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INTRODUCTION OF ZAKAT-INFAQ-SHADAQAH (ZIS) PARAMETERS IN THE GORDON-SCHAEFER FISHERIES BIOECONOMIC MODEL

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Abstract

Fisheries management has experienced significant development with various management models based on fisheries bio-techno-ecology. The bio-techno-ecological approach will not be separated from the existence of Divine Power as the true Creator and Owner of the universe (Allah). Thus, it is necessary to develop a Sharia-based fisheries resource management model. Zakat-infaq-sadaqah (ZIS) is an order from Allah SWT and those who carry it out will get multiple replacements. Therefore, the fishery bioeconomic model (FBM) needs to be introduced with ZIS parameters into the FBM that has been developed by Gordon-Schaefer. The results of the introduction show that the ZIS parameter can be represented by the coefficient α which affects the intrinsic growth rate of fish resources, the coefficient β which affects fishing opportunities, the coefficient γ which affects the ability of ecosystems to provide the carrying capacity of waters for fish resources to reproduce and grow, the coefficient ε which affects the selling price of caught fish and the coefficient ζ which affects the efficiency of extraction costs per unit of fishing effort. This Sharia-based fisheries management (SBFM) model is expected to encourage the effectiveness and efficiency of sustainable fisheries management in the future and become one of the solutions for the presence of Allah SWT's grace and blessings on humans.

Keywords: Maximum sharia economic yield, SBFM model, SBFM parameter estimation model, Sharia FBM, Sustainable fisheries management.

1.Introduction

The fisheries management model has undergone significant development. The concept of maximum sustainable yield (MSY) has been advanced by researchers [1]. The MSY concept is one of the tools for fisheries management, where fishery production must be limited not to exceed MSY. Thus, fish resources can be maintained and provide benefits to humans [2-4]. However, the MSY concept is still centred on a bio-techno-ecological approach, where the main parameters used to measure MSY are still based on the intrinsic growth rate of fish resources (denoted as r, [5]) and the carrying capacity of the aquatic environment (K) to support the growth of these fish resources, besides being influenced by fishing activities carried out by humans and this fishing powered by the coefficient of catchability (q) of fishing gear [6]. The intrinsic rate of population is a fundamental metric in ecology and the evolution of immediate practical application in conservation and wildlife management [7]. Carrying capacity is the maximum number of organisms or populations in an ecosystem that can support the growth of fish populations [1]. Coastal and marine ecosystems, such as mangrove, seagrass, and coral reefs are supporting habitats for spawning ground, feeding ground, and nursery ground for marine fisheries biotas [8-15]. Meanwhile, catchability is a concept in fishery biology that reflects the efficiency of a particular fishery, and its quantitative magnitude is expressed by the catchability coefficient, which relates the biomass abundance to the capture or fishing mortality [16].

The MSY conception was still only in Favor of the bio-techno-ecological approach [17]. Fishing activity is inseparable from the underlying economic aspects that fishing activities are carried out to meet market needs for fish supply and demand. Therefore, then introduced economic parameters represented by prices and costs of fish extraction as correction parameters for the MSY concept. In this context, the results of the introduction of economic parameters are referred to as the fisheries bioeconomic approach also known as the Gordon-Schaefer model [17]. This bioeconomic model presents the concept of maximum economic yield (MEY), where MEY can occur at the point where fisheries profits reach their peak/maximum [2-4, 6]. In addition, conditions, where the profit point is equal to zero, can also be obtained from this fishery bioeconomic model. This zero profit point is then better known as an open access (OA) condition. The Gordon-Schaefer model is still static [17], even though fish resources are dynamic, so it is necessary to develop a fisheries dynamic model [18]. While the link between fisheries economics and capital theory has long been recognized. Fisheries economics has, until the last 2 decades (1955-1975), developed largely along nondynamic lines. One of the dynamic models can be approached by entering dynamic parameters, namely the discount factor into the model. The fisheries bioeconomic model was introduced and developed into an equation that has adopted a discount factor, where optimum sustainable yield (OSY) conditions can be realized at a certain point which is located between MSY and MEY [18]. The fisheries bioeconomic model is the result of the introduction of economic parameters into the fisheries model [17]. Introductions can be made based on economic principles that aim to gain profit, where profit (π) is simply defined as the difference between total revenue (TR) and total expenditure (TC). TR in the fisheries context is the total fishery production which is the result of fishing effort (h) multiplied by the price of fish per unit (e.g., Rp/kg), while TC in the fisheries context is the total fishing effort multiplied by fishing extraction costs per unit effort (e.g., Rp/trip). In OA conditions, fisheries profits are equal to zero can simply solve calculating the level of fish resources (x) in OA conditions. The fishery bioeconomic balance will occur when the fishery profit is maximum, where the maximum profit will occur when the derivative of the profit function ($\pi(x)$) to fish resources (x) is equal to zero, where this applies to the law of the first order condition of a function which is maximized. The fisheries dynamic model is an optimal fishery resource management model that is approached using a capital theory approach [19], where the benefits of exploiting fishery resources over time can be solved by using the Hamiltonian solution [19]. The form of the Hamiltonian provides a solution that the optimal fish resource biomass level (x_{OSY}) using the logistic growth function and results from the optimum production level of fish (h_{OSY}) and the optimum fishing effort level (E_{OSY}).

After developments based on yield estimation, level of effort, and amount of fish biomass put forward by the models [1, 17, 18]. Thus, fisheries management is more focused on input and output management approaches to fishery resource utilization. In 2003, the United Nations Food and Agriculture Organization (FAO) introduced an ecosystem-based management approach (EAFM). The EAFM concept carries the concept of socio-ecological-economic balance to achieve sustainable management goals, where an ecosystem maintenance approach in the context of managing fishery resources is needed to support the growth of fish resources [12, 13]. Ecosystems are habitats that functioned as spawning and nursery grounds, and also places to find food, so efforts need to be made to maintain and/or improve the quality and quantity of related ecosystems and/or provide these three functions [2, 6]. Efforts to manage fisheries should be followed by the concept of Divinity, where Allah has determined the way, life, death, fortune, and all things related to creatures. Everything that has been given by Allah is a mercy and blessing that must be grateful for. Humans often neglect to be grateful, even though Allah said in the Suraah Ibrahim verse 7, which means "And remember when your Lord announced, indeed if you are grateful, I will surely add (Favors) to you, but if you deny (My Favors), then surely My punishment will be very heavy". The concept of gratitude is often interpreted by issuing zakat-infaq-shadaqah (ZIS) to be given to those in need. People who issue ZIS will get the best rewards from Allah. This certainty then drives the importance of ZIS to become something that can be done by fisheries business actors to implement Sharia-based fisheries management. Therefore, this article is expected to be a bridge on how ZIS parameters can be introduced into the basic model that has been developed so far, namely the Gordon-Schaefer fishery basic model [17]. The novelties from this article are (i) the introduction of ZIS into the bioeconomic fisheries model, (ii) ZIS affected biomass through the intrinsic growth rate and carrying capacity, effort through catchability coefficient, and economic benefit through prices and cost of extraction, and (iii) ZIS influences fisheries policy and management.

2.Method

The introduction of ZIS parameters into the fisheries bioeconomic model was carried out by following the line of thought of each model developer, namely [1] and [17], and then continued with the introduction of parameters into the Gordon-Schaefer model [17]. Thus, the results of the ZIS introduction equation can be obtained. The ZIS introduction model is also followed by how all parameters derived from the results of this introduction can be determined and/or estimated using the regression approach. Thus, the four components of sustainable fisheries management can be estimated to produce quantitative standards or indicators in the process of internalizing Sharia-based sustainable fisheries management policies. The flowchart of the approach to developing the introduction of ZIS parameters into the fishery bioeconomic model can be seen in Fig. 1.

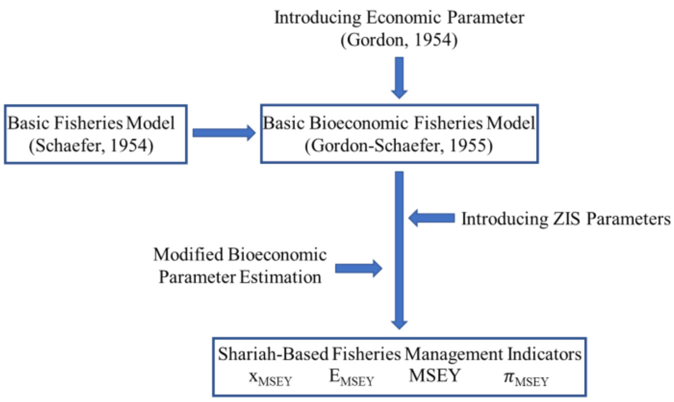

Fig. 1. Flowchart of the approach to developing the introduction of ZIS parameters into the Gordon-Schaefer fishery bioeconomic model.

3. Results and Discussion

Fishery resources can grow and reproduce properly when they receive support from the quality and quantity of the aquatic environment and related habitats as their spawning grounds, feeding ground, and nursery areas. Fish resources (x) have their intrinsic growth rate (r) which is regulated by Allah and also applies to the presence of the carrying capacity of the aquatic environment and habitat (K). Apart from that, related to the ability of the fishing gear to be able to catch fish which is denoted as "q" is also related to how great the grace of the Almighty is to provide sustenance to His servants who make fishing efforts. ZIS affected the intrinsic growth rate, carrying capacity, and catchability of fish resources. The effect of ZIS (Z) on these biological-techno-ecological parameters can be carried out by introducing $r=f(Z)=\alpha.Z$; $K=g(Z)=\beta.Z$; and $q=i(Z)=\gamma.Z$ using the logistic function can be introduced into the function of h or $f(x)$ and becomes Eqs. (1) and (2). Equations (1) and (2) are then introduced into the sustainable fisheries management development. Thus, the optimal allocation of fish resources in the bio-techno-ecological aspect of fisheries management results from the introduction of the ZIS parameter (Z) or later referred to as the Sharia Fisheries Management (SFM) model can be denoted as Eq. (3). After the optimal allocation of fish in the SFM model is known, then by introducing Eq. (3) into Eq. (1) we can obtain the optimal level of fishing effort in the SFM model as can be seen in Eq. (4). Equation (4) is then returned to Eq. (3) to obtain the justified optimal allocation of fish resources (Eq. (5)). By introducing Eq. (5) into Eq. (1), the optimal amount of fisheries production in the SFM Model can be generated as can be seen in Eq. (6). To obtain solutions from Eqs. (4), (5) and (6), it is necessary to carry out an approach that can be used in estimating the sharia parameters α, β, and γ. The Walters-Hilborn [18-20] approach in this context can be borrowed and modified into the SFM parameters estimation model (Eq. (7)).

$$f(x) = \alpha.Z.x\left(1 - \frac{x}{\beta.Z}\right) \tag{1}$$

$$h = \gamma.Z.E.x \quad (2)$$

$$x_{SFM} = \beta.Z\left(1 - \frac{\gamma}{\alpha}E\right) \quad (3)$$

$$\frac{dh}{dE} = 0 \rightarrow E_{SFM} = \frac{\alpha}{2\gamma} \quad (4)$$

$$x_{SFM} = \beta.Z\left(1 - \frac{\gamma}{\alpha}\frac{\alpha}{2\gamma}\right) = \frac{\beta}{2}\underline{Z} \quad (5)$$

$$h_{SFM} = f(x_{SFM}) = \alpha.Z.x_{SFM}\left(1 - \frac{x_{SFM}}{\beta.Z}\right) = \alpha.Z.\frac{\beta}{2}Z\left(1 - \frac{\frac{\beta}{2}Z}{\beta.Z}\right) = \frac{\alpha\beta}{4}\underline{Z}^2 \quad (6)$$

$$\frac{\frac{U_{t+1}.Z_{t-1}}{U_t.Z_t} - 1}{Z_{t-1}} = \alpha - \frac{\alpha}{\beta.\gamma}\frac{U_t}{{Z_{t-1}}^2} - \gamma.E_t \rightarrow y = \frac{\frac{U_{t+1}.Z_{t-1}}{U_t.Z_t} - 1}{Z_{t-1}};\ x_1 = \frac{U_t}{{Z_{t-1}}^2};\ x_2 = E_t$$

$$y = a - b.x_1 - c.x_2 \rightarrow \alpha = |a|;\ \gamma = |c|;\ \beta = \frac{|a|}{|b||c|} \quad (7)$$

As for the Z value, at least it can be obtained by using the assumption approach of the average total amount of annual ZIS at a certain period by all fishermen in a certain area which is a special location for calculating the utilization of sharia-based fish resources this is done. In economics, profit is calculated based on the difference between total revenue and total expenditure. In the context of capture fisheries, total revenue is the production value of fishery products which is the multiplication of the total production of fish resources and the price per unit of production, while total expenditure is the cost of fishery production which is the multiplication of the number of fishing efforts carried out and the cost of extraction per unit of fishing effort [2, 6]. Prices and costs in the economy can be formed and become factors that affect the buying and selling of products, Adam Smith, said the metaphor of the "invisible hand" is something that characterizes the mechanism where the results of socio-economic activities that provide benefits can arise from the actions of individuals who are selfish and this, indeed, triggers uncertainty in the results of buying and selling because none of the subjects intends to produce conditions as what happens in the market. Phenomena like this in Islam can be metaphorized as the existence of Divine Power in holding the human heart. Thus, every event that occurs in the market does not escape the promise of Allah as mentioned in Quran Surah Al-Baqarah verse 261. Because each price is set and the costs incurred are an integral part of the previous ZIS activity, the benefits of fisheries will experience justification due to the influence of the ZIS activity. In this context, by introducing the ZIS factor which is a function of price (p) as well as a function of extraction cost (c), we can obtain maximum sharia economic yield (MSEY) conditions for the amount of fish resource biomass (x_{MSEY}) as seen in Eq. (8) and Eq. (8) it can be obtained the amount of production in MSEY conditions as seen in Eq. (9) and the level of fishing effort in MSEY conditions as seen in Eq. (10). Completion of Eqs. (8), (9), and (10) are estimated, assuming that the amount of ZIS (Z) issued is the average amount of the total annual ZIS in a certain period/period issued by all fishermen in a certain area which is a special location for calculating the utilization of sharia-based fish resources is carried out. The coefficient of the effect of ZIS on price (ε) and the effect of ZIS on extraction costs (ζ) is shown in Eqs. (11) and (12).

$$x_{MSEY} = \frac{\beta}{2}\underline{Z}\left(\underline{Z}^2 + \frac{\zeta}{\varepsilon.\gamma.\beta}\right) \quad (8)$$

$$MSEY = h_{MSEY} = f(x_{MSEY}) = \frac{\alpha.\beta}{4}\underline{Z}^2\left(2\left(\underline{Z}^2 + \frac{\zeta}{\varepsilon.\gamma.\beta}\right) - \left(\underline{Z}^2 + \frac{\zeta}{\varepsilon.\gamma.\beta}\right)^2\right) \quad (9)$$

$$E_{MEY} = \frac{h_{MEY}}{\gamma.Z.x_{MEY}} = \frac{\frac{\alpha.\beta}{4}\underline{Z}^2\left(2\left(\underline{Z}^2+\frac{\zeta}{\varepsilon.\gamma.\beta}\right)-\left(\underline{Z}^2+\frac{\zeta}{\varepsilon.\gamma.\beta}\right)^2\right)}{\gamma.\underline{Z}.\frac{\beta}{2}\underline{Z}\left(Z^2+\frac{\zeta}{\varepsilon.\gamma.\beta}\right)} = \frac{\alpha}{2\gamma}\left(2 - \left(\underline{Z}^2 + \frac{\zeta}{\varepsilon.\gamma.\beta}\right)\right) \quad (10)$$

$$\varepsilon = \frac{p}{Z} \tag{11}$$

$$\zeta = \frac{c}{Z} \tag{12}$$

Allah created the heavens and the earth, Allah governs the universe, Allah arranges sustenance for all creatures, Allah gives and removes kingdoms as His wish to whom it in His wish, Allah increases Favors for those who are grateful, giving is a form of gratitude that a servant can make to His Creator and whoever spends in the way of the Almighty, then He will multiply the amount of "infaq" issued. Allah SWT gives His Favors and gifts to every creature in the universe. There is not a single creature in this world that escapes His Favors and gifts. Nothing is impossible for Him to give His love and affection to all the creatures He created. Every living thing is bound to face death. Every living thing pair reproduces, and benefits all. All creatures are given their affairs according to their capacity and capability. Thus, they can grow and develop according to the characteristics of their life. The universe provides various benefits that can mutually support the life cycle of each creature forming a system that is interdependent on one another. Fish populations change due to internal and external factors [3]. Internal factors that influence changes in fish populations are the intrinsic growth of the fish itself which is biologically influenced by fertility and the age-specific mortality of the fish itself which is related to survival, reproduction, and the age structure of the fish population [3]. A summary of some of the recent literature on population momentum is generally defined as the subsequent growth or decline of a population after replacement conditions are met, where momentum is created by the deviation between the age distribution of the observed population and the underlying stationary (or sometimes stable) age distribution especially at younger ages [2]. These internal factors are influenced by external factors, one of which is the ecosystem/habitat in which there is a system in which "prey" is formed as an important part of consumption for "predators" and will ultimately affect the dynamics of the fish population as a whole [4]. Ecosystems play an important role in providing regulatory and habitat services for fish and other biota, especially as spawning grounds, feeding grounds, and nursery grounds [8-13, 21]. Allah as the Substance Who Regulates everything in the universe, indeed, has an absolute role in making every life and survival of fish which in this case the intrinsic growth factor of fish (r) depends on the will of the Almighty and in turn can have an impact on the availability of fish resources itself. This predator-prey process includes one of the facts related to survival and every living thing will surely meet its death, while the life and death of creatures belong to the Almighty Creator, so the predator-prey process does not escape the grip of Allah's destiny. The existence of ecosystems as an integral part of the carrying capacity for the growth and reproduction of fish (K) is indeed a factor that cannot be separated from this discussion. Several introductions of ecosystem functions into fisheries models have been developed and published [6, 22, 23]. The three of them introduced the influence of the ecosystem into the carrying capacity parameter (K), where it was introduced that carrying capacity is a function of the quality and quantity of mangrove ecosystem habitat [22], the function of coral reef habitat [23] and the function of seagrass meadow habitat [6]. Therefore, this article is expected to be one of the bridges for understanding that the ZIS (Z) mandated to humans (including fishermen) to be issued will be replaced and multiplied by the Almighty through various parameters related to the fisheries system, namely among others through the intrinsic growth rate parameter (*r*) which influences the abundant reproduction of fish (*x*) internally, through the fishing gear coefficient parameter (*q*) which affects increasing fishing opportunities (*E*), through the environmental carrying capacity parameter (*K*) which affects increasing the ability of ecosystems to provide spawning ground, nursery ground, and feeding ground for the population growth of fish (*f(x)*), through the fish price parameter (*p*) which affects the increasing selling price of fishery products (revenue, *TR*), and through the fish resource extraction cost parameter (*c*) which affects the efficiency of extraction costs per unit of fishing effort made (expenditure, *TC*).

4. Conclusion

Fish resources are blessings and gifts from Allah that can be used by fishermen to obtain benefits that are useful for life and family livelihoods. Every Sharia-based fishing business should follow Allah's command to issue infaq. Thus, later the ZIS issued will be replaced and multiplied through various graces and other gifts in the universe, such as the abundant reproduction of fish, increasing fishing opportunities, increasing carrying capacity of waters provided by ecosystems, increasing the selling price of fishery products and efficiency of extraction costs per unit of fishing effort made. This fisheries management model that incorporates ZIS factors into the fisheries bioeconomic model can be developed into an SFM model. Hopefully, this model can encourage ecosystem-based management efforts that have been developed and combined with the issuance of ZIS as infaq as commanded by Allah. Thus, the management of fisheries can provide mercy and blessings to humanity as a whole.

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