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Norwegian Aquaculture Firms' Emphasis on Environmental and Social Sustainability Compared to Firms in Other Industries

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Abstract: Background: There has been a strong focus on environmental sustainability in the aquaculture industry, but we do not know how firms in this industry emphasize the issue compared to firms in other industries. Methods: Responding to this research gap, we compared survey data of Norwegian firms in the (1) aquaculture industry with those in the (2) manufacturing industry, (3) the consulting, finance and insurance industry, and (4) the hospitality, tourism and culture industry. Results: We found that firms in the aquaculture industry emphasize environmental sustainability more than those in the other industries do. Likewise, firms in the aquaculture industry emphasize social sustainability more than those in the other industries do, but the difference is less marked. Across industries, knowledge-intensive firms emphasize environmental sustainability and social sustainability to a lesser extent. Additionally, firms with local or regional major ownership emphasize social sustainability more than those with international major ownership do. Conclusion: Firms in the aquaculture industry have a relatively strong emphasis on environmental and social sustainability, which may be due to the industry's environmental challenges. Similarly, aquaculture firms have a relatively strong emphasis on social sustainability, which may be due to the industry's geographic and sociocultural proximity to numerous small local communities.

Keywords: environmental sustainability; social sustainability; industry analysis; knowledge intensity; responsible research and innovation (RRI)

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1. Introduction

Recently, there has been a strong focus on environmental sustainability in the aquaculture industry worldwide [1–8], which is unsurprising. For instance, in Norway alone, emissions from the sector equal untreated sewages of ten to twenty million people, and "salmon farming in open net-pens has been identified as a risk to fjord and related river environment" [9] (p. 144). In addition to emissions, other challenges are sea lice and escapees from pens that can interbreed with and hurt local salmon strains [10]. As a response to these challenges, an increasing number of studies in the aquaculture literature emphasize how industry actors deal with and respond to challenges related to environmental sustainability [2–5,7,11–16]. However, despite this growing research literature, we still lack knowledge about the extent to which aquaculture firms emphasize the importance of environmental sustainability. Thus, we do not know whether aquaculture firms have a stronger or weaker emphasis on environmental sustainability than those operating in other industries do. As a response to this knowledge gap, in this study, we compared survey data of Norwegian firms in the (1) aquaculture industry with firms in the (2) manufacturing industry, (3) the consulting, finance and insurance industry, and (4) the hospitality, tourism and culture industry. Hence, we analyzed whether firms in the aquaculture industry emphasize environmental sustainability more or less than those in the other industries do.

We argue that our research question is important because it illuminates the scholarly community and stakeholders about aquaculture firms' attitudes toward a very important topic facing the industry. Theoretically, environmental challenges can partly be a function of aquaculture firms downplaying environmental sustainability. On the contrary, it is perhaps more likely that environmental challenges have induced aquaculture firms to emphasize environmental sustainability to a relatively large extent, and if so, it can help explain that the industry is not to blame for the challenges that it faces. All the more, a strong emphasis on environmental sustainability may help amend one of the greatest challenges that the industry faces.

As a second contribution, we studied whether aquaculture firms emphasize social sustainability more or less than firms in other industries do. Historically, most actors in the Norwegian aquaculture industry have been located in rural areas in close geographic and sociocultural proximity to numerous small local communities [9]. Motivated by these historically strong rural and local attachments, we speculated and empirically tested whether they reflect how aquaculture industry actors emphasize positive local economic ripple effects, long-term economic gains for society, and job creation in general. In our opinion, these indicators tap into the concept of social sustainability [17]. Recently, however, there has been a trend shift in the aquaculture industry, and "[a]lthough primary production is still located in rural areas, ownership and a number of important functions (R&D, processing, marketing) are now mainly located in urban areas. The restructuring of the industry [has] implied automation and knowledge upgrading, reducing the demands for low skilled workers in rural areas and increasing demands for high skilled workers in urban areas" [9] (p. 144). Given this general trend shift, alternatively, we cannot rule out that aquaculture actors emphasize social sustainability to a lesser extent than the industry's historically strong rural and local attachments might indicate, and our study sheds light on this issue.

Environmental and social sustainability are related concepts tapping into "the obligations business has to society . . . [regarding] the economic, legal, ethical, and discretionary categories of . . . performance" [18] (p. 499). Hence, broadly, the concepts deal with firms' responses to society's expectations along crucial dimensions [19,20]. We define environmental sustainability with Aarstad and Jakobsen [21] (p. 1) as a firm's "proclivity to collaborate with stakeholders concerning environmental improvements, share information with competitors concerning environmental improvements, emphasize environmental improvements rather than short-term economic gains, and emphasize environmental improvements as a means of increasing earnings". Social sustainability, albeit similar in connotation to environmental sustainability, we have noted, largely emphasizes positive local economic ripple effects, long-term economic gains for society, and job creation in general [17,22,23].

Our final contribution was to investigate whether knowledge intensity is a carrier for environmental and social sustainability within and beyond the aquaculture industry. Knowledge intensity can be defined as firms' proclivity for "developing new or improved products, services, or manufacturing processes, or whether they have interfirm innovation collaboration with other organizations" [21] (p. 2). The potential links between knowledge intensity and environmental and social sustainability tap into a literature emphasizing responsible research and innovation (RRI) as a fruitful approach to addressing societal challenges, e.g., [22,24,25]. At its core, RRI focuses on sustainability, but as noted, it further emphasizes a long-term analytical and scientific knowledge pool for sustainable development. As such, the potential link between knowledge intensity and environmental and social sustainability knits together constructs reflecting crucial aspects of RRI. Previous research has demonstrated a link between knowledge intensity and environmental sustainability [21], but the potential link between knowledge intensity and social sustainability has received less attention. We added to the current body of knowledge by researching links between knowledge intensity and environmental and social sustainability, within and beyond the aquaculture industry.

Below, we present the methodology and the empirical findings, discuss the findings, address limitations, and suggest avenues for future research. Finally, we address policy implications.

2. Materials and Methods

We included two merged surveys of Norwegian enterprises as legal entities labeled as firms. One covered Norwegian aquaculture firms having at least 20% of their operations directly or indirectly in the industry. The list of surveyed firms was developed in collaboration with a research institute having close ties to and strong knowledge about the aquaculture industry. It included firms from all parts of the value chain. The number of responding firms was 201, and the response rate was 15%. The second survey covered the manufacturing industry, the consulting, finance and insurance industry, and the hospitality, tourism and culture industry. The number of firms in each industry was 200, and the response rate was 25%. The data were collected early in 2021 via telephone interviews by a professional market research and consulting firm. The responding persons in both surveys were either the firms' CEOs or deputy CEOs.

Table 1 reports items related to environmental and social sustainability (our translations from Norwegian). Items reflecting environmental sustainability were largely developed by Aarstad and Jakobsen [21], and items reflecting social sustainability were developed for the surveys used in this study. For each item, the respondents could indicate their responses on a five-point Likert scale varying between "to a very little extent" (coded 1) and "to a very large extent" (coded 5). A few absent or "do not know" responses were coded 3 ("neither-nor"). Principal component analysis showed that the items loaded on two factors, environmental and social sustainability. These factors explained 49.7% variance (the eigenvalue was 1.47 for the second factor and 0.884 for the third factor). Cronbach's alpha scores showed satisfactory values for both factors. As dependent variables, we used the average scores of the items identifying each factor, environmental sustainability and social sustainability.

Table 1. Principal component factor analysis using orthogonal varimax rotation. N = 801.

Factors 1 and 2, Respectively	Environmental Sustainability	Social Sustainability
We consult collaboration partners, authorities, or interest groups about environmental improvements.	**0.786**	0.151
We collaborate with other actors about environmental improvements.	**0.770**	0.168
We carry out development and innovation efforts to reduce our environmental footprint.	**0.770**	0.147
We apply R&D-based knowledge to reduce our environmental footprint.	**0.734**	0.075
Environmental improvements strengthen our earnings.	**0.673**	0.152
We are more concerned about environmental challenges than other enterprises in the industry.	**0.653**	0.223
Environmental improvements have greater importance than short-term economic gains.	**0.543**	0.182
We are concerned about local ripple effects of our business (jobs, purchase of goods and services, tax revenues).	0.225	**0.724**
Local jobs have greater importance than short-term economic gains.	0.111	**0.701**
We are concerned about dialogue with those who are affected by our business (for instance, the local community, environmental organizations).	0.309	**0.599**
We give economic support to voluntary activities in the local community (sports organizations, cultural events, etc.).	0.006	**0.591**
We are more concerned about creating jobs than other firms in the industry.	0.217	**0.574**
Cronbach's alpha for items in bold	*0.850*	*0.661*

As independent variables, we included industry dummies. We also included knowledge intensity as an independent variable. It was measured by adding items to the survey regarding whether the firm in the last three years (1) collaborated with other institutions or companies concerning improvement or development of processes or products, (2) introduced a new or considerably improved process innovation, (3) introduced a new or considerably improved service or product, and (4) if any new service or product was also new for the market.

We controlled for firm size using the number of employees. As the variable was skewed, it was log-transformed (the constant one was added before log-transforming, as a few firms

had zero employees). We also controlled for major ownership locally or regionally, nationally beyond the region, or internationally. Finally, we controlled for international engagements (whether the firm in the last year had production abroad, ownership abroad, or exports).

3. Results and Discussion

Regression results in Model 1, Table 2, show that firms in the manufacturing industry, the consulting, finance and insurance industry, and the hospitality, tourism and culture industry emphasized environmental sustainability significantly less than those in the aquaculture industry did. Thus, firms in the aquaculture industry emphasized environmental sustainability significantly more than those in the other industries did. Overall, we assumed that aquaculture firms' strong emphasis on environmental sustainability was in response to the industry's environmental challenges, but future research should investigate further underlying causal factors. Moreover, future research should study how this positive attitude can be efficiently used to further strengthen the industry's emphasis on environmental sustainability.

Table 2. Bootstrapped ordinary least square (OLS) regressions, including all four industries.

Dependent Variable	**Environmental Sustainability**	**Social Sustainability**
	Model 1	Model 2
Independent variables		
Manufacturing industry [1]	−0.557 *** [−0.265]	−0.177 * [−0.107]
	(0.080)	(0.070)
Consulting, finance and insurance [1]	−0.640 *** [−0.304]	−0.354 *** [−0.213]
	(0.081)	(0.075)
Hospitality, tourism and culture [1]	−0.456 *** [−0.216]	−0.225 ** [−0.135]
	(0.089)	(0.075)
Knowledge intensity	0.242 *** [0.370]	0.111 *** [0.214]
	(0.022)	(0.018)
Control variables		
Number of employees (log)	0.038	0.055 * [0.092]
	(0.025)	(0.023)
Major local or regional ownership [2]	−0.123	0.347 ** [0.160]
	(0.125)	(0.113)
Major national ownership beyond the region [2]	0.109	0.182
	(0.157)	(0.146)
International engagements	−0.047	−0.112 † [−0.071]
	(0.068)	(0.059)
R-square/R-square adj.	0.251/0.244	0.098/0.089
Wald χ^2	323.4 ***	87.4 ***

N = 800. Bootstrapped standard errors with 10,000 random replications in parentheses. Conservative two-tailed tests of significance for regression coefficients. † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Beta values for significant regressors in brackets. Intercepts are omitted. Maximum (average) variance inflation factor, VIF, is 2.27 (1.66). [1] Default is the aquaculture industry. [2] Default is major international ownership.

Additionally, firms in the aquaculture industry emphasized social sustainability significantly more than those in the other industries did (Model 2, Table 2), albeit less robustly than environmental sustainability. A possible explanation is that, historically, most actors in the Norwegian aquaculture industry have been located in rural areas in close geographic and sociocultural proximity to numerous small local communities [9]; but again, we encourage future research to investigate further underlying causal factors.

Firms' knowledge intensity positively affected environmental and social sustainability, but less robustly concerning social sustainability (Model 1 and 2, Table 1). To uncover whether these effects were consistent within and beyond the aquaculture industry, the following tables replicate the analyses; one includes the aquaculture industry only (Table 3) and the other excludes it (Table 4). Overall, the results showed a consistent pattern, except

that the effect of knowledge intensity on social sustainability was less robust in the aquaculture industry than in the other industries. Our findings align with the RRI perspective indicating a relationship between knowledge intensity and environmental sustainability (e.g., [22,24,25]). A novel contribution is that we also demonstrated a relationship between knowledge intensity and social sustainability.

Concerning the control variables, notably, firms with major local or regional ownership emphasized social sustainability more than firms with major international ownership, both within and beyond the aquaculture industry (Model 2, Tables 2–4), did. A possible explanation is that local and regional ownership positively induces strong place-based attachments to the community. In addition, major local, regional, or national (compared to major international) ownership has stronger positive effects on environmental sustainability for firms in the aquaculture industries than for those in the other industries. This effect is significantly positive as a function of major national ownership beyond the region in the aquaculture industry (Model 1, Table 3), and non-significant in the other industries (Model 1 Table 4). In addition, the effect is positive, albeit non-significantly, as a function of major local or regional ownership in the aquaculture industry (Model 1, Table 3), and significantly negative in the other industries (Model 1, Table 4). A possible explanation is that historically, most actors in the Norwegian aquaculture industry have been located in rural areas in close geographic and sociocultural proximity to numerous small local communities [9]. Finally, we observed that large firms emphasized social sustainability more than small firms did (Model 2, Tables 2–4). A possible explanation is that large firms have more organizational slack and resources to do so than small firms.

The study's cross-sectional research design was a limitation, but we assumed that the industry variables were relatively exogenous. Knowledge intensity, on the other hand, may have been both a cause and effect of environmental and social sustainability. To address this limitation, we encourage future studies to replicate our study by using a longitudinal research design or instrumental variables. A further limitation is that the limited number of items used to measure environmental and social sustainability may have induced an exclusion of crucial aspects of the concepts, which we encourage future research to address.

Table 3. Bootstrapped ordinary least square (OLS) regressions, including only the aquaculture industry.

Dependent Variable	**Environmental Sustainability**	**Social Sustainability**
	Model 1	Model 2
Independent variable		
Knowledge intensity	0.242 *** [0.391]	0.068 † [0.137]
	(0.043)	(0.035)
Control variables		
Number of employees (log)	0.023	0.019
	(0.037)	(0.034)
Major local or regional ownership [1]	0.331	0.4210 * [0.228]
	(0.210)	(0.212)
Major national ownership beyond the region [1]	0.662 * [0.231]	0.189
	(0.257)	(0.269)
International engagements	−0.289 * [−0.169]	−0.158
	(0.116)	(0.097)
R-square/R-square adj.	0.191/0.170	0.066/0.042
Wald χ^2	49.60 ***	12.80 *

N = 201. Bootstrapped standard errors with 10,000 random replications in parentheses. Conservative two-tailed tests of significance for regression coefficients. † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Beta values for significant regressors in brackets. Intercepts are omitted. Maximum (average) variance inflation factor, VIF, is 2.25 (1.54). [1] Default is major international ownership.

Table 4. Bootstrapped ordinary least square (OLS) regressions excluding the aquaculture industry.

Dependent Variable	**Environmental Sustainability**	**Social Sustainability**
	Model 1	Model 2
Independent variables		
Consulting, finance and insurance [1]	−0.070	−0.159 * [−0.104]
	(0.077)	(0.071)
Hospitality, tourism and culture[1]	0.148 † [0.080]	−0.033
	(0.084)	(0.071)
Knowledge intensity	0.239 *** [0.376]	0.124 *** [0.235]
	(0.025)	(0.021)
Control variables		
Number of employees (log)	0.040	0.083 ** [0.118]
	(0.033)	(0.030)
Major local or regional ownership [2]	−0.322 * [−0.116]	0.347 ** [0.151]
	(0.143)	(0.133)
Major national ownership beyond the region [2]	−0.139	0.209
	(0.185)	(−0.091)
International engagements	0.077	−0.091
	(0.084)	(0.075)
R-square/R-square adj.	0.186/0.177	0.095/0.084
Wald χ^2	145.6 ***	62.1 ***

N = 599. Bootstrapped standard errors with 10,000 random replications in parentheses. Conservative two-tailed tests of significance for regression coefficients. † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Beta values for significant regressors in brackets. Intercepts are omitted. Maximum (average) variance inflation factor, VIF, is 2.28 (1.54). [1] Default is the manufacturing industry. [2] Default is major international ownership.

4. Conclusions and Policy Implications

Our finding that aquaculture firms robustly emphasize environmental sustainability compared to firms in other industries is relevant for industry stakeholders and policymakers. To our knowledge, this is the first study showing that aquaculture firms do not downplay environmental sustainability. On the contrary, our findings indicate that environmental challenges have induced them to emphasize environmental sustainability more than actors in other industries, which is valuable to communicate to industry actors and society at large. Indeed, the industry has environmental challenges, but they are not downplayed by those involved in aquaculture production. This promising foundation should encourage future policy initiatives toward developing a more environmentally sustainable industry. Having said that, our findings in and of themselves do not present a solution to aquaculture environmental sustainability, but demonstrate that those engaged in the industry appear to be strongly concerned about the issue, and are by no means negligent.

In a similar vein, it is interesting to observe that aquaculture firms also emphasized social sustainability more than actors in other industries did. Thus, it appears that the industry's historically strong rural attachment is still prevalent, and accordingly important to communicate to stakeholders and policymakers. Finding that firms with major regional ownership emphasized social sustainability more than those with major international ownership did further indicates that rural attachment is crucial concerning actors' sociocultural proximity to local communities. Altogether, the findings indicate that firms and industries strongly embedded in a rural context seem to have a relatively strong emphasis on social and local values, which may also be the case for other industries, such as tourism. It can be hard to measure the monetary outcome of such an attitude, but it is not unlikely that firms with strong rural attachments represent an important glue in local cohesion and are strong carriers for place-based employment and industry development.

Finally, it is worth noting that knowledge-intensive firms emphasize environmental sustainability and social sustainability to a lesser extent. Thus, knowledge intensity appears to have ripple effects that affect both the environment and local communities, and is accordingly of value to communicate to stakeholders within and beyond the aquaculture industry.

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