

Equipping Fishing Fleet with Vessel Monitoring System for Sustainability in Fishing Operations: A Case Study in Khanh Hoa Province, Viet Nam

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The fisheries sector in Viet Nam is encountering several difficulties, especially in terms of the management and monitoring of its fishing vessels that could have led to their continued engagement in illegal, unreported and unregulated (IUU) fishing activities and consequently resulted in the issuance of a "yellow card" by the European Union (EU). The installation of vessel monitoring system (VMS) on fishing vessels has been recommended as one of the essential actions to address the concerns on continued IUU fishing activities, ensure that fishing operations are sustainable, and improve the maritime safety of the fishing vessels and crew. A pilot research study was carried out to assess the impacts of installing VMS on the offshore fishing vessels of Khanh Hoa Province, by making use of the "BlueTraker" VMS device which was chosen from among the many devices available in the market. The results of the study showed that: i) the percentage level of the message transmittal using this VMS device based on national regulations was from 85.5% to 97.3%; ii) the VMS terminals have low power consumption and no impact on the other equipment used onboard the fishing vessels, and is flexible as direct power or backup battery could be used when needed (within 3 full days); iii) the cost of the VMS device is lower compared with other devices for the same purpose so that the concerned fishers expressed their willingness to equip their fishing vessels with such device upon approval by the national fisheries authorities to manage and provide counterpart support, and issuance of other relevant policies; and iv) more than 80% of fisher-respondents were satisfied with the performance of the "BlueTraker" VMS device as a whole. Since it is necessary to combat IUU fishing activities of the country's fisheries sector, and considering that installation of VMS is one of the measures to address such concern, the use of the VMS device should be required for all offshore fishing vessels throughout the country for the effective management and monitoring of the performance of such vessels through the use of modern technologies.

In October 2017, the Directorate General for Maritime Affairs and Fisheries of the European Commission (EC) issued a "yellow card" to the capture fisheries industry of Viet Nam for its rather sluggish compliance with the requirements for combating illegal, unreported and unregulated (IUU) fishing. As a consequence, the seafood products from Viet Nam have to face many technical barriers to be able to penetrate the European market, greatly affecting the country's fisheries trade. Bearing the brunt of the effect of such warning, the fishers working in offshore fisheries have also suffered, making their lives extremely difficult. In order that the fisheries industry of Viet Nam would improve, the EC

suggested several recommendations that focus on addressing the issues related to the prevention and elimination of IUU fishing as well as improvement of the traceability of its fish and fishery products. Specifically, the recommendations include among others, the promotion of fishing fleet management and regulating the fishing effort; installation of the Vessel Monitoring System (VMS) on fishing vessels; development and implementation of the system of catch documentation and traceability; and strictly controlling the country's so-called "blue boats" from engaging in illegal fishing activities in international waters. Since then, the Government of Viet Nam has been taking measures to address these concerns, the most significant of which was the amendment of its Fisheries Law which was approved in November 2017 and implemented starting 1 January 2019. The amendments include compliance based on the conditions of the country, with several relevant international regulations including the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU).

Under the new Fisheries Law of Viet Nam, the local fisheries authorities are mandated to implement the international regulations, especially the strict measures to manage the licensing of fishing vessels, port-in port-out controls, increased patrols for preventive inspections and control at sea, and strict provisions for handling violations and imposing sanctions against IUU fishing vessels. Moreover, the country's Fisheries Law 2017 also includes a regulation on VMS, stipulating that all offshore fishing vessels are required to install VMS which should be operational on 24/24 hour basis.



Viet Nam's "blue boats" (Photo: pacifictuna.org)

Fisheries Industry in Khanh Hoa Province

Khanh Hoa Province (**Figure 1**) is one of the few provinces in Viet Nam with the most developed fisheries. In 2017, the Province has five (5) fishing ports, dozens of small fish landing sites, 44 seafood processing enterprises, and 9,837 fishing vessels, of which more than 1,300 have capacities that are greater than 90 Cheval Vapeur or 90 CV (equivalent to 90 horsepower) and engaged in offshore fishing operations (Viet Nam MCS Department, 2018).

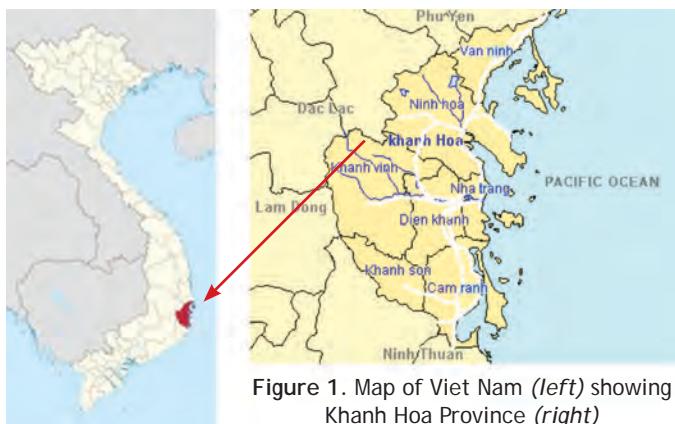


Figure 1. Map of Viet Nam (left) showing Khanh Hoa Province (right)

The fisheries industry in Khanh Hoa Province has been generating job opportunities for more than 60% of the total number of fishery workers of the Province, responsible for providing nearly 60% of the Province's fisheries production in terms of value in 2017 (Khanh Hoa Fisheries Department, 2017; Khanh Hoa Fisheries Department, 2018). However, concerns on traceability and IUU fishing activities have caused difficulties in sustaining the fishing operations, procurement and fish export activities in Khanh Hoa Province. In an effort to address the issues on IUU fishing activities and minimize the impacts of the "yellow card" on the fish and fishery products intended for export to international markets, a pilot research study was carried out on the application of modern VMS in the fishing vessel management of Khanh Hoa Province with the specific objectives of meeting the requirements for the development of modern fisheries, enhancing fisheries productivity (To, 2017), improving the safety at sea for fishers, and at the same time, safeguarding the country's national defense and security.

Management and monitoring of offshore fishing vessels in Khanh Hoa Province

The Department of Fisheries of Khanh Hoa Province is responsible for the regular inspection and control of its fishing vessels, especially the offshore fishing vessels (**Figure 2**) in accordance with regulations enforced by the Government of Viet Nam, to ensure that such vessels comply with international regulations. The inspection processes include: i) checking the vessels before leaving the fishing port for proper licensing, gear and equipment including safety measures; and



Figure 2. A typical fishing vessel from Khanh Hoa Province, Viet Nam

ii) inspecting and monitoring the vessels' fishing operations at sea as well as checking the vessels' catch upon landing. Khanh Hoa Province has many offshore fishing vessels, so that the management and monitoring of these vessels still face many difficulties due to limited human resources, inadequate budget, and few number of patrol vessels (Vu, 2018). Moreover, in monitoring the operations of the fishing vessels, patrol vessels are used but these have not been installed with modern surveillance technology, e.g. GPS (Alum-Udensi *et al.*, 2016).

Records of the Department of Fisheries of Khanh Hoa Province have also indicated that in 2017, a total of 73 patrol trips were conducted, 171 fishing vessels were inspected at sea (comprising 63 vessels from Cam Ranh, 35 vessels from Van Ninh, 23 vessels from Ninh Hoa, and 50 vessels from Nha Trang. From such inspections, 48 fishing vessels were found to have violated the regulations, and were therefore handed certain forms of disciplinary actions.

The Department of Fisheries of Khanh Hoa Province has also been quite active in its information dissemination efforts. Their records have shown that during the period from 10/2017 to 08/2018, a total of 21 training workshops were organized: 8 in Nha Trang, 4 in Ninh Hoa, 4 in Van Ninh, and 5 in Cam Ranh. The training workshops were attended by a total of nearly 2,000 vessel owners, vessel captains and crew, who were provided with and shared relevant information, and whose awareness about the impacts of IUU fishing activities had been enhanced, while also given the vision on the need to combat illegal fishing not only in their national waters but also in foreign waters as well, for the sustainability of capture fisheries as a whole.

Vessels Monitoring System

There are many types of vessel monitoring system (VMS) devices in the world. However, based on the capacity and support provided by the suppliers, the research team from the Department of Fisheries of Khanh Hoa Province selected the "BlueTraker" brand of VMS provided by the EMA Group of the Republic of Slovenia. Many countries all over the world

have also been using this VMS equipment, e.g. Slovenia, Thailand, Indonesia, Norway (BlueTraker, 2018).

Pilot Research Study on the Application of Modern VMS Technology

The study which was conducted in 2018 focused on the assessment of the efforts of Khanh Hoa Province to manage its offshore fishing vessels and promote the application of modern VMS technology for the Province's fishing fleet, and finally to analyze and evaluate the results of the study for the formulation of policy options and recommendations. Secondary data, obtained from statistical reports and published research papers, were used as source of information necessary to assess the status of fisheries as well as vessel monitoring and management in Khanh Hoa Province, and also for the assessment of the current status of VMS technology being implemented in Khanh Hoa Province. The compiled secondary information which also included those provided by the officers and experts from the Province, were then utilized for analyzing the advantages and disadvantages of the proposed application of the modern VMS technology.

In order to also obtain the primary data, a questionnaire survey was conducted on 93 offshore fishing vessels at Hon Ro Port in Khanh Hoa Province as well as the fishers and fisheries managers from the Department of Fisheries of Khanh Hoa Province and the Khanh Hoa Fisheries Association, with respect to maritime equipment and supplies for offshore fishing activities and vessel monitoring (Yamane, 1967). The primary data were used to conduct a pilot VMS application study on the impacts of the application of modern VMS technology taking into account the probabilities of receiving transmitted messages on regulation's time (under 72 minutes), the accuracy of vessel positions displayed on the SecondScreen Software accessed on land, the level of power consumption, the influence level on other equipment in operation onboard, and the quality of signal transmissions. Satisfaction level of the VMS equipment would also be derived from the pilot study and from the relevant stakeholders directly utilizing the technology.

The Department of Fisheries of Khanh Hoa Province cooperated with the EMA Group, a leading traceability specialist in Slovenia (European Union) that established the

"BlueTraker" brand for utilization in the field of VMS systems for fisheries and commercial vessels. For the pilot research study, the EMA Group provided the "BlueTraker," which is a satellite-operated equipment to support the surveillance of vessels at sea. The "BlueTraker" VMS system includes: i) terminal equipment mounted on the top of cabin to receive the satellite signals from the global positioning system (GPS), ii) conbox box mounted in the cabin to perform the collection of basic information and features; and iii) an interface Secondscreen Software that could be accessed through smart phone or computer with internet connection to based on land and where the features of the VMS system are displayed. Three (3) offshore fishing vessels of Khanh Hoa Province were involved in the pilot research study which covered a complete analysis of the data transmission in terms of signal and frequency as well as the accuracy of the coordinates where data is transmitted, and other basic features for the Secondscreen Software of the VMS device.

Results of the Pilot Research Study

Based on the secondary data compiled during the pilot research study, it could be gleaned that the fisheries activities of Khanh Hoa Province are concentrated in the coastal districts of Nha Trang, Van Ninh, Ninh Hoa, and Cam Ranh. As of 2017, the number of fishing vessels in the Province totaled 9,817 units (**Table 1**), the information also indicated that at the provincial level, Nha Trang has the most number of vessels at 3,693 units followed by Van Ninh District at 2,266 units, Cam Ranh at 1,961 units, and Ninh Hoa at 1,317 units.

The data provided by the respondents during the questionnaire survey, indicated that 100% of the offshore fishing vessels are equipped with global positioning system (GPS) device to determine their locations and routes, while only 92.5% are installed with long-range communication equipment, e.g. high frequency (HF) transceivers (**Table 2**). The study also showed that 68 of the 93 vessels sampled or 73.1% have been supported by the Government of Viet Nam under Decision No 48/2010/QD-TTg on fisheries development policies, in terms of fuel and oil support, and use of the Vortex Standard 1700 (VX-1700) to assess the usefulness of the equipment in offshore fishing operations. The efficiency of the VMS equipment (Movimar) installed in another 11 vessels out of the 93 sampled, were also assessed with respect to the

Table 1. Distribution of fishing vessels by locality in Khanh Hoa Province (Khanh Hoa Fisheries Department, 2018)

Locality	Year				
	2013	2014	2015	2016	2017
Nha Trang City	3,603	3,622	3,656	3,690	3,693
Van Ninh District	2,260	2,261	2,262	2,266	2,266
Ninh Hoa Town	1,299	1,303	1,311	1,317	1,317
Cam Ranh City	1,952	1,953	1,956	1,961	1,961
Others	580	580	580	580	580
Total	9,694	9,719	9,765	9,814	9,817

Table 2. Maritime equipment utilized by the offshore fishing vessels in Khanh Hoa Province

Maritime Equipment Used	Off-shore Fishing Vessels	
	Number	Percent (%)
Short - Range communication equipment - MF Transceiver	82	88.0
Long - Range communication equipment - HF Transceiver	86	92.5
Navigation GPS Chart Plotter	93	100.0
GPS Chart Plotter - AIS Combo	66	71.0
Vertex Standard 1700 (VX-1700)	68	73.1
Movimar VMS equipment	11	11.8

equipment's performance in offshore fishing operations. The results indicated that these 11 vessels were confronted with many issues including high amount of fuel consumption, incorrect positions recorded, frequent signal interference, and unstable transmission of the radio-equipment signal.

Installation of the “BlueTraker” VMS equipment

For the pilot research study, three (3) offshore fishing vessels in Khanh Hoa Province were installed with the “BlueTraker” VMS device, the details of which are shown in **Table 3**.

Installation of the “BlueTraker” VMS device (**Figure 3**) on the fishing vessels is simple as the equipment has only one (1) terminal, a transceiver for transmitting GPS signals placed at the roof of the cabin, and 1 box of conbox placed in the cabin. On the station on land, the system operates through the SecondScreen Software which runs on any web platform. In fact, the system can run on every smart devices (smartphones, tablets) or computer units with internet connections.

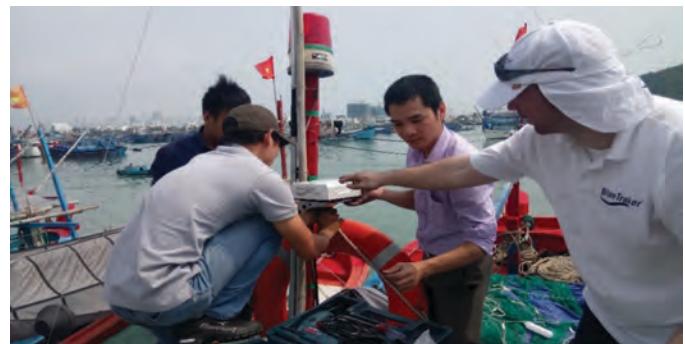


Figure 3. Installing the “BlueTraker” VMS on a fishing vessel in Khanh Hoa Province

Performance of the installed “BlueTraker” VMS equipment

In evaluating the levels of signal transmissions and assessing the performance of the device installed in fishing vessels (**Figure 4**), specifically the transmission capacity of the device, the research team considered a one-week transmission data from 07 April 2018 to 14 April 2018 for the analysis. Results of the analysis are shown in **Table 4**.

Signal transmission level of the device

As shown in **Table 4**, during the one week first pilot study trip, the vessel with device No. 18156 obtained 186 transmission signals, the vessel with device No. 18146 obtained 223, and the device No. 17618 obtained 179 transmission signals. The data transmission frequency of the three (3) devices is considerably good enough to meet the requirements of EU (which typically requires that transmission should be for every 2 hours). Specifically, the rates of message transmission to the management software after every 72 minutes (based on the “BlueTraker” VMS setting) of the 3 devices, namely: 18156, 18146, and 17618 were 98.3%, 97.3%, and 85.5%, respectively.

Table 3. Information of the offshore fishing vessels installed with the “BlueTraker” VMS device

Device Code	Vessel information				Type of Fishing Gear
	Registration No./Vessel Name	Cheval Vapeur (CV)	Owner		
17618	KH97176TS/ Vuong Len 2, Truong Sa 4	400	Vo Ngoc Tung	Gill net	
18146	KH98246TS/ Truong Sa 2, 2016	800	Mai Thanh Phuc	Handline	
18156	KH91934TS	450	Vo Van Mai	Handline	

Table 4. Interaction signals between the fishing vessels installed with the “BlueTraker” VMS device and the designated station on land

Device code	Number of signals received	Green signal (good condition)		Yellow signal (unstable condition)	Red signal (loss of signal)	Channel	
		Quantity	Percent (%)			Iridium	GPRS*
18156	186	183	98.3	2	1	174	12
18146	223	217	97.3	3	3	223	4
17618	179	153	85.5	20	6	179	0
TOTAL	588	553	ave: 94.0	25	10	576	16

*GPRS or general packet radio service is a data transmission system through the mobile phone network while GPS is a satellite tracking and navigation system

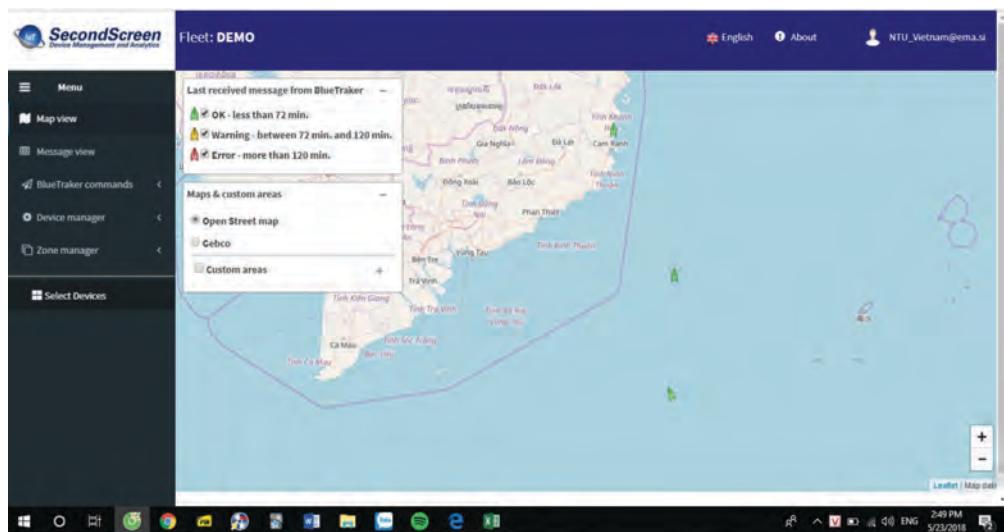


Figure 4. Status of the signals transmitted by the VMS device installed in 3 pilot vessels

Quality of the coordinate data transmitted

The research team selected the one-week data of the second pilot study trip from 16 May 2018 to 22 May 2018 to analyze and evaluate the quality of the GPS signals of the device with respect to the vessels' positions. The results are shown in **Table 5**.

Table 5. Statistics on the quality of the device' signals based on position data

Device code	Number of transmission signals	The number of qualified signals	Percent (%)
18156	160	152	95.0
18146	171	165	96.0
17618	204	200	98.0

Table 5 shows that the number of data transmission signals (*i.e.* the accuracy of vessel coordinates) with a qualified GPS quality, accounted for a very high proportion in all three devices. Specifically, the rate of qualified signals of the 3 devices: 18156, 18146, and 17618 were 95.0%, 96.0%, and 98.0%, respectively.

In particular, to carefully verify the accuracy of the coordinate data, the research team asked the vessel owners and captains

to engage in a communication using the VX-1700 and HF transceiver. This would also verify the coordinates at the time of communication (*i.e.* compare the position displayed on GPS equipment onboard the vessel with the position displayed on the Secondscreen Software on land), along with verifying the message of VX-1700 sent to the Department of Fisheries of Khanh Hoa Province. The results showed that the position of the vessels are the same and correct (**Figure 5**). The vessel position information is being constantly updated to help the authorities and vessel owners determine the route of the vessels at sea.

Power consumption of the VMS device

The electric consumption parameter of the device according to the EMA Group was only 2.0 Watts. During the 6-month pilot study, the 3 vessel captains and owners evaluated the power consumption of the VMS device and concluded that the electric consumption was very low, and had absolutely no effect on other equipment onboard the vessels. Moreover, the power usage of the “BlueTraker” device is very flexible, as it can be connected directly to a power source or to backup batteries if necessary, making the device more advantageous than any of the VMS devices commonly used by fishers in Viet Nam. One of the vessel captains also noted that when the device bearing the code 17618 was disconnected from the direct source of power and connected to a backup battery, it

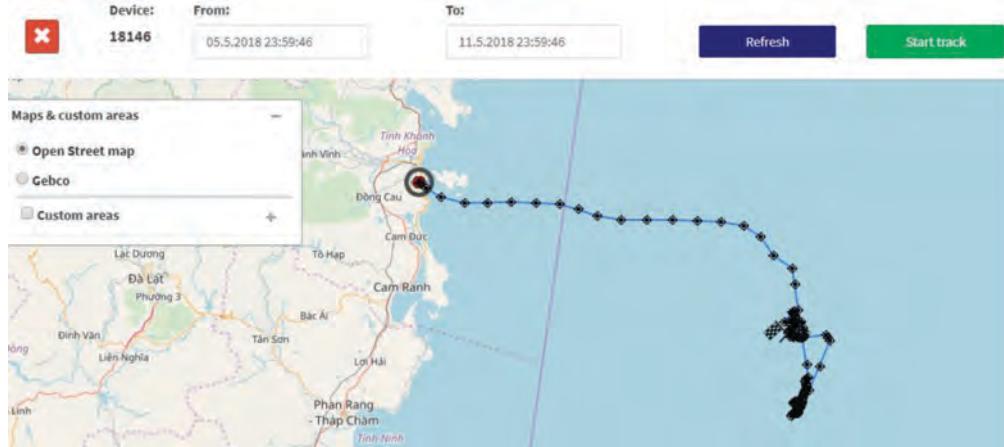


Figure 5. Position-tracking mode of the fishing vessels during the pilot study trip

still maintained the transmission quality of the satellite signal for three (3) days or 72 hours.

Access to the Secondscreen Software

Secondscreen is a software that runs on any normal web platform, so that users (*e.g.* fisheries authorities, fishers, vessel owners, crew members) can use any mobile device (*e.g.* smartphones, computers) with internet connection to access necessary information (account number and password are required) and use wherever their locations may be (**Figure 6**). Results of the survey to determine the satisfaction level of using the Secondscreen Software of “BlueTraker” VMS device showed that the users were appreciative of the Secondscreen Software interface at satisfaction level of 93% (20% were very satisfied and 73% were satisfied). The respondents also noted that the software has eye-catching 2D and 3D map modes giving a lively vessel position display, the signal level of the device could be easily distinguished, and the system is simple and suitable for all users as the functions are basic with understandable instructions.

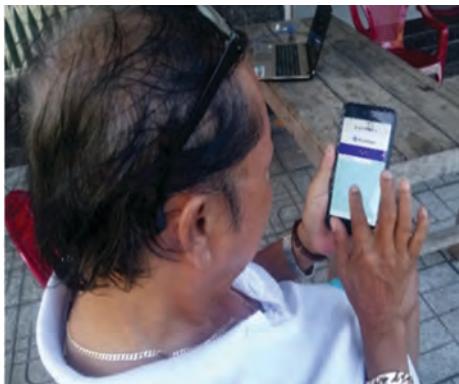


Figure 6. A vessel owner from Khanh Hoa Province accessing the Secondscreen Software on land at a certain port in the Province, using a smartphone

In spite of the high satisfaction level of the Secondscreen Software, 5% of the respondents were less satisfied with the software for two main reasons: the language used during the trial period was English, and ii) some fishers were still not familiar with the modern features on a smartphone. Nonetheless, the “BlueTraker” VMS device received high satisfaction level by the respondent-users during the pilot study. In particular, the fishers were satisfied with the mounted hardware of the device because of its compact design and low power consumption. In addition, the users also appreciate the Secondscreen Software which comes with benefits such as: signal transmission between terminal – GPS – Secondscreen Software at the station on land could be generated automatically, and the features are simple and easy to use, with very useful tracking mode.

Cost of installing a VMS system

The price of a “Bluetraker” VMS system is about 1,000 USD (mounted, and comes with a terminal, conbox, cable, and Secondscreen Software), and an additional fee of about

25 USD/month is necessary for satellite connections and telecommunication services. All of the fishers interviewed indicated that the cost of installing a VMS system is suitable for offshore fishing vessels, especially with the current situation wherein a “yellow card” had been issued to the fishing industry of Viet Nam and the urgent requirement of installing a VMS system to help fishers and fisheries managers in managing and on the hourly and daily basis, monitoring the vessels’ positions.

This is considered extremely urgent as it could convince the EU to lift the “yellow card” from the country’s fishing industry. The existence of the Secondscreen Software also helps the relatives of fishers on land to feel more secure as the vessels’ positions at sea are constantly being updated. In particular, a bulk purchase of the device would lessen the cost as the device could be purchased at discounted price. The fisher-respondents expressed the willingness to equip their vessels with the most efficient and effective VMS system, but also proposed that the Government partially support the cost of the device. They also suggested that the country’s fisheries authorities should recognize the usefulness of the device and use the information from the Secondscreen Software to confirm the performance of the device under the support programs of the Government based on Decision No 48/2010/QD-TTg on fisheries development policies.

In general, the “BlueTraker” VMS device was found to be practical and can greatly support the fishing vessel management of Khanh Hoa Province to meet the current regulations of Viet Nam and the requirements of international organizations. The system could also help the fisheries authorities in managing the operations of offshore fishing vessels as its usage could strengthen the monitoring of domestic fishing vessels while at the same time, save cost for patrolling. However, the current trial is still on a small-scale basis with the use of few devices. There is a need to confirm the results of the pilot research study in a larger scale in the near future, to obtain more accurate assessment and recognition.

Conclusion and Recommendations

After the capture fisheries sector of Viet Nam was issued a “yellow card” by EC requiring the sector to combat IUU fishing, efforts were made to improve the country’s fisheries legal system leading to the amendment of its Fisheries Law in 2017 which was adopted in early 2019. The Fisheries Law 2017 stipulates among others, that offshore fishing vessels are obligated to install and use VMS on a 24/24 basis. Such installation would also respond to the need of vessel owners and relatives of fishers on land to know the position and the safety of the vessels at sea, and support maritime safety and accident prevention at sea.

The Government of Khanh Hoa Province has been requested by vessel owners to consider providing full or partial support

to equip their vessels, starting with offshore fishing vessels, with VMS system to address the aforementioned concerns, especially on the need to have a road map for vessels to comply with the required management of fishing capacity, and as part of the Government's social responsibility. Cost-sharing could be applied with funds provided by the Government and reciprocal funds from vessel owners, as well as from the telecommunication companies. However, there is a need to replicate the results of the pilot study on the use of VMS model devices in a larger scope through the promotion of applied research studies or fisheries extension projects on the installation of VMS system on all offshore fishing vessels. An additional topic for research could include study on the integration of VMS devices and other maritime equipments with the objective of lessening the cost of the whole system.

The fisheries authorities of Khanh Hoa Province have been concerned with the sustainability of the country's capture fishing operations, after the EC issued the "yellow card" as this could impact on the fisheries trade of the country, of which the Province has been contributing a big share the country's total fisheries production. Therefore, the concerned stakeholders in the Province have been exerting efforts to comply with the national, regional and international requirements towards the sustainability of fishing operations. Considering that the installation of VMS devices on fishing vessels could contribute to the solutions that could possibly lift the "yellow card," the Province has been doing its part to ensure that all its fishing vessels, especially the offshore fishing vessels would be installed with VMS. Such installation would also help the fisheries authorities of the Province in monitoring and controlling the fishing vessels at sea 24/24.

Based on the Province's experience in VMS devices, the "BlueTraker" VMS device was chosen for trial in a pilot research study to reinforce the previously conducted researches and scientific evidence. Aside from the modern technology internal to the "BlueTraker" VMS device, the results of the pilot research study conducted in 2018 proved the effectiveness and efficiency of using the device, especially the high quality of the GPS signals, that meet the requirements of the EU. Moreover, the "BlueTraker" VMS device requires low power consumption, does not affect the other equipment on board, and is flexible that it could be used with direct power supply or through a backup battery within 72 hours.

Considering the affordable cost, many fishers and vessel owners from Khanh Hoa Province expressed their readiness to equip their vessels with the "BlueTraker" VMS device provided confirmation of support from the Government is assured. The fishers therefore suggested that the Department of Fisheries of Khanh Hoa Province should consider the development of policy recommendations for the Government of Viet Nam to support the installation of VMS devices for the increased effectiveness of the management and monitoring

of offshore fishing operations and ensure that these are responsible and aim for the sustainability of the fishery resources, and most especially, to show that such fishing vessels are not engaged in IUU fishing activities.

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