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COMPARISON OF VESSEL MONITORING SYSTEM (VMS) BETWEEN ICELAND AND INDONESIA

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ABSTRACT

One method to support a fisheries MCS system, recommended by the Food and Agriculture Organization (FAO), is using a Vessel Monitoring System (VMS). The purpose of the paper is to analyze the use of VMS technology in Indonesia and to explore potential for improvement. Firstly, the Indonesian VMS is compared to the Icelandic VMS system, to identify opportunities for improvement. Secondly, the costs and benefits of suggested improvements are estimated. The analysis of the Indonesian VMS system revealed weaknesses and constraints. The most important weakness has to do with inefficient use of data caused by underdeveloped software solutions. Comparison to the Icelandic VMS system revealed substantial opportunities to improve the usefulness and effectiveness of the system by reducing time delay and developing a better system interface. The costs and benefits of the necessary investment were estimated. The costs are estimated at $1 million. The overall yearly loss of revenue due to illegal fishing in Indonesia was however estimated at around $9 million. Based on data on the extent of illegal fishing under different VMS systems suggests that an improved VMS might reduce illegal fishing by up to 50% over a 10 year period. Given these assumptions the benefits of the improvements to the VMS far exceed the cost, in fact the ratio of benefits to costs is about 17, the benefits are 17 times larger than the cost. The breakeven point is after only about 15 months, and the internal rate of return is 80%. The results of sensitivity analysis reveal that the result of positive net benefits is robust against very large changes in model assumptions.

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1 INTRODUCTION

The conditions of fisheries in the world today are generally not good. Fish resources cannot meet the consumption needs of a global society and most are over-exploited. The fisheries need to be managed in a responsible and sustainable way.

The Code of Conduct for Responsible Fisheries (FAO 1995) Article 7 recommends that fisheries management approaches must aim towards providing solutions to the following issues:

1. Excess fishing capacity;
2. Imbalance between the interests of the various parties in the use of resources;
3. Habitat destruction, extinction of certain species of fish and declining biodiversity; and
4. Damage and deterioration of environmental quality caused by pollution.

Every country needs to promote the management of fish resources and ensure a policy of every state support law and legislation (FAO 1995). An integrated part of all fisheries management systems is Monitoring, Controlling and Surveillance (MCS). MCS is a system solution that is used to support the implementation of fisheries management that emphasizes the management and exploitation of fish resources in a responsible manner (FAO 1995).

One method to support a MCS system is using Vessel Monitoring System (VMS) technology. Application of VMS has been recommended by the Food and Agriculture Organization (FAO) for countries to manage marine and fisheries resources (FAO 2013). VMS is a part of surveillance system, which monitors vessels activities using satellite and transmitter devices, which are placed on fishing vessels and observed through the Fisheries Monitoring Center (FMC). The transmitter transmits position data to a satellite, which is then relayed to the central monitoring of fishing boats (DGS-MMAF 2010).

There are some significant differences in the implementation of VMS in Indonesia and Iceland. In VMS implementation, Indonesia only uses VMS in the fisheries sector but Iceland uses VMS for eight governmental interests including; Search and Rescue, Fisheries Control, Border Control, Immigration, Civil Defense, Customs, Communications and Air transport. The Icelandic Coast Guard uses of VMS to format digitized maps. Indonesia needs to develop a real time VMS system to reduce IUU fishing/violations at sea. This will reduce the losses that to the Indonesian people that occur due to illegal fishing.

The purpose of this report is to review and summarize the literature related to the use of VMS particularly in Indonesia. Furthermore, this report compares technology and calculates the benefit and cost analysis of the introduction of a real time VMS system in Indonesia.

The report is divided into two main sections, the first review of the use of VMS Technical Capability in Iceland and Indonesia. The second is the calculation of the Cost-Benefit Analysis of an improved VMS system in Indonesia. In general, quality VMS requires more money than poor VMS, so Cost-Benefit Analysis is an important part of the decision making process of implementing improvements to the VMS system in Indonesia. The focus is on the empirical investigation of the VMS. The final section concludes and suggests some possibilities to improve the Indonesian VMS.

1.1 Background

Indonesia, with 17,508 islands and 81,000 kilometers of shoreline, is the biggest archipelagic state with immense marine natural resources. However, these resources have not been optimally and sustainably utilized (Sularso 2009). Several decades ago, the Indonesian national development program focused on land based natural resources, which were dangerously exhausted. Marine natural resources are important in future development plans for Indonesia. After the Ministry of Marine Affairs and Fisheries (MMAF) in the Republic of Indonesia was created, the government ensured that marine and fisheries sector would play an increasingly important role in the future. The reality is that coastal and marine regions are very dynamic, with immense natural resources and many problems, which arise during extraction activities. These problems should be addressed immediately and decisively for the sake of sustainable and responsible utilization of coastal and marine natural resources (Planning Berau 2011).

There is great potential for development of marine fishery resources in Indonesia. Indonesia as a geographically maritime country with an area of 5.8 million km² (including the Indonesian Exclusive Economic Zone), the potential of the fisheries resource is as much as 6.4 million tons per year, with a current level of utilization of 5.81 million tons per year in 2012. Indonesia comprises the sea area of 0.8 million km² sea territorial, 2.3 million km² of sea archipelagic and 2.7 million km² of exclusive economic zone, (BAPPENAS 2010). The country is spread over 4,800 km along the equator, and 2,000 km from north to south. The total land area of Indonesia is about 1.9 million km². Marine areas are themselves made up of 3.4 million km² of territorial waters. The country also has many freshwater lakes, with a total surface area of 1.7 million Ha, and the fresh water reservoir with a total area of 27,000 Ha (MMAF 2013).

In 2010, the world fisheries production amounted to 145.1 million tons, with capture fisheries contributions, 90 million tons, and aquaculture 55.1 million tons. The Indonesian fishing industry is ranked third in the world with 5.81 million tons per year after China with 14.8 million tons per year and Peru with 7.4 million tons per year (Sularso 2012).

In 2012, there were 2.24 million fishermen in Indonesia. The fisheries are predominantly small scale and over 85% use vessels less than 30 GRT. There were estimated 500,000 boats less than 30 GRT and over 30 different types of gear are used (Purwadi 2012). In addition, there are industrial fisheries operated by state owned and private fishing companies, which operate their own boats or charter foreign-registered fishing vessels to fish in Indonesia.

Indonesia has a big potential for development of fisheries resources. However, currently the fisheries resources are not managed optimally (Sularso 2009). One concern is how to limit overfishing, overcapacity and illegal fishing to ensure sustainable fisheries.

The number of foreign vessels has increased rapidly in recent years, and there were 1,274 foreign vessels licensed in 2012. The activities of these foreign vessels are poorly monitored and the reported catch, particularly from the purse seiners and long liners, which have increased by over 50% in recent years, reflecting a considerable increase in effort for tuna. These are probably underestimated because some of the catch is landed in foreign ports or transshipped at sea (Purwadi 2012, Widana *et al.* 1998).

Indonesian marine fisheries have shown a substantial expansion over the past 20 years. However, recent studies on the fisheries potential suggest that additional increases would be difficult to achieve. This is due in part to the illegal fishing that result in overfishing. The shrimp fishery is considered to have reached its maximum sustainable yield level, with little scope for expansion. The demersal fishery may have some scope for increase, but will require careful resource assessment, and new fishing and processing techniques (Widana *et al.* 1998).

There is conflicting evidence on the scope for increase in the tuna fishery. A limited expansion in parts of eastern Indonesian may be possible. There is, however, an urgent need for a reappraisal of the resources, including detailed catch data on the EEZ fishery, to assist in the assessment of future potential. The small pelagic fishery offers the greatest potential for increase, in both eastern Indonesia and Sumatra. It is difficult to generalize the present and future situations, and each fishery has to be examined on a case-by-case basis (Widana *et al.* 1998).

The loss to fishermen and the Government of Indonesia as a result of IUU fishing activities might be quite large. Special studies have not been done nor has a comprehensive calculation of the exact amount of state losses due to IUU fishing been done. This leads to both financial loss as well as losses of fisheries resource. Illegal fishing undermines fisheries management and its goals of sustainable resource use, long term yield and profitability. Prevention of IUU fishing through improved management of fisheries resources is a good area to pursue as a high priority.

MCS in its implementation should be supported by many components, including capable personnel and appropriate institutional framework and coordination, coastal and marine facilities and adequate budget. The Directorate General of Surveillance and the Ministry of Marine Affairs and Fisheries were establish of 2000 as MCS has begun to receive considerable attention from the government. The main obstacles that appear in the implementation of MCS include:

- Legal aspects of the MCS system still needs to be improved
- There is a lack of trained staff capable of implementing the system.
- There is a lack of supporting facilities, particularly at sea, such as fishery inspection vessels
- Low operating budgets
- There is a lack of optimal utilization of high-technology tools such as VMS and Radar.

MCS plays a key role in supporting the goals of fisheries management. The use of VMS is one vital part of the MCS system. The effective use of VMS technology as a tool for enforcement can help establish the level of compliance and reduce the number of offenses.

2 OBJECTIVE

Many countries, such as Iceland, have developed their VMS to for multiple purposes such as search and rescue, border control, controlling smuggling as well as the classical role in fisheries management. This requires further investments in the VMS system, including real time monitoring. The multiple roles of the VMS in Iceland has required significant investment and running costs, which may not be suitable for a developing country such as Indonesia. The purpose of this study is to map the possibilities for further development of the Indonesian VMS system and make recommendations to things that Indonesia can learn related to MCS from Iceland.

This study will compare VMS technology of Iceland and Indonesia and calculate Cost Benefit Analysis (CBA) of potential improvements to the VMS system in Indonesia. This serves two main purposes. First, analyze the possibilities for efficient improvements of Indonesia’s VMS technology. Second, to estimate the net economic benefit of these improvements in VMS technology for Indonesia.

2.1 Theory of Monitoring Controlling and Surveillance (MCS)

The FAO maintains that fisheries Monitoring, Control and Surveillance are key components of the fisheries management process. Illegal fishing has been recognized as one of the greatest threats to marine ecosystems and the communities, which depend on them. To implement MCS, increased cooperation among nations has been stressed during the past decade. Many international instruments, such as the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, identify tools states can employ to combat illegal fishing and urge strengthened of MCS capacity. MCS is the mechanism for implementation of agreed policies, plans or strategies for oceans and fisheries management. The absence of MCS operations renders a fisheries management scheme incomplete and ineffective (Everet 2005).

The FAO 2013 defines MCS as a comprehensive suite of MCS activities including:

- ***Monitoring*** the collection, measurement and analysis of fishing activity including, but not limited to: catch, species composition, fishing effort, by catch, discards, area of operations, etc. This information is primary data that fisheries managers use to arrive at management decisions. If this information is unavailable, inaccurate or incomplete, managers will be handicapped in developing and implementing management measures.
- ***Control*** involves the specification of the terms and conditions under which resources can be harvested. These specifications are normally contained in national fisheries legislation and other arrangements that might be nationally, sub regionally, or regionally agreed. The legislation provides the basis for which fisheries management arrangements, via MCS, are implemented.
- ***Surveillance*** involves the regulation and supervision of fishing activity to ensure that national legislation and terms, conditions of access, and management measures are observed. This activity is critical to ensure that resources are not over exploited, poaching is minimized and management arrangements are implemented.

3 VESSEL MONITORING SYSTEMS

VMS is a tool to support MCS systems. A vessel monitoring system (VMS) is a program for fisheries surveillance, in which equipment that is installed on fishing vessels provides information about the vessels' position and activity. This is different from traditional monitoring methods, such as using surface and aerial patrols, on-board observers, logbooks or dockside interviews. VMS can monitor the movement of ships with satellite-based technology. In implementation, VMS consists of several components, including satellite that transmits data from the vessel to the Fisheries Monitoring Center (FMC). VMS is an effective tool for the successful MCS of fisheries activities. VMS provides a fishery management agency with accurate and timely information about the location and activity of fishing vessels (FAO 2013).

3.1 The VMS Technology and its components

Parts of the VMS are:

1) Shipboard Equipment
The electronic equipment installed on board a vessel is the fundamental requirement for the vessel to participate in a VMS program. This equipment typically consists of some combination of antenna and transceiver, external power source and cabling. Collectively, this equipment is referred to as the VMS Unit or Automatic Location Communicator.

2) Communication System
The communications system carries position reports and other messages from the Shipboard equipment - VMS, through space and surface lines, to the Fisheries Monitoring Centre (FMC). The service providers used for the space segment in most fisheries VMS programs are Argos, and Inmarsat-C and D+. Other service providers include Orbcomm and Qualcomm (EutelTRACS in Europe and Boatracs in North America).

3) Fishery Monitoring Center (FMC)
Based on. After data reports have been sent from a vessel's shipboard equipment, VMS and through the communications system, they are transmitted to the end user at the fishery monitoring center (Wicaksono)[1]. The transmission from the communications systems typically is conducted over commercial data networks. The positions of fishing vessels can be valuable and sensitive commercial information. Thus, monitoring agencies must make efforts to ensure the physical and operational security of shipboard equipment, communications, and fishery monitoring centers. Security is essential to the fishery managers to ensure that the VMS information is authentic and accountable, of high integrity, and private. The FMC is an information secure location where only authorized personnel can access the VMS data. The data are protected from intentional or accidental damage or disclosure. The FMC collects the data, validates and stores them, and makes the information available for analysis. The data are typically stored in a relational database. The database safeguards the data from alteration or loss. The individual parameters of the data string are expanded into multiple interrelated tables, putting the data into a form suitable for analysis (Wicaksono)[1].

[1] *Interviewed with Indonesian head of monitoring system.*

4 MCS AND VMS IN INDONESIA

The Government of Indonesia has created the provisions of responsible fisheries management, where every fishing vessel is required to install the transmitter Vessel Monitoring System. This policy is in the Law. 31 of 2004 on Fisheries, the Minister decree, which mandated obligation fishing vessels to install the transmitter Vessel Monitoring System (Hartono 2007).

Since 2005, the Directorate General of Surveillance of Ministry of Marine Resources and Fisheries (DGS-MMAF) have increased efforts to combat illegal fishing and destructive fishing in Indonesia. As of the year 2011, the DGS-MMAF has inspected 15.740 ships, 1.116 ships have been taken to court, 37 ships have been sunk[2] and 59 ships were repatriated (Sularso 2009).

These numbers suggest that the DG-PSDKP has operated consistently despite challenges, especially with the limited means of number of ship, which until now only number for 25 ships, of which 17 can carry out patrols up to the Indonesian Exclusive Economic Zone (Mukhtar 2008).

There is a limited budget to support patrol and other surveillance activities. The wealth of marine resources and fisheries to date has not been fully utilized for the welfare of the community, especially the fishermen.

The vision of the Ministry of Marine Affairs and Fisheries is to make Indonesia the largest producer of fishery products in the world (MMAF 2013). Fisheries productivity will not increase if illegal fishing plunders the fish in the sea or when fish is killed by destructive fishing methods such as bombs and poisons, that cause damage to juveniles and breeding grounds.

The VMS in Indonesia is used to detect fishing vessel traffic in the workers of Indonesia. In simple terms, the system is used to monitor every ship of a certain size that has a fishing license. Each ship was given a transponder to be installed on the vessel. The movement of the vessel is monitored via satellite that captures the signal from the transponder. The results is forwarded on satellite imagery surveillance unit and sent to the Network Operation Center (NOC). The end result is data on vessel traffic in the Directorate General of Surveillance, Ministry of Marine Affairs and Fisheries. In addition, VMS data on individual vessels allows special scrutiny to the fleet, which are considered to show suspicious activity (Hartono 2007).

4.1 VMS rules and regulations in Indonesia

The development of the VMS system in Indonesia started in 2002 in collaboration between the Ministry of Marine Affairs and Fisheries and *Collecte Localisation Satellite* (CLS) in France (Wicaksono 2013). Application of VMS in Indonesia started in 2003 and began with the signing of the Ministry Decree Number.29/MEN/2003 about the Implementation Fishing Vessel Monitoring Systems.

According to the provisions in responsible fisheries management, any fishing vessel which is fishing and transporting are required to install the transmitter VMS, as mandated by Law No.

[2] *Indonesia has a policy to sink foreign fishing vessels in the territory of Indonesia to create a deterrent effect.*

45 of 2009 and the Ministerial Regulation No.5 of 2008 on Business fisheries mentioned there that fishing vessels are obliged to install the transmitter VMS.

With regard to the stipulation of Ministerial Regulation No.5 of 2007 on the implementation of VMS, it is compulsory for ships larger than 60GRT to install VMS transmitter on the ship. Detail description of the law governing the MCS in Indonesia is in the appendix.

4.2 VMS technologies in Indonesia

The installation and operations of the fishing vessel monitoring is done following this sequence:

1) Fishing boats are mounted device called Transmitter (Automatic Location Communications) consisting of the components of the signal from the satellite navigation receiver and sender component data to the satellite communications.
2) The ship's position received by the transmitter and sent automatically to the satellite communication.
3) From a communications satellite data sent to the ground station **Fourth,** through ground stations in data is sent to the control center at the headquarters of Jakarta, the Directorate General of Surveillance (DGS). The activities of fishing vessels are processed and analyzed.
4) Through website http://kkpvms.kkp.go.id/public/default.asp fishing boats firms can access information related to their own ship.

There are several elements of VMS infrastructure used in the control center, also known as Fishing Monitoring System (FMC) this include:

1) *Communication Server*
2) *Database Server*
3) *Web Tracking VMS Server*
4) *Server of VMS offline*
5) *Workstation (5 Client)*
6) *Local Area Network*
7) *Software*

The software and database is the most important instrument in the practical use of the VMS. Basically, the hardware is the same in all VMS technology. However, the software is developed to support the design in different ways. Working with Terravision a company in Australia, Indonesia has developed interface software in the form of spatial database to monitor the movement of the vessels.

Since 2004, the MMAF has built a software application to compare ship's position data from VMS and from satellite radar. If no match is found it is assumed that the vessel may be involved in illegal fishing. Based on the analysis of data of VMS in the Fishery Monitoring Center (FMC), enforcement analysis can plan a surveillance operation and send a patrol boat to the target. This is one way to arrest violating boats that do not have a license or use VMS. The high cost of satellite radar data is a big problem, limiting this type of detection to short sample periods. Currently, the agency of research and development of Ministry of Marine Affairs and Fisheries has signed an agreement with the French company *Collecte Localization Satellites (CLS)* project called INDESO to build antennas and satellite receivers including data processing, so that satellite radar data can be continuously acquired by DG- PSDKP to monitor illegal vessels through this application.

A website provides access to data with information on tracking of vessels. The website was originally built for the owners of the ships and the VMS does thus benefit not only from MMAF as a means of monitoring and surveillance, but boat owners can also monitor the movement of ships each fishery for the benefit of control and operational management. Each ship owner can only access his own ship. The website is used by law enforcement officials (Indonesia Maritime Security, Navy and Police Water) and port authorities in other supervisors of the fishery.

4.3 Near Real Time Data

Generally VMS Data at MMAF is online in real time, because the GPS position sent by the transmitter and the time of receipt at the VMS server is on a 5 minutes delay. However, there are differences with the Argos delivery system provider Inmarsat+D or Pasifik Satelit Nusantara (PSN). Inmarsat system and PSN uses fixed satellite position over the coordinates on the earth, so the satellite moves to follow the movement of the earth and is not controlled to shift position to match a given point on the earth. The Inmarsat satellite network is set up so that the whole earth is covered by the satellite network, so at any time VMS transmitter can communicate with satellites transmit position specified time intervals such as once every hour, and the data can be directly received by the ground station. In such systems, the transmitted position data can be received directly by the VMS server in a short time may (even under one minute).

Argos systems, which uses a NOOAA owned satellite, a satellite that revolves around the Earth in a polar orbit from the north pole to the south pole, and vice versa. Thus, the transmitter does not know when the satellite is in the position, so the transmitter is blind to until Argos satellites pass by and receive the transmitted position. If the satellite passes over the transmitter and the satellite receives the data, it takes longer for the satellite to pass over the ground station to unload the data that has been received satellites. This time lag can take a short or long depending on the position of the transmitter and receiver earth station, so Argos VMS Data is near real time (NRT). To make up the system, many are using Argos satellites (about 3-6 satellites) and the transmitter sends the last position and also the same two positions even earlier on a single row of data delivery. For example, delivery of position at 09:16, then the position at 09.00 hours and 08.00 also sent simultaneously. In this example, the position of the ship was at 08.00 over an hour late (Wicaksono 2013)**.**

4.4 Application of VMS in fisheries in Indonesia

The implementation of VMS project in Indonesia began in 2003 through a loan from the Republic of France with the contractors *Collecte Localization Satellites*, France. The fund bought 1,500 units Argos MARGE transmitters; the construction of Fishing Monitoring Center FMC in Jakarta and it's for cost satellite airtime payments. The monitoring application that used was made Saffire Bluefinger (UK) with use two servers (Comm and DB servers) and four workstations. The VMS data form provider can be processed only from Argos, its can not be processed by other providers.

In 2006, the Ministry of Marine Affairs and Fisheries (MMAF) upgraded the system by using application from Terravision from Australia. The system can process data from various providers of VMS. In accordance MMAF began to receive information from providers other than the Argos. The main device held was the server and database, and five units workstation. The Terravision application has been used for VMS monitoring until now.

In 2007, a new policy was issued by the Ministerial Regulation NO.PER.05/MEN/2007 about Providing on board Fishing Vessel Monitoring System. A few of the policy changes are:

- Fishing boats > 100 GT shall install transmitters online to buy airtime and pay for it self (free to choose the provider that has been previously approved)
- Fishing boat size 60-100 GT able to use state-owned transmitters (borrow and use), while stocks last, but they have to pay for satellite airtime
- Ship size 30-60 GT uses transmitters offline (not satellite-based), unit and GPRS data charges borne by the government.
- As evidence that the ship has been fitted and can actively be monitored by Monitoring Center, each is issued transmitter activation certificate (SKAT) is valid for one year.

5 MCS AND VMS IN ICELAND

The MCS and VMS in Iceland evolved as a result of Iceland situation of the fisheries sector is important, in a relatively small country and its particular historical evolution and institutional setup, the underlying concepts of closer collaboration among related institutions and organizations at the national level through creative and dedicated approaches, which can be adapted to a wide variety of circumstances.

The integrated system has proven to be effective in combating and eliminating IUU fishing in the Icelandic EEZ and the North Atlantic Ocean. In addition to facilitating safety and security, the integrated system is a highly effective tool for combating organized crimes beyond fishing such as trafficking illegal immigrants and drugs. This approach emphasizes using all available data, including identification of the vessel, its movements, IUU lists, notifications, reports, fishing licenses, permits, port state control reports (Geirsson 2011)

Management of fisheries resources in Iceland has been relatively successful, particularly in the field of MCS. It is possible for Indonesia to gain insight into the possibilities of improving its own MCS by comparing MCS in this two country, particularly related to controls conducted by the Coast Guard and the Fisheries Directorate.

5.1 VMS rules and regulations in Iceland

Management of VMS in Iceland is fully under the responsibility of the Icelandic Coast Guard (ICG). The implementation is regulated by the Icelandic law and regulation regarding the role of the Icelandic Maritime Service (IMTS) in Law 41/2003 on Maritime Traffic Service and vessel traffic monitoring and information system. In addition, rules of VMS associated bare on Regulation no 672/2006 for the Icelandic Maritime Service, Two changes have been made on the regulation number 565/2009 and 948/2010 and Law for the Icelandic Coast Guard no 52/2006 .

5.2 Technologies and components of VMS in Iceland

The use of VMS technology in Iceland started in 1997. It is used in other countries and is supported by standard technology used elsewhere. VMS in Iceland is backed with more than 10 units of hardware as a workstation and a second unit as database servers and satellite Inmarsat C + (Saemundsson)[3]. For that matter, the facilities used are not much different between Indonesia and Iceland. The difference is mainly in the development of the software and its use in the field[3].

The software Iceland uses was made in Iceland, based on collaboration ideas of the coastguard and developed by Trackwell software company are several years. The software was developed according to Iceland's needs (Saemundsson)[3]. Main components used to shipping registry for many costumer including vessel and aircraft from the transmitter data mapped on a map. The movement of the points of data is in real time. Vessels can be monitored even if outside Icelandic territory. All the activities of vessels visible on the screen used in colors. If the indicator lights are off it will automatically send a message to the vessel. And if there is no response and distress within 30 minutes, a helicopter will be sent to observe the vessel.

VMS data are used only by government and is not open for public. VMS software was developed by Icelandic Coast Guard (ICG) together with Trackwell Company since 1997 (Saemundsson)[3].

5.3 Application of VMS in fisheries in Iceland

The VMS is operated by the Icelandic Coast Guard Operation Center. The operations centre was established April 14th 1954 at the ICG headquarters. The operations centre is the first operational unit of the ICG (Saemundsson)[3].

The ops room expedites all emergency response for the ICG, organizes search and rescue (SAR) operations, alerts ICG and other SAR units, coordinates operations and maintains communications. The operations centre is a coordinating agent for all ICG operations. ICG operations wherever they are, at sea, on land, or in the air, are coordinated from the ICG operations. ICG operations are open 24/7 all year, at least 3 controllers are always on duty.
The main tasks of the ICG operations centre are:

1) Communications centre for ICG vessels and aircraft.
2) Joint Rescue and Coordination Centre (JRCC) Iceland.
3) Maritime Traffic centre, MTS,
4) Part of the Icelandic security and safety system,
5) Fisheries Monitoring Centre, FMC,
6) Reception of transit reports from all vessels passing through Icelandic Waters,
7) Monitoring of fishing activities inside and outside of the Icelandic Exclusive Economic Zone, IEEZ,
8) Reception of reports and monitoring of maritime arrivals from abroad i.e. Schengen and SafeSeaNet etc (Saemundsson 2013).

[3] *Interviewed with Chief Controller Icelandic Coast Guard in Iceland Mr. Sæmundsson.*

The operations centre cooperates with the Icelandic police regarding SAR and law enforcement and the Air Traffic Control regarding flight incidents and other flight matters if needed. Its also communicate with ICG defence unit Keflavik regarding flight of unidentified aircraft, international rescue stations, JRCC, MRCC or RCC´S and others (Saemundsson)[3].

The ICG ops will warn Icelandic vessels at sea without valid licenses of seaworthiness insufficient crews or without valid fishing licences. ICG ops may order vessels to port if conditions of vessels warrant it. The ICG operations are sometimes referred to as the heart of the Icelandic Coast Guard (Saemundsson 2013).

6 COMPARISON OF VMS BETWEEN INDONESIA AND ICELAND

Utilization of VMS for MCS can be evaluated based on three aspects including; rules and regulations, technology and application. The rules and regulations aspects are too broad to be discussed here; they must be discussed in context of different geography, natural and social influence between Indonesia and Iceland.

In the application aspect, there are striking differences between the two countries. Indonesia only uses VMS for MCS needs in the fisheries sector. But Icelandic is utilizing VMS for eight requirements; Search And Rescue, Fisheries Control, Border Control, Immigration, Icelandic Civil Defense, Customs, Communications, Air transport. From this point of view the utilization of VMS in Iceland has greater benefit than in Indonesia.

Regarding the technology there are not many significant differences between Indonesia and Iceland. Satellite, transmitter, and software are the basic tools needed to develop the VMS. However, there are several differences in the interface software. The interface software developed in Iceland is more user friendly and displays much more data on vessels. Special layout data on the computer screen is visually appealing dynamic and describe the data as needed.

The most striking difference is the technology aspect. This one-hour delay in the transfer of data to the Fisheries Monitoring Center (FMC) in Indonesia, while at the FMC in Iceland data are generally transmit within one minute.

7 COST BENEFIT ANALYSIS

Cost-Benefit Analysis (CBA) is methodological framework first developed in the 1930s for use in public policy decision-making, particularly at the federal level. CBA can be thought of as providing a framework for measuring efficiency. In situations in which analysts care only about efficiency, CBA provides a method for making direct comparisons among alternative policies (Weimer 2011).

Cost Benefit Analysis can be defined as an economic technique applied to public decision making that attempts to quantify the advantages (benefits) and disadvantages (costs) associated with a particular project or policy. This technique has been used to analyze policies affecting transportation, urban regeneration, agriculture, public health, criminal justice, defense, education, the environment etc. (Alberini 2004).

Cost Benefit Analysis (CBA) is based on the philosophy of utilitarianism. Policy action is evaluated based in by the size of the policy benefit to all parties. The benefits here are measured by metrics that heavily based on humanity. Consumers know about their needs, and have defined what is considered to be useful and what is most needed. In fulfilling their needs, people are driven by self-oriented motives. These methods do not change the nature of human ethical position. Everything is measured by the size of the economy. CBA tends to reduce the significance of the environment in mathematical calculations, which often lead to miscalculations. Seeing its inherent weaknesses, efforts have been made to eliminate the weaknesses. It can be done by taking into account environmental aspects in economic calculations. The impact of a policy on the environment can harm the state at trial to be converted in a matter of economic mathematical hopes of mitigated through the mechanism of economic life cycle (Foster 1999).

Cost Benefit Analysis requires estimates of costs and benefits to be expressed in units of currency (in this report using the US$). If it turns out the benefit is higher than the cost of the system it may be feasible to implement. Otherwise, if the benefit is lower than the costs already incurred, then the system is not feasible to implement. The basic principle of the CBA is:

1) Achieving maximum benefits (including social welfare) at minimal cost, based on the logic of the market economy
2) Increase the benefits of a series of actions and reduce the costs associated with a series of actions within a certain period they will required

CBA within a simple shape that simply using cost and profit. The CBA principle is the Pareto improvement; the project is to improve the quality of life of people, but do not make others lose. However, in a complex society, any project or policy will certainly make others lose. A project or policy creates a potential Pareto improvement if their profits are more than its loss (Zerbe Jr 2006). The principles of the use of CBA are:

1) Determining the standard, usually is money
2) Using the logic of buyers and sellers for each activity
3) Profit is defined as the market option (market choice)
4) Some measure of advantage requires the values of human life (Valuation of Human Life)
5) Analysis a project must involve a comparison between the existing projects with no project (With Versus Without Comparison)
6) Requires a study of a particular area
7) Double counting between the costs and benefits should be avoided
8) Need to calculate discounting rate (the ratio between the value of money now with the value of future money) (Zerbe Jr 2006).

7.1 Cost Benefit Analysis of VMS

Taking a broad view of the Benefit Costs of VMS and suggested approaches and some of the arguments for cost-benefit evaluation is possible. The main question to be addressed is what constitutes effective management of MCS for fisheries. After answering these questions it is then possible to evaluate if effective management is being achieved. Effective management is not possible without the quantitative and measurable outputs. In terms of fisheries management it means measuring the amount of fish caught and identify places where the fish were caught. This VMS provides information that is relatively reliable and accurate location of the vessel

and, with a reasonable degree of probability, in where fishing takes place. VMS is the first practical way to collect and use information about all vessels, in the history of fisheries management.
Use of VMS can be measured using the Cost Benefit Analysis. This method used by comparing the total cost already invested and estimated benefit from the use of VMS itself. CBA could be used as evaluation tools to see whether or not a VMS project has been suitable by objective goal. In this paper, the benefit's only rated by real time data system of VMS. Generally, the VMS technology utilization between Indonesia and Iceland are the same. The different is the only in the real time data and the optimization interface software.

7.2 Net Present Value (NPV)

This research will use a simple method of calculating Cost Benefit Analysis using Net Present Value (NPV). The NPV of a project is the sum of present values of its benefits minus the sum of present values of its cost. In equitation this is:

$$NPV = \sum_{t=0}^{T} d^t B^t - \sum_{t=0}^{T} d^t C^t$$

If exponential discounting is used this becomes:

$$NPV = \frac{B^0}{(1+r)^0} + \cdots + \frac{B^t}{(1+r)^t} - \frac{C^0}{(1+r)^0} + \cdots + \frac{C^t}{(1+r)^t}$$

Where:
B^t = benefit in period *t;*
C^t = cost of period *t;*
r = interest rate used for discounting;
d^t = discount factor for period
T = number of periods the project will last

So, the net present value is the sum of the present value of the net benefits in each period (Zerbe Jr 2006).

Net Present Value is also a difference between the present values of current benefits to the present value stream costs. NPV indicates net benefits received from a business over the life of the business at a certain discount rate.

Criteria NPV:
a) NPV> 0 (zero) → business / project feasible (feasible) to be implemented.
b) NPV <0 (zero) → business / project is not feasible (feasible) to be implemented.
c) NPV = 0 (zero) → business / projects in the state Break Even Point where B*t* = C*t* in the present value.

To calculate the NPV, data on the estimated investment costs, operation and maintenance as well as the estimated benefits of the proposed project are required (Weimer 2011).

From the above criteria, a conclusion can be drawn:
a) the higher of income, the higher NPV
b) the earlier arrival of income, the higher the NPV

c) the higher of discount rate, the lower NPV

If the NPV of a project is positive, it means that the project is expected to increase the government value by the amount of positive NPV and is calculated from the investment and that the investment is expected to yield a rate of return higher than the desired level of profit.

8 COST AND BENEFIT OF VMS IN INDONESIA

8.1 Benefit of VMS in Indonesia

Over the last decades a growing literature on illegal, unreported and unregulated fishing has emerged (see e.g. (Sumaila *et al.* 2006, Agnew *et al.* 2009). Estimating the extent of illegal fishing is however difficult, since illegal fishers are unlikely to truthfully admit to the extent of their operations. In addition estimating economic losses is also quite difficult. The losses depend on the utilization of illegal catches, who benefits and where. If the fishers are local and the illegal catch is processed in the same manner as legal catch, the loss is primarily in terms of income loss to government, data fouling and loss of future harvest. In a comprehensive study of world wide illegal catches, (Agnew *et al.* 2009) estimated the quantity between 11 and 26 million tons, out of a total catch closer to 100 million tons and the economic loss was estimated between $10 billion and $23,5 billion, out of a total value of $220 billion (FAO 2012). In this analysis of Indonesian illegal catches, it is assumed that the loss in economic value is similar to the average for world capture fisheries. The focus in this report is on the economic loss and the lost revenue for government.

According to data from the Directorate General of Surveillance, 4,275 fishing vessels were inspected in Indonesian waters in 2012. It is estimated more than 4,000 fishing vessels fish illegally in Indonesia water (Batam News Paper 2012). The number of inspections and as well as suspects and processed cases is shown in Table 1.

Table 1: Operation of Patrol Boat Result 2005 - 2012 (DG-SMR 2010).

YEAR	**Number of Vessel Inspection**	**Suspect and Processed in The Court (Vessel)**		
		Local Vessel	**Foreign Vessel**	**Local + Foreign**
2005	344	91	24	115
2006	1,447	83	49	132
2007	2,207	95	88	183
2008	2,178	119	124	243
2009	3,961	78	125	203
2010	2,253	24	159	183
2011	3,276	29	75	104
2012	4,275	-	-	114
TOTAL	**15.666**	**519**	**644**	**1.277**

The table shows that the extent of violations is substantial and that a large proportion of the vessels caught for violations are foreign. This will be taken into in the analysis by separately addressing foreign and domestic vessels. It is assumed that the whole gross margin of the fish value chain is lost when the violating vessel is foreign, while only the proportion of the landed value indicated by Agnew *et al*. (2009), between 4.5 and 11%, is lost when the vessels are domestic.

In 2012, the VMS management system recommended that the licenses of 280 fishing vessel be revoked. By the end of the year 57 vessels have had their licenses revoked (Bisnis Indonesia 2012). A mayor assumption of the analysis is the effect of improving the VMS on the extent of illegal fishing. This is very difficult to assess. The estimate in this report is based on the different effectiveness of VMS systems in Europe, as reported in an EFTEC report for the Pew environment group in 2008 (EFTEC 2008). In this report the best monitoring systems (Iceland and Norway) scored four times better than the worst (Turkey, Italy, Latvia and Morocco) and almost twice as well as the average. Here it is assumed that an improved VMS could reduce illegal fishing by 50% over the suggested 10-year period of use (investment period of 12 years), 5% a year. Since this may be an over optimistic assumption it will be subject to sensitivity analysis in the final analysis. The following assessment of the effectiveness of introducing a real time VMS to reduce economic losses due to illegal is therefore based on the following assumptions:

- For foreign vessels the loss is the overall gross margin for the entire value chain, assumed to be 33% of landed value (Gudmundsson *et al*. 2006), plus the loss in license fees to the government ($200 per license). Foreign vessels are assumed 55% of all illegal vessels (Table 1).
- For domestic vessels the loss is assumed to be the average economic loss of illegal fishing as reported by Agnew *et al.* (2009), or 7,6% of landed value, plus a license fee to the government ($20 per license).). Domestic vessels are assumed 45% of all illegal vessels (see Table 1).
- Yearly catch is assumed 2000 kg.
- Average catch price is assumed $5 per kg.
- There are assumed to be about 4000 illegal vessels in operation that will be effected by the change in the VMS.
- It is assumed that the system could over the period of 10 years achieve the efficiency of similar European systems.
- The real discount rate of the Indonesian government is assumed to be 5%.

Overall cost of illegal fishing:
Cost estimate for foreign vessels:

6000 vessels*55%*2000 kg/year/vessel*$5/kg*33%=	$7.260.000/year
6000 vessels *55%* $200/vessel=	$440.000/year
Total:	$7.700.000/year

Cost estimate for domestic vessels:

6000 vessels*45%*2000 kg/year/vessel*$5/kg*7,6%=	$1.404.000/year
6000 vessels *55%* $200/vessel=	$36.000/year
Total:	$1.404.000/year

Overall cost of illegal fishing:	$9.104.000/year

As stated earlier, it is assumed that the effectiveness will gradually increase, by 5% per year. The first year of running (third year of project) the expected benefits will therefore be

Year 3: 9.104.000/year*5%=	455.200/year
Year 4: 9.104.000/year*10%=	910.400/year
Year 5: 9.104.000/year*15%=	1.365.600/year
Year 6: 9.104.000/year*20%=	1.820.800/year
Year 7: 9.104.000/year*25%=	2.276.000/year
Year 8: 9.104.000/year*30%=	2.731.200/year
Year 9: 9.104.000/year*35%=	3.186.400/year
Year 10: 9.104.000/year*40%=	3.641.600/year
Year 11: 9.104.000/year*45%=	4.968.800/year
Year 12: 9.104.000/year*50%=	4.552.000/year

8.2 Estimated Cost of VMS in Indonesia

There is no exact data investment cost of VMS in Indonesia and Iceland. But in this paper will estimate how much an improvement of the VMS might cost based on several assumptions. Cost assumptions are made based of data obtained from several Indonesian reports and result of interview at Trackwell Company and Icelandic coast guard. It is estimated that the cost of the VMS investment is similar between Indonesia and Iceland, since much of it involves investment in programming and hardware that are global commodities.
Cost considerations of the improved VMS include:

a) Investment costs, the investment costs of the hardware and software technologies for the VMS.
b) Maintenance costs, the cost of maintenance in the event of damage to the VMS technology.
c) Operating Costs, the cost of labor and supporting devices running the VMS for the government and cost rental or airtime each month for the employer.
d) Development costs, which are expenses that must be paid when there is new technology development of the existing VMS

The costs of infrastructure such as hardware, Local Area Network, and procurement of transmitters can be assumed will be same between Iceland and Indonesia. Since Indonesia has already developed and installed the infrastructure for a VMS, the analysis only considers how much it would cost to develop new software for a real time VMS system technology. The estimates for the new software development takes into account the cost of software expert, installation, transportation, office administration and maintenance (Table 2 and 3). It is assumed that the development of a new system will take two years to complete.

Table 2: Operation of Patrol Boat Result 2005 - 2012 (DG-SMR 2010).

	LABOR DIRECT EXPENCE						
	Developing of Master Plan						
NO	**DESCRIPTION**	**PERSON**	**MAN MONTH**	**BILLING RATE**		**TOTAL**	
1	Project Manager	1	3	USD	5.000,00	USD	15.000,00
2	System Analyst	3	3	USD	2.500,00	USD	22.500,00
3	Networking Expert	1	3	USD	2.500,00	USD	7.500,00
4	Security Expert	1	3	USD	2.000,00	USD	6.000,00
					TOTAL B.1.1	*USD*	*51.000,00*
	Software Development						
NO	**DESCRIPTION**	**PERSON**	**MAN MONTH**	**BILLING RATE**		**TOTAL**	
1	Project Manager	1	24	USD	3.000,00	USD	72.000,00
2	System Analyst	3	24	USD	2.000,00	USD	144.000,00
3	Networking Expert	1	24	USD	1.500,00	USD	36.000,00
4	Security Expert	1	24	USD	1.000,00	USD	24.000,00
5	Programmer	7	24	USD	1.000,00	USD	168.000,00
6	Graphic Designer	2	24	USD	1.000,00	USD	48.000,00
7	Database Administrator	2	24	USD	1.000,00	USD	48.000,00
8	Software Tester	5	24	USD	700,00	USD	84.000,00
9	Network Enginer	3	24	USD	700,00	USD	50.400,00
10	Trainer	2	24	USD	500,00	USD	24.000,00
					TOTAL B.1.2	*USD*	*698.400,00*
	Consultation Cost						
NO	**DESCRIPTION**	**PERSON**	**MAN MONTH**	**BILLING RATE**		**TOTAL**	
1	Project Manager	1	8	USD	1.500,00	USD	12.000,00
2	System Analyst	1	8	USD	1.000,00	USD	8.000,00
3	Trainer	1	8	USD	500,00	USD	4.000,00
4	Database Administrator	1	8	USD	750,00	USD	6.000,00
5	Networking Expert	1	8	USD	500,00	USD	4.000,00
					TOTAL B.1.3	*USD*	*34.000,00*
					TOTAL B.1 (B1.1+B.1.2+B.1.3)	**USD**	**783.400,00**

Table 3: Estimated cost development of real time VMS system.

NO	COST/EXPENSE	TOTAL	
A.1.1	**LABOR DIRECT EXPENCE**	**USD**	**783.400,00**
A.1.1.1	*Developing of Master Plan*	*USD*	*51.000,00*
A.1.1.2	*Software Development*	*USD*	*698.400,00*
A.1.1.3	*Consultation Cost*	*USD*	*34.000,00*
A.1.2	**NON LABOR EXPENSE**	**USD**	**68.000,00**
A.1.2.1	*Allowance for Survey, Instalation & Training*	*USD*	*50.000,00*
A.1.2.2	*Work tools expense*	*USD*	*10.000,00*
A.1.2.3	*Comunications Expense*	*USD*	*5.000,00*
A.1.2.4	*Computer Supplies*	*USD*	*2.000,00*
A.1.2.5	*Report*	*USD*	*1.000,00*
	TOTAL	**USD**	**851.400,00**
	TAX 10%	**USD**	**85.140,00**
	TOTAL AFTER TAX	**USD**	**936.540,00**
A.2	**ADDITIONAL COST**		
A.2.1	*Additional Server,Workstation and LAN*	USD	10.000,00
A.2.2	*Satellite System Changes*	USD	20.000,00
A.2.3	*Software and Database*	USD	50.000,00
	TOTAL	**USD**	**80.000,00**
	TAX 10%	**USD**	**8.000,00**
	TOTAL AFTER TAX	**USD**	**88.000,00**
	TOTAL COST	**USD**	**1.024.540,00**

8.3 Cost Benefit Analysis of VMS real time system in Indonesia

The estimated flow of costs and benefits in the project is reported in Table 4.

Table 4: Results of cost benefit analysis for the VMS.

Year	Cost	Benefits	Net benefits	NPV
1	307.362		- 307.362	- 292.726
2	717.178		- 717.178	- 650.502
3		455.200	455.200	393.219
4		910.400	910.400	748.988
5		1.365.600	1.365.600	1.069.983
6		1.820.800	1.820.800	1.358.709
7		2.276.000	2.276.000	1.617.511
8		2.731.200	2.731.200	1.848.584
9		3.186.400	3.186.400	2.053.982
10		3.641.600	3.641.600	2.235.627
11		4.096.800	4.096.800	2.395.314
12		4.552.000	4.552.000	2.534.724
Total				**15.313.413**

The results in Table 4 are quite clear. It is very profitable to improve the VMS if the outcome is a roughly as effective VMS as European ones. The ratio of benefits to costs is about 17; the benefits are 17 times larger than the cost. I we look only at the net benefits (benefits net of cost) the ratio is roughly 15. The breakeven point is after only about 15 months, and the internal rate of return is 80%. It is therefore quite clear from these results that this is a highly beneficial project to undertake for Indonesian authorities.

8.4 Sensitivity analysis

Several assumptions had to be made to estimate the net benefits of an improved VMS in Indonesia. Key assumptions are:

- Number of illegal vessels.
- Economic losses of illegal catch.
- Effectiveness of the improved VMS against illegal fishing.

Each of these factors is based on an assumption that may or may not hold. The following ranges are assumed realistic for these key assumptions:

- Number of illegal vessels: 2000-6000
- Economic losses
    - Foreign: 15-40%
    - Domestic: 0-25%
- Effectiveness of improved VMS: 1-7,5%

Figure 1 shows clearly that the result is least sensitive to assumptions about the loss of illegal fishing for domestic vessels. It also shows that the overall result of positive not present value is not changed by even the most extreme assumptions included in the sensitivity analysis. The result is therefore quite robust.

9 CONCLUSIONS

The purpose of the paper was to analyze the use of VMS technology in Indonesia and to explore potential for improvement. First, the Indonesian VMS is compared to the Icelandic VMS system, to identify opportunities for improvement. Second, the costs and benefits of suggested improvements are estimated.

The analysis of the Indonesian VMS system revealed weaknesses and constraints. The most important weakness has to do with inefficient use of data caused by underdeveloped software solutions that lead to a significant time delay in monitoring. Comparison to the Icelandic VMS system revealed substantial opportunities to improve the usefulness and effectiveness of the system by reducing time delay and developing a better system interface. Simple and relatively cheap investments in technology and software solutions in Indonesia can potentially improve the systems performance in fisheries monitoring to reduce the extent of IUU fishing activity. Further, the comparison with the Icelandic VMS system suggests a much more widespread use of VMS for various other purposes such as; search and rescue, border control, immigration, civil defense, customs, communications and air transport.

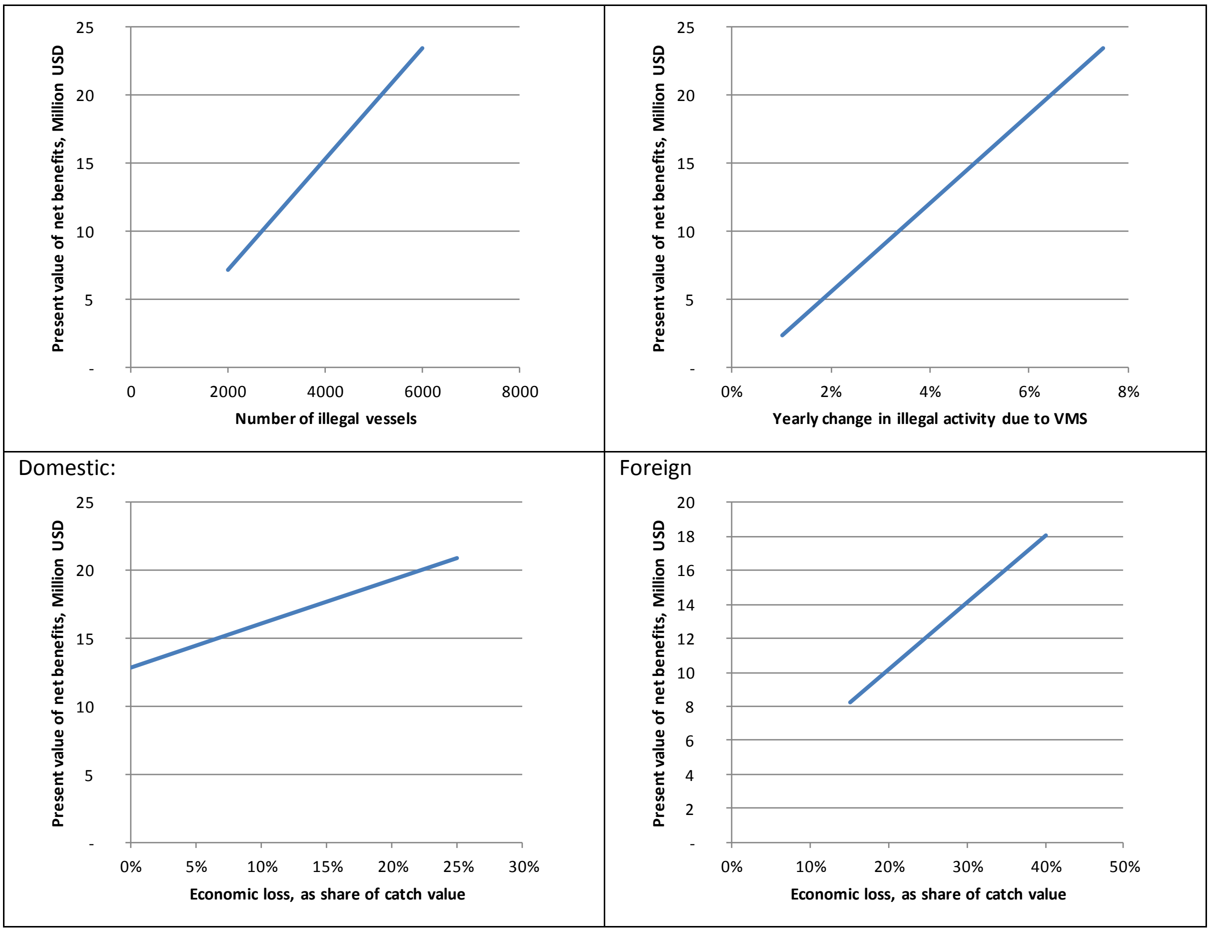

Figure 1: Shows the results from the sensitivity analysis.

The costs and benefits of the necessary investment to improve the Indonesian VMS were estimated. The costs were estimated at $1 million. The most important benefit from an improved VMS is better control of illegal fishing. The extent of illegal fishing was estimated based on available data about the number of vessels involved, their catch, revenue and costs as well as data on the expected number of foreign as compared to domestic vessels. The overall yearly loss of revenue due to illegal fishing in Indonesia was estimated at around $9 million, where $1,4 million is due to domestic vessels and $7,7 million due to foreign vessels. Based on data on the extent of illegal fishing under different VMS systems suggests that an improved VMS might reduce illegal fishing by up to 50% over a 10 year period. Given these assumptions the benefits of the improvements to the VMS far exceed the cost. in fact the ratio of benefits to costs is about 17, the benefits are 17 times larger than the cost. The breakeven point is after only about 15 months, and the internal rate of return is 80%. The results of sensitivity analysis reveal that the result of positive net benefits is robust against very large changes in model assumptions.

Based on analysis and conclusions, some suggestions are delivered:

1) Investment in improving the Indonesian VMS towards real time monitoring and improved system interface has very large net benefits and is a very viable investment for the Indonesian government.

2) The applications of VMS technology for other purposes than fisheries monitoring has substantial additional benefits that should be further investigated. These include application for customs, search and rescue, water police, navy etc.

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APPENDIX

There are several basic laws relating to the implementation of VMS in Indonesia, namely:

1) Ministry Marine and Fisheries Decree No. 60/MEN/2001 about Structuring use fishing vessel at Exclusive Economic Zone (EEZ). This states that the fishing vessels acquired by joint venture, purchase by credit, licensed, shall install the transmitter for the purpose of Vessel Monitoring System (VMS).
2) Ministry Marine and Fisheries Decree No. 10/MEN/2001 about Licensing of fishing. This states that every fishing vessel shall install transmitters for vessel monitoring system (VMS).
3) Ministry Marine and Fisheries Decree No. 29/MEN/2003 about execution of Fishing Vessel Monitoring System.
4) Ministry Marine and Fisheries Decree No. 05/MEN/2007 about operation of Fishing Vessel Monitoring System, it is compulsory for vessels larger than 60 Gross Tons to install Vessel Monitoring System (VMS) transmitter.
5) Republic Indonesia Act No. 45, 2009 about Fisheries. Mandate that the government should conduct fisheries monitoring facility and infrastructure.

The purpose of implementation of VMS in Indonesia by Ministry Marine and Fisheries Decree No. 05/MEN/2007 is:

1) Improving the management of fish resources by monitoring and controlling of fishing vessels.
2) Improving the management of fishing effort by fishing companies.
3) Improving adherence of fishing vessels conducting fishing or transporting fish to the rules.
4) Obtain information on the activities of fishing vessels for me management of fish resources and sustainable development.