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The Role Of Vessel Monitoring Systems (VMS) In Mitigating Illegal, Unreported And Unregulated (IUU) Fishing

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1. ABSTRACT: Blue Economy is a broad concept that explore the sustainability within different industries including the shipping, fisheries, and maritime transport, moreover, a sustainable blue economy aims to provides social and financial benefits for next generations , in this regard the applications of smart technology in the marine industry aims to relish the previously unattainable ocean resources , moreover the implementation of the IOT in the fishery industry can enormously boost the degree of fishery modernization which plainly feature the need to speed up the improvement of the fishery Internet and large information industry, The purpose of this paper is to review the sustainable technologies implemented in the blue economy , especially the vessel monitoring system (VMS) ,In order to identify the best technological solutions applied in the blue economy.

Keywords: technology development, fisheries, maritime transport, shipping, Blue Economy, vessel monitoring system (VMS), The UN Sustainable Development goals (SDGs), The Internet of Things (IOT), illegal, unreported and unregulated fishing (IUUF).

2. INTRODUCTION

The concept of "blue economy " was firstly revealed on the Rio+20 United Nations Conference on Sustainable Development, held in Rio de Janeiro in June 2012. This convention addressed key themes: the in addition improvement and refinement of the Institutional Framework for Sustainable Development and the development of the "green economy" concept. The final recommendations of the assembly considered poverty eradication as a key objective and encouraged the developing and developed countries to promote sustainable development initiatives that eradicate poverty and protect the environment. [30]

The Blue Economy encompasses mainly five major sectors which – Renewable energy, Biotechnology, Coastal and maritime tourism, Aquaculture, Mineral resources – and mentions the other four above listed fields – Shipbuilding and ship repair, Transport, Fishery, Offshore oil and gas – as "other sectors" of the Blue Economy [33], the above mentioned sectors includes twenty sixth industries and services which constitute about 20 percent of the employees in some countries [23].

From an economic perspective, "Blue Economy" is meant to boost economic growth and create using sustainable procedures especially on the marine industry including construction, transportation, mineral resources development, ship building, communication cable laying, pharmaceutical enterprises, equipment deployment, sustainable energy from waves, currents, seaside leisure tourism, and fisheries

and aquaculture[14], in this respect the blue economy supports the progress towards 'low carbon' economies that relies on the Blue Carbon to realize their sustainable development goals .[28]

Generally speaking, blue economy evidently affect the global maritime security as the inefficient use of the natural resources will probably lead to economic crises and political instability , which fuels insecurity, stimulate illicit activities and even radicalization.[11]

In such manner, fishing innovation, has a significant role to play in the fishery development, consequently a dramatic change is happening in the design, management and the navigation on board fishing vessels, which will facilitate the synchronization of different operations on board of the fishery vessels , the expected development of the fishing operations from manual to automated operations that relies more on IOT technologies, will consequently boost the entire fishery industry, the development of the fishery industry is expected to accelerate during the next few decades, Indeed some of the IOT applications in the fishery industry are widely adopted in Canada, Denmark and Iceland.[3]

This paper is organized as follows The first section gives a brief overview of the concept of Blue Economy, The second section demonstrates countries blue economy strategic Plan , the third section reviews different IOT solutions for blue economy ,the fourth section reviews the implementation of the vessel monitoring systems (VMS) in the fishery industry , Our conclusions are drawn in the final section.

BACKGROUND

The UN Member States agreed on the 2030 Agenda for Sustainable Development in 2015, which present a framework for the Sustainable Development agenda that aims to maintain peace and prosperity for people and the planet today and in the future. The 17 Sustainable Development goals (SDGs) encourages all countries - developed and developing - to align together to fulfil the agreed upon goals, that mainly aims to eradicate ,poverty , improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.[32]

In this regards ,(Lee, K.-H, et al, 2020) studied the relevancy of the United nations Sustainable Development Goals (SDGs), the research reviewed the number of published research concerning the blue economy and the 17 sustainable development goals , according to the research results the BE is highly linked to SDGs 14–17 , As the blue Economy deals mainly with the optimization use of the mineral resources and aquatic resources ,consequently the SDG 14 Life Below Water , SDG 15 Life On Land and SDG 12 Responsible Consumption & Production were highly linked to the blue economy concept .[16] Mesut S. (2021) referred to the Blue economy as a blue ocean strategy that creates new markets that promote productivity and boost economic productivity within a country. [19]

BLUE ECONOMY STRATEGIC PLAN

It's fair to say that around ninety seven percentage of the world's fishers lives in a developing countries where the fishing activities provides them with income and nutrition's [11], Indeed, The National Oceanic and Atmospheric Administration (NOAA) indicated that the US fishery industry generated more than $244 billion in sales and supported more than 1.7 million jobs in 2017. [36]
Blue Economy account for around 1.5 percent of European Union (EU-27 GDP) and 4.5 million direct jobs, or 2.3 percent of overall employment in the European Union. New Blue Economy industries, such as ocean renewable energy, blue biotechnology, and algae manufacturing, are creating new markets and jobs. [7]

The emerging concept of the blue economy has led many governments to set out framework that supports the Blue Economy expansion as a main contributor to the economic and social development, indeed as a mean for achieving sustainable economic development based on an ocean-based economy, Meanwhile, many countries started to include their blue economy vision in their strategic plans, in order to sustainably maximize its wealth from the nautical resources.
In this regard, In January 2021, The National Oceanic and Atmospheric Administration NOAA of the united states released the country Blue Economy Strategic Plan for 2021-2025, that provides the guideline to promote the American Blue Economy and to improve the global

maritime economy, The Strategic Plan was based on five main pillars that the NOAA will rely on in achieving the strategic objectives which includes the development of the following sectors : marine transportation, ocean exploration, seafood competitiveness, tourism and recreation, and coastal resilience. NOAA plans to develop these industries significantly by encouraging the public-private sectors cooperation , support more innovation, and implementing creative STEM education and outreach programs to prepare the next generation of Blue Economy leaders.[.31]

Bari, A. (2017). Analyzed the blue economy performance in Bangladesh in comparison with other south-Asian countries , given the fact that the fishing productivity of Bangladesh is quite high in comparison with the other regional countries ,however the number of merchant fleets is very small in comparison with other regional countries .[1]
In this regard, the seventh Bengaline five year plan FYP has set the following actions to be taken in order to "create and maintain a prosperous and sustainable blue economy":

- securing and dealing the marine resources for the present the future,
- fostering a solid renewable resources using the ocean ,wind and other natural resources
- Keeping up with the technological development in the ship building industry
- Extending the fishing areas using new technologies, in order to increase the fishing capacity beyond the "Exclusive Economic Zone (EEZ)" of Bangladesh that the country currently rely on.
- Fostering a solid capacity building programs that develop the labor force for the upcoming challenges in the global marine industry.
- Substantially increasing fisheries production and export earnings through improved aquaculture and introduction of marine culture.
- give special priority to anticipated Climate Change impacts on all relevant matters, and adjust policies and plans
- Increasing the contribution of the maritime economy to the country nominal GDP by the expansion of domestic fleet, destinations, transshipment, transit provisions, linking sea-ports. give unique need to expected Climate Change impacts on every single pertinent matter, and change approaches and plans
- Keep up with the inland waterway frameworks and environments for fishery, dregs transport, and inland delivery,
- Implementing R&D Strategies that encourages research in the topics related to the blue economy development .
- The establishment of a marine institute in Khulna

(Bax, N., et al , 2020) conducted a comparative study between New Zeeland and Myanmar to define the main challenges facing the blue economy in both countries and the undertaken initiatives , part of the initiatives was the development of the legislation and regulations that were enforced to protect the fertility of terrestrial and marine resources , moreover the informative channels as www.gbif.org and futureearth.org that raise the awareness about the global biodiversity .[2]. With the aim of protecting aquatic ecosystem, the European Union issued an amendment to the common fisheries policy (CFP) in 2018 , to modernize, strengthen and simplify the EU fisheries control system, ensure sustainability and increase the level playing field in fisheries control.[4]

In a similar context ,(Voyer, D. M., & van Leeuwen, D. J. 2019) investigated the challenges faced to issue a Social license to operate in the Blue Economy (SOL), the study suggested the implementation of the SOL as a part of the formal, regulatory approvals process that integrate different stakeholders from the governmental and nongovernmental organizations (NGOs) , in order to abide the legislative and environmental concerns , especially the ones associated with seabed mining and oil and gas explorations .[34]

THE BLUE ECONOMY TECHNOLOGIES

The Internet of Things (IOT) can be defined as an interconnected processing gadgets, mechanical and computerized apparatus, things, and individuals with unique identifiers and the capacity to transfer data without expecting human-to-human or human-to-PC association, according to an individual point of view, from a personal perspective, the Internet of Things (IOT) can be defined as the collection of devices connected to a smart home network that provides them an IP address and allows them to communicate with one another directly or through the cloud networking.[27]

Maksimovic (2017) defined the green IoT (G-IoT) as a concept based on the same computing hardware, communications protocols, and networking architectures as the IoT, but with more environmentally friendly and energy efficient manufacturing paradigms (significantly reduced energy usage, carbon emissions, and toxic pollutions). Consequently , the G-IoT includes RFID, Wireless Sensor Networks (WSN), cellular networks, Machine-to-Machine communications (M2M), energy harvesting devices and communications, cognitive radio, Edge/Fog/Cloud computing, and Big data analysis as well [20]

In this regard ,the implementation of Internet of Things technologies in the blue economy industries is still at early stages in many countries , and in many instances its used for exploration and examination but not adopted as an alternative solution, for instance , the application of fishery Internet of Things is very limited , due to the associated cost and the required know how to implement the IOT solutions in the fishery industry , accordingly , the technological developed countries are more likely to examine and implement IOT technologies to realize their blue economy objectives .

According to Spalding, M. J. (2016), the blue technology sector includes providers of infrastructure, including producers of sensors, instruments, through the establishment of frameworks that securely shares the data among the different stakeholders, in order to realize a sustainable aquaculture development [26]

In a similar context ,Ji, J., & Li, Y. (2021) analyzed the effect of the information technology utilization on the fishery industry in china, the research results indicated that the IT infrastructure and the human capacity are mainly affecting the fishery economic efficiency, as the technological solutions increases the efficiency of the fishery associated processes , which includes : the fishery resource management, environmental protection, fishing situation detection and forecasting, fishing vessel navigation, and real-time command of offshore operation.[18].

According to Song, Y., & Zhu, K. (2019) Fishery internet of things and big data industry have the Following characteristics:

1) Universalization of perceptual recognition
2) Interconnection of heterogeneous equipment
3) Intelligent management and control
4) Chain of application services [27]

(Fujii, H.,et al ,2017) referred to the Organization for Economic Co-operation and Development OECD fishery technologies in their analysis for the fishery technology development in the top north-east Asian markets , the OECD classified the fishery technology in to three categories : harvesting technology, aquaculture technology, and new products technology. , in this respect the research investigated the technology development of these three sectors in china , south Korea and Japan , the results of the cross sectional data analysis showed that the aquaculture and harvestings technologies attracted most of the R&D investments among the three countries.[8]

In February 2020 , UNISOT, unveiled a new Block-chain supply chain solution that servers the Seafood and Aquaculture industries , the new revealed solution aimed to help the supply chain stakeholders to record and display insights into the supply chain by using Smart Digital Twins and Product DNA. The Global Traceability, Proof-of-Quality and Product Provenance capacities give upgraded straightforwardness and satisfaction , by developing the supply chain network that offers the end customer to evidently monitor the supply chain process to assure the timeliness and quality of the transport. The new block chain technology offers a more simple way to comply with the legal and regulatory requirements . [25]

In a similar context, Jæger, B., & Mishra, A. (2020) deployed an IOT tracing platform for seafood product using electronic product code technologies and Serial Shipping Container Code (SSCC) as a unique identifier to trace the fish crates along the supply chain process , the platform proved that IoT technology can improve quality management capability, logistics management competence, and competitiveness of domestic and international trade in the process of seafood traceability. [35]

Accordingly, (Vedachalam, N., et al ,2018) demonstrated the different adopted technologies to protect the marine environment in India , which includes deep ocean mineral exploration using remotely operated vehicle (ROSUB 6000), LIDAR-based data collection platforms to measure the wind electricity generating capacity and PROVe monitoring system designed to protect the coral reefs.[35]

Mulema, S. A., & García, A. C. (2019) proposed an IOT that monitor water quality using four different sensors that measures temperature, dissolved oxygen, potential hydrogen (pH) value and water level, the data was calculated in a specific time span and then transferred to the central processor. The central processor processes the parameters received and if the parameters are exceeding the threshold values it gives the buzzer signal and then corresponding relay is activated to bring back the measured value to the normal level, moreover the system send the measured value back to the authorized person for review via email and short message .[21]

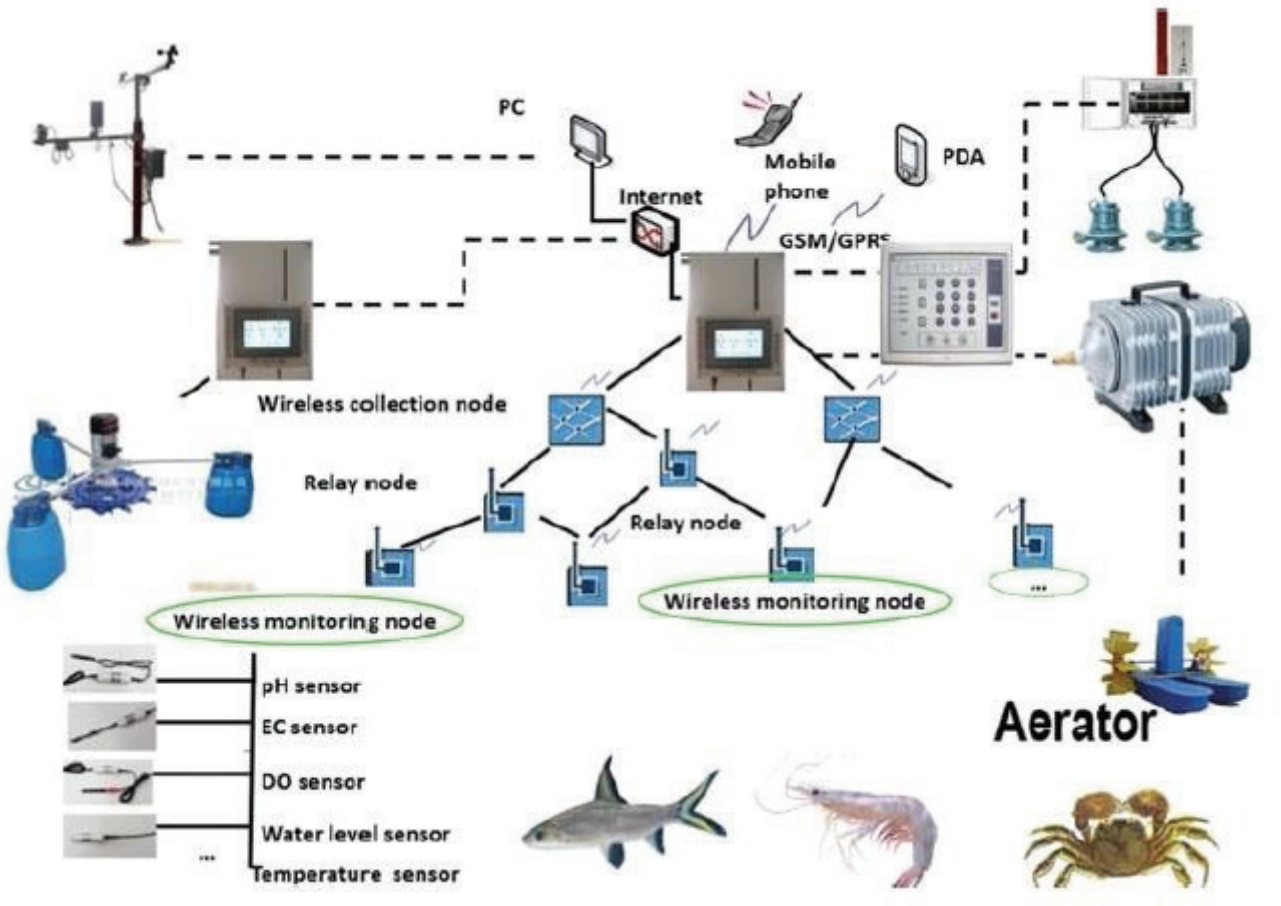

Figure (1) depicts the IOT utilize in aquaculture [29]

SATELLITE-BASED VESSEL MONITORING SYSTEM (VMS)

Recent developments in the fishery industry have increased the need to monitor fishing fleets, in order to predict fishing grounds and to deal with illegal, unreported and unregulated fishing (IUUF), given the fact that the International Maritime Organization (IMO) mandates that all vessels with a gross tonnage of 300 GT and larger to install automatic identification system (AIS) on board , henceforth the vast majority of fishing boats are not required to install any tracking system on board .

Vessel Monitoring System (VMS) could be defined as the system utilized in monitoring the fishery activities within the countries territorial water, in this regards the with the country business fishing inside the country Marine domain, in this regard this inn (VMS) is considered as a very useful tool that aid in the realization of the blue economy strategic objective as the aquaculture sustainability and economic sustainability , moreover, VMS can be utilized to monitor vessels navigating in the exclusive economic zone (EEZ), by monitoring vessels the navigation of vessels navigating within the range of 200 nautical miles (370.4 km) from the regional waters, consequently, VMS system is utilized by different administrations to guarantee legitimate fishing, forestalling illicit fishing and consequently securing and working on the livelihoods of anglers. [37]

Consequently government authorities have taken various regulatory actions to prevent fishing illegal activities , in this aspect the European Union (EU) enacted Commission Regulation (EC) No 2244/2003 that prohibited fishing vessels from engaging in fishing activities unless they have installed on board a device, which allows them to be detected and identified by remote monitoring systems , in this regard fishing vessels flying a EU member flag and with a length exceeding 15 meters are required to install a satellite-based Vessel Monitoring System (VMS)on board .[6],accordingly the Indonesian government in 2015 requested all the vessels of a gross tonnage greater than 30 tons to install a VMS transmitter before starting fishing activities on the Republic of Indonesia Water Region and the high seas .[29], alternatively , many Arab countries including : Morocco[22] ,Tunisia [9] and Oman[10] requires a VMS terminal to be installed on board of fishing boats , indeed the united kingdom (UK) requires I-VMS which is similar to VMS tracking devices to be installed on board of y fishing vessels 12 meters and greater in overall length. [12]

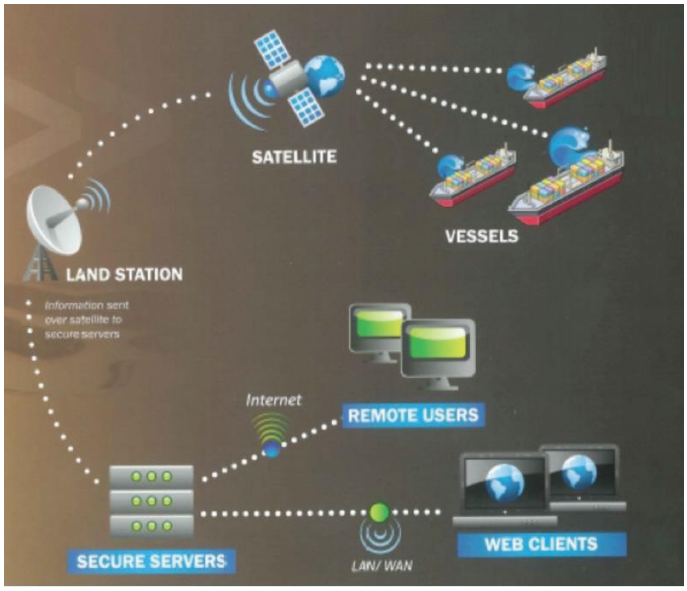

Figure (1) demonstrates how vessel monitoring system works
Source: https://www.bhsfu.gov.bz/mcs/vms/

The above figure shows that the Vessel Monitoring System (VMS) comprises of a following unit on board of vessel, a Mobile Transceiver Unit (MTC), the transmission medium. In the BHSFU's VMS, MTU's with inherent global positioning system (GPS) to transmit data of the vessel position, course and speed through an Inmarsat correspondences satellite to land earth station. This data is sent by secure web network to the data base of the Fisheries Monitoring Center (FMC) , the FMC maps the coordinates of the vessel location view using an installed software , further the FMC staffs can adequately monitor fishing activity of individual vessel by creating tracks between polls as the information enters the FMC [24]

(Li, J.,et al ,2021) analyzed the lighting fisheries in china based on VMS data transmitted via Beidou navigation system, the research results showed a highly significant positive between the lighting fisheries activities and the catching rate .[20]

Two of the main goals of fishery monitoring is to determine the fishery exploitation and abundance

estimation of fish stocks , in this respect (Ducharme-Barth, et al , 2018) reviewed the abundance pattern of the fishing species, the research compared the catch per unit of effort (CPUE) provided by the indices standardized by the Delta-GLM and the data collected by the VMS , the results showed the VMS method is comparatively simpler than delta-GLMs, and robust to changes in species and effort distributions. [5]

CONCLUSION

The Blue Economy is meant to boost economic growth using sustainable procedures especially
,on the marine industry including construction, transportation, mineral resources development, ship building, communication cable laying, pharmaceutical enterprises, equipment deployment, sustainable energy from waves, seaside leisure tourism, and fisheries and aquaculture , from a global perspective, the blue economy employs over 350 million in fishing, aquaculture, beach and marine tourism, five millions of them located in Europe [13]

In many countries, the blue economy isn't just represented in a few initiatives but rather in a broad strategy that encourage the Aquaculture & Blue economy development Programs, indeed , the countries efforts to achieve the UN sustainable development goals (SDGs), encouraged the government's to recognize the growth opportunities of the Blue Economy and its strategic position within the world's economy .

One of the main challenges facing the blue economy is the adoption of new technology that serves the blue economy, in order to regulate, and control fishing, to maintain food security and nutrition, to increase the proportion of renewable energy in the world's energy supply.

In this paper, we presented the adoption and use of digital technologies and IoT in the blue economy, many IOT solutions could be implemented to boost the performance of the blue economy related industries which includes; Biotechnology, Coastal and maritime tourism, Aquaculture, Mineral resources.

Given the fact the International Maritime Organization (IMO) doesn't require the small fishing vessel 15 meter length and over to install a tracing system on board of vessels , many countries enforced the fishing vessels to install a vessel monitoring system (VMS) to operate in the country territorial water.

Vessel Monitoring Systems (VMS) and Automatic Identification System (AIS) are widely used in monitoring fishing vessels from different aspects, however, VMS offers an efficient monitoring of the fishing vessels navigating through the territorial water at a lower cost in comparison with other monitoring technologies.

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