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Vessel Automatic Operational Identification System (AOIS): A Proposed System to Prevent Illegal Fishing in Indonesia

Debby Ratna Daniel[a*], Shinta Pratiwi[b], Ivana Laksmono[c], [a,b,c]Universitas Airlangga, Email: [a*]debby.daniel2006@gmail.com

Two-thirds of parts of Indonesian territory is oceans that have a high potential to produce marine and fishery products that should be used to support the Indonesian economy, but this is affected by the existence of illegal fishing practices carried out by other countries. Our research used a qualitative exploratory research methodology, which aims to design an operational information system through implementing the automatic identification system by installing the LAPAN Satellite in order to detect the illegal vessels entering Indonesia, and to increase the national income from non-tax revenue. The result of this research assists in detecting all vessels carrying out illegal fishing practices, in that the process can be viewed using data flow diagrams, flowcharts, entity relationship diagrams, and examples of reports and illustrations of notifications. Further research about legal information systems can be implemented to deal with illegal fishing.

Key words: *Illegal fishing practices, automatic identification system, national income.*

Introduction

Indonesia is well-known as an archipelago and a maritime country with the number of islands reaching 18.110, and two-thirds part of the territory is oceans, based on geographical conditions. Moreover, Samosir (2014) stated that the marine wealth in Indonesia is very abundant, so that it has a high potential in producing fisheries products contributing to improve the Indonesian economy sector. One of the products of fisheries which is mostly consumed by all people to fulfil their nutritional needs is fish. According to the opinion of

health experts, fish contains many nutrients for the human body, such as protein, fat, vitamins, minerals, and omega 3's, especially for the growth and development of the human brain.

Table 1: Indonesian Fisheries Production Numbers during 2013 - 2017 (tons)

Parameter	**2013**	**2014**	**2015**	**2016**	**2017**
Capture Fisheries Production	6.115.377	6.484.346	6.677.802	6.580.191	6.933.293
Aquaculture Production	13.300.906	14.359.129	15.634.093	16.675.033	17.217.701
Fisheries Production	19.416.283	20.843.475	22.311.895	23.255.224	24.150.994

Source: Ministry of Maritime Affairs and Fisheries Performance Report, 2017

Furthermore, the data from the Indonesian Ministry of Maritime Affairs and Fisheries (2017), indicated that the production number of fisheries products has rapidly increased, both in capture fisheries and aquaculture from 2013 to 2017 (Table 1.). Nonetheless, this increase reveals an imbalance with the increasing value of non-tax income deriving from marine and non-marine sectors (Table 2.).

Table 2: Target and Realisation of Indonesian Non-Tax Revenue of Fisheries Production during 2012 - 2017

Year	**Target (IDR billion)**	**Realization (IDR billion)**	**Achievements (%)**
2012	150	215	143,7
2013	250	227,6	91
2014	250	214,4	85,8
2015	578,8	137,1	23,7
2016	693	480,64	69,4
2017	1.017	683,85	67,24

Source: Indonesian Ministry of Maritime Affairs and Fisheries Performance Report, 2017

The low level of state income compared to the targets set for the results of fisheries production performance in Indonesia, based on the Performance Report of the Indonesian Minister of Fisheries and Marine Affairs (2017), shows that there are some weaknesses in the management of marine resources, which should be used a tool to strengthen the country's economy. One of the weaknesses currently faced by the government is the practice of exploiting marine resources through illegal fishing by other countries. This practice can be regarded as an act that violates Indonesian marine law, followed by unregulated and unreported fishing. Therefore, this has resulted in difficulties for local authorities in monitoring how much of the existing resources have been exploited. Hence, several

eradication efforts have been mobilised in Indonesia through consistently implementing monitoring, control, and the surveillance system (MCS), including the applyication of a fishing vessel monitoring system: the integrated VMS with the Indonesian Fisheries Electronic Log Book (ELPI). Nevertheless, despite the efforts resulting from the development of technology, the result was not strong enough to wipe out illegal fishing in Indonesia.The eradication effort can be made more effective when the designing of an operational information system can be combined with the integrating expert system.

In dealing with the problem of illegal fishing, our research aims to help the government by suggesting the use of an automatic operational identification system for detecting all types of vessels operating in Indonesia, so that they can be matched with the registered vessel documents in the Ministry of Maritime Affairs and Fisheries (KKP). This system will generate an output in the form of vessel images and documents which have been registered to make it easier to supervise every activity of ships entering and leaving Indonesia.

Literature Review

Previous Research

The previous studies used in our current research come from four qualitative study oriented local journals. Two of those journals are non-maritime sector and the others are maritime sector.

1. Non-Maritime Sector Journals:

a. Daniel et al (2018), suggested the use of operational information systems in detecting traffic violations in Indonesia through an Automatic Number Plate Recognition System (ANPR) called E-Tilang, allowing greater accuracy and effectiveness when dealing with traffic violations in Indonesia.

b. Nauvalia (2018) recommended the implementation of an operational information system in the weighbridge area in the form of the Weigh In Motion (WIM) system, to assist the Indonesian government in detecting vehicle owners who attempt to bring in goods exceeding the JBI standard.

2. Maritime Sector Journals:

a. Hadhi et al (2013) stated that the integrated system between the electronic logbook hardware system of fisheries (ELPI) based on GPRS and the fishing vessel monitoring system (VMS) can help to collect the accurate data of fishing vessel positions especially for vessels sized under 30 GT.

b. Julzarika (2017) described that remote sensing and hydrography can play an important role in the development of marine tolls to support the realisation of Indonesia as the maritime centre of the world. Remote sensing technology can be used to support the

development of hydrography in the sea toll. Indonesia has much potential and great resources for creating a strong maritime world presence by 2045.

Operational Information System Concept

The operational information system component, according to Daniel (2018), consists of input: transaction processing subsystem, operational engineering subsystem, operational intelligence subsystem; database: managing processes using hybrid databases with fog computing technology; output: operational subsystem, effectiveness and efficiency subsystem, inventory subsystem, quality subsystem, cost subsystem, as outlined in (Figure 1). .

Expert System

A model of the expert system consists of two parts, namely: 1) user environment and 2) development environment (Marakas, 2003). Marakas (2003), also stated that the focus of the user environment is simplifying the use of the expert system in terms of reliability and error minimisation to solve a problem through the implementing of the expert system. On the other hand, the development environment is used to insert the expert knowledge into the system (Turban et al.,2011).

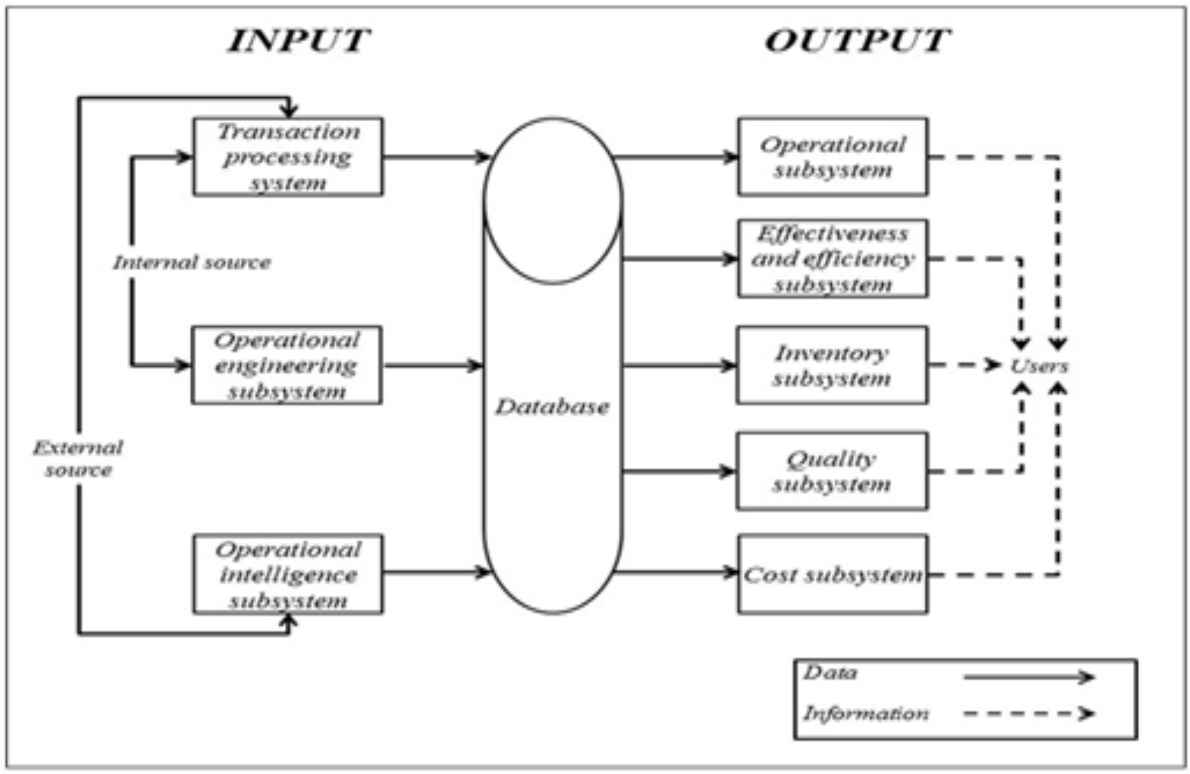
Automatic Identification System

The Automatic Identification System (AIS) is an automatic ship tracking mechanism that must be owned by vessels weighing more than 30 GT. In principal, this system is usually used in vessels and vessel traffic services (VTS) to identify the location and movement of vessels. Moreover, the AIS also provides a tool for vessels to exchange data electronically, including a tool for ships to exchange data electronically including: identification, position, activity or condition of the vessels, and speed with other nearby vessels and VTS stations.

System Development Life Cycle

Laudon & Laudon (2016) defined that system development life cycle as a group of interrelated components that work together to collect, to process, to store and to disseminate information for decision making, coordinates, control, analysis and visualisation in the organisation.

Figure 1. An Operational Information System Model



Source: Daniel et al, 2018. E - Traffic Operational Information System Based on Automatic Number Plate Recognition (ANPR) System as a Tool to Detect Traffic Violations and to Manage the Traffic Fines in Indonesia – JCAE Symposium, Bali.

Research Methodology

Research Approach and Scope

Our research used an exploratory qualitative research approach by studying, explaining, and defining the daily problems occurring through observation (Yin, 2009). Moreover, we also combined several dimensions to answer the main research questions (Neuman, 2013). Besides that, our research is aimed to provide the best recommendations for the Indonesian government through using an automatic identification operational system designed to detect violations occurring in Indonesia's marine areas, especially illegal fishing. Our recommendation system will generate an output in the form of data integrating with related parties to detect the amount of income which can be received by the country.

Data Source and Types

Our current research used data sources such as words and images obtained from documents, observations and writings, sound recordings or videos, pictures or photographs (Laudon &

Laudon, 2016). Besides that, we also used two other types of data (Yin, 2009) to support our research, they are:

1. Primary data

This data was derived from interviews with three parties: 1) the Fisheries and Marine Services of East Java Province, 2) the Lamongan and Benoa Marine and Fisheries Resources Monitoring Unit, and 3) the ex-former students (alumnus) of the Shipping Engineering Department, ITS University (Surabaya).

2. Secondary data

In supporting our current research, we also used theoretical data from textbook theories and previous research (local and international research journals) about laws, the minister of maritime affairs and fisheries, regulations of the minister of finance, and standard operating procedures (SOP). All data were gathered to help us in obtaining some information such as: the general description of the current detection system, the current regulations related to fisheries and marine affairs, and the implementation of the Automated Identification system (AIS), both domestically and abroad, supported by the application of GIS and expert systems.

Results and Discussion

Overview of the Current Detection System of Vessel Violations and the Prosecution

The current detection and prosecution system of vessel violations in Indonesia can be explained by the following steps (Figure 4.1). In the beginning, the regulation of the Indonesian Minister of Maritime Affairs and Fisheries Number 42 PERMEN - KP Year 2015 declared that every large vessel measuring more than 30 GT was required to install and to activate their transmitter or Automatic Identification System (AIS) equipment at all times, so that every vessels' activities could be monitored by PUSDAL PSDKP. This activated system emitted the signal and sent the data, which was received by the satellite to be translated by the PUSDAL PSDKP. Furthermore, the data is used to analyse some information, such as: the vessel's origin, whether domestic or overseas, the compliance of the vessel's operator with current Indonesian maritime regulations and laws, and the legality of fishing activity. Subsequently, this information will be matched with the Ministry of Maritime Affairs and Fisheries (KKP) database, including the applicable laws and regulations. The result of this matching process will be used to detect violations as a basis for issuing the Inquiry Letter and delegation to SatGas 115 for stopping the vessel and conducting an investigation. After the investigation process, SatGas 115 will be process the Investigation Letter if a violation has been found and deliver it to the attorney. Hereinafter, the vessel and others such as vessel captains, crews, and the stolen fish will be brought to the nearest court under the supervision of SatGas 115. Before the court process, the stolen fish must be auctioned by an Auction

Official as a representative from the Indonesian Directorate General of State Assets & Financial Minister and the auction process must follow the applicable law and regulation. The result of this process refers to the current market value and then the *Risalah Lelang* (auction process report) must be made. Before the court process, the auction result must be deposited to the bank through using Bank Proof Deposit and gathered with the *Risalah Lelang* to be used as evidence in the court. At the end, the court process will be conducted by The Indonesian Court to earn the penalty for the violators, and the auction result will be added as Non-Tax State Revenues (PNBP) and recorded into the Ministry of Finance database. In addition, the penalty of overseas or foreign vessels will be sought in accordance with the applicable law.

The Weaknesses of Current Detection System of Vessel Violations and the Prosecution

The current system of detection and prosecution for the vessels has been violating the Indonesian Law of Marine and there still have been some weaknesses. According to the applicable regulation of Minister of Maritime Affairs and Fisheries Number 37 PERMEN - 2017 KP, Minister of Finance Number 13 PMK.06 in 2018 & 27 PMK.06 in 2016, and results of the interview process with related parties, we carried out an analysis using the PIECES framework (Bentley & Whitten, 2007). We can explain some weaknesses such as:

1. Performance (P): Information from the satellite obtained by the PUSDAL PSDKP should be analysed first and the investigation letter should be created when the violations are indicated . Other than that, the waiting time of that letter can open the opportunity for illegal vessel operators to run away before they have become known to SatGas 115.
2. Information (I) and Data: The data analysis carried out by the PUSDAL PSDKP was only limited to the vessels which had turned on the Automatic Identification System (AIS). On the other hand, the vessels which did not turn on the AIS could not be detected, so they will not be able to be monitored and analysed by PUSDAL PSDKP.
3. Economics: The detection system of vessel violations, especially vessels that carry out illegal fishing must be more sophisticated in order to increase the country's PNBP through the catches of fish caught by illegal vessels. In addition, the auction process must be carried out immediately to keep the quality of fish catches fresh so that they have high prices, so it is very important for the DKJN to follow the SatGas 115.
4. Control (C) and Security: The examination of vessel documents by SatGas 115 to prove that the documents were genuine or not genuine will reveal fraud when there was a hidden agreement between the vessel captain and SatGas 115. Besides that, the illegal vessels that intend to steal fish in Indonesia will turn off the AIS to avoid the detection system of PUSDAL PSDKP.
5. Efficiency (E): The manual vessel examinations conducted by SatGas 115 were taking a lot of time and resources, so this current inspection process was very inefficient. This

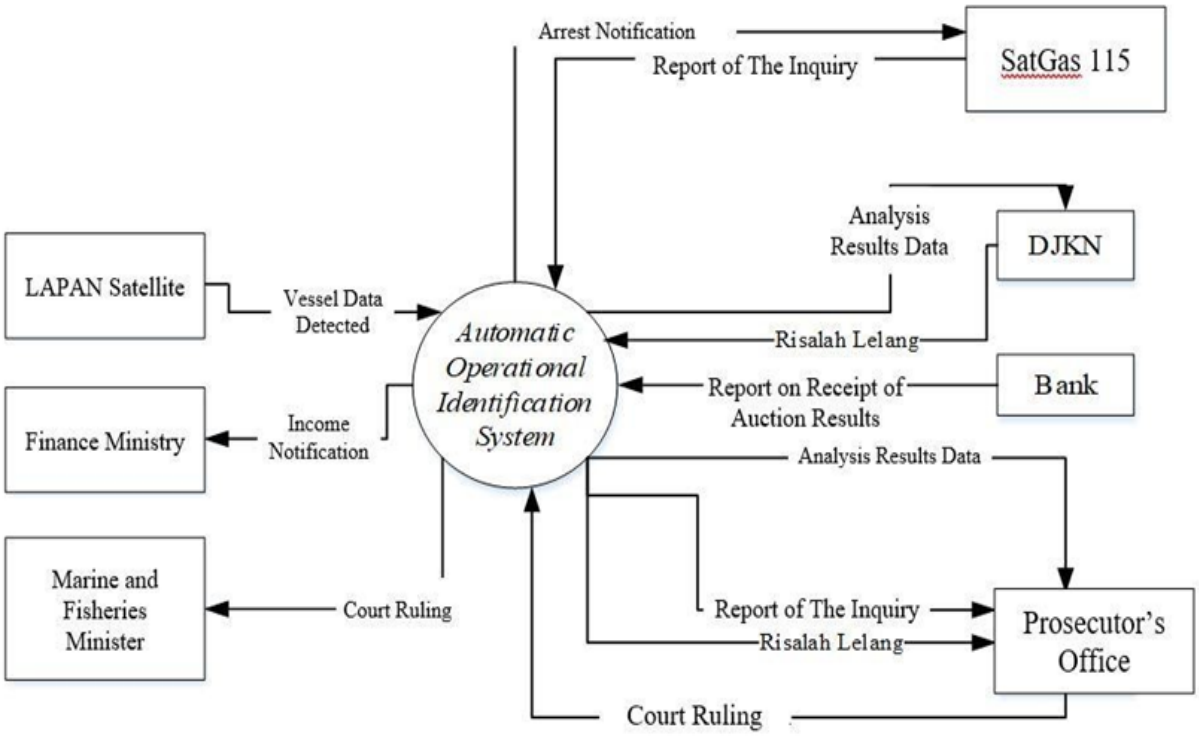
inefficiency has been showed by the SatGas 115, who must check the completeness and authenticity of each document . Moreover, the current system had limited access to control every vessel, because it depended on the AIS system and the Sea Patrol who were not able to control all areas because of limited staff numbers.

6. Service (S): Between the detection and the further prosecution process of vessel violations, a long time is needed to find out how much PNBP has been derived from illegal fishing.

The Recommendation of the New Detection System

I. The current detection system implemented in Indonesia is considered less effective in eradicating illegal fishing cases. Therefore, we recommend an effective system through using the concept of the Automating Operational Identification System (AOIS) which can be clearly seen in the context diagram below (Figure 2). Information and system quality has been shown as a proxy that could enhance service quality.

Figure 2. Context Diagram



Additional Note

1. LAPAN Satellite: The Indonesian satellite used for monitoring systems and providing real-time data on all active vessels sailing in and out of the Indonesian sea area (with and without turning on the AIS).

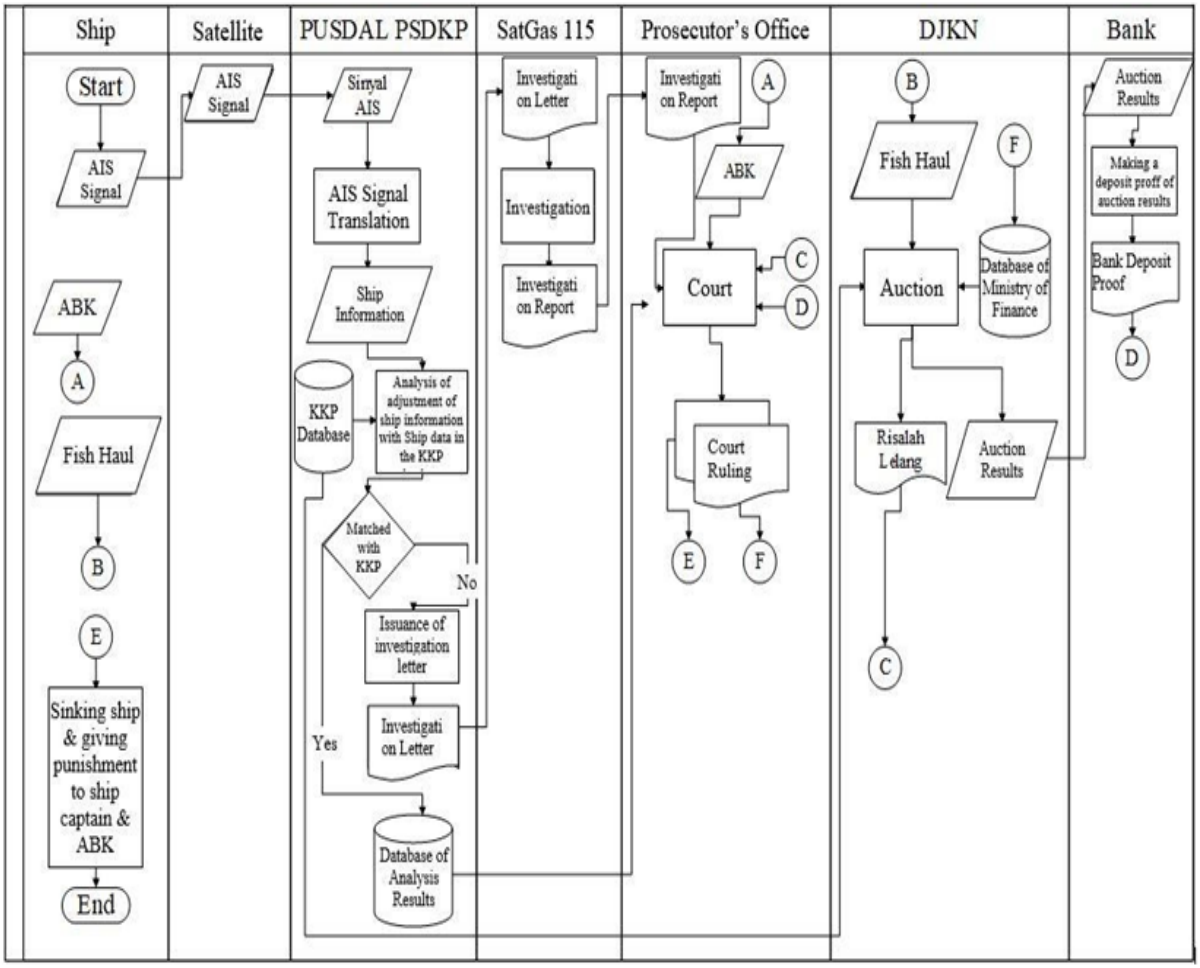
2. SatGas 115: A marine security team in Indonesia consisting of UPT PSDKP, TNI AL, and Polair which has a responsibility to catch the "naughty" vessels and conduct investigations based on the notifications sent by the automatic operational identification system (AOIS) to obtain proof of investigation . This proof will be evidence in the court process at the Prosecutor's Office.
3. Directorate General of State Assets (DJKN): An institution under the Indonesian Ministry of Finance which has an authority to conduct an auction process on illegally caught fish in accordance with applicable laws, regulations and Standard Operational Procedure (SOP) issued by the Ministry of Finance. The auction process is carried out by looking at the results of the analysis of the automatic operational identification system (AOIS) and valuing the price of the fish catch according to the market value. This process will produce a Minutes of Auction used as evidence in the court process at the Prosecutor's Office.
4. Bank: A trusted financial institution as a place to deposit the money from the auction process, with proof to be given to the Financial Minister for PNBP reporting.
5. Prosecutor's Office: A law institution appointed to conduct the court process through using any data from AOIS analysis, investigation reports from SatGas 115, and *Risalah Lelang* from the auction process by the DJKN.
6. Finance Ministry: A government institution which has the authority issue laws, regulations and SOPs concerning the auction process conducted by the DJKN. It also has a duty to record and to report the receiving of auction process material to be declared in the PNBP.
7. Marine and Fisheries Minister: A government institution which is responsible for arranging and issuing the laws and regulations of the Indonesian seas. Besides that, it has all data of vessels, cases, and the court reports (fines, sought vessels, etc) of vessels violating the regulations.
8. Automatic Operational Identification System (AOIS): The designated system used to detect any vessel violations through utilising of the LAPAN Satellite technology. It also processes and analyses the data into information that is useful for related parties automatically.

II. The next concept of context diagram will be drawn into a Level 0 Diagram (Figure 6), to find out the thinking flow of this system until it reaches the final process. The description of the process and information flow will be explained through the recommendation *flowchart* below (Figure 7). In addition, the beginning process will show the process of vessel detecting by the LAPAN Satellite through the following steps:

1. The detection process of vessels is carried out by the LAPAN Satellite using the camera features and AIS devices installed in the LAPAN Satellite. This process will produce the data of detected vessels and record it into the *database*.

2. The AOIS will process the detected vessels in the database and translate the data to be saved as vessel information.
3. The vessel information will be analysed and adjusted with several types of *databases,* namely *the* CTF *database*, registered ships, and auction regulations.
4. The adjusted information will be analysed and recorded to the *database* of analytical results.
5. The analytical result will proceed to becoming a notification for SatGas 115 by AOIS. Then, the searches and investigations are carried out on vessels detected in accordance with the *database* analysis obtained from the AOIS, which then produces an investigation report. This report will be used as evidence in the court proceedings carried out by the Prosecutor's Office.
6. The result of *database* analysis of the AOIS is sent to the DJKN for the auction process. This process will produce a *Risalah Lelang* document and be used as one of the evidences in the court process by the Prosecutor's Office.
7. The court process will announce the winner. He/she is obliged to transfer the money to the Bank appointed by the DJKN, and the Bank prepares the Auction Receipt Report. This report will be the basis for the PNBP reporting by the Ministry of Finance.
8. The investigation report and *Risalah Lelang* are used as evidence in the court proceedings by the Prosecutor's Office. Moreover, the analysis results from the AOIS are also used as a consideration for court proceedings. The court process will produce a court decision.
9. The court decision will be handed over to the Ministry of Maritime Affairs and Fisheries. Then, KKP will send a notification to the Ministry of Finance that the auction report received by the bank can be recognised as a Non-Tax State Revenue (PBNP). Furthermore, the KKP can use that decision as a reason to sink the “naughty” vessels.
10. The investigation report and minutes from the auction are used as evidence in the court proceedings by the Prosecutor's Office. The analysis results from the AOIS are also used as a consideration for court proceedings. The court process will produce a court ruling.
11. The court decision is given to the Ministry of Maritime Affairs and Fisheries and the KKP sends a notification to the Ministry of Finance that the report on receipt of auction results at the bank could already be recognised as a Non-Tax State Revenue. A report is created on receipt of auction results from the Bank and notification from the CTF then recapitulation of PNBP to produce a PNBP Report.
12. The court ruling obtained by the CTF was also the basis for the ship sinking process which was assisted by the Marine Task Force 115.

Figure 3. Current Flowchart of The System



Source: Processed Data Results from Interview Transcripts, Minister of Maritime Affairs and Fisheries Regulations, and Minister of Finance, 2018

I. This system has two notifications that will be sent to the SatGas 115 and the Financial Minister connecting with AOIS. The first notification is arrest notification (Figure 4) for SatGas 115 and the second notification is income notification (Figure 5) obtained by the Financial Minister from the KKP after receiving a court decision document.

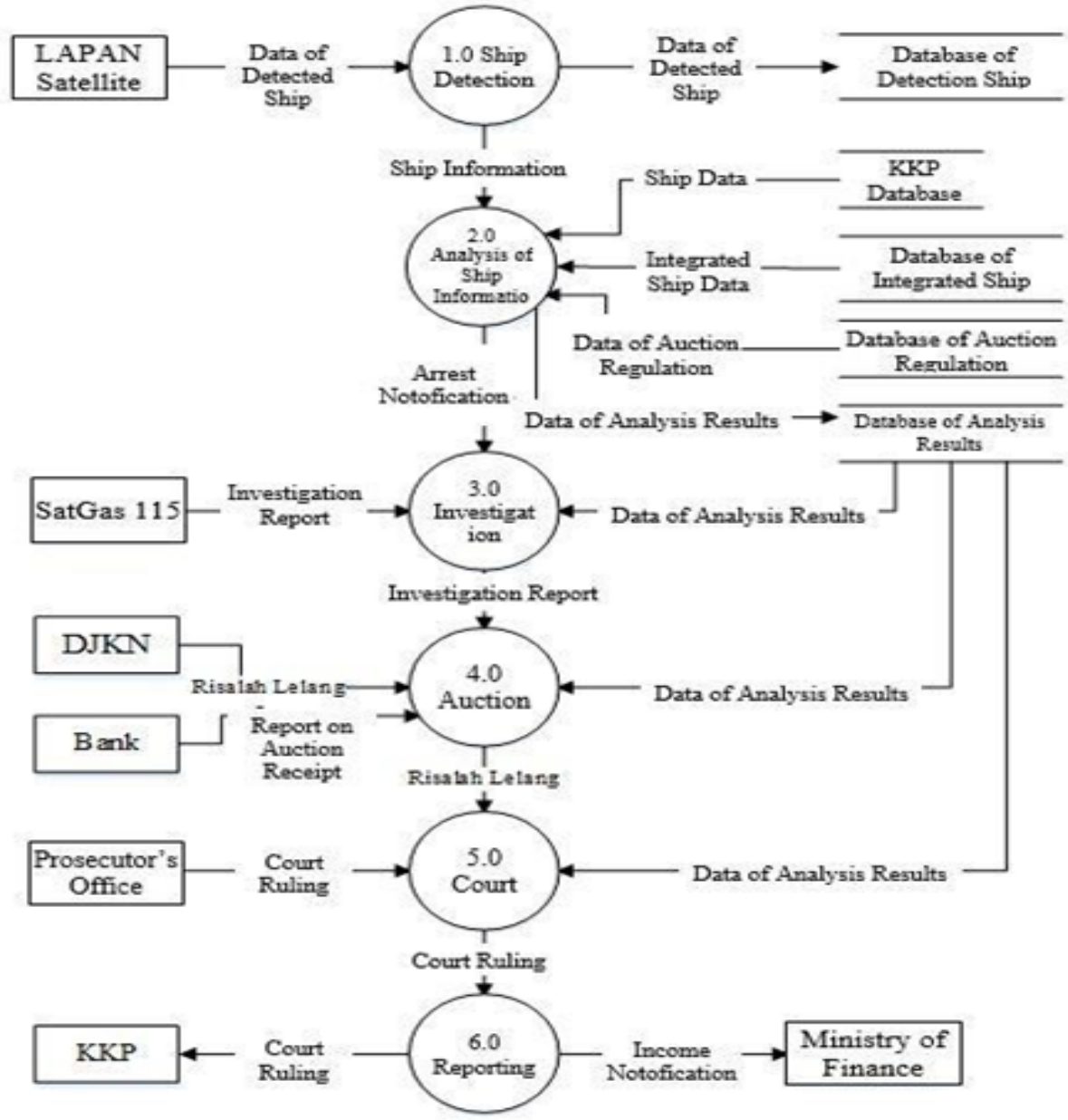
Figure 4. Illustration of Arrest Notification

KEMENTRIAN KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA	
Notifikasi Penangkapan **No. 01/01/Januari/2019**	
Nama Kapal	: BRO ELIZABETH
No. MMSI	: 244670836
No. IMO	: 9210892
Koordinat Kapal	: -6,529984° / 112,5501°
Kecepatan	: 1,6 knot
***Draft* Kapal**	: 8
Foto Kapal	: 
Rincian	: Kapal tersebut telah berhenti bukan di area yang ditetapkan

Figure 5. Illustration of Income Notification

DIREKTORAT JENDERAL KEKAYAAN NEGARA REPUBLIK INDONESIA	
Notifikasi Pendapatan **No. . 01/01/Januari/2019/PNBP**	
No. Putusan	: 326/PID.SUS/2016/PT.PBR
Nama Kapal	: BRO ELIZABETH
Jenis Ikan	: Kakap Merah
Harga Ikan/kg	: Rp. 65.000
Jumlah Ikan (kg)	: 70 Ton
Harga Lelang (Rp)	: Rp. 60.000
Total Lelang (Rp)	: Rp. 4.200.000.000
No. Laporan	: 909568

Figure 6. Level 0 diagram



In addition, arrest and income notifications can be obtained by integrating all information recorded through the database. The database will collect all input subsystem data deriving from the transaction processing subsystem, operational engineering subsystem, and operational intelligence subsystem. After that, the database model or entity relationship diagram (ERD) of the Automatic Operational Identification System (AOIS) to detect the violations of vessels (Figure 8) will show the relationship among the related parties.

Conclusion

Based on the current research that has been carried out, we conclude that:

1. The Automatic Operational Identification System creates a system of detection and analysis of vessel violation data on ships until the implementation of court decisions becomes more efficient and prevents fraud.
2. The design of the *Automatic Operational Identification System* uses several inputs which are divided into 3 main subsystems, namely:

a. *Transaction Processing System* in the form of vessel names, owner names, tonnage, vessel type, vessel speed, vessel *draft*, fishing gear, vessel materials, engine brands, numbers and validity time of vessel registration proofs, vessel documents, vessel photos, violations committed, and market value of fish catches.
b. *Operational Engineering Subsystem* contains data on the results of analysis, investigation, auction, and court findings.
c. *Operational Intelligence Subsystem* contains data on laws and regulations, ministerial regulations and fisheries SOPs and auctions.

Figure 7. Proposed Flowchart of Automatic Operational Identification System

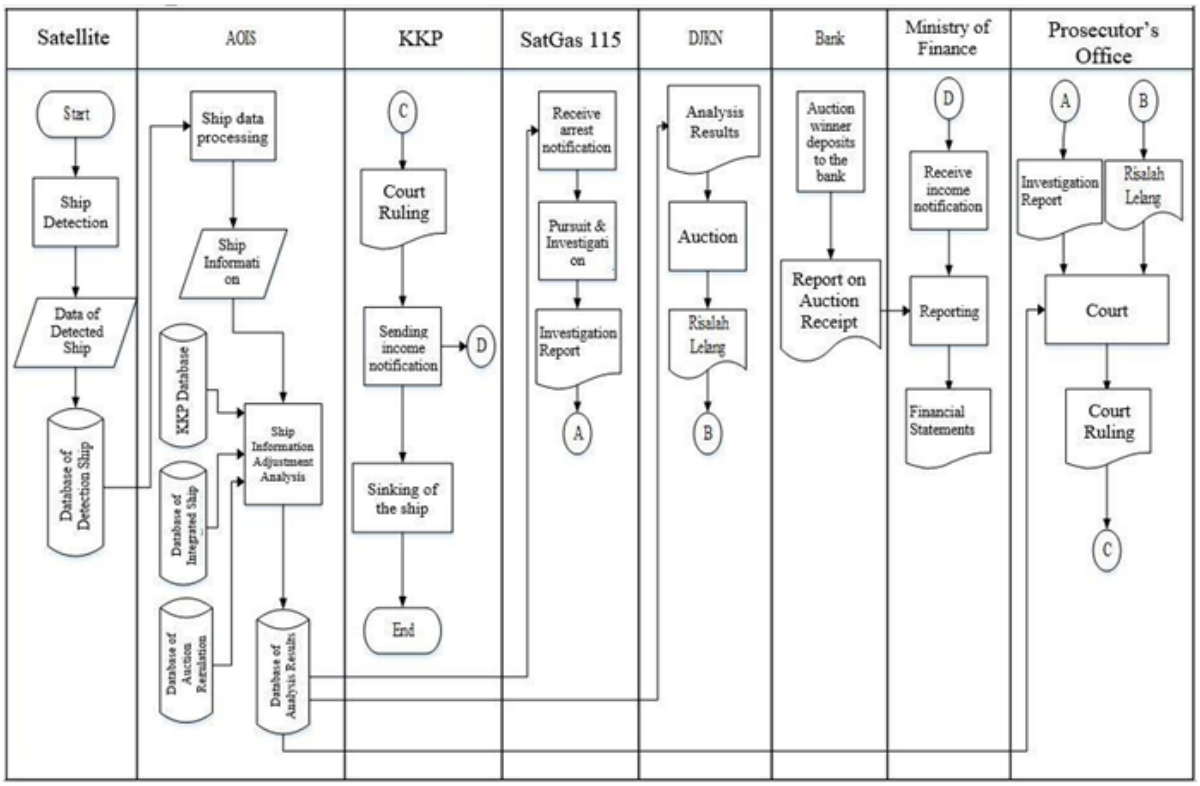
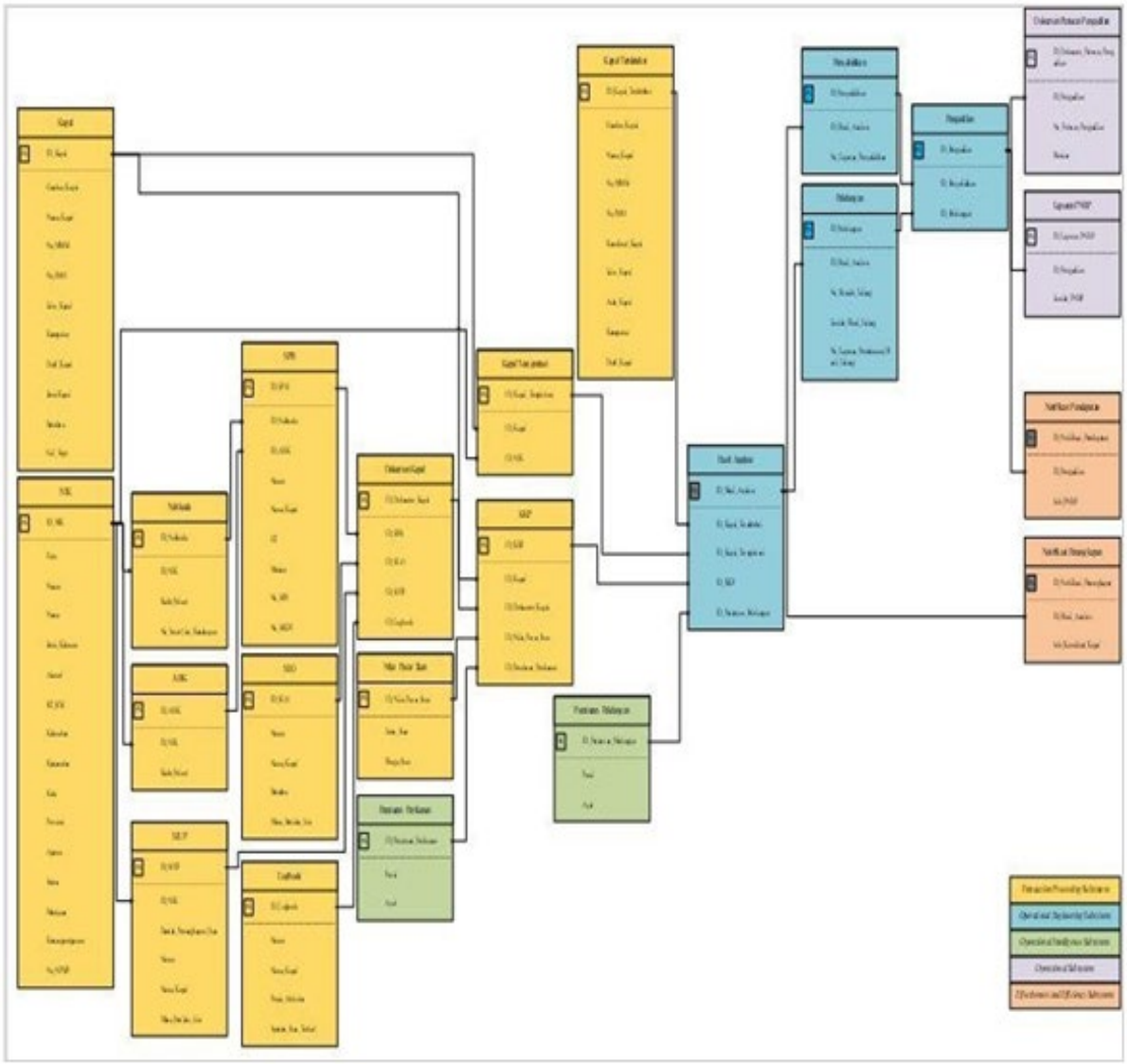


Figure 8. Entity Relationship Diagram Automatic Operational Identification System



1. *The database* collects and processes data from *input* to *output*. *The output* will produce a court decision document and PNBP report. *The result of the Effectiveness and Efficiency subsystem* is an arrest notification for SatGas 115 and an income notification for the Financial Minister as a sign that the auction results can be recognised as PNBP.
2. When the system has been implemented properly, the system goals will be achieved, namely preventing the occurrence of *illegal fishing* in Indonesia so that state revenues through PNBP can increase and advance the prosperity of Indonesia .

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