Managing sustainable trap nets fishery in the Bontang Marine Conservation Area

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Abstract. The main aims of the study were to evaluate the current situation of traditional trap nets fishery in the Bontang Marine Conservation Area (MCA) of Indonesia and to offer a development strategy for its sustainable management. To achieve these, various approaches were applied, including focus group discussions and interviews using questionnaires with small-scale fishers and stakeholders. Strengths, weaknesses, opportunities, and threats (SWOT) and quantitative strategic planning matrix (QSPM) approaches identified the required planning strategies. Results revealed that the existing activities of traditional trap nets fishery in the MCA are not fulfilling the sustainability requirements. However, policy makers could solve the current weaknesses and threats, based on the prioritization of the primary relationships between weaknesses and opportunities, by developing alternative livelihoods for the traditional trap nets fishers to improve their welfare.
Key Words: small-scale fisheries, East Kalimantan, MCA, SWOT, QSPM.

Introduction. Besides poverty alleviation, fisheries and aquaculture play a role in the livelihoods and national economy, and are a crucial source of animal protein and of income for the coastal communities (Celik et al 2012; Susilo et al 2019; Halim et al 2020). Globally, a total first-sale value of fish production was evaluated at USD 401 billion in 2018, from 179 million tons. Of the total, 87.15% were intended for human consumption, equal to a counted annual supply of 20.50 kg per capita (FAO 2020). Worldwide, 59.51 million people worked directly in fisheries and aquaculture, of which 65.50% were employed in fisheries. More than 90% of fishers work within small-scale fisheries and 97% live in developing countries. Many small-scale fishers live in poverty and are ignored by resource the management and from the social and economic development standpoint (FAO 2020; Malcolm et al 2021).

Small-scale fisheries are identified as traditional fisheries using low-technology, comparatively low-capital and energy, generally labour-intensive activities, and primarily low productivity (FAO 2015; Béné et al 2016). Small-scale fisheries supply food security and livelihoods for coastal communities and also contribute to gross national products (Bravo-Olivas et al 2015; Malcolm et al 2021). However, they are still vulnerable in developing countries, regarding the income, ecological management, health, and political marginalization (Salas et al 2007; Kittinger 2013; Bene et al 2016; FAO 2019). Moreover, social-economic factors are a crucial issue, in small-scale fisheries, caused by a poor ecological management that led to over-exploitation of the resource, due to the tolerance to multiple users, gear types, and target species. The lack of facilities, infrastructure and insufficient data related to fisheries resources have also contributed (Malcolm et al 2021; Salas et al 2007; FAO 2019; Espinosa-Romero et al 2014).

The geographical location of Bontang, one of the cities in Indonesia is closely connected to their marine fisheries resource characteristics. Bontang area is 497.57 km^2, it is dominated by the sea with 349.77 km^2 or 70.30% of the total area (Central Bureau of Statistics 2021). Coastal management in Bontang is a complex issue due to resource

use conflicts often occurring among users. For instance, small-scale fishers who use the traditional barrier trap as static fishing gear may conflict with other users, such as fishers with other fishing gears, industries, and shipping. Traditional barrier trap materials derived from mangrove woods are also affecting the decline in the mangrove ecosystem. As explained above, Bontang must establish a good-management for traditional barrier trap development to reduce the conflicts among coastal resource users and the mangrove loss. Moreover, Bontang is currently supported by the presence of Minister of Marine Affairs and Fisheries Decree No. 27/Kepmen/2021 on Marine Conservation Area (MCA) in Bontang waters.

This study aimed to explore the development strategy for Bontang to design a sustainable traditional barrier trap in the MCA. The strengths, weaknesses, opportunities and threats (SWOT) technique and a quantitative strategic planning matrix (QSPM) analysis are critical to determining the multiple elements required for a sustainable traditional barrier trap development. The SWOT technique has been significantly applied in several locations relating to fisheries management, such as Turkey (Celik et al 2012), Iran (Savari & Amghani 2022), Alaska (Glass et al 2015) and Tuvalu (Siaosi et al 2012). However, studies that combine the two approaches, SWOT and QSPM, in order to initiate a strategic planning for small-scale fisheries, are scarce. Therefore, this study concentrates on internal (strengths and weaknesses) and external factors (opportunities and threats) in Bontang, by applying SWOT and QSPM analysis.

Material and Method

Study area. Bontang Municipality is administratively one of the cities in East Kalimantan Province, consisting of three sub-districts: North Bontang, South Bontang, and West Bontang. It is located on the trans-East Kalimantan roads and directly adjacent to Makassar Strait, bounded by $0^0$01' up to $0^0$12' latitude and $117^0$23' up to $117^0$38' East (Figure 1).

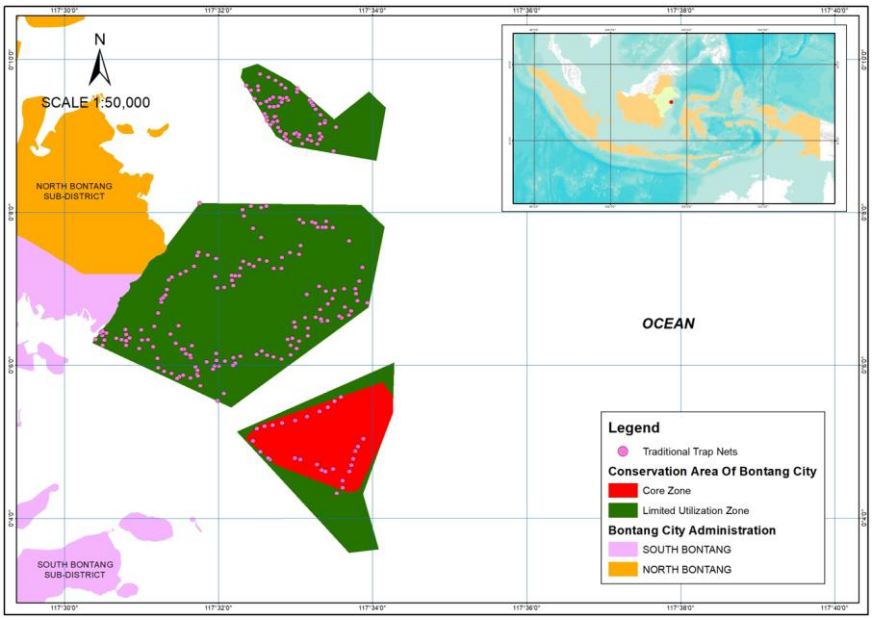

Figure 1. Distribution of traditional trap nets in the Bontang MCA.

Data collection. The survey was carried out for three months, from July to September 2021. Conducting sustainable small-scale fishery management (SSFM) strategic planning requires comprehensive data for analysis. In this study, mixed data was collected, as primary and secondary data. Primary data were sourced from focus group discussions (FDGs) to obtain qualitative information and questionnaires for small-scale fishers using traditional trap nets. At the same time, secondary data consisted of literature studies and reports from related institutions. The FDGs were implemented to determine the current

strengths, weaknesses, opportunities, and threats in managing small-scale fishery in Bontang Municipality. The participation of stakeholder representatives involved in the FGD included the Food Security, Fishery and Agriculture Office of Bontang Municipality; the Regional Development Planning Agency of Bontang; the Regional Disaster Management Agency of Bontang; the Tourism Office of Bontang; the Marine and Fisheries Agency of East Kalimantan Province; university; private sectors and local fishers.

Hereafter, based on the results from the FGDs, questionnaires were designed to elicit the primary data by employing interviews with one hundred small-scale fishers applying traditional trap nets as respondents. The results were employed to identify the planning strategies using SWOT analysis. Lastly, the quantitative strategic planning matrix analysis (QSPM) was carried out by applying survey data using questionnaires from representatives of previous FDGs to identify the priority of planning strategies for developing sustainable small-scale fishery management in the study area.

SWOT analysis. This study analyzed the strengths, weaknesses, opportunities, and threats (SWOT) to gather information about traditional trap nets management. A SWOT analysis is an efficient method to evaluate internal and external factors as well as to identify the priorities of a goal for strategy planning, which derives from opinions of experts or policymakers familiar with the research goals (Glaister & Falshaw 1999; Duarte et al 2006; Buta 2007; Helms & Nixon 2010). Previously, SWOT analysis was applied to determine strategic plans in business fields. However, it has now been developed in fisheries to support the policy directives in sustainable fisheries management (Stead 2005; Çelik et al 2012; Glass et al 2015).

Also, SWOT analysis aims to evaluate existing policies by identifying internal and external factors; an internal factor covers strengths and weaknesses, whereas an external factor covers the opportunities and threats (Harfst et al 2010). This study employs the internal factors estimated matrix (IFEM) and the external factors estimated matrix (EFEM) to gather information from internal and external factors. Furthermore, these factors are assigned a score by a panel of key informants, representatives of the FDGs. The scoring process is as follows (Ghorbani et al 2015):

1. The factors (internal and external) are assigned a coefficient between 0 and 1, representing the "not important" and "most important" factors, respectively. This coefficient describes the relative significance of the factor in terms of completion rate and is characterized by the term "weight" in the IFEM and EFEM. A higher weight describes a more influential factor in managing sustainable traditional trap nets.
2. Each factor from internal and external factors is assigned a score from 1 to 4, denoting the definition of fundamental weakness, minor weakness, strength, and high strength, respectively.
3. The weight of the factor is multiplied by its score to define the final score.
4. The total final score of IFEM and EFEM is obtained by summing the calculation result from each factor's total score.
5. Interpretation of the total score: a value higher than 2.5, it indicates that strengths or opportunities outweighed weaknesses or threats, and vice versa (David 1986; Bohari et al 2013).

The quantitative strategic planning matrix (QSPM) analysis. QSPM is an analytical approach for comparing appropriate alternative efforts. David (1986) stated that QSPM evaluated the feasible alternative strategies by employing input information from the success factors analysis based on external and internal factors formerly identified. Some steps are required in sustainable traditional trap nets management. Firstly, for identifying the primary strategic factors, the IFEM and EFEM are applied to evaluate significant strengths and weaknesses (IFEM) and to visualize the opportunities and threats (EFEM) that have been identified from the input information based on FGDs. Secondly, the most attractive strategy is formulated using the SWOT analysis and result from the identity of primary strategic factors in the first stage. Lastly, the relative attractiveness of some strategies is determined by using the QSPM approach. The relative attractiveness of each

strategy is calculated by selecting the cumulative effect of each external and internal critical success factor.

Results and Discussion. After collecting primary and secondary data, the study analyzed the internal and external factors, SWOT and QSPM to identify strategic planning priorities of sustainable traditional trap nets management.

Internal factor estimation matrix (IFEM). Regarding internal factors, FGDs results showed that six factors were identified as strengths, and five factors were determined as weaknesses. These factors, then, will be analyzed into IFEM. Table 1 displays six factors connected to the strengths, which weigh 0.017 and 0.133, and effectiveness scores between 3 and 4. For weaknesses, five factors have weights between 0.075 and 0.125 and effectiveness scores between 1 and 2. In the case of strengths, results revealed that the most crucial factor, that obtained the highest weight, was "adequate prosperity of the traditional trap nets fishers". The following essential factors respectively included "having relatively reachable access to the fishing ground", and "having an abundant supply of fishery resources." On the contrary, the least important factor to sustainable traditional trap nets management was "the existence of patronage social institutions", followed by "having high abundance of small-scale fishery households" and "sufficient experience of the traditional trap nets fishers".

Results presented that an essential factor that obtained the highest weight for weaknesses was "having a limited fishing ground area". The following crucial factors respectively included "low technology of trap nets gear", "poor awareness of fishery resources management", and "low formal education of the traditional trap nets fishers", whereas a minor crucial factor was the "influence of seasonal variation on fishing activity". The total value of IFEM was estimated at 2.475, which was less than 2.500, indicating the strengths were overcome by the weaknesses. This finding also suggests that the traditional trap nets management at the moment has not optimized its strengths to overcome the weaknesses.

Table 1

Internal factor estimation matrix (IFEM)

No	*Internal factors*	*Weights*	*Effectiveness score*	*Final score*
	Strengths			1.800
1	Having an abundant supply of fishery resources	0.100	4	0.400
2	Having high availability of small-scale fishery households	0.067	3	0.200
3	Sufficient experience of the traditional trap nets fishers	0.067	4	0.267
4	The existence of patronage social institutions	0.017	3	0.050
5	Having relatively reachable access to the fishing ground	0.117	3	0.350
	Weaknesses			0.675
1	Influence of seasonal variation on fishing activity	0.075	2	0.150
2	Having a limited fishing ground area	0.125	1	0.125
3	Low technology of trap nets gear	0.100	1	0.100
4	Poor awareness of fishery resources management	0.100	1	0.100
5	Low formal education of the traditional trap nets fishers	0.100	2	0.200
	Total	1.000		2.475

External factor estimation matrix (EFEM). Regarding external factors, six factors for opportunities and five factors for threats were respectively chosen and analyzed. Table 2 presents that six opportunities factors have weights between 0.067 and 0.117 and effectiveness scores between 3 and 4, whereas five factors connecting to threats weigh 0.075 and 0.125, and effectiveness scores between 1 and 2. For opportunities, "the local government supports the trap nets development", "having high interest from the private sector for post-harvest development", and "the high economic potential of processed fish products" had the highest weights. On the contrary, "high level of fish demand from the traditional trap nets", "the existence of a central government policy in facilitating licensing to local fishers", and "driving the development of fisheries micro, small and medium enterprises (MSMEs)" had the lowest weights.

In case of threats, the highest weights were "the conflicts among a variety of fishing gear users", followed by "operation of the traditional trap nets in the core zone", " shipping channel dredging activities", and "changes in the ecology of the mangrove forest due to massive the uncontrolled traditional trap nets operation". On the other hand, "water pollution potential" had the lowest weight. The total value of external factors was estimated as 2.450, which was less than 2.500, implying that the opportunities were less than the threats. This finding also indicates that traditional trap nets management at the moment has not exploited its opportunities to resolve the threats.

Table 2

External factor estimation matrix (IFEM)

No	*External factors*	*Weights*	*Effectiveness score*	*Final score*
	Opportunities			1.750
1	High level of fish demand from the traditional trap nets	0.067	4	0.267
2	The existence of a central government policy in facilitating licensing to local fishers	0.067	4	0.267
3	The high economic potential of processed fish products	0.083	3	0.250
4	Driving the development of fisheries micro, small and medium enterprises (MSMEs)	0.067	3	0.200
5	The local government supports the trap nets development	0.117	4	0.467
6	Having high interest from the private sector for post-harvest development	0.100	3	0.300
	Threats			0.700
1	Operation of the traditional trap nets in the core zone	0.100	1	0.100
2	Water pollution potential	0.075	1	0.075
3	Shipping channel dredging activities	0.100	2	0.200
4	The conflicts among a variety of fishing gear users	0.125	1	0.125
5	Changes in the ecology of the mangrove forest due to massive the uncontrolled traditional trap nets operation	0.100	2	0.200
	Total	1.000		2.450

SWOT strategies. Once evaluated the most significant internal and external features and analyzed the linkages between internal and external factors, SWOT analysis will formulate planning strategies by combining four types of strategies to improve sustainable traditional trap nets management. The four types are the combined results from strengths and opportunities (SO), weaknesses and threats (WT), strengths and

threats (ST), and weaknesses and opportunities (WO). Eight key strategies have been determined for sustainable traditional trap nets management by pairwise matching of SO, WO, ST and WT. The SO strategies offered strengths appropriate to the opportunities. The two best SO strategies were "developing processed fish products industrialization originating from the traditional trap nets production" and "the institutional capacity building between private and government community partnerships for integrated trap nets management". The ST strategies diagnose the ways to decrease susceptibility to external threats. The two best recommendations in these strategies comprise "determination of environmental carrying capacity for the traditional trap nets in the MCA", and "enhancing integrated mangrove conservation program in the region".

Further, the WO strategies analyze how to resolve weaknesses to optimize opportunities. The two best WO strategies were "planning for the sustainable management of the trap nets in the region", and "alternative livelihoods development for the traditional trap nets fishers to improve the welfare". Finally, the WT strategies offer a defensive plan to prevent weaknesses that are susceptible to external threats. The two best WT strategies were "improvement of supervision and law enforcement in space utilization in the MCA", and "improvement of fishers' awareness regarding the function of MCA in the region". The results are presented in Table 3.

Table 3

Sustainable trap nets management strategies based on SWOT analysis

	Planning strategies
	Strengths-opportunities strategies
1	Developing processed fish products industrialization originating from the traditional trap nets production
2	The institutional capacity building between private and government community partnerships for integrated trap nets management
	Strengths-threats strategies
1	Determination of environmental carrying capacity for the traditional trap nets in the MCA
2	Enhancing integrated mangrove conservation program in the region
	Weaknesses-opportunities strategies
1	Planning for the sustainable management of the trap nets in the region
2	Alternative livelihoods development for the traditional trap nets fishers to improve the welfare
	Weaknesses-threats strategies
1	Improvement of supervision and law enforcement in space utilization in the MCA
2	Improvement of fishers' awareness regarding the function of MCA in the region

QSPM strategies. The QSPM analysis provides further guidance and the best planning strategies for sustainable traditional trap nets management. The priority of the strategy is obtained from the value of the total attractiveness score (TAS), where the highest TAS value can be the most acceptable strategy for the sustainable traditional trap nets management in the study area. Results in Table 4 presented that the best strategy was "alternative livelihoods development for the traditional trap nets fishers to improve the welfare" (WO2 strategy) with a TAS value of 7.90, followed by "the institutional capacity building between private and government community partnerships for integrated trap nets management" (SO2 strategy) and "planning for the sustainable management of the trap nets in the region" (WO1 strategy), with TAS values of 7.88 and 7.78, respectively. Afterward, three other vital strategies were "improvement of fishers' awareness regarding the function of MCA in the region" (WT2 strategy), "developing processed fish products industrialization originating from the traditional trap nets production" (SO1 strategy), and "enhancing integrated mangrove conservation program in the region" (ST2 strategy). TAS values of those were 7.72, 7.63, and 7.60, respectively, whereas "determination of environmental carrying capacity for the traditional trap nets in the MCA" (ST1 strategy) and "improvement of supervision and law enforcement in space utilization in

the MCA" (WT1 strategy) obtained TAS values of 7.53 and 7.49, respectively, as the least essential strategies influencing sustainable traditional trap nets management.

Table 4

The final result of QSPM analysis for SWOT strategies proposed

Code	*Planning strategies*	*Total attractiveness score*
WO2	Alternative livelihoods development for the traditional trap nets fishers to improve welfare	7.90
SO2	The institutional capacity building between private and government community partnerships for integrated trap nets management	7.88
WO1	Planning for the sustainable management of the trap nets in the region	7.78
WT2	Improvement of fishers' awareness regarding the function of MCA in the region	7.72
SO1	Developing processed fish products industrialization originating from the traditional trap nets production	7.63
ST2	Enhancing integrated mangrove conservation program in the region	7.60
ST1	Determination of environmental carrying capacity for the traditional trap nets in the MCA	7.53
WT1	Improvement of supervision and law enforcement in space utilization in the MCA	7.49

Conclusions. The study displays qualitative and quantitative assessments using SWOT and QSPM analysis to reach the best strategies for sustainable traditional trap nets management in the Bontang MCA. The study area has the best opportunities to manage sustainable traditional trap nets considering the local government supports their development and the high economic potential of processed fish products. However, the current management situation is not as expected in the sustainability requirements due to the limited fishing ground area. Moreover, the conflicts among various fishing gear users, changes in the mangrove forest ecology due to massive uncontrolled traditional trap nets operation, and operation of the traditional trap nets in the core zone threaten the sustainable traditional trap nets management in the study area. However, policymakers could solve the current weaknesses and threats by making the best priorities considering the primary relationships between weaknesses and opportunities. The best strategy is the alternative livelihoods development for the traditional trap nets fishers to improve their welfare. Another good strategy could be indicated by a crucial relationship between strengths and opportunities: the institutional capacity building between private and government community partnerships for integrated trap nets management. This study provides a crucial valuable technique for policymakers to determine a sustainable trap nets management in the MCA by applying a combination between SWOT and QSPM. Those approaches could also be an alternative to identifying positive and negative factors influencing the trap nets management in sustainable capture fisheries.

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