

Export Potential without Export Readiness: A Capability-Based Assessment of Seaweed Producers in Bangladesh

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A B S T R A C T

Bangladesh has substantial ecological potential for seaweed cultivation, yet the commercial capabilities required for sustained export participation remain underdeveloped. This study develops the Seaweed Export Readiness Index (ERI) as a five-domain diagnostic index comprising export market orientation, blue technology adoption, operational export readiness, dynamic capabilities and institutional support. The analysis draws on a purposive, cross-sectional, self-report survey of 375 seaweed producers from Cox's Bazar and the southwestern coast, administered through a structured KoboToolbox questionnaire. The mean ERI was 19.02 on a 0 to 100 scale, with 61.1 per cent of respondents located in the lowest descriptive readiness band and none in the two highest bands. Export market orientation and operational export readiness recorded the lowest domain scores, indicating pronounced weaknesses in market intelligence and practical export systems. Blue technology adoption and dynamic capabilities showed the strongest bivariate associations with perceived export potential. The composite ERI was also strongly associated with perceived export potential ($r=0.773$), although this relationship is interpreted cautiously because both measures were obtained from the same questionnaire at a single point in time. Cox's Bazar recorded higher readiness scores than the southwestern coast, but the comparison is descriptive because the sample was not regionally balanced. Overall, the findings provide a producer-level diagnostic profile of capability constraints and identify priority areas for capability development without claiming causal inference or independent validation of export readiness.

Keywords: Blue technology adoption, Dynamic capabilities, Export market orientation, Export readiness, Institutional support

1. Introduction

The export base of Bangladesh is very much concentrated in ready-made garments and export diversification is an important economic priority. Knitwear and woven garments combined

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exports rose to 82.11 per cent in FY2024, and the total export value decreased by 4.34 per cent in the same period compared to the previous fiscal year (Bangladesh Bank, 2024). The World Bank also reported that real GDP growth moderated to 5.2 per cent in FY2024 amid persistent inflation, balance-of-payments pressure and financial-sector vulnerabilities (World Bank, 2024). These circumstances consolidate the argument to explore other export-oriented activities instead of looking mainly at the already known sectors. One such potential is seaweed, as part of the blue economy. The production of algae in the world continues to be large in 2022, with 37.8 million tonnes (FAO, 2024). The country Bangladesh is ecologically well positioned to explore this opportunity as it has a long coast, shallow sea water and documented commercially viable species, but being ecologically suitable does not make the producer export ready.

An ecological basis for seaweed cultivation is documented in Bangladesh. Researches have identified commercially viable species and suitable coastal environment, mostly in the southeastern coast and in the brackish water of the southwestern coast (Ahmed & Taparhudee, 2010; Chowdhury et al., 2022; Ahmed et al., 2022; Hossain et al., 2021). Cultivation trials in Cox's Bazar also indicate the production of viable biomass with varying performance among the sites and seasons as well as cultivation systems (Mohiuddin et al., 2023; Sobuj et al., 2023, 2024). But studies in Bangladesh also reveal poor buyer-connectivity, lack of awareness and knowledge on standards, limited processing facilities, and lack of institutional supports (Ahmed et al., 2022; Chowdhury et al., 2022; Shaika et al., 2022). These constraints point to the fact that the ecological potential and production potential do not necessarily lead to export readiness. Market intelligence, proper technology, quality processes, financing, and standards adherence and institutional connections are also necessary for export participation. The present study thus looks at whether these producer level capabilities are sufficiently developed to be able to support credible export participation.

This paper considers such a gap as a management issue. It uses 375 valid producer-level survey responses of Cox's Bazar and the southwestern coast in developing and validating the Seaweed Export Readiness Index, a formative five-dimension diagnostic tool of the export market orientation, blue technology adoption, operational export readiness, dynamic capabilities, and institutional support. Perceived export potential is not a readiness input, but a related outcome construct that has been kept separate to maintain conceptual clarity and to eliminate the circularity that has undermined similar assessments in other places. The paper contributes to the work in three ways. It redefines the seaweed production as a capability issue, where coastal producers are emerging microenterprise units with the same logic of export readiness as other SMEs that demand internationalisation. It offers a scientifically validated, producer level diagnostic tool that isolates preparation and potential in a quantifiable manner. And it can find, by analysing dimensions, weakest capabilities and at which point intervention should start. By so doing it relates the literature of blue economy commercialisation to the small business management and innovation tradition, and it provides a diagnostic model that can be applied to similar emerging coastal economies in the developing world.

This study aims to solve the issue of lack of linkage between the potential of seaweed export and the readiness of the export level of producers. Bangladesh has evidence of cultivation and blue-economy applicability, yet producers are loosely linked to export-market information, buyer relations, relevant technology, quality regimes, finance, and institutional follow up. The business system needed to internalize, commercialize, and compensate seaweed harvesting, based on buyer connection, after harvest infrastructure, aggregation, standards compliance and integrated institutional assistance, is yet to be established or disjointed. This poses a potential-readiness trap: the industry is environmentally attractive but not commercially ready to cater to the export businesses. In the case of small-business management, it is a problem of

conversion of capabilities. However, interest in export participation alone is not enough for seaweed producers to be credible players in international markets. It needs the understanding of buyers, proper utilization of technology, quality discipline, post-harvest control, availability of finance, adaptive capacity, and institutional support.

Recent SME and export studies concur ability-building, market orientation, preparedness to innovate, and favourable conditions of export performance are dependent, and not opportunity recognition (Hoque et al., 2022; Ishii & Kikumori, 2024; Sadeghi et al., 2023; Singh et al., 2024). Only the quantitative producer survey aspect of a bigger project on seaweed perceived export potential are used in this paper and the evidence re-packaged by viewing seaweed producers as new small-based businesses. To that end, the study has three objectives. First, it examines export preparedness of the sampled seaweed growers based on their level and distribution. Second, it points to the readiness areas where the capability gaps are greatest and most applicable for intervention. Third, it explores the empirical relationship between Seaweed Export Readiness Index and perceived export potential. To address these objectives, the study constructs and applies a five-domain Seaweed Export Readiness Index comprising export market orientation, blue technology adoption, operational export readiness, dynamic capabilities and institutional support.

2. Review of Relevant Literature

2.1. Purpose of the Literature Review

This literature review forms the theoretical and empirical background of the reasoning behind regarding the seaweed producers as a nascent small-business unit in lieu of subsistence cultivators or fisheries beneficiaries. It determines the conceptual building blocks of the Export Readiness Index (ERI), i.e., export market orientation, adoption of blue technology, operational export readiness, dynamic capabilities, and institutional support. Above all, it reveals the disjunction between a well-documented ecological potential, and the near-total lack of evidence regarding producer-level commercial potential, which is the very issue this study is tackling.

2.2. Seaweed as a Blue Economy Commodity

The seaweed industry has grown massively in the last 20 years due to the increasing demand in food, feed, fertiliser, cosmetics, pharmaceutical, and industrial bio-based products (Zhang et al., 2022). Production is highly geographically concentrated in Asia, and commercial value is not created by the amount of biomass but by organised cultivation, quality management of harvest, processing, meeting standards, and maintaining a buyer connection (FAO, 2003, 2024). The discussion of international policy has brought seaweed to the forefront as a resource with significant roles in the food system resilience, environmental sustainability, fair trade, and economic empowerment of women (UNCTAD, 2024). Such dimensions are consistent with the more comprehensive blue economy approach, which focuses on the sustainable utilisation of marine resources to develop the economy, have coastal livelihoods, and manage ecosystems (World Bank, 2017). Bangladesh is strategically located ecologically in this global opportunity. The existence of commercially viable species, appropriate coastal ecosystems and favourable cultivation environments are recorded, mostly along the south-eastern coast of Cox's Bazar and in some selected brackish-water situations in the southwest (Ahmed & Taparhudee, 2010; Ahmed et al., 2022; Chowdhury et al., 2022; Hossain et al., 2021). Experimental cultivation in Cox's Bazar confirms that under suitable environmental factors certain systems, such as floating raft designs, can produce viable biomass yields but results are sensitive to place-specific practices and seasonal fluctuation (Mohiuddin et al., 2023; Sobuj et al., 2023, 2024). The broader literature therefore establishes ecological viability and commercial potential but

provides limited evidence on whether seaweed producers possess the business capabilities required to convert cultivation into export-oriented enterprise activity.

2.3. Value Chain Governance and Export Competitiveness

Value chain analysis is a conceptual framework that helps to explain how economic value is created, shared, and lost throughout the interdependent processes of seaweed production and commercialisation. The seaweed industry stretches between the seed or propagule supply and cultivation, harvest, washing, drying, sorting, aggregation, processing, distribution, and ultimate market delivery (Donovan et al., 2015; Valderrama et al., 2015). Export competitiveness is not about a particular stage but governance of the whole chain, such as quality of coordination, specification compliance, logistics, traceability, and fair distribution of returns to participants of the chain. In the case of small producers, fragmented and weakly controlled chains raise transaction costs, decrease bargaining power, and generate chronic market access failures. Research specific to Bangladesh confirms that the nature of seaweed value chains is a structural weakness with precisely such structural weaknesses. Researchers recognize weak buyer linkages, informal and ineffective drying and storage facilities, lack of aggregation systems, lack of awareness of the importance of standards, insufficient processing facilities, and fragmented institutional follow-ups as common limitations (Ahmed et al., 2022; Chowdhury et al., 2022; Shaika et al., 2022). All these results point at the fact that the key issue of the sector is not a biological or agronomic one; it is management and organisational. When the downstream chain is not capable of absorbing, upgrading, and delivering buyer-ready product, the production volume is not adequate to produce commercial results. This difference between production-led and market-led development is the main focus of the analytical framework of the current paper.

2.4. Export Market Orientation

Export market orientation refers to a firm's capability to generate, disseminate and respond to intelligence concerning foreign customers, competitors and market conditions (Cadogan et al., 2002). Recent studies still treat it as an information-processing ability, comprising export-market intelligence and responsiveness, and its effectiveness might be influenced by international channel relations and partner selection (Ishii & Kikumori, 2024). This view also complicates the previous view of export market orientation as being a primarily internal managerial disposition. Ishii and Kikumori (2024) show that the choice to orient the firms towards export markets is significantly influenced by the selection strategies and the export channels conditions, rather than by the internal motivation or managerial intention. The implications of this discovery are significant to the smallholder producers of seaweed in Bangladesh. The concept of market orientation is not a capability that a firm can build in isolation at the firm-level; it is a chain-level capability that is contingent upon access to organised buyer networks, middlemen with knowledge about the export market, and institutional actors that can convert international market intelligence into actionable advice. Producer level export readiness requires access to relevant information about international seaweed demand and buyer requirements. The needs of the producers are specialized, translated intelligence on target buyer profiles, acceptable product forms, quality and safety standards, volume requirements, pricing benchmarks, packaging specifications, and certification pathways. Such lack of intelligence, which is reported in the Bangladesh-specific and general smallholder export literature, is one of the most restrictive possibilities of export capability formation in the industry.

2.5. Operational Export Readiness: Concept and Measurement

Export readiness is the degree to which a firm has resources, knowledge and organisational conditions, that enable it to start and continue to export. It is generally regarded as a multi-faceted phenomenon that includes financial capacity, market knowledge, trade capability and preparedness for operations (Van Eldik & Viviers, 2005; Gerschewski et al., 2020). In the context of the current research, operational export readiness is defined as the physical, financial, standard, document, logistics and order-fulfilment resources that are needed to perform export activity. These two constructs are often confused in emerging commodity industries: the perception of opportunity is taken as a sign of preparedness and preparedness is believed to be an inevitable result of production activity. The harmful impact of this conflation on policy design in similar sectors has been disastrous. The result of export promotion that comes before the capability development is that the producers are subjected to market, finance, and compliance risks before the basic business systems necessary to handle the risks have been established. The outcome is usually the disengagement of farmers, destroyed institutional trust and a period of experimentation without commercial consolidation. To be more analytically rigorous, readiness should be assessed independently of potential, on a validated multidimensional scale that is scaled to producer-level capabilities. This methodological and conceptual requirement is directly addressed in the present study by developing the Seaweed Export Readiness Index.

2.6. Innovation Capability and Blue Technology Adoption

Technology adoption is the uptake and use of technologies that change or enhance business processes and is influenced by the technological, organisational and environmental conditions (Faiz et al., 2024). In this study, the term blue technology adoption is employed as an application of the general concept in the context of a sector and is not a stand-alone scale. It refers to producers' uptake and use of appropriate technologies for seaweed cultivation, post-harvest handling, storage, quality management and production scalability. In this context, technology adoption can be seen as a tangible manifestation of innovation capability, as producers enhance existing production and quality processes using technologies that are appropriate for the environment and changing market needs. The wider rationale is supported by research on dynamic marketing capabilities and SME internationalisation: adaptive and knowledge-upgrading capabilities have some of the most robust predictive performance in volatile and uncertainty-intensive markets when it comes to export performance (Hoque et al., 2022; Sadeghi et al., 2023). This has a direct implication on the seaweed producers: innovation capability is no longer a preserve of technologically advanced companies; it is the feasible ability to learn, adapt and develop commercially viable routines prior to export scaling being pursued.

2.7. Dynamic Capabilities and SME Internationalisation

Dynamic capabilities are the organisational capacities through which firms sense opportunities and threats, seize opportunities and reconfigure their resource base as operating conditions change (Teece et al., 1997). In recent international-business studies, sensing, seizing and resource reconfiguration have been found to be the core mechanisms by which firms adapt to varying international contexts in order to remain adaptable (Pitelis et al., 2024). These capabilities are useful in SME internationalisation for learning, adapting and making resource adjustments in the face of new markets and changing buyers' needs. Sadeghi et al. (2023) demonstrate the strong correlation between post-entry export performance and the speed and quality of capability building. This relationship is supported by more recent evidence. Fernandes et al. (2025) find that seizing and reconfiguring capabilities strengthen the

relationship between international entrepreneurial orientation and international performance among internationalised SMEs. Based on data from 8,278 SMEs from 84 emerging economies, Dabić et al. (2025) also find that dynamic capabilities can offset the disadvantages of late internationalisation. This view allows for an analysis of adaptive orientation, partnership building and learning routines as existing capability conditions and not as the automatic result of participation in cultivation programmes as export readiness.

2.8. Institutional Support and Business Ecosystem Conditions

Institutional support is used here to denote financial and non-financial support, information, training and enabling conditions offered by public agencies and other support organisations which aim to minimise constraints on enterprise development. Recent SME studies differentiate direct support (e.g., finance, training, advisory services) from indirect support, which involves creating the regulatory and entrepreneurial landscape (Prasannath et al., 2024). In an export setting, this support can also help to provide access to standards knowledge, technology, networks and market capabilities that smaller enterprises may not be able to develop on their own. Institutional support in the seaweed scenario involves availability of technical training, cultivation and quality inputs, financial services, policy guidance, standards awareness, and buyer-related demonstration activities. Empirical research on SMEs in the recent past supports this argument. Prasannath et al. (2024) establish a positive relationship between government support policies and entrepreneurial orientation and SME performance, and Singh et al. (2024) establish an institutional support-innovation capacity, export readiness, and export performance in green and sustainability-focused sectors. The evidence in Bangladesh, however, shows the critical difference between institutional support and its effectiveness. Government programmes and training inputs can be provided to producers without any linkage with buyer needs, quality requirements, assured purchase outlets, and systematic follow-up evaluation. This creates an institutional activity lacking commercial momentum, a trend that the current paper defines as one of the main structural inhibitors within the seaweed industry.

2.9. Research Gap and Theoretical Positioning

It is observed that the literature reviewed here shows that there is a clear gap of empirical and analytical study of seaweed in Bangladesh, but not a lack of knowledge. Previous research in Bangladesh has developed ecological suitability, cultivation performance and constraints in different sectors, which include post-harvest handling system (Ahmed et al., 2022; Chowdhury et al., 2022; Hossain et al., 2021; Mohiuddin et al., 2023; Sobuj et al., 2023; 2024). In parallel, export and SME research identifies market orientation, operational capability, adaptive capacity, technology use and institutional support as important conditions for internationalisation (Cadogan et al., 2002; Hoque et al., 2022; Ishii & Kikumori, 2024; Sadeghi et al., 2023; Singh et al., 2024; Van Eldik & Viviers, 2005). But the relationship between the two literature is still somewhat weak. The studies reviewed in Bangladesh do not offer a producer-level, multi-dimensional evaluation separating export readiness from perceived export potential. This unanswered question is the specific motivation for the development of the ERI in the current study.

Given this background, this study has three interrelated objectives. The first one is to determine the export readiness of the sampled seaweed producers using a multidimensional diagnostic index. The second is to determine the capability domains where the readiness constraints are greatest, which will help to interpret where capability development may be most needed. The third is to analyse the empirical relationship between the composite Seaweed Export Readiness Index and the perceived export potential, while keeping the conceptual separation between what is already achieved (readiness) and what is seen likely to be achieved (export potential)

in the future. These goals relate to the existing literature on export orientation, operational capability, technology adoption, dynamic capabilities and institutional support in the context of seaweed in Bangladesh. The study thus places the seaweed producers as new microenterprise actors whose export readiness can be analysed using concepts from SME internationalisation, but who are still operating in the typical production and value chain context of an early-stage coastal industry.

3. Materials and Methods

3.1. Research Design

This study uses a quantitative cross sectional research design to assess producer level export readiness in the emerging seaweed industry in Bangladesh. The quantitative element presented here was part of a bigger mixed-methods seaweed export-potential initiative which included stakeholder interviews, focus group discussions, value-chain mapping, and case narratives. The present paper examines the producer-survey segment and sees the seaweed growers as nascent micro-enterprise actors, whose present export-readiness can be assessed systematically. The analytical objective is to produce evidence for producers and not for ecology or institutions on a sector level. The unit of analysis is an individual seaweed producer directly engaged in cultivation at the production stage of the value chain. Empirical claims regarding processors, exporters, regulators, and institutional actors are not made in the study. This boundary helps to maintain the empirical scope in line with the unit of analysis and to limit readiness claims to producers at the cultivation end of the value chain.

3.2. Study Context and Sampling

Data were collected from seaweed producers in Cox's Bazar on the southeastern coast and selected locations in the southwestern coastal region of Bangladesh. Respondents directly involved in seaweed production at the value chain production stage in the study locations were invited. As no complete and verified register of active seaweed producers was available, probability sampling could not be implemented. Respondents were then purposefully selected using institutional contacts, NGO networks and the extension staff who are aware of the active cultivation areas. After data harmonisation and quality screening, 375 valid responses were retained for analysis, 313 respondents from Cox's Bazar and 62 respondents from the southwestern coastal region. The sample is geographically unbalanced and cannot be viewed as representative of the national seaweed producer population. Therefore, the regional comparisons are descriptive, and the findings of the study is for the sampled producers only and not for all the seaweed producers in Bangladesh.

Recruitment via institutional, NGO and extension networks might have been biased towards producers with a history of supporting organisations, and these producers may have had more access to training, development programmes or institutional assistance than less connected producers. This possibility is especially pertinent as institutional support is an element of the ERI domains and can be different for producers not in support networks. The recruitment pathway is consequently recognised as a potential source of selection bias rather than treated as a neutral mechanism for accessing respondents. The purposive sampling strategy also restricts statistical generalisation to the observed sample, particularly because of the high number of respondents in Cox's Bazar. These limitations are not to the detriment of the diagnostic intent of the study, but they must be taken into account when interpreting the results. Hence, the ERI outcomes are reported as an indicator of readiness conditions of sampled producers and not as a population indicator of export readiness of the seaweed sector in Bangladesh.

3.3. Survey Instrument

Structured questionnaires were used for data collection, and this was done using KoboToolbox, a data collection platform that is appropriate for mobile and field-based collection. Harmonisation of compatible response sheets was conducted before pooling, and the same questionnaire structure was applied at both study areas. The questionnaire measured six constructs, each represented by ten items; the constructs were export market orientation, blue technology adoption, operational export readiness, perceived export potential, dynamic capabilities, and institutional support. Everything was assessed with a six-point Likert agreement scale (with 1 (strongly disagree) to 6 (strongly agree) as extremes). The 6-point scale was chosen to remove the neutral centre and facilitate directional responses, which is especially suitable in field settings where the bias of acquiescence and central tendency bias are prevalent. Items were constructed to reflect the particular capabilities, routines, access conditions, and behavioural patterns linked with individual constructs and contextualised to the context of seaweed cultivation and early commercialisation in Bangladesh. Perceived export potential was held in the instrument as a distinct construct but not included in the Export Readiness Index. This division is a key methodological choice. By conceptualizing perceived export potential as an outcome and related outcome construct, instead of a readiness input, the study does not commit the circularity that would be the case with the inclusion of the perceived opportunity to the index that claims to assess the readiness to pursue it on the part of the producers. This distinction also allows the study to test the hypothesis that increased perceived export potential is related to increased readiness, which is a validation strategy based on consistent evidence, as opposed to definitional overlap.

3.4. Measurement Development and Administration

The quantitative instrument was composed of 6 producer-level constructs pertinent to export readiness and perceived export opportunity as follows: export market orientation, blue technology adoption, operational export readiness, perceived export potential, dynamic capabilities and institutional support. Established literature on export marketing, technology adoption, export readiness, dynamic capabilities and institutional support provided the basis for the construction of selection. Individual statements were contexted for seaweed cultivation and early commercialisation in Bangladesh. There were 10 positively worded statements for each construct, and the questionnaire included four general respondent characteristics for a total of 60 substantive measurement items. Each construct item was rated using a six-point Likert agreement scale with no neutral point (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree, 6 = strongly agree). A higher score thus indicated a higher level of the corresponding construct, and no reverse coding was necessary. The entire questionnaire, including all 60 measurement statements and the response format used in the survey is included in Appendix A to facilitate transparency and to allow for direct inspection of the construct coverage.

The two survey datasets were combined, with the response categories being translated to numbers 1 to 6 for data preparation. Strongly disagree was coded as 1 and strongly agree as 6, intermediate categories were coded in the same direction. Equivalent intermediate categories, e.g. slightly and somewhat disagree or slightly and somewhat agree, were harmonised prior to analysis. The coded item scores were then converted to a 0-100 scale to create the readiness sub-indices and the composite ERI. Five constructs contributed to the ERI: export market orientation, blue technology adoption, operational export readiness, dynamic capabilities and institutional support. In order to minimize definitional circularity between the current state of readiness and perceived export opportunity, perceived export potential was intentionally not included in the index, but instead, maintained as a separate outcome construct. The instrument

is producer-centred and perception-based and does not directly measure physical output, laboratory quality, moisture content or documentary compliance.

3.5. Construct Operationalisation

The operationalisation was guided from previous conceptual and empirical studies on similar constructs, but the questionnaire was not copied from any existing scale. Export market orientation was adapted from the market intelligence, dissemination and responsiveness logic of Cadogan et al. (2002) and recently Ishii and Kikumori (2024). Van Eldik and Viviers (2005) and Gerschewski et al. (2020) provided a multidimensional consideration of finance, market knowledge and trade capability as a basis for operational export readiness. The process of adapting blue technology adoption was adapted from a broader SME technology-adoption research (Faiz et al., 2024) and contextualized with evidence from the seaweed sector related to cultivation and post-harvest technologies. Dynamic capabilities adopted the sensing, adaptation and resource-reconfiguration logic of Teece et al. (1997); Sadeghi et al. (2023) and institutional support was based on financial and non-financial support conditions as discussed by Prasannath et al. (2024); Singh et al. (2024). These sources were used as guidance for construct coverage and did not provide the same wording used for items; the wording was adapted to the context of seaweed production in Bangladesh.

- Export market orientation captures producers’ awareness and use of export-market information, including knowledge of international buyer requirements, competitor awareness, and the generation and application of foreign-market intelligence in production and quality decisions.
- Blue technology adoption measures the extent to which producers use appropriate technologies for cultivation management, post-harvest quality control, scalability, and environmental compatibility. This construct represents a practical, sector-specific operationalisation of innovation capability within an emerging coastal enterprise context.
- Operational export readiness assesses readiness across the practical conditions required for export participation: production infrastructure, finance access, familiarity with quality and safety standards, documentation awareness, logistics capacity, partnership development, and order fulfilment capability.
- Dynamic capabilities capture producers’ adaptive orientation, including their ability to sense market and environmental changes, adjust practices and processes, build new partnerships, and reconfigure resources in response to uncertainty (Teece et al., 1997).
- Institutional support measures access to and perceived effectiveness of training, technical assistance, financial services, policy guidance, standards-related support and network-building through government, NGO, and other institutional channels.
- Perceived export potential, the outcome and related outcome construct, measures producers’ perceived opportunity and subjective confidence in their ability to participate in international seaweed markets.

Table 1 summarises the measurement structure and the analytical role assigned to each construct.

Table 1: Measurement Structure and Analytical Role

Construct	Items	Operational Meaning	Analytical Role
Export Market Orientation	10	Awareness and use of export-market information, buyer needs, and competitor trends	ERI dimension
Blue Technology Adoption	10	Use of appropriate technologies for cultivation, quality, scalability, and environmental compatibility	ERI dimension
Operational Export Readiness	10	Readiness in infrastructure, finance, standards, documentation, partnerships and fulfilment	ERI dimension
Dynamic Capabilities	10	Ability to adapt, innovate, reconfigure resources and respond to uncertainty	ERI dimension
Institutional Support	10	Access to training, finance, policy support, infrastructure, networks, and standards guidance	ERI dimension
Perceived export Potential	10	Perceived opportunity and ability to participate in international markets	Related outcome construct, excluded from the ERI

Perceived export potential was retained outside the ERI as a related outcome construct rather than as an independent criterion for validating readiness. Conceptualizing the five ERI domains as current producer conditions, market orientation, technology use, operation readiness, adaptive capability and institutional access, and perceived export potential as the respondents' judgements about their prospects of entering and serving international markets, it is possible to conceptualize the four conditions that are necessary and sufficient for a producer to become an exporter.

A closer look at the items, however, reveals some conceptual similarity between the two sets of measures. Several perceived export potential items refer to production capacity, access to market information, conformity with export quality standards, logistical support, market exploration and buyer feedback, which are also reflected to varying degrees within the readiness domains. The study thus does not make an assumption of complete discriminant separation between perceived export potential and the ERI. The complete questionnaire is reproduced in Appendix A to make this distinction and the areas of overlap transparent. Relationships between the two constructs are therefore viewed as providing relational evidence but not as independent evidence for construct validity.

3.6. Index Construction and Measurement Logic

The ERI was determined as a theory-based additive diagnostic index instead of a latent psychometric scale. Its five domains, export market orientation, blue technology adoption, operational export readiness, dynamic capabilities and institutional support, contribute jointly and non-interchangeably to producer-level export readiness. A producer might be good in one area and bad in another, so good production in one does not make up for poor production in another. The ten items within each domain were grouped a priori to represent complementary aspects of that capability area and were averaged after normalisation to form the respective domain score. The study therefore does not assume that the item sets have a strict reflective first order measurement model. Cronbach's alpha is only included as an additional measure of within domain response consistency and is not used as a measure of internal homogeneity or psychometric validation of the higher-order ERI. The composite ERI is calculated by averaging the five domain scores, in line with the diagnostic and capability-based purpose of the ERI.

The principal component analysis was not used to test for formative construct validity, but as a supplementary structural and weighting-sensitivity diagnostic. The analysis included an investigation of the common variation across the five readiness domains and what impact an empirically weighted index would have on the conclusions drawn from an equal-weighted index. Accordingly, the proportion of variance represented by the first principal component is reported as descriptive evidence of shared structure, not as proof that the five domains constitute a reflective scale. The PCA-derived weights are used only to construct an alternative index for comparison with the primary equal-weighted ERI. Similarly, the composite Cronbach's alpha over the five domain scores is not a necessary criterion for a formative additive index and thus is not reported here for validation. The findings on the links between the ERI and perceived export potential are presented separately, and are not treated as definitive evidence, but as supporting empirical evidence. This distinction is in line with the analytical claims and the index specification and the design of the cross-sectional study.

The scores were originally obtained on a six-point Likert scale which was converted to a 0 to 100 metric by applying the following formula: $[(x - 1) / 5] \times 100$, where x represents the response recorded. This transformation results in the scores 0 (strongly disagree) and 100 (strongly agree) and maintains the order and spacing of the response categories. The ten normalised items within each readiness domain were then averaged to obtain a domain score. The composite ERI was computed as the arithmetic mean of the five domain scores, with each domain contributing equally to the composite ERI (20 per cent). The weighting was left equal since the index is designed to be a first-generation diagnostic instrument that is easily understood and there is currently no theoretical or external empirical evidence to support differential weighting of the five domains. A PCA based weighting exercise was only kept as a sensitivity check to find out whether an alternative empirical weighting scheme affected the overall interpretation of producer readiness.

These five readiness bands are only used as descriptive reporting categories to find a score within the 0-100 continuum. They are not considered as proven thresholds of exportability and the shift from one category to another does not imply that a producer has objectively become export ready. The new intervals are set as 0-20, above 20-40, above 40-60, above 60-80, and above 80-100 to prevent any gaps between categories. Category frequencies are only used to describe the distribution of respondents in the study sample and continuous ERI and domain scores are the main basis for interpretation. Alternatively, new cutoffs would be another arbitrary interpretation without adding any value and there is no external benchmark to compare seaweed producer export readiness in Bangladesh. Future research should calibrate meaningful thresholds against observed outcomes such as verified export participation, buyer acceptance, standards compliance or documented transaction performance.

3.7. Data Analysis

The quantitative analysis was done in a number of consecutive steps. The process of data cleaning included the examination of the missing values, out-of-range answers, and inconsistency between the pooled KoboToolbox sheets. The items were coded and normalised between their initial scale 1 to 6. All constructs as well as the composite ERI were calculated to determine the descriptive statistics, such as means, standard deviations and frequency distributions. Cronbach's α was provided as an additional within-domain response-consistency diagnostic for the five ERI domains and was not used as a test of construct validity or as a criterion for keeping the domains, since the ERI is specified as an additive diagnostic index rather than a reflective psychometric scale. The five sub-index scores were subjected to principal component analysis to determine whether they have a common readiness structure

i.e. whether they can be explained by a dominant first component whilst leaving the interpretation of each domain of capability intact. Three complementary analyses were used to examine the structure of the ERI and its empirical association with perceived export potential.

Pearson r correlation was chosen as the main association measure as both the composite ERI and perceived export potential were analysed as continuous composite scores, ranging from 0–100. Spearman’s ρ rank correlation was also included as a secondary sensitivity variable to test whether the correlation found was maintained when the respondents were ranked instead of using the metric scores. The two coefficients are therefore reported for complementary purposes rather than as competing alternatives. A simple ordinary least squares regression was retained to summarise the proportion of sample variation in perceived export potential associated with the composite ERI. The five readiness domains were then explored simultaneously using multiple regression as an association analysis. Conditional coefficient patterns and shared variance among the domains are reported in the form of standardised coefficients and variance inflation factors. The model is not interpreted as a forecasting exercise, causal specification or formal test of suppression. Since the data are cross sectional and based on the same questionnaire, coefficient estimates may be due to both substantive relationships and covariance due to common measurement and conceptual overlap. So, VIF values are taken into account while interpreting the sign and magnitude of the coefficients. There are no definitive best predictors identified in the analysis and all the regression results are limited to conditional associations that are found among the producers sampled.

4. Results

4.1. Construct-Level Readiness

The construct scores indicate generally low producer level export readiness across the five capability domains. The lowest mean score was obtained for export market orientation (6.54) which implies that the sampled producers had very limited market intelligence and buyer related capability. Export readiness was also low, with a mean score of 11.17, indicating significant production system, documentation, finance, standards compliance and order fulfilment constraints. The mean score for blue technology adoption was 18.60 and was also in the lowest descriptive readiness band. Dynamic capabilities and institutional support were relatively high, with mean scores of 30.17 and 28.60 respectively, both in the low readiness category. These findings suggest that the major limitations are not only in producer interest, but also in market facing and operational capacities. The pattern therefore points to uneven capability development across the readiness domains rather than a uniform absence of commercial potential. Table 2 reports the construct means, standard deviations and supplementary within domain response consistency diagnostics.

Table 2: Construct Scores and Reliability

Construct	Mean (0–100)	SD	Cronbach’s α	Readiness Interpretation
Export Market Orientation	6.54	5.13	0.465	Very weak market capability
Blue Technology Adoption	18.60	11.90	0.827	Very low innovation readiness
Operational Export Readiness	11.17	8.09	0.678	Very low operational readiness
Dynamic Capabilities	30.17	14.81	0.781	Low adaptive capability
Institutional Support	28.60	15.59	0.820	Low support availability
Perceived export Potential	28.28	14.31	0.726	Outcome higher than readiness

Note: Perceived export potential was excluded from the ERI and retained as an outcome and related outcome construct. Cronbach’s α is reported only as a supplementary within-domain response-consistency diagnostic. The value of 0.465 for Export Market Orientation indicates low internal consistency and should be interpreted cautiously; it does not determine the domain readiness score.

Export market orientation had a low response consistency within the domain (Cronbach's $\alpha = 0.465$) and should be interpreted with caution. This finding does not necessarily indicate that the construct itself is of little significance or that the low mean score reflects the reliability of the measurement. All ten export market orientation items were positively worded, so reverse coding was not required. The ERI is not a reflective psychometric scale, thus alpha is merely a supplemental diagnostic, not a criterion for retention or validation of the domain. The construct of export market intelligence is maintained because it is conceptually at the core of export readiness at the producer level, and it is a construct that is represented directly in the ERI framework. But the low α suggests that the current set of items might not be internally consistent in an early-stage producer context to adequately measure this capability. Future refinements of these instruments should thus rethink the wording of items and the development of coverage based on independent samples and a psychometric assessment before making stronger measurement claims.

4.2. Export Readiness Index

The overall ERI mean is 19.02 on 100 which puts the producer base in the very low readiness category. It is a median of 17.60; thus, over half of the population sampled are below even the low-readiness level. It is more informative than the mean per se: 229 respondents (61.1 percent) are in the very low readiness band, 143 (38.1 percent) are in the low readiness band, only three (0.8 percent) are moderate readiness, and none are high or very high readiness. The sub-index profile attests that the most significant weaknesses are export market orientation and operational export readiness. They are fundamental small-business management holes since they influence export planning, buyer communication, quality routines, production discipline, and readiness to transact. The general trend is in favour of a readiness-gap explanation: the perceived opportunity to export by producers is evident to outrun the abilities needed to actually pursue the opportunity in terms of plausible export-oriented enterprise activity. Table 3 gives the final ERI results with sub-index scores and readiness distribution.

Table 3: Seaweed Export Readiness Index Results

ERI Component or Category	Mean or n	SD or %	Category
Export Market Orientation	6.54	5.13	Very low
Blue Technology Adoption	18.60	11.90	Very low
Operational Export Readiness	11.17	8.09	Very low
Dynamic Capabilities	30.17	14.81	Low
Institutional Support	28.60	15.59	Low
Composite ERI	19.02	8.55	Very low
Perceived export Potential	28.28	14.31	Low; related outcome construct
Very low readiness	229	61.1%	Distribution
Low readiness	143	38.1%	Distribution
Moderate readiness	3	0.8%	Distribution
High or very high readiness	0	0.0%	Distribution

Note: $n = 375$. Scores are normalised to a 0 to 100 scale.

4.3. Associations, Dimension Effects and Sensitivity

The first principal component explained 56.6 per cent of the variance in the five domain scores, suggesting that there was a great deal of shared variance while maintaining the analytic separation of the domains. The main Pearson correlation revealed that the composite ERI had a high positive correlation with perceived export potential ($r = 0.773, p < 0.001$). The supplementary Spearman rank correlation yielded a highly similar coefficient ($\rho = 0.770, p < 0.001$), reflecting the same association when the respondents were ranked. On a simple

regression of the perceived export potential on ERI, $R^2 = 0.597$ is obtained. The observed association between the ERI and perceived export potential is interpreted with additional caution because both were measured from the same respondents, within the same questionnaire, at a single point in time and using the same response format. These design characteristics can increase observed relationships due to shared method effects and substantive relationships (Podsakoff et al., 2003). The Pearson correlation is therefore retained as the main bivariate association statistic, and the Spearman's rank correlation is provided as a sensitivity statistic, and the simple regression is used to summarise the sample-level association. The coefficient of determination is reported descriptively as the proportion of variation in perceived export potential associated with the composite ERI in the sample, without implying independent prediction or causal influence. Strong associations at the domain level are interpreted in the same manner. Future validation of the ERI should be conducted by external criteria, including export transactions verified, quality compliance objective, buyer valuation, longitudinal participation of exports. The diagnostic and association evidence is summarised in Table 4.

Table 4: Supporting Diagnostic and Association Evidence for the ERI

Diagnostic or Association Check	Result	Interpretation
PCA structure	$PC1 = 56.6$ of variance	Readiness domains exhibit substantial shared variation.
Primary Pearson association	$r = 0.773$, $p < 0.001$	ERI strongly associated with perceived export potential
Supplementary Spearman association	$\rho = 0.770$, $p < 0.001$	Similar rank-order association observed
Regression association	$R^2 = 0.597$	Composite ERI is strongly associated with variation in perceived export potential.

Blue technology adoption and dynamic capabilities showed the strongest bivariate associations with perceived export potential, with correlations of 0.854 and 0.857 respectively. Their positive standardised coefficients in the multiple regression indicate that these relationships remained positive when the other readiness domains were considered simultaneously. However, coefficient magnitude should be interpreted cautiously because several domains share appreciable variance, as reflected in VIF values of 4.01 for blue technology adoption and 3.81 for dynamic capabilities. Export market orientation and institutional support produced negative conditional coefficients despite weak or positive bivariate associations. These coefficients are not interpreted as suppression effects because the present analysis does not establish a formal suppression mechanism. Nor should they be understood as evidence that either capability has a harmful effect on perceived export potential. They are reported as conditional associations arising within a model containing correlated readiness domains. Table 5 therefore presents the regression as exploratory association evidence rather than as a ranking of definitive predictors or causal effects.

Table 5: Dimension-Level Association with Perceived Export Potential

Capability Domain	Bivariate r with PEP	Conditional Std. β	VIF	Interpretation
Export Market Orientation	.084	-.125**	1.37	Weak bivariate association; negative conditional regression coefficient after adjustment for other domains
Blue Technology Adoption	.854***	.456***	4.01	Strong positive conditional association
Operational Export Readiness	.549***	.118**	2.91	Positive conditional association
Dynamic Capabilities	.857***	.507***	3.81	Strong positive conditional association
Institutional Support	.339***	-.179***	2.30	Positive bivariate association; negative conditional regression coefficient after adjustment for other domains

Note: $n = 375$. Dimension-level regression $R^2 = 0.817$; adjusted $R^2 = 0.814$. ** $p < 0.01$; *** $p < 0.001$. Coefficients are conditional associations, not causal effects. PEP = Perceived Export Potential. Standardised regression coefficients represent conditional associations after simultaneous adjustment for the other readiness domains and should not be interpreted as causal effects.

The weighting sensitivity analysis produced the same substantive readiness pattern as the primary equal-weighted index. The mean ERI rose from 19.02 to 20.87 and the correlation with perceived export potential rose from $r = 0.773$ to $r = 0.796$ when weights derived from the first principal component were applied. Therefore, the alternative weighting scheme had only a modest impact on the numbers but did not affect the overall finding that readiness among the sampled producers was low. This comparison validates maintaining equal weighting of the primary ERI since it is easier to interpret, replicate and apply in future monitoring. The readiness bands are provided as descriptive support and are not applied as a validated decision threshold. The principal interpretation therefore is based on the continuous ERI score, domain profile and distribution of respondents across the scale. Any future attempt to establish substantive cut-offs should be calibrated against external evidence of export participation, standards compliance, buyer acceptance or comparable observed outcomes.

4.4. Location-Level Pattern

Location level results are presented descriptively because the sample is not regionally balanced. Cox's Bazaar had higher mean scores than the southwestern coast for all the reported readiness measures (overall ERI, technology adoption and institutional support). This trend is in line with the longer seaweed cultivation history and experiment with buyers from Cox's Bazar. The lower scores in the southwest are not indicative of lack of ecological opportunity as the present study does not test ecological suitability comparatively. Instead, they suggest that sampled producers in that area reported less capability in that time period. In practical terms, this implies that capability development in the southwest may need to be more focused on technical validation, producer confidence, access to technology and institutions prior to export-oriented scaling. Table 6 provides a descriptive comparison of the two locations, and no population-level inferences are drawn from the regional differences in the present cross-sectional sample.

Table 6: Descriptive Location-Level Comparison

Location	n	Mean ERI	Export Potential	Technology	Support
Cox's Bazar	313	20.87	30.73	21.41	30.82
Southwestern Coast	62	9.69	15.90	4.45	17.42

Note: Scores are normalised to a 0 to 100 scale. Location comparisons are descriptive only.

4.5. Discussion

The results place the study in the wider context of the small business internationalisation and export readiness literature. As part of the producer survey, the main limitations are capability related, such as market orientation and operational readiness. The value of export market orientation of 6.54 stands out when compared to the literature. Kohli and Jaworski (1990) and Cadogan et al. (2002) consider market orientation as the basis of export performance, and Ishii and Kikumori (2024) show that it is strongly determined by access to partner networks and channel circumstances, as opposed to internal motivation alone. It is exactly what this paper discovers: producers are not indifferent; they just lack an organised way in which market intelligence finds its way to them. The score indicates structural alienation to buyer networks, rather than attitudinal failure. This observation supports the argument made by Ishii and Kikumori (2024) that market orientation cannot be built at the individual producer level: it must be a chain-level structure of middlemen and institutional translators, and buyer-connected demonstration programmes.

The dimension level results reveal a more robust trend for blue technology adoption and dynamic capabilities. These domains had the highest bivariate correlation with perceived export potential (0.854 and 0.857, respectively) and their conditional coefficients were also positive when the readiness domains were taken together. This aligns with the findings of Hoque et al. (2022) and Sadeghi et al. (2023) who highlight the importance of adaptive learning and upgrading of knowledge in an uncertain export environment. For seaweed production, innovation does not necessarily have to be formal R&D or technological investment. It can involve practical improvements in cultivation, drying, grading, quality management, resource adjustment and coordination with buyers or aggregators. These activities are highly aligned with the behaviours evident in the blue technology adoption and dynamic capabilities domains. The results thus indicate a potential significant relationship between practical adaptation and producers' perceived export opportunity, and the cross-sectional design does not allow for the interpretation of these relationships as predictive or causal effects.

Although evidence of institutional fragmentation exists, the mean score for institutional support was 28.60, which was relatively high when compared to other readiness domains. This seeming strength is to be interpreted with some caution. Prasannath et al. (2024) and Singh et al. (2024) both discover that government support programmes can only enhance the entrepreneurial orientation and export readiness when linked to buyer requirements and market results. The evidence of Bangladesh has a consistent pattern where training and input programmes are delivered to the producers without establishing channels of purchase or standard pathways. Therefore, exposure to institutional practices does not necessarily mean effectiveness of the institutions. The domain reflects producers' reported access to support and not verified effectiveness of institutions. This difference is important in policy design and consistent with the ecosystem argument of Mason and Brown (2014), that it is not the existence of any individual actor acting in isolation that is the driver of capability development but rather the coordination between institutions, buyers, finance providers, and producers.

The readiness and perceived potential measures should therefore be interpreted as related but not fully independent constructs. The perceived export potential was higher than the composite readiness score and the observed regression results show a high degree of association between the readiness domains and producers' export opportunity ratings. The proportion of the sample variation in perceived export potential explained by the dimension level model was 81.7 per cent, which must not be interpreted as evidence that readiness is a cause of, or predictor of, export potential. The two measures were given to the same respondents at a single point in time, with several readiness domains having appreciable overlap. Therefore, the regression results are employed to determine patterns of conditional association, and not explanatory dominance among the domains. The importance of the ERI for policy is that it indicates where the lack of competence is focused within the sampled producers. This diagnostic profile can be used to inform the sequencing of market, technology, operational and institutional interventions but does not assume causal relationships that cannot be demonstrated by the cross-sectional design.

This descriptive difference between Cox's Bazar and the south-west coast could be partly explained by exposure to buyer related activities and accumulated cultivation experience. It is a measure of the extent of exposure of the producer to buyer-related activity and the learning effects of the repeated cultivation and sale experiences. Sobuj et al. (2023, 2024) and Mohiuddin et al. (2023) record that Cox's Bazar has had a larger number of sustained cultivation trials compared to the southwest. Within the sample, producers in Cox's Bazar scored higher with respect to technology adoption, institutional support and perceived export potential, indicating more opportunities for learning, adaptation and interaction. The southwestern coast may still be ecologically promising but be at a less advanced level of capability development, suggesting a different order of interventions.

5. Conclusion

This study addressed three objectives concerning the level of export readiness, the most pronounced capability constraints and the association between readiness and perceived export potential among the sampled seaweed producers. First, the composite ERI had a mean score of 19.02 on the scale of 0 to 100, which is in the lowest descriptive readiness band, with 61.1 per cent of the respondents in that band. Second, export market orientation and operational export readiness showed the lowest domain scores, suggesting that a lack of market intelligence and export systems were the largest capability limitations in the sample studied. Third, the strongest association of the composite ERI was with perceived export potential, and that the strongest bivariate associations at the domain level were with the adoption of blue technology and dynamic capabilities. Such relationships are viewed as associations, and not as predictive or causal effects. In general, the results indicate that there is a higher perceived opportunity than current producer capability and that the latter should be developed first before expanding export participation.

The practical consequence is sequencing. Export has to be developed on capability. In the case of Cox's Bazar, buyer related learning, quality hubs, and producer group formalisation are some of the near-term priorities that can be realised. In the case of the southwestern coast, trust-building and technical validation are the initial ones. On the sector level, periodic ERI evaluations would enable policy makers to monitor the improvement of capabilities and amend intervention priorities as time goes. Limitations of the study are clearly indicated. It has a producer-centred, cross-sectional, and non-probabilistic sample. Export readiness is a producer perception and not based on actual export transactions or objective quality measurements. Future studies ought to engage in longitudinal ERI monitoring, objective

quality measures, cost-margin measures, and modules of separate surveys between the processors and exporters and institutional actors. Such extensions would shift the diagnostic model out of the present cultivation-end orientation to a full chain readiness measure, which ultimately is what a plausible export industry needs.

Declarations

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

The data that support the findings of this study were collected through a structured producer-level survey conducted in the southeastern and the southwestern coast of Bangladesh. The dataset is available from the authors upon reasonable request, subject to ethical considerations regarding the privacy and confidentiality of survey participants.

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