the coherence (ρ) can be regarded to be low and/or poor if its value was smaller than 0.9, to be good in case of between 0.9 and 0.93; and, values from larger than 0.93 to 1 are seen as the high group coherence.

3.1.6 Cluster analysis

According to Mark & Roger (1984), amongst the more various representations of distance, Euclidean distance is the most popular metric for continuous features. Euclidean distance is regarded as the geometric distance between two cases (or objects) and calculated by

$$d_{ij} = \sqrt{\sum_{k=1}^{p} \left(x_{ik} - x_{jk}\right)^2} \qquad (9)$$

Where: d_{ij} is the distance between cases i and j, and

x_{ik} is the value of the k^{th} variable for the i^{th} case.

To avoid the use of the square root, the value of distance is often squared, and this is usually indicated by the term of d_{ij}^2. As might be expected, this expression is referred to as "squared Euclidean distance".

3.2 Data Analysis

In this study, Expert Choice 11.0 as the first software specializing in AHP (Davies, 2001) was used to analyze the results from questionnaires to find out the priorities from each individual and its consistent index.

Excel was used to analyze the results from Expert Choice 11.0 to determine the standard deviation and to test the result of priority weights by ANOVA single factor and T-test. The coherence for each group and/or cluster, and Euclidean distance were also calculated by Excel.

SPSS 17.0 was used to demonstrate the analysis of hierarchy clustering analysis and to draw the dendrogram.

4. Results

4.1 Priority Weights of Performance Indicator Preference in NTB-MPA

4.1.1. The overview of the sample

There were only 111 of the 120 responds of preference matrixes which were useable for analysis (9 contained high inconsistent ratios – CR greater than 20%). These matrixes created 1665 acceptable pairwise comparisons. All stakeholders were analyzed by the AHP method at group level to express the comparison between and within group. In compared with the other groups in the survey, the local household group occupied the largest portion (nearly half the total sample); meanwhile, the groups of managers and researchers were in the smallest ones (5 % of the total sample). The proportions of each respondent group were demonstrated in the table 4.1. Besides, the unusable number of responses from local households was highest (6% in comparison with the total number of sample that were intended to survey). The total unusable number of respondent was 9 (about 1% of the total sample).

Table 4.1: The proportions of each respondent groups

Group	Planned number of respondent	Practical number of respondent	Percentage	Number of unusable respondent	Percentage
Manager	5	5	4.5%	0	0%
Researcher	5	5	4.5%	0	0%
Household	60	53	47.7%	7	6%
Fishermen	27	25	22.5%	2	2%
Aquaculturemen	15	15	13.5%	0	0%
Tourist	8	8	7.2%	0	0%
Total	**120**	**111**	**100%**	**9**	**8%**

The discharge of 9 samples was caused by the illogical responses from the stakeholders. According to Himes (2007b), the logical process in complex situations was not simple like in the case that a respondent preferred "*Increase quantity of fish in local water area*" to "*Increase employment*" and "*Increase employment*" to "*Increase the management efficiency*" so that he or she must be putting a higher priority in ranking "*Increase quantity of fish in local water area*" than in "*Increase the management efficiency*". This process was considered as a cyclic triad. In practice, the four strong cyclic triads should be correct to obtain a rated consistent trial (Jowett, 1966). Because of the number of sub-criteria in this study (6 performance indicators), the illogic therefore occurred when the responses contained more than 4 strong cyclic triads and it needed to remove the

responses. This was solved by the measurement of inconsistent ratio in AHP method (not more than 20% - the way to calculate could be seen more in Appendix B).

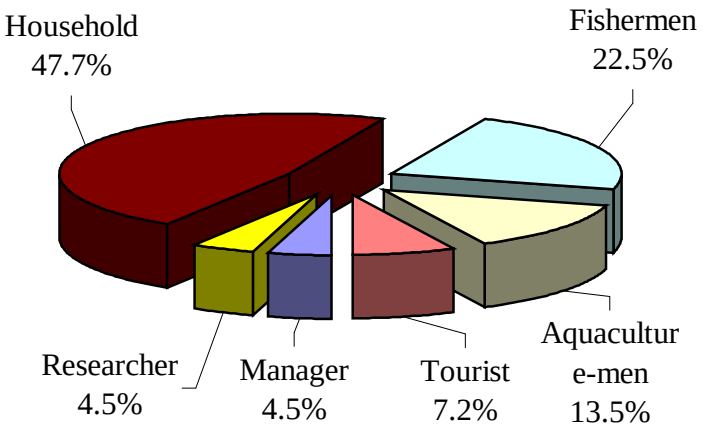


Figure 4.1: Sample proportions by stakeholder groups

4.1.2. Priority weights of MPA performance indicator preference

According to 3 various NTB-MPA performance indicator categories, all stakeholder responses ranked in average were displayed in table 4.2 and figure 4.2. The priority of each performance indicator category ranked by all stakeholder groups was not equivalent. The preferences from all stakeholders for the "*biological indicators*" were ranked together with the high priority weights (from about 0.3 to 0.47). However, for the other indicator groups, the variation was clear and the range of divergence was quite large (from poor at about 0.2 to very high at approximately 0.55). The different opinions belonged mostly to the category of socioeconomic indicators. In general, there was no similarity in ranking the priority of all NTB-MPA performance indicators by the whole stakeholders

It is also obvious that there was no similarity in ranking each performance indicator category by each group of stakeholders. The group of managers mainly focuses on the biological indicator category (with priority weights of 0.470). In comparison with managers, researchers had the similar opinions in regarding the biology category (0.394) as the most important criteria. Both of these groups would rank management indicators more important than socioeconomic ones. For local household and fishermen, they mainly preferred the social indicators (0.450 for local household and 0.398 for fishermen) to the others. Moreover, the management category was mentioned greatly by the groups of aquaculturemen (0.406) and tourists (0.547) surprisingly. Thus, it seemed that the biology and management categories received a little more concern than the socioeconomic by all stakeholders (see more in figure 4.2).

Table 4.2: Priorities of performance indicator preference by each stakeholder group

Performance indicators	Manager	Researcher	Local Household	Fishermen	Aquaculture-men	Tourist
Biology indicators	**0.470**	**0.394**	**0.342**	**0.333**	**0.302**	**0.249**
Increase quantity of fish in local water area (C1)	0.294	0.322	0.202	0.259	0.221	0.202
Standard Deviation	*0.126*	*0.102*	*0.092*	*0.095*	*0.108*	*0.129*
Reinforce regulations of banning trawlers in the water of NTB-MPA (C2)	0.176	0.072	0.141	0.074	0.082	0.047
Standard Deviation	*0.080*	*0.037*	*0.138*	*0.057*	*0.080*	*0.017*
Socioeconomic Indicators	**0.226**	**0.288**	**0.450**	**0.398**	**0.291**	**0.203**
Increase employment (C3)	0.105	0.219	0.174	0.147	0.223	0.145
Standard Deviation	*0.036*	*0.138*	*0.142*	*0.109*	*0.137*	*0.070*
Increase amount of fish caught (C4)	0.120	0.069	0.276	0.251	0.068	0.058
Standard Deviation	*0.071*	*0.029*	*0.146*	*0.134*	*0.050*	*0.017*
Management indicators	**0.304**	**0.318**	**0.209**	**0.271**	**0.406**	**0.547**
Increase the management efficiency (C5)	0.202	0.244	0.082	0.093	0.180	0.196
Standard Deviation	*0.097*	*0.088*	*0.059*	*0.081*	*0.105*	*0.057*
Increase the available information about MPA (C6)	0.102	0.074	0.127	0.179	0.226	0.351
Standard Deviation	*0.056*	*0.046*	*0.110*	*0.111*	*0.142*	*0.087*

De facto, the standard deviation was quite large for most of aggregated priorities from all performance indicators responded by all stakeholders. In considering the various characteristics from all responses, the difference happened more frequently when all stakeholders were asked about the indicators "*Increase quantity of fish in local water area*" and "*Increase employment*". However, in case of each stakeholder group, this trend was only significant for the groups of researchers, aquaculturemen, and tourist. Meanwhile fishermen and local households had their various expressions about "*Increase amount of fish caught*" instead of about "*Increase quantity of fish in*

local water area"; managers demonstrated their preferences variously for "*Increase the management efficiency*" instead of for "*Increase employment*" (see *Standard Deviation* in table 4.2).

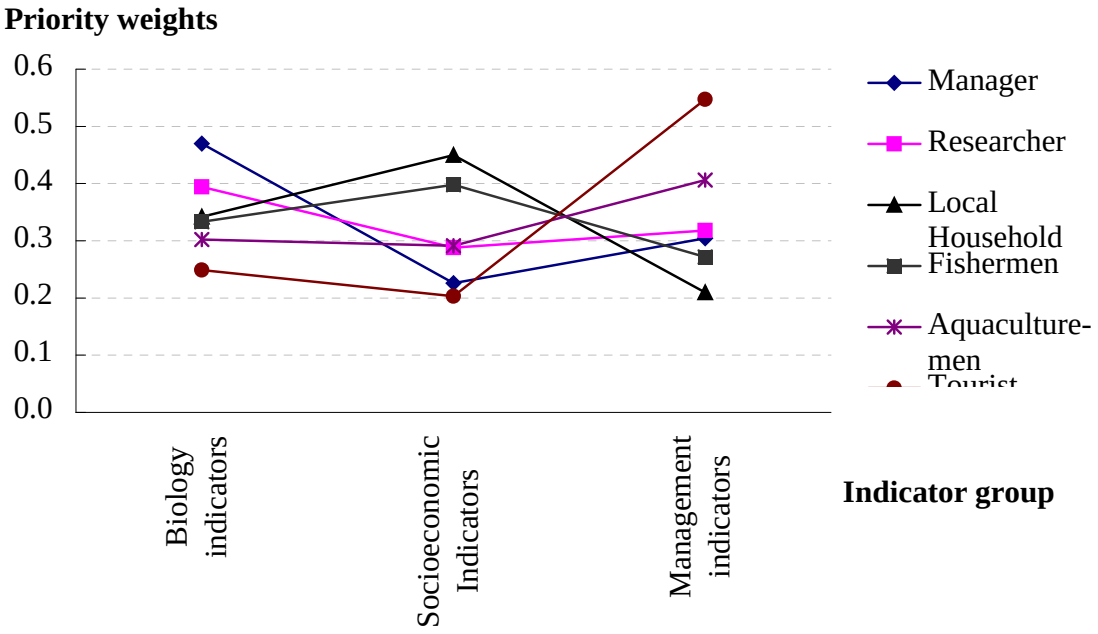


Figure 4.2: Priority weights amongst the stakeholder groups

At the sub-criteria level or indicator level, the difference in ranking the priority for NTB-MPA performance indicators were significant by each group of stakeholders. The indicator "*Increase quantity of fish in local water area*" was mostly chosen by managers (0.294 in priority weight; ANOVA, *F*-value = 7.754, *p*-value = 0.0005) and researchers (0.322; ANOVA, *F*-value = 4.405, *p*-value = 0.008) with the highest score of priority. For the group of researchers, the highest priority reached at peak of "*Increase the management efficiency*" (0.244), and it was higher than that franked by the other groups (ANOVA, *F*-value = 10.929, *p*-value = 1.69E-08). Meanwhile, the local household group mostly liked indicators "*Increase amount of fish caught*" (0.276 in average; ANOVA, *F*-value =17.008, *p*-value = 7.13E-15), fishermen deeply mentioned the most important indicator about "*Increase quantity of fish in local water area*" (0.259 scored; ANOVA, *F*-value = 14.09, *p*-value = 8.9E-12) in spite of the lower priority (0.333 in average) from their responses to biological indicators. Following this, the high priority in "*Increase amount of fish caught*" (0.251) was also ranked by fishermen. In comparison with all other groups, in ranking "*Increase amount of fish caught*" local households gave a threefold priority what the other stakeholders did; except for fishermen (ANOVA, *F*-value = 12.126, *p*-value = 2.68E-09). In contrast to tourists who mainly preferred the indicator "*Increase the available information about MPA*" (0.351), aquaculturemen preferred both indicators "*Increase the available information about MPA*" (0.226) and "*Increase*

employment" (0.223) equal (see more in figure 4.2). Interestingly, the "*Increase the available information about MPA*" received the priority from tourist half as much again as from the other stakeholders (ANOVA, *F*-value = 6.588, *p*-value = 2.24E-05). On the other hand, the indicator "*Reinforce regulations of banning trawlers in the water of NTB-MPA*" was not concerned so much by all stakeholders in general, although it was remarked by the manager group, respectively.

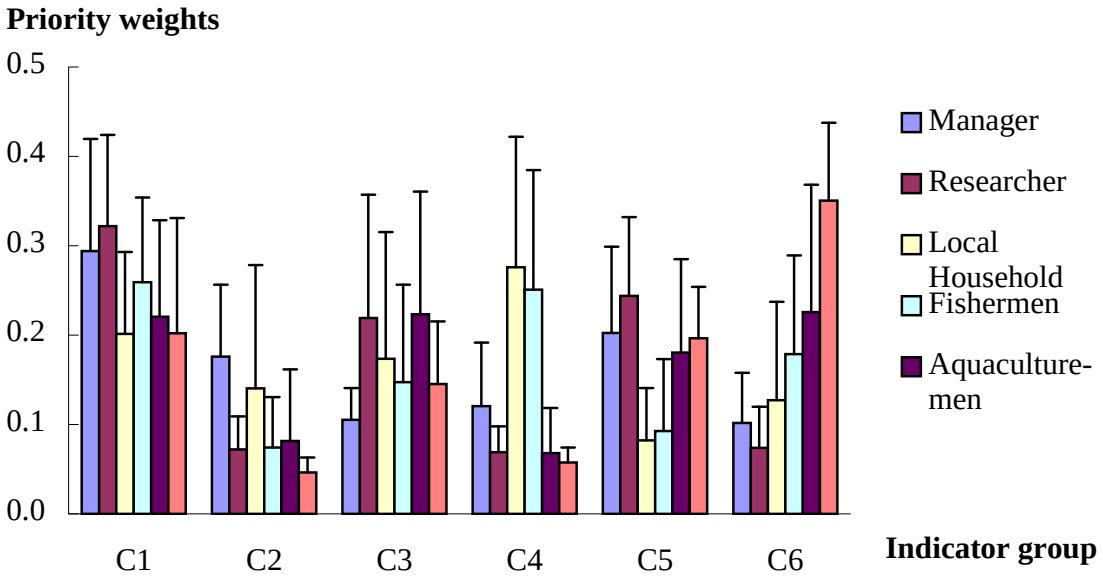


Figure 4.3: Priority weights of performance indicator group

Note: C1 stands for "*Increase quantity of fish in local water area*"
C2 for "*Reinforce regulations of banning trawlers in the water of NTB-MPA*"
C3 for "*Increase employment*"
C4 for "*Increase amount of fish caught*"
C5 for "*Increase the management efficiency*"
C6 for "*Increase the available information about MPA*"

4.1.3. Group coherence

By considering the standard deviation above, the opinions from all stakeholders about performance indicators of NTB-MPA could be regarded to be various and changeable to some extent. The error bars in figure 4.3 showed us this variability quite obviously. However, there was still the appearance of similar points of view in ranking priorities of some indicator that did not affect their whole response. Such changeable trends within each stakeholder group were summarized in table 4.3 through the coherence measurement. Basing on a vector-based approach, the group coherence can be measured by determining the angles between vectors. Zahir (1999) introduced how to use the method of group cluster analysis to find out the coherence in AHP data. Himes (2007b) notified one advantage of this method that the calculation of coherence within the group, which gauged a certain priority, can be feasible. He also mentioned about the condition for measurement of coherence by using an assumption that in a same group, individuals who give the

same response structure are possible to be tested. The higher coherence each group of stakeholders was, the more different level in their opinions in weight of priority for all performance indicators in NTB-MPA. Hence, the coherence within and amongst the group of stakeholders was displayed in table 4.3 below.

Table 4.3: Stakeholder Group Coherence

Stakeholder Groups	n	Coherence
Manager	5	0.937
Researcher	5	0.933
Household	53	0.901
Fishermen	25	0.915
Aquaculturemen	15	0.915
Tourist	8	0.956
All respondents	111	0.892

It is obvious that the coherence of all stakeholders (0.892) without considering the original source of responses was smallest and referred to be low or poor, interestingly. Meanwhile, within each stakeholder group, the coherence gained most in group of tourists (0.956) and least within local household group (0.901). The coherence of fishermen (0.915) and aquaculturemen (0.915) groups was evaluated closed to the good level; surprisingly, both of these coherence values were equal. For managers and researchers, there was a little bit difference between these two groups' coherence [managers (0.937) had slightly higher coherence than researchers (0.933) did]. It sorted both of them into the category of high coherence.

4.2 Analysis of Variability through Hierarchy Cluster

4.2.1. Hierarchy clustering analysis for priority weights

The variability of preferences by each stakeholder group can be viewed clearly via the analysis of coherence above. It is the differences which appeared between these groups of stakeholders. Within or inside each group, however, there were always the existence of similarities and dissimilarities amongst individuals. The cluster analysis is often applied to measure such differences

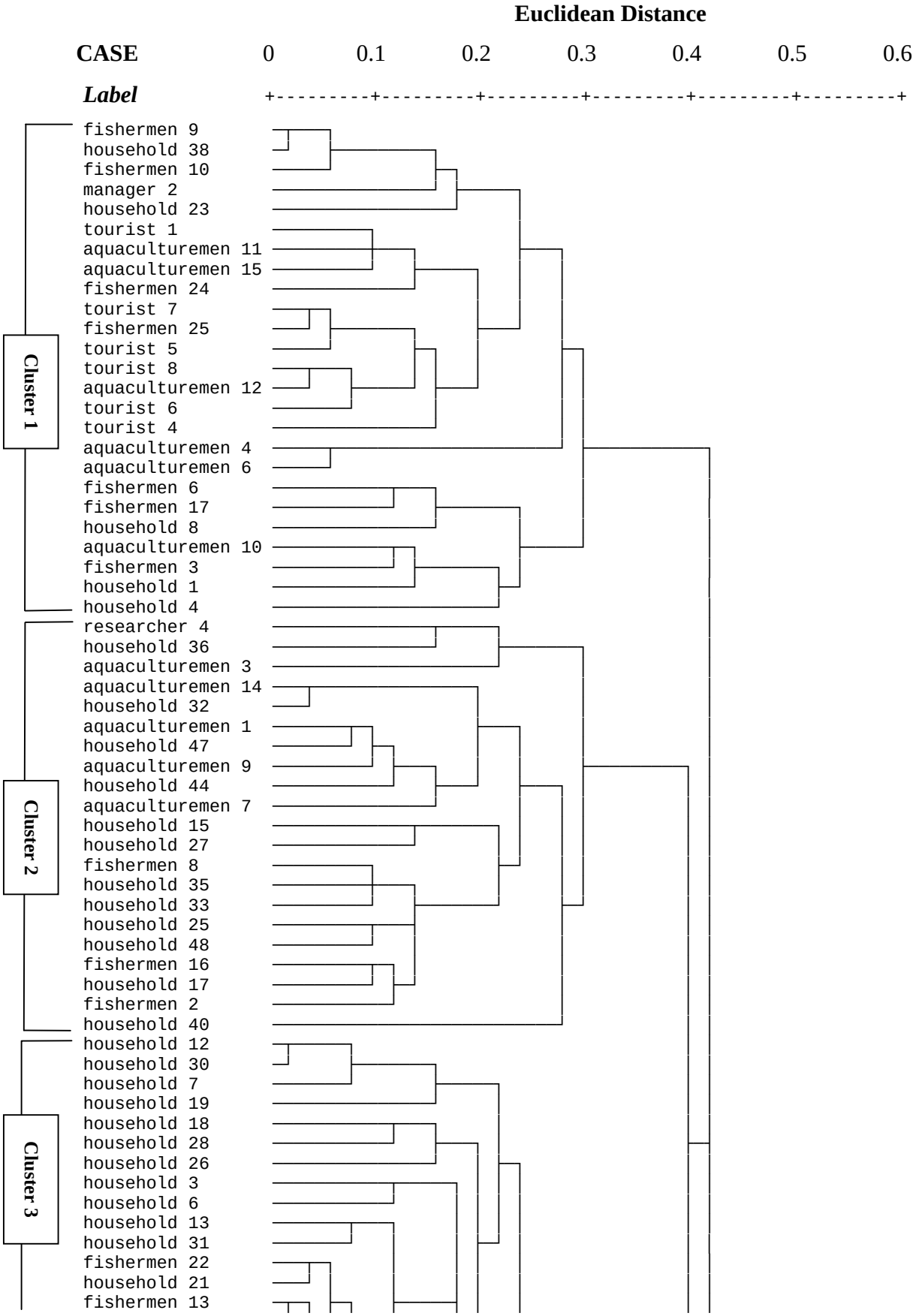
and resemblances basing on AHP database; even if, the coherence amongst individuals is shortcoming or not apparent (Himes, 200b). In this study, there were identified 5 clusters (more detailed in table 6 of cluster memberships in Appendix) related to the preference priorities ranked by each group. The number of cluster was recognized by the first sudden change in coefficients[10] from stage 106 (2.779) to stage 107(3.435) so that this predicted number would be counted by N - 106 = 111 – 106 = 5 (table 5 of agglomeration schedule in Appendix presented the trend of the coefficients more clearly). The clusters were labeled from 1 to 5 and displayed in figure 4.4.

Table 4.4: Aggregated Priorities of performance indicator preference by each cluster

Performance indicators	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Biology indicators	**0.213**	**0.235**	**0.382**	**0.391**	**0.592**
Increase quantity of fish in local water area (C1)	0.152	0.174	0.279	0.325	0.138
Standard Deviation	*0.058*	*0.081*	*0.092*	*0.072*	*0.048*
Reinforce regulations of banning trawlers in the water of NTB-MPA (C2)	0.061	0.061	0.103	0.067	0.454
Standard Deviation	*0.058*	*0.035*	*0.073*	*0.029*	*0.074*
Socioeconomic Indicators	**0.194**	**0.532**	**0.424**	**0.221**	**0.314**
Increase employment (C3)	0.077	0.395	0.119	0.135	0.110
Standard Deviation	*0.066*	*0.072*	*0.062*	*0.088*	*0.080*
Increase amount of fish caught (C4)	0.117	0.136	0.305	0.086	0.204
Standard Deviation	*0.077*	*0.072*	*0.160*	*0.042*	*0.042*
Management indicators	**0.311**	**0.233**	**0.196**	**0.388**	**0.094**
Increase the management efficiency (C5)	0.118	0.089	0.083	0.307	0.048
Standard Deviation	*0.071*	*0.068*	*0.050*	*0.076*	*0.036*
Increase the available information about MPA (C6)	0.194	0.144	0.113	0.081	0.047
Standard Deviation	*0.142*	*0.074*	*0.086*	*0.054*	*0.022*

[10] More detail in how to use SPSS to apply the cluster analysis and to determine the number of clusters can be found in http://faculty.chass.ncsu.edu/garson/PA765/cluster.htm

Himes (2007b) said that each cluster showed a homogenous relation instead of a homogenous group. For cluster 1, there was only one manager involved in and this cluster represented the trends in tourists and aquaculturemen and some part of fishermen and local household who mainly paid their attention to the preference for improving the management efficiency of NTB-MPA and knowing more useful information of the MPA (priority of management indicators was 0.311 in average). The individuals in cluster 1 needed more information from NTB-MPA (0.194 in average). It is clear that in cluster 1 there might include 2 sub-groups: one from tourists and the other representing for fishermen and aquaculturemen that cared of the indicator of increasing biomass. The combination in this cluster was only in ranking the socioeconomic category less than the other clusters. Interestingly, cluster 2 contained one researcher who together with some fishermen, half the aquaculturemen and local households loved the supports for increasing socioeconomic indicators more than the other indicators; especially, the members of cluster 2 extremely preferred the enhance in vocational supports, livelihood activities, and so on. Their ranking of priorities for the socioeconomic (0.532) was double for the other indicators. For cluster 3 which contained most of mangers, local households and fishermen belonged to, the quite similarity occurred with the socioeconomic indicators (0.424) received the highest regard in priority. However, the members in cluster 3 also preferred the biological indicators (0.382) as well. They mainly focused on how to harvest more fish and how the amount of fish in local water area around and/or inside NTB-MPA increases. Moreover, in cluster 4, it seemed that there were a little various choices from its individuals to rank three performance indicator categories. In considering each performance indicators, the members in this cluster, which represented for group of researchers, conversely showed the large difference in their opinions to rank the high priority in "*Increase quantity of fish in local water area*" (0.325) and "*Increase the management efficiency*" (0.307). Individuals in cluster 5 concentrated on the biological indicators of which the criterion "Reinforce regulations of banning trawlers in the water of NTB-MPA" (0.454) was ranked highest (nearly four times more than the other indicators). Interestingly, all members of this cluster were only local households.


Euclidean Distance
CASE
0
0.1
0.2
0.3
0.4
0.5
0.6
Label
fishermen 9
household 38
fishermen 10
manager 2
household 23
tourist 1
aquaculturemen 11
aquaculturemen 15
fishermen 24
tourist 7
fishermen 25
tourist 5
tourist 8
aquaculturemen 12
tourist 6
tourist 4
aquaculturemen 4
aquaculturemen 6
fishermen 6
fishermen 17
household 8
aquaculturemen 10
fishermen 3
household 1
household 4
researcher 4
household 36
aquaculturemen 3
aquaculturemen 14
household 32
aquaculturemen 1
household 47
aquaculturemen 9
household 44
aquaculturemen 7
household 15
household 27
fishermen 8
household 35
household 33
household 25
household 48
fishermen 16
household 17
fishermen 2
household 40
household 12
household 30
household 7
household 19
household 18
household 28
household 26
household 3
household 6
household 13
household 31
fishermen 22
household 21
fishermen 13
Cluster 1
Cluster 2
Cluster 3

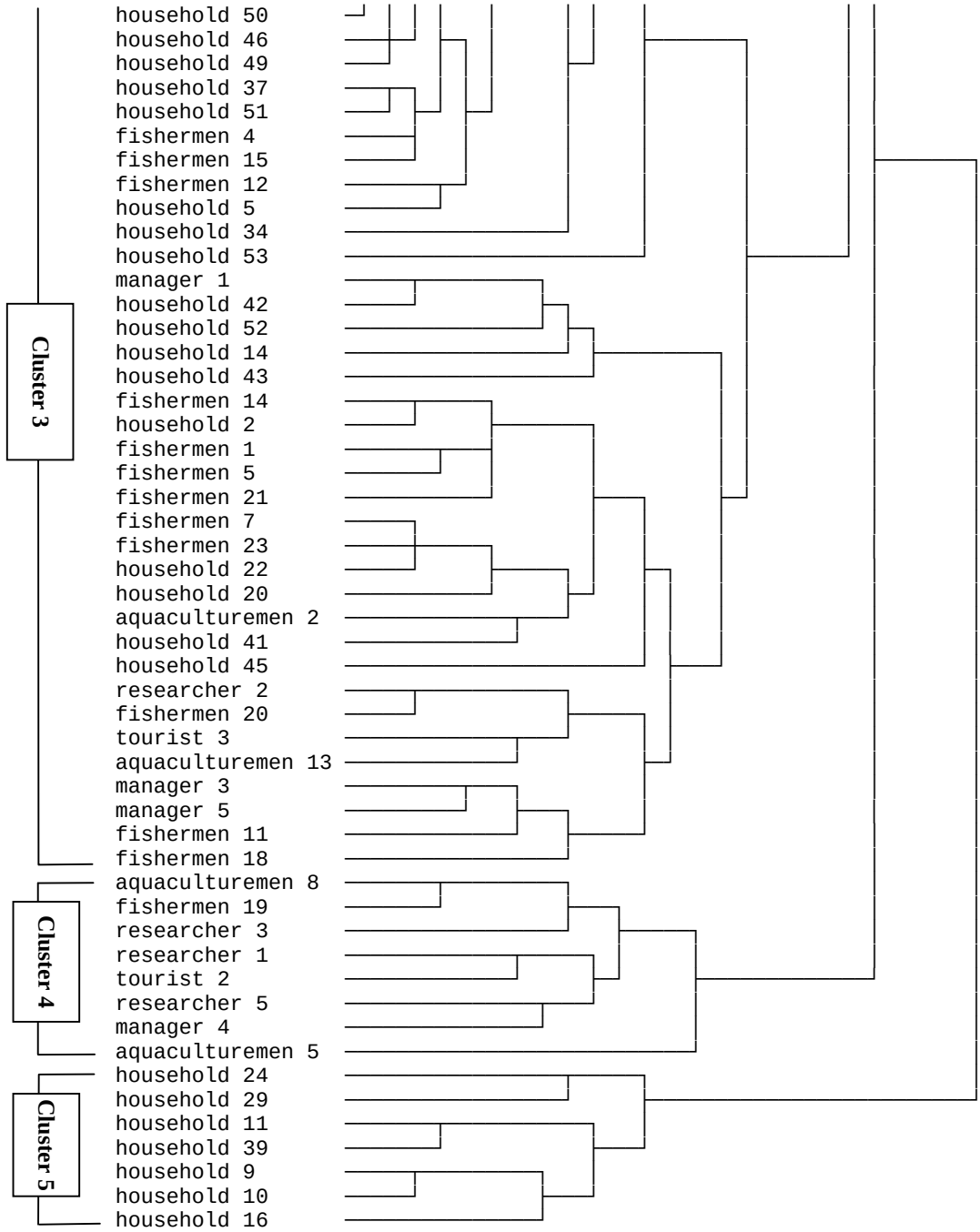


Figure 4.4: Dendrogram using Average Linkage between Groups

The figure 4.4 described the hierarchy clustering analysis of priority ranking for all performance indicators in NTB-MPA by the whole stakeholders. It is obvious that fishermen, local household and aquaculturemen scattered greatly among nearly all clusters; fishermen and aquaculturemen did not spread over cluster 5 and local households not over cluster 4. Half the group of managers extended over cluster 3 and half the group of researchers over cluster 4. On the other hand, nearly all tourists concentrated into cluster 1 and two of them expanded into cluster 3 and 4.

Thus, cluster 5 can be regarded to be the homogenous relation as well as to the homogenous group. The cluster 1 and 3 contained the high level of diversity in considering what kind of member joined into them; each of them contained 4 out of 5 different stakeholder groups.

In addition, in ranking all 6 performance indicators at once time, the value of Euclidean distance varied individual by individual and/or cluster by cluster. In this study, the Euclidean distance in AHP analysis described the difference in each stakeholder compared with the other in ranking NTB-MPA performance indicators. It can be easily understand that individual A like one or two indicators in the category of "*biology*" as much as the individual B did; however, both of them had a different choice in ranking the priority for the last categories of "*socioeconomic*" and "*management*". Thus, this divergence created the distance among them and called as the Euclidean distance. Absolutely, such distance will differ from the variation between individual A and C who preferred the indicators in category of "*socioeconomic*" but had various opinions in concerning the others. De facto, for all stakeholders, the Euclidean distance was large (about 0.56). The divergence among clusters was also demonstrated by the values of Euclidean distance (approximately 0.3) half as much as the distance from global. It seems that there was a certain semblance among individuals in each cluster. Therefore, the dendrogram in figure 4.4 showed that in cluster 5 which contains only local households from Tri Nguyen Island, the semblance reached at the peak; following by cluster 4 in which all researchers from VNIO were (see more in Appendix B). The semblance and divergence from all clusters can be seen more clearly by the coherence analysis.

4.2.2. Cluster Coherence

In fact, the coherences of the homogenous group of stakeholders measured in sub-chapter 4.1.3 above pointed out that the whole of stakeholders was classified into the poor homogeneity; even if each homogenous group of stakeholders received good and high coherence. This can be explained by the diversity in their geographical backgrounds, occupational knowledge and so on.

Table 4.5: Coherence for clusters of stakeholder groups

	n	**Coherence**
Cluster 1	25	0.771
Cluster 2	21	0.958
Cluster 3	50	0.934
Cluster 4	8	0.961
Cluster 5	7	0.955

The table 4.5 displayed the divergence of priority weights by individual in each cluster. Surprisingly, the coherence of cluster 1 was in very poor (0.771). Probably, this contributes mostly into the reason for the poor coherence amongst all stakeholders in table 4.3. Cluster 3 gained the good coherence (nearly 0.96) in spite of the highest number of individuals as well as the various components in these groups. The high coherence was also found out in clusters 2, 4 and reached at peak (0.961) in cluster 5. Indeed, it produced a similar conclusion compared with the results from hierarchy clustering analysis above. Interestingly, the highest coherence level of cluster analysis (0.955) for cluster 5 was higher than that of group analysis (0.937) for managers (displayed in table 4.2); and, the lowest coherence of group analysis (0.892) for all stakeholders was lower than that of cluster analysis (0.771) for cluster 1 (shown in table 4.2).

4.3 Discussion

4.3.1. Various desires by stakeholder group for NTB-MPA performance indicators

The success of management process in an MPA to set up an effective plan for fisheries management depends a lot on the compatibility between the objectives of an MPA establishment and the understanding from stakeholders about the important of these goals (Pascoe et al., 2009; Jones, 2002). Hence, the objectives of an MPA establishment should combine with the participation of local users or communities (Claudet & Pelletier, 2004). The goals are sometimes changed and little by little get away from the initial objectives of an MPA establishment. The changes happens when the objectives have not met the interests from stakeholders; especially, from local residents and fishermen mainly. Besides, the conflicts among the stakeholders induce the challenges in keeping the management in right way. Obviously, the success of an MPA management depends on to extent how much the MPA objectives or goals were obtained (Jones, 2002).

Different groups of stakeholders put their various judgments about the importance of each objective group of MPAs (Mardle, 2004; Himes, 2007b). It revealed 3 trends of opinions among all stakeholders living and related to NTB-MPA. The first group including fishermen and local households particularly paid their whole attention to the socioeconomic category (figure 4.2). This caused by such indicators connected directly to their present requirements for life (Sesabo 1999). More than that, in comparison to the results from the survey done by AIGs in 2004 (Thu, 2004), it seems that needs for occupational supports from local residents was still high. In fact, they did not care so much on the management efficiency for NTB-MPA. However, the indicators in increasing biomass and increasing information were still preferred in good priorities (table 4.2). That why's, Lan (2009) said that the perceived perception from fishermen about the decline of natural resource

was high together with the present decreasing condition of fish diversity and density was reported (Dung, 2007). Actually, the success of NTB-MPA management in term of biodiversity protection leads to the great engagement to NTB-MPA management process from all stakeholders; via their profound conceptions on the role and benefits of the diversified natural resources as well as their supports to the preservation activities to increase the natural resources.

The next direction in stakeholders' opinions was of tourists who considered the improvement in available information of NTB-MPA as the highest priority. This occurred might cause by the sample survey which took place only in Hon Mun Island inside the core zone of the MPA where tourists had a chance to visit the NTB-MPA house center. For this, in cluster analysis most of them concentrated into the cluster 1 of which individuals focused on the amount of fish and available information of the MPA increased as well as on the increased amount of fish in local water (table 4.4). This study showed the fact that even though tourists have been approached the large amount of information available near to where they visit, they still offer the more source of information to look for and to study such as from internet, brochure, library and so on.

For the other groups which aquaculturemen, researchers and managers involved in, they regarded the importance of all 3 categories (biological, socioeconomic and management) to be quite balancing and same. However, managers together with researchers concerned a little less about socioeconomic term. Once more thing, compare to the study of Lan (2009) the same attitudes from researchers and managers on the reason for establishing NTB-MPA were higher than local households and fishermen who only thought of the benefits from livelihood activities. The obvious evidences of this can be seen in cluster analysis in which the ranks of 3 category of the MPA performance indicators from the members in cluster 3 and 4 (table 4.4) were similar. Hence, the groups of managers and researchers have had the good perception in the equal roles between direct values (economic benefits from fisheries and tourism) and indirect values (the improved fisheries resource through the protection of natural habitats, the limitation of illegal fishery activities, the efficiency of management operation and so on) (see more Boersma and Parrish, 1999). In practice, managers, together with researchers who show the evidence by their studies, should encourage the other stakeholders (fishermen, local residents, aquaculturemen and the others) in taking responsibility for achieving the goals of the MPA (Sanchirico, 2002).

Interestingly, in case of regarding "*Reinforce regulations of banning trawlers in the water of NTB-MPA*" as a tool to protect the natural resources, most of stakeholders did not agree with the efficiency of this regulation. Even though, half the manager group still mentioned the feasible application of this tool, the other stakeholders including researchers, aquaculturemen, and tourists

completely said nothing about the efficiency. The large amount of fishermen and local households, who paid their attention to this regulation (table 4.4 and figure 4.4), mainly came from the islands (Tri Nguyen, Dam Bay, Hon Mot, Vung Ngan) inside NTB-MPA instead of in the vicinities (Vinh Luong, Vinh Truong) (see table 5 in Appendix B). It is not surprising that the amount of fishermen, who did not concern this regulation tool, lives in the vicinities and most of them are fishermen in trawlers in practice. These fishermen belong to cluster 1 and 2 of which individuals ranked the higher priorities in socioeconomic factors and management factors than in biological category. It is obvious that the conflicts among the fishermen group and between some fishermen and the local household group possibly caused by the divergence of fishing gears they used [see the internal conflicts from the MPA design and management suggested by Jones (2002)] instead of their perception of the efficiency for resource reservation from the legislation. Hence, Ngoc (2009) concluded that no effective protection of fish resource was produced from the reinforcement of banning trawlers. It requires the support and participation in building one management policy equivalently from all key stakeholders who realize the effectiveness of that regulation in reality. De facto, the enforcement of any policy or regulation without the high agreement from all stakeholders will be possible to make the conflicts between stakeholder group and the inner conflicts within each group become more serious.

Furthermore, the information of NTB-MPA for nearly all stakeholders is not fulfilled enough; even tourists still need more. This is only explained by the cessation of the Hon Mun MPA pilot project 4 years ago (Dung, 2007). Even if the information did not provide the real effects on the MPA management, the more sufficient communication between the managers and the others (especially fishermen and local households) is, the greater efficiency in reducing the divergence among stakeholders to understand one of the MPA management tool will be obtained together with the less amount of user-interest conflicts (McClanahan et al., 2005).

Nevertheless, the difference opinions amongst the various group of stakeholder on "*Increase employment or create more new jobs*" was not significant at the confident level of 95% (P-value is about 0.303 > 0.05– Appendix D). Obviously, in compared with the other performance indicators, this indicator was the only one that cannot reach at the significance level (Alpha level) of 0.05 so that it created the uncertainty in ranking the priority for the issue of "*Increase employment or create more new jobs*" from all stakeholders related to NTB-MPA. It seemed that the divergence in considering the performance indicator occurred between some certain groups of stakeholders instead of the whole stakeholders. That's why; in the hierarchy clustering analysis in figure 4.4, only cluster 3 contained all types of different stakeholder groups, while the other clusters felt short of the

representative from at least one group of stakeholder. In other word, the statistical analysis tool of T-test pointed out that the homogenous opinions of stakeholders appeared in some comparison groups of stakeholders in weighting the priorities for this performance indicators with the significance level less than 0.05 (Appendix D). The same option seemingly happened when comparing the group of mangers or the group of aquaculturemen with the others. The reason was unclear and possibly difficult to be found out. De facto, it was said that the difference in the knowledge and perception of each stakeholder individual about the role and effects from the livelihood activities might create such an issue. The other possible cause can be the lack of full and completed participation from some key stakeholders such as local households and fishermen into the NTB-MPA management process (Anh and Khanh, 2009) so that they did not see a great shared benefit from the NTB-MPA management activities in term of socioeconomic. Therefore, this study showed that the failure of the NTB-MPA management process in term of providing the alternative livelihood was unclear. Indeed, the social and livelihood activities during the time of Hon Mun MPA pilot project still had certain positive impacts somehow and somewhere.

De facto**, the main thread** for achieving the success of NTB-MPA management is possible to be the poor perception among the key stakeholder groups (local households and fishermen) about the important role of indirect values (protection of natural resource by regulation, management policy and others else). This shortcoming will lead to the status of pollution and/or over-exploitation as the study of Ngoc (2009) mentioned. To obtain the enhancement of sustainable resources management, it is challenging to solve these issues.

In short, the perception of protection of natural fish resources tends to be well and equivalent in all stakeholders. For the other objective in term of improving social conditions, the different opinions still appeared among some groups of stakeholders because of the disagreement between stakeholder group and the internal conflicts within each stakeholder group. Especially, the conception of the role of management process in NTB-MPA was not good in most of key stakeholder groups (fishermen and local household).

4.3.2. The conflicts between and within groups

In practice, the variation takes place among groups of stakeholder as well as between individuals from each group. Each kind of these differences will lead to the dissimilar effects on the process of managing an MPA.

The different amount of yields can cause the disagreement among fishermen in point of marine reserve size and fisheries management implementation (Armstrong, 2007). In this study, the

homogeneity in assessing the performance indicators amongst individuals of fishermen and local household group was not high (table 4.3). This could be explained more clearly by the scatter level of these groups in cluster analysis where they spread over nearly all clusters (figure 4.4). It means that there were still remarkable inner-conflicts within groups; even conflicts between these groups. Indeed, the higher **high** and lower **low** cluster coherence than group coherence mentioned in sub-chapter 4.2.2 showed the obvious evidence about the existence of conflicts among the stakeholder groups. Such kind of arguments created the reduction of the coherence of cluster 1 due to the components of this cluster made by most of various stakeholders from all different geographical locations (see more in Appendix B). In compared with the analysis for cluster 1, the coherence for whole stakeholder was higher because of the participation of the others stakeholders, who did not reveal the opposition or informed this disagreement in part in ranking the priority for NTB-MPA performance indicators. Obviously, cluster 1 did not include these additional stakeholders. Thus, through the hierarchy clustering analysis in this study, the conflicts between stakeholder groups and between individuals from each separate group of stakeholders were displayed more clearly.

Moreover, in comparison to the coherence value among the individual from separate groups of stakeholders, the coherence from the whole stakeholders displayed in table 4.3 reached at the lowest value. The highest value of coherence appeared in the cluster 4 and 5 of which the members mainly were local household and researchers coming from the same geographical location (Appendix B). Thus, the present study demonstrated that the different opinions amongst the groups occurred more obviously than the internal divergence between individuals from each separate group of stakeholders.

In comparison to the study of Himes (2007b) of which the heterogeneity appeared among the key stakeholders (managers), this study, however, points out that such heterogeneous key stakeholders were fishermen and local households instead of managers. It also proves that managers in NTB-MPA board as one of the key stakeholders and researchers understood the whole mean of MPA establishment. As Senaratna (1995) reported, socioeconomic factors played a more important role in making the use of natural resources sustainable. For the other key stakeholders (fishermen and local households), this trend still appeared consistently and clearly. In considering the participation of all stakeholders, the whole success of NTB-MPA management in both major objectives has not yet obtained in term of biology and socioeconomic. Thus, it needs an equivalency in valuation of each performance indicator category, which correlated with the MPA goals, from all stakeholders.

Through hierarchy clustering analysis and the coherence evaluation, the conflicts not only occurred between the stakeholder groups but happened as the internal contradiction inside or within each group as well. Obviously, the most important key stakeholder groups including fishermen and local households expressed their greatly various opinions about the NTB-MPA management operations. Even though, some of them still had a good perception about it (shown by the small number of local households and fishermen belonging to the nearly homogenous cluster 4 and 5 of which the coherence values were high and the Euclidean distance small – figure 4.4 and table 4.5), many of them appeared in cluster 1, 2, and 3 with the high heterogeneity (shown by the great Euclidean distances and the low coherence values). Compared with the results from Anh and Khanh (2009), it proved the same results that the tendency of conflicts among the local communes was still increasing slightly. This will be challenging for improving the efficiency of NTB-MPA management.

In general, together with the poor perception about the importance of indirect values from key stakeholders –fishermen and local households, the conflicts among the groups of stakeholders and the internal conflicts among individuals of each group were obvious. Actually, they would cause much difficulties and challenges for maintaining and improving the management process in NTB-MPA in an efficient and sustainable manner now and in future.

4.3.3. Limitations of this study

The chosen sample size for this study satisfied the Acceptable Margin of Error of 0.03 and Alpha Level of 0.05. However, due to the removing of unusable 9 pairwise comparison matrixes, the confident level of this study only reached at 90% (or Alpha Level was at 0.1). On the other hand, the large part of sample belonged to the group of local households and fishermen; meanwhile, the amount of researchers and managers was poor. Furthermore, the concentration of this study only focused on managers who were still taking an account of NTB-MPA management and researchers who were doing their studies of NTB-MPA. Further studies should involve in the former or retired managers as well as researchers who did an evaluation about the efficiency of NTB-MPA management. In fact, the sample of researchers only contained natural scientists instead of involving the social experts. This can make the great bias in finding out the real central point from the stakeholder group of researchers. Therefore, this should be improved in further studies.

Moreover, the sample of tourists was only done in Hon Mun Island because of the survey taking place in 3 days at that time there were no visitors in the other islands. Besides, it was not the

tourism season (often from April to August) during the time the survey was done so that it was lack of foreign tourists in this sample. It hopes that the other studies could avoid this problem.

The other problem was about the questionnaires. In our survey, there was 95% of people expressed the interesting in this topic issue; however, only 68.42% of them supposed that the questionnaires were clear (Appendix C). In practice, there was no report related to the assessment of the NTB-MPA management about how much percentage will be enough to conclude that the questionnaires in the survey were clear or unclear. It was obvious that it will not be assure to confirm the clearness of this survey. However, it can always be better if the percentage of interviewees, who confirmed about the ease to understand throughout the questionnaires, was more than or at least equal to 90%. Therefore, it requires the enhancement in designing the questionnaires to help interviewees understand the issues greater clearly and profoundly as well as to regard the survey actually to be clear.

5. Conclusion

Overall, the heterogeneity occurred when stakeholders gave their preferences for the performance indicators of the NTB-MPA objective in providing the livelihood to improve the socioeconomic criteria for local communities. However, this divergence possibly did not appear amongst all stakeholders. In addition, the homogeneity was found when the priority of performance indicators in term of protecting the biological resources was ranked by the whole stakeholders. The conflicts appeared not only between the various groups of stakeholders, but within each of them as well. The most important findings from the present study is that the key stakeholders including fishermen and local households proved to be most heterogeneous; meanwhile, it was likely to happen least in the group of managers. On the other hand, the results of this study showed that there was a great requirement for approaching the source of information about NTB-MPA from nearly all stakeholders.

i. Performance indicators in NTB-MPA

To gain the supports to the MPA establishment and operation from local communities, it needs the entire and profound understand of the various stakeholder participation to the MPA (Sesabo, 1999). This study points out that the priority from all stakeholders is reached at the great level in the performance indicators of biomass and information increasing.

It is obvious that the efficiency of management operations in NTB-MPA was not in high perceptions of key stakeholder groups. It leads the state of shortcoming the understanding and knowing why and how such management activities were done. Besides, the policy or regulation did not meet the acceptation and expectation from nearly all stakeholders for its purposes such as in term of resource protection.

ii. Diversification among stakeholders

Different goals of fisheries management are emphasized by various groups of stakeholder (Pascoe et al., 2009). The identification of the various role of all stakeholder groups is likely to be the main factor to make and control the MPA manage strategies efficient and successful (Brown et al., 2001; Sesabo, 1999). The results of this study pointed out that the between-groups conflicts occurred among nearly all stakeholders and more common than the internal ones. Unsurprisingly, this study also indicates that the internal divergences among all groups of stakeholders are high in 2 key groups (fishermen and local households). There is a similarity among the managers, the researchers and the aquaculturemen in acknowledging the whole purpose of NTB-MPA

establishment; however, this homogeneity is not so clear. Basing on these important results, the managers of NTB-MPA can find where the conflicts happen most and how to deal with.

iii. Management efficiency

Through the analysis of local households' perceptions, the NTB-MPA management process has regarded with the success in term of biodiversity protection objective; however, it has not met the expectations in improving the livelihood for local island communities together with the efficiency of livelihood activities were regarded with the failures (Anh and Khanh, 2009). Versus to the results from Anh and Khanh (2009), when involving some more other stakeholders in analysis, this study demonstrate that the success or failure in NTB-MPA management for the purpose in improving the socioeconomic conditions was unclear. Thus, it can be said that the objectives for protection of fish natural resource is regarded as the only obvious success of the NTB-MPA management in term of the assessment of the stakeholder perception.

The lack of preferences from all stakeholders (except for managers) for NTB-MPA regulation or policy about "*banning trawlers in the waters of NTB-MPA*" have revealed the possible failures of NTB-MPA management in using the tool of policy without the high level of agreement from all stakeholders to protect the natural resource.

iv. Application of AHP in assessing the NTB-MPA management and recommendations

Using AHP method seems to be the effective way to assess the efficiency of NTB-MPA management. It removes the difficulties from the requirement of data as the CBA or the other quantitative methods need. The results from our study basing on AHP method give the nearly similar conclusion in comparison to the other previous studies. In the case of the qualitative evaluating analysis of an MPA management, it could easier and more effective to get the clear and significant results from the application of AHP in finding out the efficient aspects of the management process of NTB-MPA as well as in the other MPAs in Vietnam in term of society and economic.

By doing this study, some recommendations for improving the NTB-MPA management process can be seen; as follows:

- ✓ Increase the dialogue process among key stakeholders (managers, local households and fishermen) to reduce the conflicts and arguments (Mangi and Austen, 2008).
- ✓ Create the participation of local households and fishermen into the process of building some regulation to avoid the disagreements and conflicts. Co-management should be

regarded as one of alternative and/or supportive tools (Pascoe et al., 2009) for the top-down management approach in NTB-MPA (Nguyen, 2009).

- ✓ Support local household, fishermen, aquaculturemen and tourist in assessing the information from NTB-MPA more easily and conveniently (such as using the internet more efficiently)
- ✓ Improve the present livelihood activities by the creating more participation and receiving more support from all stakeholders for instance; even cease and replace the ineffective ones.

v. Further studies

By the limitations of this study, it suggests for further studies in a greater sample to improve the significance level and in more various characteristics of the sample within each stakeholder group to avoid the bias in ranking the priorities. The more diversity of each stakeholder group in sample should be encouraged to avoid the bias in weighting the priority.

The extension for the number of performance indicators in each category is encouraged (e.g. the pollution or cultural activity supports). Each indicator should be explained more obvious and related directly to the stakeholders' experiences and knowledge. The other study using AHP method for each separate category (such as socioeconomic) and/or each group of stakeholder (fishermen, tourists) should be encouraged.

It will be more interesting if the alternatives of NTB-MPA objectives and/or performance indicators are put into AHP analysis in further studies. Last but not least, the survey of future studies and researches should take place in the summers to get rid of some bias in collecting samples.

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Appendix

A. Questionnaire

Questionnaires for Stakeholders' preferences

Survey in Nha Trang Bay MPA

Section 1: General information from interviewees. (Question 1 to 4)

1. ***What is your name?*** .....
2. ***Gender***

   Male ☐ Female ☐
3. ***What is your job relevant to NTB-MPA?***

Manager ☐ Researcher ☐ Local household ☐ Fisherman ☐ Aquaculturemen ☐ Tourist ☐

4. ***If your family goes fishing, which kind of gear you and/or the others in your family use to fish?***

   Trawlers ☐ Lifting net ☐ Driftnet ☐ Purse seine ☐ Hand line ☐
5. ***Where are you working or living now?***.....

   .....

Section 2: Interviews of stakeholders' preferences for the performance indicators in NTB-MPA

Note:

+ *To increase biology indicators, it should gain "the greater biomass" and/or "ban trawlers"*
+ *To increase social-economic indicators, it should "increase employment" and/or "increase amount of fish caught"*
+ *To increase management efficiency indicators, it should "increase the management efficiency" and or "increase the available information about the MPA to tourists and local residents"*

Question 6 to 10

A. Please write on the box (element 1) the criteria code that you assess more or equal important than other, and express on the verbal scale the importance of the more or equal important criteria (element 1) over the other.

1 = Equal 3 = Moderate 5 = Strong Importance 7 = Very strong Importance 9 = Extreme Importance										
Pair-wise	**Element 1**									
Increase quantity of fish in local water area (C1) Reinforce regulations of banning trawlers in the water of NTB-MPA (C2)		1	2	3	4	5	6	7	8	9
Increase quantity of fish in local water area (C1) Increase employment (C3)		1	2	3	4	5	6	7	8	9
Increase quantity of fish in local water area (C1) Increase amount of fish caught (C4)		1	2	3	4	5	6	7	8	9
Increase quantity of fish in local water area (C1) Increase the management efficiency (C5)		1	2	3	4	5	6	7	8	9
Increase quantity of fish in local water area (C1) Increase the available information about MPA (C6)		1	2	3	4	5	6	7	8	9

Question 11 to 14

B. Please write on the box (element 1) the criteria code that you assess more or equal important than other, and express on the verbal scale the importance of the more or equal important criteria (element 1) over the other.

1 = Equal 3 = Moderate 5 = Strong Importance 7 = Very strong Importance 9 = Extreme Importance										
Pair-wise	**Element 1**									
Reinforce regulations of banning trawlers in the water of NTB-MPA (C2) Increase employment (C3)		1	2	3	4	5	6	7	8	9
Reinforce regulations of banning trawlers in the water of NTB-MPA (C2) Increase amount of fish caught (C4)		1	2	3	4	5	6	7	8	9

Reinforce regulations of banning trawlers in the water of NTB-MPA (C2) Increase the management efficiency (C5)		1	2	3	4	5	6	7	8	9
Reinforce regulations of banning trawlers in the water of NTB-MPA (C2) Increase the available information about MPA (C6)		1	2	3	4	5	6	7	8	9

Question 15 to 17

C. Please write on the box (element 1) the criteria code that you assess more or equal important than other, and express on the verbal scale the importance of the more or equal important criteria (element 1) over the other.

1 = Equal 3 = Moderate 5 = Strong Importance 7 = Very strong Importance 9 = Extreme Importance										
Pair-wise	**Element 1**									
Increase employment (C3) Increase amount of fish caught (C4)		1	2	3	4	5	6	7	8	9
Increase employment (C3) Increase the management efficiency (C5)		1	2	3	4	5	6	7	8	9
Increase employment (C3) Increase the available information about MPA (C6)		1	2	3	4	5	6	7	8	9

Question 18 to 19

D. Please write on the box (element 1) the criteria code that you assess more or equal important than other, and express on the verbal scale the importance of the more or equal important criteria (element 1) over the other.

1 = Equal 3 = Moderate 5 = Strong Importance 7 = Very strong Importance 9 = Extreme Importance										
Pair-wise	**Element 1**									
Increase amount of fish caught (C4) Increase the management efficiency (C5)		1	2	3	4	5	6	7	8	9
Increase amount of fish caught (C4) Increase the available information about MPA (C6)		1	2	3	4	5	6	7	8	9

Question 20

E. Please write on the box (element 1) the criteria code that you assess more or equal important than other, with respect to the goal: and express on the verbal scale the importance of the more or equal important criteria (element 1) over the other.

1 = Equal 3 = Moderate 5 = Strong Importance 7 = Very strong Importance 9 = Extreme Importance										
Pair-wise	**Element 1**									
Increase the management efficiency (C5) Increase the available information about MPA (C6)		1	2	3	4	5	6	7	8	9

*** ***Please give us few more seconds by answering to the following questions in order to improve our analysis (optional):***

	Yes	***No***
Did you find the questionnaire clear?		
Do you find the topic issues interesting?		

Please give us any additional comment (optional):

With thanks so much for your effort and time

B. Measurement of Priority Weights in AHP Analysis

B.1 Analysis of pairwise comparison reciprocal matrix

The pairwise comparison reciprocal matrix was shown in table 1 basing on 6 criteria (as mentioned in sub-chapter 3.1.2 and figure 3.1). We took the responds from researcher 1 as an example and tried to explain how to calculate the priority weights without the supports from computer software such as Expert Choice.

- In step 1, to avoid the problem of rank reserve in the original AHP method, we normalized the columns by summing all values vertically by each criterion.

$$\mathbf{A} = \begin{array}{c} \\ C1 \\ C2 \\ C3 \\ C4 \\ C5 \\ C6 \\ \textbf{Sum} \end{array} \begin{array}{c} \begin{array}{cccccc} C1 & C2 & C3 & C4 & C5 & C6 \end{array} \\ \left\{ \begin{array}{cccccc} 1 & 7 & 5 & 6 & 1 & 7 \\ \frac{1}{7} & 1 & 1 & 1 & \frac{1}{5} & 3 \\ \frac{1}{5} & 1 & 1 & 1 & 1 & 4 \\ \frac{1}{6} & 1 & 1 & 1 & \frac{1}{4} & 1 \\ 1 & 5 & 1 & 4 & 1 & 3 \\ \frac{1}{7} & \frac{1}{3} & \frac{1}{4} & 1 & \frac{1}{3} & 1 \end{array} \right\} \\ \begin{array}{cccccc} \mathbf{2.65} & \mathbf{15.333} & \mathbf{9.25} & \mathbf{14} & \mathbf{3.783} & \mathbf{19} \end{array} \end{array}$$

- In step 2, the revised AHP or the variant of the original AHP was used to obtain the reciprocal matrix by dividing each column by the sum which we have just counted. The reciprocal matrix looks like the description below.

$$A = \begin{array}{c} \\ \\ \\ \\ \\ \\ \textbf{Sum} \end{array} \begin{array}{c} \\ \left\{ \begin{array}{cccccc} 0.337 & 0.457 & 0.541 & 0.429 & 0.264 & 0.368 \\ 0.054 & 0.065 & 0.108 & 0.071 & 0.053 & 0.158 \\ 0.075 & 0.065 & 0.108 & 0.071 & 0.264 & 0.211 \\ 0.063 & 0.065 & 0.108 & 0.071 & 0.066 & 0.053 \\ 0.377 & 0.326 & 0.108 & 0.286 & 0.264 & 0.158 \\ 0.054 & 0.022 & 0.027 & 0.071 & 0.088 & 0.053 \end{array} \right\} \\ \begin{array}{cccccc} \mathbf{1} & \mathbf{1} & \mathbf{1} & \mathbf{1} & \mathbf{1} & \mathbf{1} \end{array} \end{array}$$

- In step 3, we calculated the average for each row to get the normalized **Principal Eigenvector** or the **priority vector**; as follow:

$$w = \frac{1}{3}\begin{Bmatrix} 0.337 + 0.457 + 0.541 + 0.429 + 0.264 + 0.368 \\ 0.054 + 0.065 + 0.108 + 0.071 + 0.053 + 0.158 \\ 0.075 + 0.065 + 0.108 + 0.071 + 0.264 + 0.211 \\ 0.063 + 0.065 + 0.108 + 0.071 + 0.066 + 0.053 \\ 0.377 + 0.326 + 0.108 + 0.286 + 0.264 + 0.158 \\ 0.054 + 0.022 + 0.027 + 0.071 + 0.088 + 0.053 \end{Bmatrix} = \begin{Bmatrix} 0.406 \\ 0.085 \\ 0.133 \\ 0.071 \\ 0.253 \\ 0.052 \end{Bmatrix}$$

The priority weight for each performance indicator was shown as the description in table 1

Table 1: The priority weight for performance indicators

Indicators	Priority
Biomass	0.406
Banning trawler	0.085
Employment	0.133
Fish caught	0.071
Management efficiency	0.253
Information	0.052
Sum	**1**

Furthermore, we could calculate the Principal Eigenvalue (λ_{max}) to check the consistency of responses from researcher 1. The Principal Eigenvalue is produced by summating products between each element of Eigenvector and the sum of columns of the reciprocal matrix.

$$\lambda_{max} = 0.406 * \frac{1}{0.377} + 0.085 * \frac{1}{0.065} + 0.133 * \frac{1}{0.108} + 0.071 * \frac{1}{0.071} + 0.253 * \frac{1}{0.264} + 0.052 * \frac{1}{0.053} \approx 6.55556$$

We have λ_{max} = 6.55556 and the size of comparison matrix is n = 6 so that the Consistency Index would be

$$CI = \frac{\lambda_{max} - n}{n-1} = \frac{6.55556 - 6}{6-1} \approx 0.111112$$

Consistency Ratio in formula in sub-chapter 3.14 is

$$CR = \frac{CI}{RI} = \frac{0.111112}{1.24} \approx 0.0896 \quad or \quad \approx 9\% < 20\%$$

Thus, the subjective evaluation of researcher 1 about his preferences for NTB-MPA performance indicators was quite consistent.

B.2 Measurement of Coherence

We used priority weights from the group of managers for example to estimate the coherence of each cluster or the homogeneous group. The detailed priority weights of performance indicator preference from the managers' responds were displayed in table 2

Table 2: Priority weights in the group of managers

	Biomass	**Banning trawler**	**Employment**	**Fish caught**	**Management efficiency**	**Information**
Manager 1	0.217	0.217	0.155	0.101	0.155	0.155
Manager 2	0.118	0.144	0.128	0.231	0.214	0.165
Manager 3	0.416	0.210	0.095	0.051	0.160	0.067
Manager 4	0.322	0.052	0.080	0.146	0.364	0.036
Manager 5	0.397	0.257	0.069	0.073	0.119	0.086

Firstly, we converted the summation normalized priorities to Euclidean form by taking square roots.

Table 3: Euclidean Distance in the group of managers

	Biomass	**Banning trawler**	**Employment**	**Fish caught**	**Management efficiency**	**Information**
Manager 1	0.466	0.466	0.394	0.318	0.394	0.394
Manager 2	0.344	0.379	0.358	0.481	0.463	0.406
Manager 3	0.645	0.458	0.308	0.226	0.400	0.259
Manager 4	0.567	0.228	0.283	0.382	0.603	0.190
Manager 5	0.630	0.507	0.263	0.270	0.345	0.293

Then, we had 5 grand preference vectors (from $\mathbf{V^1}$ to $\mathbf{V^5}$). Secondly, the scalar products of all combinations were taken by the equation mentioned in sub-chapter 3.5. Each scalar product was the multiplication of one rand preference vector with the transpose of the other {such as $\mathbf{(V^1)^T}$ was

multiplied with $\mathbf{V^2}$}. Finally, the coherence was the average of all such scalar products. The results were shown in table 4

Table 4: Coherence of the manager group

	V1	**V2**	**V3**	**V4**
V2	0.972*			
V3	0.966	0.904		
V4	0.916	0.922	0.934	
V5	0.970	0.911	0.995	0.914
Average of each column	0.956	0.913	0.964	0.914
Coherence = Average of all	**0.937**			

*: we have

$$(V^1)^T = \begin{pmatrix} 0.466 \\ 0.466 \\ 0.394 \\ 0.318 \\ 0.394 \\ 0.394 \end{pmatrix} \quad and \; V^2 = (0.344 \quad 0.379 \quad 0.358 \quad 0.481 \quad 0.463 \quad 0.406)$$

Therefore

$\mathbf{(V^1)^T * V^2}$ = 0.466*0.344 + 0.466*0.379 + 0.394*0.358 + 0.318*0.481 + 0.394*0.463 + 0.394*0.406 = 0.972

B.3 Clustering Analysis

Table 5: Agglomeration Schedule (Average Linkage Between Groups)

Stage	**Cluster Combined**		**Coefficients**	**Stage Cluster First Appears**		**Next Stage**
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	42	96	.000	0	0	15
2	70	88	.092	0	0	25
3	46	108	.115	0	0	5
4	17	58	.193	0	0	16
5	46	104	.255	3	0	9
6	55	79	.266	0	0	17
7	18	30	.299	0	0	24
8	95	109	.336	0	0	18
9	46	107	.339	5	0	17
10	32	90	.355	0	0	86
11	40	56	.357	0	0	19
12	37	48	.369	0	0	18

13	6	100	.383	0	0	64
14	67	68	.401	0	0	66
15	42	43	.423	1	0	70
16	15	17	.423	0	4	56
17	46	55	.459	9	6	27
18	37	95	.464	12	8	27
19	40	80	.474	11	0	48
20	47	60	.499	0	0	49
21	22	24	.514	0	0	100
22	2	53	.521	0	0	75
23	19	105	.536	0	0	35
24	16	18	.542	0	7	56
25	65	70	.572	0	2	62
26	71	89	.576	0	0	45
27	37	46	.586	18	17	39
28	45	63	.610	0	0	39
29	69	97	.616	0	0	80
30	34	38	.645	0	0	44
31	26	52	.707	0	0	78
32	8	10	.713	0	0	51
33	41	93	.720	0	0	40
34	11	29	.740	0	0	38
35	19	27	.765	23	0	50
36	83	106	.768	0	0	52
37	49	75	.779	0	0	42
38	11	33	.784	34	0	55
39	37	45	.809	27	28	45
40	41	91	.880	33	0	58
41	61	64	.902	0	0	74
42	35	49	.928	0	37	52
43	28	36	.960	0	0	60
44	34	54	.972	30	0	49
45	37	71	.983	39	26	74
46	39	50	.983	0	0	65
47	76	86	1.009	0	0	69
48	40	78	1.032	19	0	72
49	34	47	1.046	44	20	81
50	19	102	1.058	35	0	63
51	8	44	1.074	32	0	76
52	35	83	1.084	42	36	58
53	20	99	1.095	0	0	72
54	73	85	1.116	0	0	87
55	11	57	1.133	38	0	85
56	15	16	1.157	16	24	61
57	13	31	1.196	0	0	75
58	35	41	1.199	52	40	87
59	1	12	1.211	0	0	82

60	28	59	1.217	43	0	90
61	14	15	1.277	0	56	85
62	65	77	1.279	25	0	89
63	19	25	1.287	50	0	86
64	6	110	1.290	13	0	71
65	39	66	1.294	46	0	96
66	67	74	1.299	14	0	80
67	4	94	1.308	0	0	88
68	5	9	1.320	0	0	82
69	76	84	1.384	47	0	83
70	7	42	1.404	0	15	77
71	6	72	1.437	64	0	84
72	20	40	1.460	53	48	81
73	82	87	1.483	0	0	95
74	37	61	1.484	45	41	79
75	2	13	1.495	22	57	94
76	8	51	1.496	51	0	94
77	7	81	1.505	70	0	97
78	3	26	1.510	0	31	91
79	37	92	1.577	74	0	83
80	67	69	1.605	66	29	95
81	20	34	1.645	72	49	92
82	1	5	1.649	59	68	91
83	37	76	1.661	79	69	89
84	6	101	1.722	71	0	104
85	11	14	1.726	55	61	97
86	19	32	1.774	63	10	93
87	35	73	1.822	58	54	93
88	4	21	1.869	67	0	105
89	37	65	1.894	83	62	98
90	28	62	1.935	60	0	96
91	1	3	1.953	82	78	102
92	20	103	1.984	81	0	99
93	19	35	2.004	86	87	101
94	2	8	2.050	75	76	99
95	67	82	2.052	80	73	110
96	28	39	2.088	90	65	103
97	7	11	2.091	77	85	100
98	37	111	2.094	89	0	106
99	2	20	2.282	94	92	104
100	7	22	2.365	97	21	103
101	19	98	2.424	93	0	105
102	1	23	2.448	91	0	109
103	7	28	2.523	100	96	108
104	2	6	2.576	99	84	106
105	4	19	2.579	88	101	107
106	2	37	2.779	104	98	107

107	2	4	3.435	106	105	108
108	2	7	3.602	107	103	109
109	1	2	3.672	102	108	110
110	1	67	4.444	109	95	0

Table 6: Cluster Membership

Cluster 1		Cluster 2		Cluster 3				Cluster 4		Cluster 5	
Individual	***Location***	***Individual***	***Location***	***Individual***	***Location***	***Individual***	***Location***	***Individual***	***Location***	***Individual***	***Location***
manager 2	NTB-MPA	researcher 4	NTU	researcher 2	NTU	household 7	Tri Nguyen	researcher 1	VNIO	household 9	Tri Nguyen
tourist 1	Hon Mun	aquaculturemen 1	Hon Mot	manager 1	NTB-MPA	household 12	Tri Nguyen	researcher 3	NTU	household 10	Tri Nguyen
tourist 4	Hon Mun	aquaculturemen 3	Dam Bay	manager 3	NTB-MPA	household 13	Tri Nguyen	researcher 5	VNIO	household 11	Tri Nguyen
tourist 5	Hon Mun	aquaculturemen 7	Dam Bay	manager 5	NTB-MPA	household 14	Tri Nguyen	manager 4	NTB-MPA	household 16	Tri Nguyen
tourist 6	Hon Mun	aquaculturemen 9	Hon Mot	tourist 3	Hon Mun	household 18	Tri Nguyen	tourist 2	Hon Mun	household 24	Tri Nguyen
tourist 7	Hon Mun	aquaculturemen 14	Dam Bay	aquaculturemen 2	Hon Mot	household 19	Tri Nguyen	aquaculturemen 5	Hon Mot	household 29	Tri Nguyen
tourist 8	Hon Mun	fishermen 2	Vinh Truong	aquaculturemen 13	Hon Mot	household 20	Tri Nguyen	aquaculturemen 8	Hon Mot	household 39	Vung Ngan
aquaculturemen 4	Hon Mot	fishermen 8	Hon Mot	fishermen 1	Tri Nguyen	household 21	Tri Nguyen	fishermen 19	Tri Nguyen		
aquaculturemen 6	Dam Bay	fishermen 16	Tri Nguyen	fishermen 4	Vinh Luong	household 22	Tri Nguyen				
aquaculturemen 10	Hon Mot	household 15	Tri Nguyen	fishermen 5	Vinh Truong	household 26	Tri Nguyen				
aquaculturemen 11	Hon Mot	household 17	Tri Nguyen	fishermen 7	Vinh Truong	household 28	Tri Nguyen				
aquaculturemen 12	Dam Bay	household 25	Tri Nguyen	fishermen 11	Bich Dam	household 30	Tri Nguyen				
aquaculturemen 15	Dam Bay	household 27	Tri Nguyen	fishermen 12	Tri Nguyen	household 31	Tri Nguyen				
fishermen 3	Vinh Truong	household 32	Bich Dam	fishermen 13	Vung Ngan	household 34	Vung Ngan				
fishermen 6	Vinh Luong	household 33	Hon Mot	fishermen 14	Hon Mot	household 37	Vung Ngan				
fishermen 9	Tri Nguyen	household 35	Hon Mot	fishermen 15	Tri Nguyen	household 41	Dam Bay				
fishermen 10	Tri Nguyen	household 36	Hon Mot	fishermen 18	Tri Nguyen	household 42	Bich Dam				
fishermen 17	Tri Nguyen	household 40	Dam Bay	fishermen 20	Tri Nguyen	household 43	Bich Dam				
fishermen 24	Hon Mot	household 44	Dam Bay	fishermen 21	Tri Nguyen	household 45	Bich Dam				
fishermen 25	Tri Nguyen	household 47	Bich Dam	fishermen 22	Tri Nguyen	household 46	Dam Bay				
household 1	Tri Nguyen	household 48	Bich Dam	fishermen 23	Tri Nguyen	household 49	Vung Ngan				
household 4	Tri Nguyen			household 2	Tri Nguyen	household 50	Vung Ngan				
household 8	Tri Nguyen			household 3	Tri Nguyen	household 51	Vung Ngan				
household 23	Tri Nguyen			household 5	Tri Nguyen	household 52	Hon Mot				
household 38	Vung Ngan			household 6	Tri Nguyen	household 53	Hon Mot				

Table 7: Cluster Membership for Fishermen with classification of Gear used

Cluster 1			Cluster 2			Cluster 3			Cluster 4			Cluster 5		
Individual	***Location***	***Gear***	***Individual***	***Location***	***Gear***	***Individual***	***Location***	***Gear***	***Individual***	***Location***	***Gear***	***Individual***	***Location***	***Gear***
Fishermen 3	Vinh Truong	Trawler	Fishermen 2	Vinh Truong	Trawler	Fishermen 4	Vinh Luong	Trawler	Fishermen 19	Tri Nguyen	Lifting net			
Fishermen 6	Vinh Luong	Trawler	Fishermen 8	Hon Mot	Lifting net	Fishermen 5	Vinh Truong	Trawler						
Fishermen 9	Tri Nguyen	Lifting net	Fishermen 16	Tri Nguyen	Hand line	Fishermen 7	Vinh Truong	Trawler						
Fishermen 10	Tri Nguyen					Fishermen 11	Bich Dam	Trawler						
Fishermen 17	Tri Nguyen	Lifting net				Fishermen 12	Tri Nguyen	Hand line						
Fishermen 24	Hon Mot	Lifting net				Fishermen 13	Vung Ngan	Lifting net						
Fishermen 25	Tri Nguyen	Lifting net				Fishermen 14	Hon Mot	Lifting net						
						Fishermen 15	Tri Nguyen	Lifting net						
						Fishermen 18	Tri Nguyen	Lifting net						
						Fishermen 20	Tri Nguyen	Hand line						
						Fishermen 21	Tri Nguyen	Lifting net						
						Fishermen 22	Tri Nguyen	Driftnet						
						Fishermen 23	Tri Nguyen	Hand line						

C. The supporting questionnaires

Table 8: Responses of the clearing and interesting for Questionnaires

	All respondents				Respondents for interesting	
	Interesting	***Percentage***	***Clear***	***Percentage***	***Clear***	***Percentage***
yes	114	95%	82	68%	78	68.42%
no	6	5%	38	32%	36	31.58%
all/sum	120	100%	120	100%	114	100%

D. Statistic Analysis

D.1 ANOVA single factor

D.1.1 Test for performance indicators

ANOVA for Manager

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.138	5	0.028	4.045	0.008	2.621
Within Groups	0.164	24	0.007			
Total	0.303	29				

ANOVA for Researcher

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.241	5	0.048	7.754	0.0005	2.773
Within Groups	0.112	18	0.006			
Total	0.353	23				

ANOVA for Local Household

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.195	5	0.239	17.008	7.13E-15	2.243
Within Groups	4.385	312	0.014			
Total	5.580	317				

ANOVA for Fishermen

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.755	5	0.151	14.904	8.89E-12	2.277
Within Groups	1.459	144	0.010			
Total	2.214	149				

ANOVA for Aquaculturemen

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.402	5	0.080	6.824	0.00002	2.323
Within Groups	0.989	84	0.012			
Total	1.391	89				

ANOVA for Tourist

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.502	5	0.100	18.278	1.33E-09	2.438
Within Groups	0.231	42	0.005			
Total	0.733	47				

D.1.2 Test for stakeholder groups

ANOVA for Biomass

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.133	5	0.027	2.705	0.024	2.301
Within Groups	1.035	105	0.010			
Total	1.168	110				

ANOVA for Banning Trawler

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.155	5	0.031	2.748	0.023	2.301
Within Groups	1.187	105	0.011			
Total	1.342	110				

ANOVA for Employment

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.099	5	0.020	1.223	0.303	2.300
Within Groups	1.713	106	0.016			
Total	1.812	111				

ANOVA for Fish Caught

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.917	5	0.183	12.126	2.68E-09	2.300
Within Groups	1.604	106	0.015			
Total	2.521	111				

ANOVA for Management

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.301	5	0.060	10.929	1.69E-08	2.300
Within Groups	0.584	106	0.006			
Total	0.885	111				

ANOVA for Information

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.418	5	0.084	6.588	2.24E-05	2.300
Within Groups	1.345	106	0.013			
Total	1.763	111				

D.2 T-test for each comparison pair of stakeholder groups

t-Test: Two-Sample Assuming Unequal Variances

	Manager	*Aquaculturemen*	*Manager*	*Household*	*Fishermen*	*Aquaculturemen*	*Aquaculturemen*	*Tourist*
Mean	**0.11**	**0.22**	**0.11**	**0.17**	**0.15**	**0.22**	**0.22**	**0.14**
Variance	0.00	0.02	0.00	0.02	0.01	0.02	0.02	0.00
Observations	5	15	5	53	25	15	15	9
Hypothesized Mean Difference	0		0		0		0	
df	18		21		25		22	
t Stat	-3.03		-2.72		-1.83		2.03	
P(T<=t) one-tail	**0.00**		**0.01**		**0.04**		**0.03**	
t Critical one-tail	1.73		1.72		1.71		1.72	
P(T<=t) two-tail	**0.01**		**0.01**		**0.08**		**0.05**	
t Critical two-tail	2.10		2.08		2.06		2.07	