Journal of Agricultural and Marine Sciences 2024, 29(2): 64 - 79
DOI: 10.53541/jams.vol29iss2pp64 - 79
Received 25 June 2023
Accepted 20 June 2024

RESEARCH PAPER

Sustainable Development in Oman Fisheries Industry: Status and Potential of Fishing Companies

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التنمية المستدامة في صناعة الثروة السمكية العمانية: وضع وإمكانات شركات الصيد

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ABSTRACT. Our study examines the condition of sustainable development in Omani fisheries industry, with specific focus on the extent to which the fishing companies practice sustainable fishing that meets the objective of food security. We also detect, characterize, and analyze the compliance of the fishing companies with the principles of social, economic, and environmental sustainability. Using 55 completed questionnaires of 70 surveyed operating fishing companies, a multivariate general linear model was used to determine the impact of economic and environmental factors on achieving sustainability, and domestic demand of fisheries sector in Oman. Our results revealed that more than 63% of companies believed that sustainability is extremely important in the fisheries industry, and around 42% of the companies 'strongly agree' that Oman meets its domestic demand from its own harvest. The model displayed significant effects of the amount of production for local consumption, climate change adaptation, and water waste management on improving sustainability of the fisheries sector. Analysis also confirmed significant effects on the amount of production for local consumption, amount of production for export, and using technology to locate stock on enabling the country to meet its domestic demand through its own harvest. We conclude by arguing that our findings have important implications for managing production in terms of food security and safeguarding domestic consumption.

KEYWORDS: sustainable development; sustainable fisheries; sustainability; food security; climate change; Oman.

الخلاصة: تبحث دراستنا في حالة التنمية المستدامة في قطاع الثروة السمكية العمانية، مع التركيز بشكل خاص على مدى ممارسة شركات الصيد للصيد المستدام الذي يلبي هدف الأمن الغذائي. كما نقوم باكتشاف وتوصيف وتحليل امتثال شركات الصيد لمبادئ الاستدامة الاجتماعية والاقتصادية والبيئية. باستخدام 55 استبانة مكتملة من 70 شركة صيد عاملة تم مسحها، تم استخدام نموذج خطي عام متعدد المتغيرات لتحديد تأثير العوامل الاقتصادية والبيئية على تحقيق الاستدامة والطلب المحلي لقطاع الثروة السمكية في سلطنة عمان. كشفت نتائجنا أن أكثر من 63٪ من الشركات تعتقد أن الاستدامة مهمة للغاية في صناعة مصايد الأسماك، وحوالي 42٪ من الشركات "توافق بشدة" على أن عمان تلبي طلبها المحلي من حصادها الخاص. أظهر النموذج آثارا كبيرة لكمية الإنتاج للاستهلاك المحلي، والتكيف مع تغير المناخ، وإدارة نفايات المياه على تحسين استدامة قطاع مصايد الأسماك. كما أكد التحليل وجود آثار كبيرة على كمية الإنتاج للاستهلاك المحلي، وكمية الإنتاج للتصدير، واستخدام التكنولوجيا لتحديد موقع المخزون على تمكين الدولة من تلبية الطلب المحلي من خلال حصاده الخاص. نختتم بالقول إن النتائج التي توصلنا إليها لها آثار مهمة على إدارة الإنتاج من حيث الأمن الغذائي وحماية الاستهلاك المحلي

الكلمات الرئيسية: التنمية المستدامة، مصايد الأسماك المستدامة، الاستدامة، الأمن الغذائي، تغيرالمناخ، عُمان.

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Introduction

The pressing issues of climate change, natural calamities and national crises pose major challenges to the effort of achieving food security (Rizal and Anna, 2019). For instance, COVID-19 caused widespread effects on employment, poverty, healthcare, education, nutrition, food security, and the overall functioning of food systems (Amare et al., 2021; Barrett, 2020). The entire global supply chain system was badly affected by the pandemic and lately by the Russian-Ukraine crisis, putting more pressure on the food security systems. Taylor et al. (2019) also stressed the damaging effect of climate change on food security and the coastal and marine ecosystems, consequently spoiling the fisheries industry.

Fisheries Industry, including capture fishery and aquaculture, provides vital sources of food, recreation, employment, social health, trade, and economic well-being for people (Chubado, 2021; Cojocaru et al., 2022). It offers better livelihoods worldwide, as more than 250 million people depend directly on fisheries and aquaculture, and millions are employed in processing and marketing of fisheries and aquaculture (Chubado, 2021). The growing demand for fish and fish products is triggering pressure on the global fish stock and the need for meeting domestic consumption. Even though the capture of fisheries and aquaculture amounted to 178.5 million tons, of which 96.4 million tons of fisheries in 2018, there is an urgent need to increase these amounts to sustainable levels to support nutritional value, status of food, and livelihood of people and animals (Pędziwiatr et al., 2017; Wangkheirakpam et al., 2019).

Therefore, sustainable development of the fisheries industry topped the political and economic agenda of many developed and developing countries. Funge-Smith and Bennett (2019) highlighted the efforts by many nations to achieve the sustainable development goal 14, which deals with life below water, and specified conservation measures pertaining to oceans, seas, and marine resources. Rizal and Anna (2019) also underlined the importance of sustainable development of the fisheries industry to meet the objective of food security via optimum and efficient use of domestic resources.

Analytically, our study aims to examine the status and pattern of sustainable development of the fisheries industry in the context of the Sultanate of Oman. Recent statistics show sustained growth in the fisheries industry, with its share to gross domestic product (GDP) accounting for OMR 214.8 million in 2017, OMR 257.4 million in 2019, and OMR 299 million in 2020 (NCSI, 2021). To sustain this growth, substantial improvement must be attained in the governance system, the upgrade of technology, the quality of landings, and utilization of fisheries resources. According to MOAF & World Bank (2015) Oman Vision 2040 aims to "create profitable world class sector that is ecologically sustainable and a net contributor to Oman's economy". This Vision set target of over 220,000 tons of aquaculture, which will contribute US$ 500 million to US$ 900 million to the economy by 2040.

Methodologically, we use key concepts such as sustainability and sustainable development, while defining sustainable fisheries. The role of sustainable fisheries is vital to maintain the viability of the species caught, without affecting other species or fishing communities that benefit from the ecosystem. This indicates that sustainable development has become more comprehensive and measurable (Emas, 2015), and that the best way for managing fisheries is to restore high level of sustainable fish stocks, catches, and revenues (Cámara and Sánchez, 2019). Attaining this outcome requires extensive assessment of the three sustainability factors - economic, social, and environmental sustainability. We used a survey questionnaire and semi-structured interviews to collect primary data from the operating fishing companies in Oman between March and June 2022. The multivariate general linear model is used to analyze the data and to measure the importance of sustainability at the company level. Thus, the study aimed to achieve the following objectives: (i) To detect, characterize, and analyze sustainable development in the fishing companies in Oman by concentrating on economic and environmental sustainability factors, (ii) To evaluate the extent to which fishing companies exercise sustainable fishing practices to meet the objective of food security.

The remainder of the paper consists of five sections. Section 2 provides literature review including conceptual underpinnings that explain sustainable development in the fisheries sector and its relations with food security and climate change. Section 3 explains the materials and methods used to achieve the objectives of the study. Section 4 presents the results of the analysis. Section 5 discussed the implications of the findings, followed by a brief conclusion.

Literature Review

Sustainable Development in Fisheries

The concept of sustainable fisheries is defined as "the stewardship of the fisheries resources so as to provide economic and social benefits for the present while conserving the renewable resource based for future generations" (Modayil, 2014). This definition underpins the role of sustainable development to maintain the viability of the species caught, without affecting other species or fishing communities that benefit from the ecosystem (Camera and Sanchez, 2019). Sustainable fisheries with regard to climate change and food security involves ensuring sustainability that increases productivity and production particularly implementing resilient practices of increasing food production, ending hunger and ensuring access of sufficient food and nutritious to all members of the community. Moreover, achieving sustainable management in fisheries entails adaptation to climate change, efficient use of natural resources and extreme weather that help to maintain ecosystems (WWF, 2019b; Chubado, 2021).

Sustainable development in the fisheries sector is equally important for the developed and developing nations. In Bangladesh for example, the dependency on coastal and marine ecosystems is likely to rise further (UNEP, 2006) which is why the government has emphasized on enhancing blue-growth economy as well as SGDs where the ocean and marine resources would play a key role (Islam and Shamsuddoha, 2018). In developing nations, small-scale fisheries, although play a crucial role, they are squeezed by large industrial fleets and the advancement of aquaculture (Bavinck et al., 2017). Cohen et al. (2019) pointed out how blue economy and sustainable development practices should be adaptable to diverse small-scale fisheries in different nations that would also be more inclusive in nature towards the various cultures and interests.

Sustainable Fisheries and Food Security

Sustainable fisheries through fish and other fish products provide essential economic and social sources by improving food and nutrition security (Cojocaru et al., 2022). The United Nation's Food and Agriculture Organization (FAO) discoursed that global production from fisheries remains very significant for global food security (Chubado, 2021; Heck et al., 2022), For instance over 87% of global fish production is used for human consumption (Galappaththi et al., 2021). Moreover, fisheries provide minerals to 400 million people in developing countries, almost 100 million tons of protein for direct human consumption per year, and provide 50% of animal protein (Chubado, 2021).

Artisanal fisheries in many countries play a critical role in ensuring food security, amending livelihood, and preventing hunger and poverty. (March and Failler, 2021). The world fish catch from small-scale fisheries account for about half of the production, as two- thirds of it destined for human consumption (Aguion et al., 2022). Loring et al. (2019) highlighted how small-scale fisheries also play a crucial role in local and global food security through fish being an object of cultural identity and fisheries being a link between the well-being of the community and the health of the marine and freshwater ecosystems.

Several studies examined the crucial role of fisheries in food security. Lauria et al. (2018) underlined the importance of this industry in Bangladesh, India, and Ghana, while Teh and Pauly (2018) focused on the role of fisheries in the development of Cambodia, Malaysia, Thailand, and Vietnam. Further examinations underlined the role of blue economic in achieving sustainable growth in various maritime sectors, with special attention for achieving food security in the Indian Ocean (Techera, 2018), Bangladesh (Hossain et al., 2018) and Commonwealth countries (Voyer et al., 2022).

Sustainable Fisheries and Climate Change

Fisheries is one of the sectors that is sensitive to environmental circumstances particularly its vulnerability to climate change conditions (Galappaththi et al., 2021). Climate change negatively affects the fisheries industry in various ways. For example, it negatively affects the marine ecosystem and the viability of fish stocks through reducing yield, increasing yield variability, changing distribution of stocks, causing sea-level change, causing flooding, and wave surges. Climate change effects also increase risks of fishing, causing social disruptions and new fisher influx, bust cycles to marine small pelagic stocks, change in abundance, and mix of harvested species (FAO, 2021). Recently it is also reported that long-term warming or heat waves have devastating impact on the marine ecosystem (Smale et al., 2019). Climate change also has detrimental effects on the physical and biogeochemical aspects and causes changes in the primary production and marine ecosystems and was also found to impact the maximum catch and in turn the revenue (Lam et al., 2020).

Climate change has trivial impact on the four dimensions of food security including viability, stability, access, and utilization of food (FAO, 2020). For instance, fish species shift because of global warming from countries of high latitudes to new environments. This indicates that the home environment encounters losing significant portions of their fish stocks and production (Cojocaru et al., 2022).

Full adaptation of climate change identifies taking responsibility of addressing challenges in fisheries management in both ocean productivity that implies biodiversity of marine food web and population density, and instability in the distribution of marine resources (WWF, 2019a). Potential adaptation measures to address the impacts of climate change on fisheries include protecting and managing marine areas, with providing inshore low-cost fish aggregating devices (Dey et al., 2016).

FAO (2020) has improved adaptation toolbox for industries, governments, and individuals including fishers and fish farmers. Moreover, the FAO (2020) suggested mitigation strategies to reduce GHG emissions and fuel use in fisheries and aquaculture. The strategies involve improving fuel efficiency through reducing vessel speed, using insulation for heating and cooling, and utilizing waste heat. Beside using alternative gears that require less fuel and gears of high-strength materials, using larger mesh sizes, thinner twines, efficient otter boards, and selecting feedstuff with low emissions, as oil seeds are better than fish oil and fish meal products, alongside with optimizing fertilization guidelines of pond aquaculture.

The above literature helps us draw the hypotheses of the study, thus enabling the achievement of the objectives. The hypotheses of the study are as follows:

H_1: Increased local production leads to increased sustainability and domestic demand achieved.

H_2: Increased and improved exports lead to more sustainability and domestic demand being achieved.

H_3: Decreased duration of landing is associated with increased sustainability and domestic demand being achieved.

H_4: Better wastewater management is associated with increased sustainability and domestic demand being achieved.

Materials and Method

Model Specification

This study aimed to assess whether fisheries companies in Oman practice sustainable development by focusing on the economic, environmental, and social sustainability factors, while determining if these companies try to achieve food security by exercising sustainable fishing practices. To meet these objectives, primary data is collected through online questionnaire surveys and telephone interviews. We received a list of 120 companies registered in the fisheries sector from the Ministry of Agriculture and Fisheries, of which only 70 companies are operating, and many companies registered by one owner under several names. The total sample size of the study was 55. For this study two techniques are applied: descriptive statistics and a general linear model (multivariate tests).

where y is a dependent variable, mx are inde-

$$Y_{S,DD} = mx_{TLS} + mx_{CCP} + mx_{CCD} + mx_{ww} + mx_{DL} + mx_{LC} + mx_{EX} + b$$

pendent variables, and *b* is y-intercept. After several trials of omission and addition of variables, it was decided that (S) sustainability in fisheries, and (DD) domestic demand for fish would be the dependent variables. Sustainability variable covers extremely important, important, neutral, not important, and extremely not important. Domestic demand includes strongly agree, agree, neutral, disagree, and strongly disagree. Since a multivariate general linear model has been used, independent variables had to be categorized as factors and covariates. Factors included (TLC) the technology that the company uses to locate the stock which covers sonar system, navigation system, both, and others. The (CCP) factor related to climate change effect on the production, which includes strongly agree, agree, neutral, disagree, and strongly disagree. The (CCD) factor is about how the company deal with climate change to save its production, which covers: freezing, importing fish during low harvest, reducing wages of fishermen and other employees, and other. The last factor is (WW) which is about how the company deals with water waste, it includes: thrown it in the ocean, filter it and reuse it for processing, filter it and use it for irrigation, and filter it and use it for drinking. Covariates were (DL) the duration of landing that contains less than one hour, one hour, two hours, three hours, four hours, more than four hours. The (LC) local consumption covariate includes less than 20%, 20% - 39%, 40% - 59%, 60% - 79% and 80% - 100%. The last covariate (EX) represents production for export, which covers: Less than 20%, From 20% - 39%, From 40% - 59%, From 60% - 79%, From 80% - 100%.

Data Collection

The study used online questionnaires and semi-structured interviews. The online questionnaire was designed through (QuestionPro) by the Centre of Statistics in SQU. It was distributed among executives and managers of the fishing companies. The semi-structured interviews were conducted with over 20 company executives. A non- probability purposive sampling method was applied and a sample of around 55 companies from all the governorates were targeted. Information regarding the companies were collected from Oman Chamber of Commerce and Industry and from the Ministry of Agriculture and Fisheries, particularly from Directorate General of Marketing in Agriculture and Fisheries. The companies are specialized in different activities associated with fisheries, namely catching, processing, canning, distribution, freezing, trading, marketing, and fish packaging.

Analysis and Results

Descriptive Statistics

Several questions highlighting the importance of sustainable development in the fisheries industry and climate change were asked to the fisheries companies. Table 1 shows the descriptive statistics of some of the questions, providing a clearer picture of companies' perceptions. Two of the most important questions that were asked to respondents, and which are also the independent variables in the multinomial logistic regression are how companies perceive the importance of sustainable fishing practices, and how the com-

Table 1. Descriptive statistics of the companies' perceptions on importance of sustainable fishing and domestic demand

How important is sustainability			
Degree of Sustainability	**Frequency**	**Percentage**	**Cumulative Percentage**
Extremely Important	35	63.6	63.6
Important	18	32.7	96.4
Neutral	1	1.8	98.2
Extremely not Important	1	1.8	98.2
Total	55	100.0	100.0
Oman domestic demand			
Degree of Sustainability	**Frequency**	**Percentage**	**Cumulative Percentage**
Strongly agree	23	41.8	41.8
Agree	13	23.6	65.5
Neutral	11	20.0	85.5
Disagree	7	12.7	98.2
Strongly Disagree	1	1.8	100.0
Total	55	100.0	41.8

panies meet the domestic demand for fish.

Since the importance of sustainability in fisheries is a function of economic, environmental, and social sustainability, around 63.64% of the sample (comprised 35 companies) agreed that sustainability is 'extremely important', followed by 32.73% (18 companies) that viewed sustainability is 'important' for company's continued operation and survival. A company thought that sustainability is 'not important'; this reflects how fishing companies consider achieving sustainable development in the fisheries industry a key contribution in the gross domestic product and national domestic product. Furthermore, since domestic demand in one case measures the dependence of local people and the domestic market on the consumption of the companies' products. About 41.8% of the sample (23 companies) 'strongly agree' that Oman meets its domestic demand through its own harvest, while 23.6% comprised 13 companies 'agree' on this matter. One company only 'strongly disagree' of the potentiality of fisheries sector to afford the domestic demand through its own harvest and manufacturing. This reflects the possibility of the fisheries sector fulfilling the needs and requirements of local people and local market demand.

Table 2 shows that the month of July witnessed the highest percentage of 43.6%, with the highest reduction in the production in the year; it is followed by the month of June of 25.5%. However, production was not affected during April and October, and was less affected during the rest of the year. Respondents interpreted the reasons of why some months run into a decrease in the production than others due to weather conditions, high temperature, monsoon season, rough sea waves, and difficulty of fishing during autumn season.

Companies gave some suggestions

Table 2. The impact of climate change on production per month

Month	Frequency	Percentage
January	2	3.6
February	1	1.8
March	1	1.8
April	0	0.0
May	2	3.6
June	14	25.5
July	24	43.6
August	3	5.5
September	1	1.8
October	0	0.0
November	1	1.8
December	1	1.8
Not affected by seasons	5	9.1

for the government to address negative consequences of climate change on marine life and species. They invited the government to increase artisanal fishing and stop commercial fishing that depends on using dredges (Trawlers). Dredges are types of fishing gear that depend on catching big amount of fish stock. Companies also threw a great blame on fish meal and fish oil factories, that require high number of fish for processing and production. They encouraged the government to enforce the laws and regulations in fisheries to stop overfishing, conserve the environment, and protect marine life and species. Government ought to expand export and import to activate trading and economic diversity. The companies recommended that the government should provide fishermen and fishing companies with training courses to enhance awareness of the appropriate methods of catching, and best ways of dealing with the ecosystem. They also indorse other companies to use proper trolling ban, enhance aquaculture systems, and expand on pollution control systems.

With respect to the assistance the companies expect from the government, the respondents anticipated a variety of facilities and support to be offered by the government for the benefit of the country, fishermen, and fisheries industry. The requirements can be summed in the following: (1) provide easily permits, clearances, and approvals; (2) organize the sector in a better way to protect the biomass; (3) monitor and implement tough penalties for the violators, specially fishmeal factories and trawlers; (4) study and publish the condition of the biomass; (5) training and empowering Omani youth in the field of shrimp farming, as this sector is new and requires local leadership in the coming years in line with Vision 2040; (6) cooperation between public and private companies in fisheries; (7) providing fishing companies with some incentives in import and export; (8) financing companies and supplying them with money and equipment; (9) easing the procedure of bringing foreign workers from outside Oman; (10) promoting policies that encourage sustainability; and (11) setting flexible rules and regulations in terms of licences of fishermen and boats.

Regarding reducing the air pollution resulting from fish processing, most companies surveyed mentioned that they do not have any significant air pollution. Rather, the respondents considered fishmeal and fish oil companies the main source of air pollution during fish process-

Table 3. Between-subjects factors

Factor		Value Label	N
Technology for locating the stock	0	0	2
	1	Sonar system	14
	2	Navigation system	12
	3	Both	7
	4	Other	20
Has climate affected production?	1	Strongly agree	22
	2	Agree	20
	3	Neutral	12
	4	Disagree	1
How do you deal with climate change?	1	Freezing	28
	2	Importing fish during low harvest	10
	3	Reducing the wages of fishermen and other employees	5
	4	Other	12
Dealing with wastewater	1	Thrown it in the ocean	6
	2	Filter it and reduce it for processing	12
	3	Filter it and reuse it for irrigation	25
	5	Other	12

ing. Ultimately, companies agreed to use certain techniques to reduce air pollution, the techniques can be summarized in using refrigerant gas, chlorine, filters, air fans, and decarburization projects.

Results of the Multivariate General Linear Model

The results of the multivariate general linear model have many components because they do not only show interactions of the independent variables with those of the dependent variables, they but also show interactions between each of the factors as well.

Table 3 shows the interaction between subject factors, which quickly give us a snapshot of the sample size of each variable and the count of the responses under each category of the responses. The table shows that out of the various systems for locating stock, there were 14 responses for the sonar system and 12 under the navigation system and 7 that use both systems. The table shows that of 42 companies, a majority of the companies 'strongly agree' and 'agree' on climate change’s effect on companies' production and output. Depending on that around 28 companies chose freezing method to adapt with climate change condition, while 10 of the companies preferred to import fish during climate change time because of the low harvest during this time. Dealing with water waste is at the highest priority of fishing companies in Oman, to manage the wastewater result from using large volumes of potable water during fish processing, about 25 companies filter it and reuse it for irrigation, and 12 companies filter it and reuse it for processing.

Table 4 depicts one of the main compo-

Table 4. Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.787	14.788[b]	2.000	8.000	.002
	Wilks' Lambda	.213	14.788[b]	2.000	8.000	.002
	Hotelling's Trace	3.697	14.788[b]	2.000	8.000	.002
	Roy's Largest Root	3.697	14.788[b]	2.000	8.000	.002
DL	Pillai's Trace	.312	1.816[b]	2.000	8.000	.224
	Wilks' Lambda	.688	1.816[b]	2.000	8.000	.224
	Hotelling's Trace	.454	1.816[b]	2.000	8.000	.224
	Roy's Largest Root	.454	1.816[b]	2.000	8.000	.224
LC	Pillai's Trace	.806	16.618[b]	2.000	8.000	.001
	Wilks' Lambda	.194	16.618[b]	2.000	8.000	.001
	Hotelling's Trace	4.154	16.618[b]	2.000	8.000	.001
	Roy's Largest Root	4.154	16.618[b]	2.000	8.000	.001
EX	Pillai's Trace	.483	3.731[b]	2.000	8.000	.072
	Wilks' Lambda	.517	3.731[b]	2.000	8.000	.072
	Hotelling's Trace	.933	3.731[b]	2.000	8.000	.072
	Roy's Largest Root	.933	3.731[b]	2.000	8.000	.072
TLS	Pillai's Trace	.965	2.100	8.000	18.000	.091
	Wilks' Lambda	.238	2.103[b]	8.000	16.000	.098
	Hotelling's Trace	2.354	2.060	8.000	14.000	.113
	Roy's Largest Root	1.906	4.289[c]	4.000	9.000	.032
CCP	Pillai's Trace	.748	1.791	6.000	18.000	.158
	Wilks' Lambda	.365	1.750[b]	6.000	16.000	.173
	Hotelling's Trace	1.435	1.675	6.000	14.000	.200
	Roy's Largest Root	1.173	3.519[c]	3.000	9.000	.062
CCD	Pillai's Trace	.823	2.098	6.000	18.000	.104
	Wilks' Lambda	.248	2.692[b]	6.000	16.000	.053
	Hotelling's Trace	2.753	3.212	6.000	14.000	.034
	Roy's Largest Root	2.645	7.935[c]	3.000	9.000	.007
WW	Pillai's Trace	.693	1.591	6.000	18.000	.207
	Wilks' Lambda	.317	2.070[b]	6.000	16.000	.115
	Hotelling's Trace	2.123	2.477	6.000	14.000	.076
	Roy's Largest Root	2.108	6.323[c]	3.000	9.000	.013
TLS * CCP	Pillai's Trace	.674	1.525	6.000	18.000	.226
	Wilks' Lambda	.353	1.819[b]	6.000	16.000	.159
	Hotelling's Trace	1.752	2.044	6.000	14.000	.127
	Roy's Largest Root	1.706	5.118[c]	3.000	9.000	.024
TLS * CCD	Pillai's Trace	.468	1.375	4.000	18.000	.282
	Wilks' Lambda	.532	1.483[b]	4.000	16.000	.254
	Hotelling's Trace	.878	1.537	4.000	14.000	.245
	Roy's Largest Root	.878	3.949[c]	2.000	9.000	.059

TLS * WW	Pillai's Trace	.641	2.123	4.000	18.000	.120
	Wilks' Lambda	.391	2.398[b]	4.000	16.000	.093
	Hotelling's Trace	1.477	2.585	4.000	14.000	.083
	Roy's Largest Root	1.419	6.386[c]	2.000	9.000	.019
CCP * CCD	Pillai's Trace	.596	1.908	4.000	18.000	.153
	Wilks' Lambda	.437	2.053[b]	4.000	16.000	.135
	Hotelling's Trace	1.216	2.127	4.000	14.000	.131
	Roy's Largest Root	1.151	5.181[c]	2.000	9.000	.032
CCP * WW	Pillai's Trace	.514	4.225[b]	2.000	8.000	.056
	Wilks' Lambda	.486	4.225[b]	2.000	8.000	.056
	Hotelling's Trace	1.056	4.225[b]	2.000	8.000	.056
	Roy's Largest Root	1.056	4.225[b]	2.000	8.000	.056
CCD * WW	Pillai's Trace	.992	4.432	4.000	18.000	.011
	Wilks' Lambda	.094	9.072[b]	4.000	16.000	.001
	Hotelling's Trace	8.760	15.330	4.000	14.000	.000
	Roy's Largest Root	8.654	38.941[c]	2.000	9.000	.000
TLS * CCP * CCD	Pillai's Trace	.000	.[b]	.000	.000	.
	Wilks' Lambda	1.000	.[b]	.000	8.500	.
	Hotelling's Trace	.000	.[b]	.000	2.000	.
	Roy's Largest Root	.000	.000[b]	2.000	7.000	1.000
TLS * CCP * WW	Pillai's Trace	.000	.[b]	.000	.000	.
	Wilks' Lambda	1.000	.[b]	.000	8.500	.
	Hotelling's Trace	.000	.[b]	.000	2.000	.
	Roy's Largest Root	.000	.000[b]	2.000	7.000	1.000
TLS * CCD * WW	Pillai's Trace	.000	.[b]	.000	.000	.
	Wilks' Lambda	1.000	.[b]	.000	8.500	.
	Hotelling's Trace	.000	.[b]	.000	2.000	.
	Roy's Largest Root	.000	.000[b]	2.000	7.000	1.000
CCP * CCD * WW	Pillai's Trace	.000	.[b]	.000	.000	.
	Wilks' Lambda	1.000	.[b]	.000	8.500	.
	Hotelling's Trace	.000	.[b]	.000	2.000	.
	Roy's Largest Root	.000	.000[b]	2.000	7.000	1.000
TLS * CCP * CCD * WW	Pillai's Trace	.000	.[b]	.000	.000	.
	Wilks' Lambda	1.000	.[b]	.000	8.500	.
	Hotelling's Trace	.000	.[b]	.000	2.000	.
	Roy's Largest Root	.000	.000[b]	2.000	7.000	1.000

nents of the results. It shows the interactions of all the independent variables with that of the dependent variables and the interactions between each of the independent variables. The multivariate tests show the overall ANOVA. The Wilks' Lambda is significant in cases of production aimed for local consumption, production aimed for exports, technology used for locating stock and dealing with climate change. This implies that across the dependent variables there appears to be something going on as a function of the independent variables. To further understand what is going on between these variables, we move on to table 5 which shows the tests of between-subject

Table 5. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	How sustainability is important	4.711[a]	45	.105	7.511	.001
	Oman domestic demand	61.181[b]	45	1.360	1.307	.352
Intercept	How sustainability is important	.373	1	.373	26.771	.001
	Oman domestic demand	6.248	1	6.248	6.005	.037
DL	How sustainability is important	.033	1	.033	2.364	.159
	Oman domestic demand	1.712	1	1.712	1.645	.232
LC	How sustainability is important	.371	1	.371	26.617	.001
	Oman domestic demand	10.542	1	10.542	10.131	.011
EX	How sustainability is important	.003	1	.003	.218	.652
	Oman domestic demand	8.558	1	8.558	8.225	.019
TLS	How sustainability is important	.129	4	.032	2.316	.136
	Oman domestic demand	12.152	4	3.038	2.920	.084
CCP	How sustainability is important	.135	3	.045	3.232	.075
	Oman domestic demand	3.255	3	1.085	1.043	.420
CCD	How sustainability is important	.314	3	.105	7.508	.008
	Oman domestic demand	2.559	3	.853	.820	.515
WW	How sustainability is important	.191	3	.064	4.561	.033
	Oman domestic demand	5.306	3	1.769	1.700	.236
TLS * CCP	How sustainability is important	.082	3	.027	1.962	.190
	Oman domestic demand	9.991	3	3.330	3.201	.077
TLS * CCD	How sustainability is important	.104	2	.052	3.714	.067
	Oman domestic demand	.422	2	.211	.203	.820
TLS * WW	How sustainability is important	.054	2	.027	1.929	.201
	Oman domestic demand	9.597	2	4.798	4.611	.042
CCP * CCD	How sustainability is important	.022	2	.011	.783	.486
	Oman domestic demand	9.634	2	4.817	4.629	.041
CCP * WW	How sustainability is important	.053	1	.053	3.791	.083
	Oman domestic demand	5.761	1	5.761	5.537	.043
CCD * WW	How sustainability is important	.975	2	.488	34.992	.000
	Oman domestic demand	8.307	2	4.154	3.992	.057
TLS * CCP * CCD	How sustainability is important	.000	0	.	.	.
	Oman domestic demand	.000	0	.	.	.
TLS * CCP * WW	How sustainability is important	.000	0	.	.	.
	Oman domestic demand	.000	0	.	.	.
TLS * CCD * WW	How sustainability is important	.000	0	.	.	.
	Oman domestic demand	.000	0	.	.	.

CCP * CCD * WW	How sustainability is important	.000	0	.	.	.
	Oman domestic demand	.000	0	.	.	.
TLS * CCP * CCD * WW	How sustainability is important	.000	0	.	.	.
	Oman domestic demand	.000	0	.	.	.
Error	How sustainability is important	.125	9	.014		
	Oman domestic demand	9.365	9	1.041		
Total	How sustainability is important	66.000	55			
	Oman domestic demand	311.000	55			
Corrected Total	How sustainability is important	4.836	54			
	Oman domestic demand	70.545	54			

effects. This table breaks down the impact each of the subjects have on each of the dependent variables.

There are some very interesting findings, which can be seen from Table 5. The results of the in- between effects are in tandem with the results of the multivariate tests. As we can see, there is a significant difference for the function of the production for local consumption on the importance of sustainability (0.001), as well as Oman's domestic demand. Similarly, we can see a significant effect of production for exports on domestic demand (0.019); technology used for locating stock has a significant effect on domestic demand (0.084); CCP has a significant effect on the importance of sustainability (0.075); dealing with climate change significantly impacts the importance of sustainability. Lastly, dealing with wastewater significantly affects the importance of sustainability.

With respect to in-between interactions between the factors, TLS*CCP has a significant bearing on domestic demand and TLS*CCD has a significant difference of the function for importance of sustainability. In the cases of TLS*WW and CCP*CCD, both significantly affect domestic demand. Interestingly, both CCP*WW and CCD*WW are significant in cases of the dependent variables. This is important to mention because CCP and CCD are components that highlight the effect of climate change, while wastewater treatment effects have significant outcomes throughout, especially in the case of the importance of sustainability.

Discussion

The data analysis and findings of this study indicate the realization of our research objectives. The results reveal that Omani fisheries companies have realized sustainable development through the facets of social, economic, and environmental sustainability. The surveyed fishing companies are keen to achieve social and economic sustainability, as they directed substantial proportion of production for local consumption, which, in turn, has a significant impact on both the importance of sustainability and domestic demand for fishing companies. Analysis shows that although the duration of landing had no significant effect on either of the dependent variables, production aimed for exports significantly affected the domestic demand. The analysis also underlines the interaction between the variables, depicting environmental sustainability through companies dealing with climate change, the effect of climate change on production, and the management of wastewater. The variables and the in-between interactions of these variables are significant, implying that environmental sustainability is crucial for attaining sustainable development.

Our analysis also confirms that commercial fishing companies are enabling the objective of food security through exercising sustainable fishing practices. When companies make significant contributions to production aimed for local consumption and that production is carried out in a sustainable manner, this implies that these companies are adhering to achieve the objectives of food security. This, however, cannot underestimate the dampening effects of climate changes on production, which, in turn, hinders products being available to meet the domestic demand.

With respect to the hypotheses, results show a positive result for local consumption on both independent variables thus proving H1. In the case of H2, the results realize the propensity of consumption for exports to the domestic demand only and not in the case of sustainability. The results also expose a negative consequence of the effect of duration of landing on both variables, thus proving H3. Lastly, in the case of H4, the results show a favorable tendency for the impact of dealing with wastewater in case of sustainability, but not in the case of domestic demand.

Moreover, our findings underscore the capability of Omani fishing companies to use technology and deal with climate change and water waste, hence having a positive effect on the country's efforts to realize its sustainable development goals. Statistics reveal that 33 companies are using technology involving sonar systems, navigation systems, and both. There are 34 companies with good adaptation to climate change by freezing and importing fish. Another 37 companies have good water waste management by filtration for either irrigation or processing. This finding confirms that most surveyed companies have respectable adaptation strategies for climate change and dynamic water waste management systems.

Interestingly, our study reveals a significant impact of the environmental factors on sustainability and less significant results in terms of effect of economic factors on sustainability. This affirms that there are no significant results of the technology used to locate stock, duration of landing, and the amount of production for export on sustainability. Meanwhile, our results display a positive result of economic variables to domestic demand, and no significant effects of the environmental factors such as dealing with climate change condition, dealing with water waste, and the importance of adapting to climate change on domestic demand. Our analysis can have significant impact on companies by following stock migration by seasons, as there are months when stock reduction is low, developing more technologies to know the location of fishing grounds, monitoring new and more abundant species, and developing gears used to enable greater flexibility in fishing. Overall, companies are aware of the importance of recognizing climate change trends, threats, and opportunities.

Additionally, our study makes a significant contribution by underlining the effects of sustainability on fish production and processing. Our findings support existing literature that highlights the effects of climate change and food security on small-scale fishing, commercial fishing, ecosystem, marine life, and coastal areas. They also support the emerging emphasis on the fisheries institutions, where corporate social responsibility - in terms of the relations with suppliers and customers - has positive impact on the fisheries companies (Scarpato et al., 2020). Our findings also raise the importance of the use of technology and developing innovative strategies to increase production, guarantee food security, and protect the environment. This corresponds with the findings of Dehyouri et al. (2022), who concluded that innovation management and application of marketing advantage were the most independent variables, which had significant effects on innovation capacity of the fisheries companies in Iran during covid-19 pandemic.

Concluding Remarks and Implications

Our study provided a descriptive analysis of the sustainable development of the fisheries industry in the Sultanate of Oman. It assessed the capacity of Omani fishing companies to realize sustainable development, with particular focus on economic and environmental sustainability. The study found that most Omani fishing companies adhere to the principles of sustainability and abide by the rules of sustainable fishing practices. This is a positive outcome in terms of the current statues and potential of these companies to play a greater role in increasing the share of this promising sector to GDP and achieving the objective of food security.

Our analysis also underscored the role of the state to develop a sound governance system that guarantees the enforcement of laws and regulations and mitigates the detrimental impact climate changes and illicit human activities on the ecosystem, marine life, and biodiversity. Although Oman's fishing companies are few and small, analysis affirmed the importance of government incentives, concessions, and various forms of subsidies that enable these companies to continue operating ethically and sustainably, while aiming at achieving the objectives of food security.

This study also stressed the need to develop appropriate strategies to guarantee food security, provide better adaptation to climate change, manage water waste and air pollution to achieve fisheries and aquaculture management and guarantee continual benefits for future generations from sea resources and ecosystem services. These strategies must be aligned with the sustainable development goals of ending poverty, improving nutrition, ensuring sustainable management of water and sanitation, and take urgent action to combat the worse effect of climate change.

However, achieving fisheries management in food security and climate change and applying sustainable management goals requires further research on other institutions in fisheries like laboratories of fish quality control and fishermen associations, as well as measuring the impact of overfishing, illegal, unreported, and unregulated practices on fish stock outcome. Although this study is probably the first of its kind to apply sustainable development to the fisheries industry in the context of Oman, we acknowledge of limitation of our research in terms of sample size and call for future research that compare Oman experience with neighboring countries.

In terms of implications, our study underscored the importance of government policies to provide facilities for fishing companies in terms of vessel registration, facilitating the authorization to operate inside and outside the ports' zones, while lowering cost of inputs including support for fuel, and support to vessels construction and modernization. It is also imperative that policy makers enforce progressive policy measures to cope with climate change effects and enhance a resilient fisheries system through applying Catch Documentation Schemes and Vessel Monitoring Scheme.

We also stress the importance of increasing the government financial contribution to fishing companies to contribute better to the development of the local economy, food security, sustainability, and self-sufficiency. Company executives must also develop flexible seasonal rights, water management strategy to sustain fishery services, stock management strategy during time of climate difficulties to take into account changes in distribution, and temporal and spatial planning to increase production during periods when climate is favorable to permit stock recovery.

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