

Article

Consumer Awareness on Sustainable Seafood in Hong Kong's Supermarkets: Current Status and Potential Drivers

Xiangping Dong ¹, Siying Chen ¹, Dingzhe Guo ¹, Qingyang Wu ¹, Cheuk Yu Hau ² and Tin Yan Hui ^{1,3,*}¹ Master of Cities and Governance Programme, Lingnan University, Hong Kong, China² Swire Institute of Marine Science & School of Biological Sciences, The University of Hong Kong, Hong Kong, China³ Division of Science, Lingnan University, Hong Kong, China

* Correspondence: tinyanhui@ln.edu.hk; Tel.: +852-26268532

Abstract

Globally, sustainable seafood has become an important marketing means to promote sustainable fisheries practices. To support its production, however, characterising the consumer market, such as the demand, awareness and identification of sustainable products, is essential. This study investigated the current status of sustainable seafood and consumer awareness in Hong Kong, a city with one of the highest levels of per capita seafood consumption in the world, using the framework of Cognitive-Behavioural Theory. By conducting market surveys across 18 supermarkets using a stratified and convenience sampling approach, as well as face-to-face questionnaires ($n = 415$) to assess consumer traits, we found that the availability of sustainable seafood was highly polarised, with a complete absence of ecolabelled seafood in low-end supermarkets and only limited availability (~17% in proportion) in mid- and high-end supermarkets. In terms of price, ecolabelled fish products were more expensive than those without certification labels, but ecolabelled molluscan products were cheaper. Consumer cognition, attitudes, and behaviours towards sustainable seafood varied with supermarket grade, with sustainable products being more aware of and accepted in high-end supermarkets than in other supermarkets. Both younger age and higher education were key demographic factors enhancing the cognition level on sustainable seafood. This research contributes a transferable framework for assessing sustainable consumption in high-density urban markets and identifies retailer-driven information barriers as a key constraint. We propose targeted strategies, including visual nudging and enhancing information transparency, to promote responsible consumption.

Keywords: sustainable seafood; cognitive-behavioural theory; consumer awareness

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1. Introduction

Aquatic animals contribute ~15% to the world's supply of animal source protein [1], providing 3.2 billion people worldwide with at least 20% of their animal protein supply [2]. Currently, seafood is predominantly sourced through two major methods: wild capture fisheries and aquaculture [3,4]. However, both sources face challenges to their sustainability [5–8]. Overfishing, in particular, is one long-standing issue in wild capture fisheries, with broad ecological, economic and social impacts [9–12]. Aquaculture, though offering an alternative to wild capture fisheries, can also lead to environmental impacts such as habitat degradation, pollution and invasive species [13–16].

In response to these challenges, the concept of “sustainable seafood” has been developed, aiming to balance the integrity of aquatic ecosystems with long-term production

to meet market demand [17]. The National Oceanic and Atmospheric Administration (NOAA) has provided a pragmatic definition: “seafood—including fish, shellfish, and seaweed—that is harvested or farmed in ways that meet present needs without compromising the ability of species to reproduce, habitats to thrive, and ecosystems to remain productive for future generations” [18]. To promote this concept in the consumer market, certification and ecolabel schemes have been established [19]. Common ecolabels in the market include the Marine Stewardship Council (MSC) for wild capture fisheries, the Aquaculture Stewardship Council (ASC) and Best Aquaculture Practices (BAPs) for aquaculture, among others (see Table S1 in the Supplementary Information for details on common ecolabels). By providing standardised criteria and third-party verification, certification schemes promote transparency and accountability in the seafood industry [20]. They also serve as important market-based tools, indicating sustainability credentials to downstream retailers and consumers [21].

Consumers’ characteristics, such as awareness, level of education, and income, have been widely recognised as key determinants of their sustainable purchasing decisions [22–27]. These characteristics influence whether consumers are able to identify sustainably certified products [28], as well as their evaluations of product quality, price and environmental footprint [29,30]. Generally, consumers with better environmental knowledge and/or awareness are more likely to differentiate products with eco-certifications or lower environmental impacts [31]. Such differentiation is crucial for filtering out false claims through unstandardised labels [32]. As such, consumer decisions based on ecolabels are indicative of their awareness and/or knowledge of sustainable fisheries methods, which is similar to the identification of ecolabels on non-seafood products such as soaps, detergents, forestry products and batteries [33–35].

Another key variable influencing purchasing decisions is product price. Sustainable seafood products are typically more expensive than those produced through unsustainable practices [36]. In the wild capture sector, sustainable fishing practices, such as seasonal closures and species-specific catch limits, reduce short-term yields and increase operational costs [37]. Similarly, sustainable aquaculture involves additional investments in environmentally friendly feed, better water treatment systems, and lower stocking densities, which contribute to higher production costs compared to traditional intensive farming practices [38]. Third-party certifications further add to the cost of production [39]. Apart from these added costs, retail typologies, such as supermarkets, specialty stores, or wet markets, which differ in operational costs, product assortments, sourcing channels, and pricing strategies, would further contribute to price variation among seafood products [40]. Consumer decisions, therefore, entail a trade-off between environmental awareness and product price, which is reflected in their willingness to pay (WTP) [41–44]. Consumers with higher incomes generally have a higher WTP for sustainably harvested products compared to those with lower incomes, although such a relationship may be attributable to their education levels [45].

Hong Kong has an important role to play in the global seafood consumer market. In terms of consumption, Hong Kong ranked 8th in the world [46]. In 2017, the per capita seafood consumption rate of Hong Kong was 2.7 times the global average [47]. This consumption promotes fisheries markets both locally and globally [48,49], leading to overfishing, which reduces the diversity, abundance and size of important marine resources such as fish, crustaceans, molluscs and echinoderms [50–52]. Globally, the proportion of fish stocks being overfished increased from 35.4% in 2019 to 37.7% in 2021 [2]. To mitigate these issues and promote sustainable seafood in the consumer market, NGOs in Hong Kong have led educational programmes such as establishing seafood selection guides and online resources for the general public since 2007 [53,54]. Recently, local catering

and hospitality industries have also been advertising the use of sustainable seafood as a means of boosting their Environmental, Social and Governance (ESG) performance [55–57]. Although sustainable seafood has been promoted for more than a decade in Hong Kong, the overall awareness of seafood sustainability has remained uncommon, as reflected by over 35% of local citizens being unaware of the term “sustainable seafood” in 2014 [58].

One major avenue to further promote sustainable seafood in Hong Kong is through supermarkets, the primary source of raw seafood products apart from wet markets and direct harvesting [59]. In 2015, Hong Kong consumers purchased ~US\$8.77 billion worth of food, of which 50.62% was spent in supermarkets [60]. In conjunction with the variations in citizens’ income and commodity prices among the 18 districts of Hong Kong [61], as well as the distribution of local real estate [62], supermarket retailers of different price levels are located in different places in Hong Kong [63]. “High-end” supermarkets, offering premium-priced products, are concentrated in business centres and residential areas with higher incomes. “Low-end” supermarkets, where commodity prices are relatively lower, are primarily located in public housing estates and low-income districts. “Mid-end” supermarkets with moderate price levels are, however, widespread in Hong Kong [60]. As such, high-, mid-, and low-end supermarkets target customers with varying spending power [60]. Seafood is available as frozen and/or packaged items in these supermarkets and, occasionally, sold fresh in fresh produce sections. Based on the positive relationship between income and environmentally informed purchasing decisions [64–66], the availability of and demand for sustainable seafood are expected to vary among the three categories of supermarkets in Hong Kong.

To test this assertion, this study assessed the availability of sustainable seafood in Hong Kong’s supermarkets and examined how consumers’ demographic characteristics were associated with their attitudes, cognition, and purchasing behaviours under the framework of Cognitive-Behavioural Theory [67,68]. Based on preliminary market observations and the theoretical links between cognition and action, we proposed the following hypotheses:

- H1.** *High-end supermarkets offer a greater proportion of sustainable seafood in their products.*
- H2.** *Customers in high-end supermarkets demonstrate higher levels of cognition and a more positive attitude towards sustainability.*
- H3.** *Purchasing behaviour is primarily influenced by income, whereas cognition and attitude of the consumers are more driven by their education level.*
- H4.** *A higher level of cognition and a positive attitude towards sustainability enhance consumers’ willingness to pay a price premium for sustainable products, but such willingness may differ from actual purchasing frequency due to perceived barriers such as price sensitivity and information transparency.*

By testing these hypotheses, this study aims to identify key drivers of responsible consumption and propose strategies to promote sustainable seafood in Hong Kong.

2. Materials and Methods

2.1. Supermarket Selection and Market Survey on Frozen Seafood

Supermarkets were stratified into three grades according to their market positioning, commodity prices and target customers, and two to three brands were selected within each grade: high-end (YATA, TASTE, city’super), mid-end (Wellcome, PARKnSHOP) and low-end (759 Store, Kai Bo Food). For market surveys on frozen seafood, one to three shops were conveniently sampled per brand across the three main areas of the territory: Hong

Kong Island, Kowloon and the New Territories ($\sum n = 18$, see Table S2 and Figure S1 for shop locations in the Supplementary Information). While this stratified and convenience sampling approach ensured representation across districts with various socio-economic statuses, the full diversity of retail outlets might be underrepresented, particularly for smaller independent retailers. The supermarket brands covered in our surveys were, however, widely known locally and have retail shops in multiple regions across the territory. Only frozen seafood, defined as products stored at temperatures below -18°C , was considered; other seafood-containing items (e.g., dried or canned seafood, sauces, and crackers) were excluded. This criterion was applied because frozen seafood was available across all surveyed shops, enabling direct comparisons. Market surveys were conducted between June and August 2023 in selected shops to quantify the availability and price of frozen seafood products. In the surveys, frozen seafood products were quantified by their product types but not stocking number. For each product type, the following variables were recorded when available: taxonomic group (fish, crustacean, molluscs or echinoderms), harvesting method, product origin, unit price, weight and the presence of certified ecolabels for sustainable seafood. Based on preliminary surveys, the most common sustainable seafood ecolabels observed in Hong Kong supermarkets were those from the MSC, ASC, and BAP [69–71]. Therefore, in this study, seafood products were classified as “sustainable” if they carried at least one of these three ecolabels on the product packaging, and “ordinary” seafood otherwise. Although seafood without the ecolabels above may also be sustainably sourced, ecolabels offer a direct indication of sustainable seafood from a consumer perspective. Therefore, only products with ecolabels were considered sustainable seafood in this study.

2.2. Consumer Cognition, Attitude and Behaviour on Sustainable Seafood

Supermarket consumers were assessed for their cognition, attitude and behaviour towards sustainable seafood through a face-to-face questionnaire survey. The questionnaire was developed based on the Cognitive-Behavioural Theory to investigate the psychological mechanisms driving sustainable consumption [72]. The questionnaire was composed of three sections: (1) demographic background, including gender, age, occupation, education and income levels (Questions 1 to 5); (2) seafood consumption habits, including purchasing frequency (Question 6), recognition of ecolabels (Question 7) and acceptable premium for sustainable compared to ordinary seafood (Question 8); and (3) traits on understanding sustainable seafood issues, including cognition (Questions 9 and 10), attitude (Questions 11 to 13) and behaviour (Questions 14 to 16). The trait-related questions in the third section utilised a 5-point Likert scale to quantify consumer responses. The questionnaire was pretested by independent individuals to ensure validity and reliability of the questions for each of the cognition, attitude and behaviour question sets (Cronbach’s $\alpha \geq 0.78$, $n = 30$; see Table S3 in the Supplementary Information). Twenty adult (age > 18) consumers were interviewed conveniently in each shop from June to July 2023 ($\sum n = 3$ (grades) $\times 2 - 3$ (supermarkets) $\times 3$ (shops) = 21 shops), and in total, 415 valid responses were collected (see Part II in the Supplementary Information for the full questionnaire and Table S4 for answer distributions). A preliminary survey ($n = 77$) was conducted in March–April 2023 via face-to-face interviews at four local supermarkets. This pilot study aimed to identify the baseline of local consumers’ sustainability awareness, providing an empirical context for questionnaire design and interpreting the findings of the present study (see Part III in the Supplementary Information).

2.3. Statistical Analysis

To investigate whether the availability of sustainable seafood varied between supermarkets with different grades, as well as between taxonomic groups of seafood products (fish, crustaceans, and molluscs; hypothesis H1), the proportion of sustainable seafood products (number of products with certified ecolabels over the total number of products) was tested using a generalised linear mixed model (GLMM) with Tweedie distribution (to account for zero proportions in some supermarkets; all proportions were < 0.67) against supermarket grades (fixed, two levels), taxonomic groups (fixed, three levels) and their interaction. Low-end supermarkets and echinoderms were excluded, as low-end supermarkets had no sustainable seafood, and all echinoderm products surveyed did not have ecolabels. To investigate the price difference between sustainable and ordinary seafood among supermarkets of various grades, both the unit price (USD, using the rate 1 USD = 7.8246 HKD as in June to July 2023) and price per unit weight (USD/g) of all frozen seafood were tested using GLMMs (with gamma distribution and a log link function) with supermarket grade (mid- and high-end), taxonomic group (crustacean, fish and mollusc), seafood type (sustainable and ordinary seafood), and their interactions as explanatory variables. Shop identity and product were treated as random intercepts in all GLMMs to account for variations in product prices and proportions of sustainable seafood due to different shops (e.g., the same products tend to be similar in prices across shops). Model residuals were checked using the DHARMA package in R 4.5.1 [73], and significant factors were further investigated with *post-hoc* Tukey's tests via the package emmeans in R 4.5.1 [74].

Variations in consumers' traits on sustainable seafood were investigated using generalised linear models (GLMs, hypothesis H2). Specifically, the cognition, attitude, and behaviour of consumers regarding ecolabels were treated as separate response variables and tested against supermarket grade (fixed, three levels) and consumer occupation (fixed, nine levels), as well as their interactions. Environmental professionals, self-employed and unemployed consumers were excluded from the analyses due to their low sample size in one of the supermarket grades ($n < 5$). Cognition scores were categorised into three ordinal levels according to whether the respondents correctly answered both questions related to sustainable seafood (score = 3), only one question (score = 2), or answered incorrectly for both questions (score = 1). Similarly, for the recognition of ecolabels, responses were categorised into seven ordinal levels based on whether the respondents correctly identified true ecolabels and ignored false labels. Both attitude and behaviour scores were first averaged across the respective questions (three questions in each of attitude and behaviour) and categorised into five ordinal levels due to the observation that five ranks of averaged scores were evident during the data exploration process. Thus, an ordinal scale approach was adopted. To test for these ordinal responses, ordinal multinomial distributions were used for the GLMs via the "ordinal" package and the cumulative link model function in R 4.5.1 [75]. Significant factors identified by these main tests were further investigated using *post-hoc* Tukey's tests as above. Variations in the demographics (income: four levels; education: five levels; and age: six levels) of the consumers were also tested using ordinal GLMs against supermarket grades.

To elucidate the relationships between consumers' demographics, supermarket grade and key determinants of traits on sustainable seafood (cognition, attitude and behaviour; hypotheses H3 and H4), a structural equation model (SEM) was proposed based on the potential links between cognition, attitude and behaviour, and the observation that age and education level correlated with these sustainable seafood traits (see model in Figure 1). The acceptable premium that consumers were willing to pay for sustainable over ordinary seafood was also included in the model, since this premium may reflect the perceived value of sustainable seafood, which then influences the attitude and behaviour of the consumers.

The SEM was built from the full dataset (without exclusion of various occupations as in the previous section, since occupation was not tested in the SEM), tested and visualised using the packages “lavaan” [76] and “lavaanPlot” in R 4.5.1 [77].

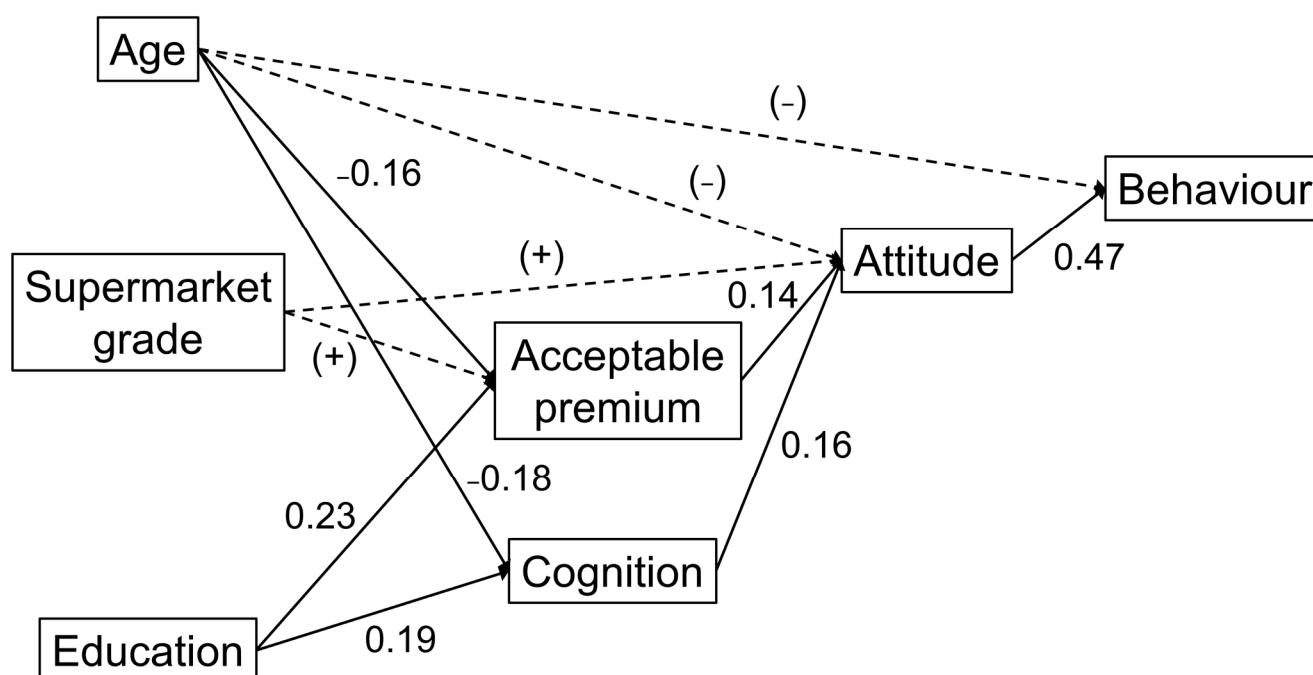


Figure 1. Structural equation model (SEM) constructed to explain the variations in consumer traits on sustainable seafood in Hong Kong’s supermarkets. Solid and dotted lines are statistically significant and insignificant effects, respectively, whereas the direction of the arrows indicates potential cause-and-effect relationship. Numbers next to the lines are standardised coefficients indicating the strength of the effects, with negative/positive values representing negative/positive effects. For insignificant effects, the signs of the effects are also shown for reference. The SEM was fitted using data from all valid respondents ($n = 415$).

3. Results

3.1. Market Survey on Frozen Seafood Among Hong Kong’s Supermarkets

All seafood surveyed in low-end supermarkets did not contain ecolabels, while the proportion of sustainable seafood in mid-end supermarkets was similar to that in high-end supermarkets (Figure 2, Table 1). These findings partially support H1. In terms of price, both unit price and price per unit weight of seafood products were higher in high-end than low-end supermarkets, but there were no differences in price per unit weight between sustainable and ordinary seafood (Figure 3, Table 1). Sustainable and ordinary seafood differed in their unit prices within different taxa, however, with sustainable seafood being cheaper and more expensive than ordinary ones for molluscan and fish products, respectively (Figure 3, Table 1). Such taxa-specific variation was also seen in price per unit weight, where crustacean products had a higher price per unit weight than fish and molluscan products (Figure 3, Table 1).

3.2. Cognitive-Behavioural Discrepancy of Consumption on Sustainable Seafood

Consumers in supermarkets of various grades had different demographic backgrounds, with more elderly visiting low- and mid-end supermarkets (ordinal generalised linear model, $\chi^2_2 = 239.4$, $p < 0.001$, Figure 4), and consumers in mid- to high-end supermarkets having higher education and income levels as compared to low-end supermarkets (education: $\chi^2_2 = 94.8$, $p < 0.001$; income: $\chi^2_2 = 126.9$, $p < 0.001$, Figure 4). The cognition,

attitude and behaviour of consumers towards sustainable seafood varied between supermarkets and their occupations. In general, consumers in high-end supermarkets had higher cognition and attitude scores as compared to those in low-end supermarkets (Figure 5, Table 2). Consumers in high-end supermarkets also had higher behaviour scores and knowledge on ecolabels (able to identify true labels) when compared to low-end supermarkets (Figures 5 and 6, Table 2). Indeed, the education level of the consumers was found to be positively correlated with cognition score, which then influenced attitude and subsequently behaviour scores (structural equation model in Figure 1, Comparative Fit Index = 0.981, $\chi^2_7 = 11.5$, $p = 0.119$, p of root mean square error of approximation $\leq 0.05 = 0.620$). Age was identified as another demographic factor, but it showed a negative correlation with cognition. Acceptable premium for sustainable over ordinary seafood was positively and negatively correlated with education level and age of the consumers, respectively, whereas supermarket grade had a positive, albeit insignificant, influence on the acceptable premium. The survey results provided strong evidence supporting H2 and H3 (Figure 1). The SEM analysis revealed that the acceptable premium for sustainable seafood directly and positively influenced consumer attitudes, which subsequently led to a significant increase in behaviour. This indicates that H4 was not supported, as the anticipated ‘action-gap’ between willingness to pay and behaviour did not emerge as a significant discrepancy in our model.

Table 1. Analyses of deviance on the generalised linear mixed models used to investigate how the proportion of sustainable seafood (using Tweedie distribution), price and price per weight of seafood products (both using Gamma distribution) varied with supermarket grade (low-, mid- and high-end), taxonomic group (crustacean, fish and mollusc), seafood type (ordinary and sustainable) and their interactions. Seafood type was not tested for the proportion of sustainable seafood since such proportion was calculated as the number of ecolabelled seafood products divided by the total number of seafood products. Shop identity and product were treated as random effects, and their variation components are shown. Numbers are chi-squared statistics with significance levels labelled by * (<0.05), ** (<0.01) and *** (<0.001). For significant factors, *post-hoc* Tukey’s tests were further performed, and the results are listed in ascending order (in terms of the mean response). In case of significant interaction, *post-hoc* tests were performed on the interaction but not the main effects.

Source of Variation	Proportion	Price	Price Per Weight
Grade	$\chi^2_1 = 0.01$	$\chi^2_1 = 12.9$ ***	$\chi^2_1 = 5.6$ *
Type		$\chi^2_1 = 1.6$	$\chi^2_1 = 1.1$
Taxa	$\chi^2_2 = 5.6$	$\chi^2_2 = 45.3$ ***	$\chi^2_2 = 21.9$ ***
Grade $\times$ Type		$\chi^2_1 = 0.8$	$\chi^2_1 = 0.2$
Grade $\times$ Taxa	$\chi^2_2 = 1.0$	$\chi^2_2 = 0.9$	$\chi^2_2 = 1.8$
Type $\times$ Taxa		$\chi^2_2 = 12.6$ **	$\chi^2_2 = 4.1$
Grade $\times$ Type $\times$ Taxa		$\chi^2_2 = 3.9$	$\chi^2_2 = 2.6$
Random effect			
Shop	<0.01	0.05	0.16
Product		0.29	0.28
<i>Post-hoc</i> Tukey’s tests			
Grade		Mid-end < High-end	Mid-end < High-end
Taxa		Crustacean: Sustainable = Ordinary	Mollusc = Fish < Crustacean
Type $\times$ Taxa		Fish: Ordinary < Sustainable	
		Mollusc: Sustainable < Ordinary	

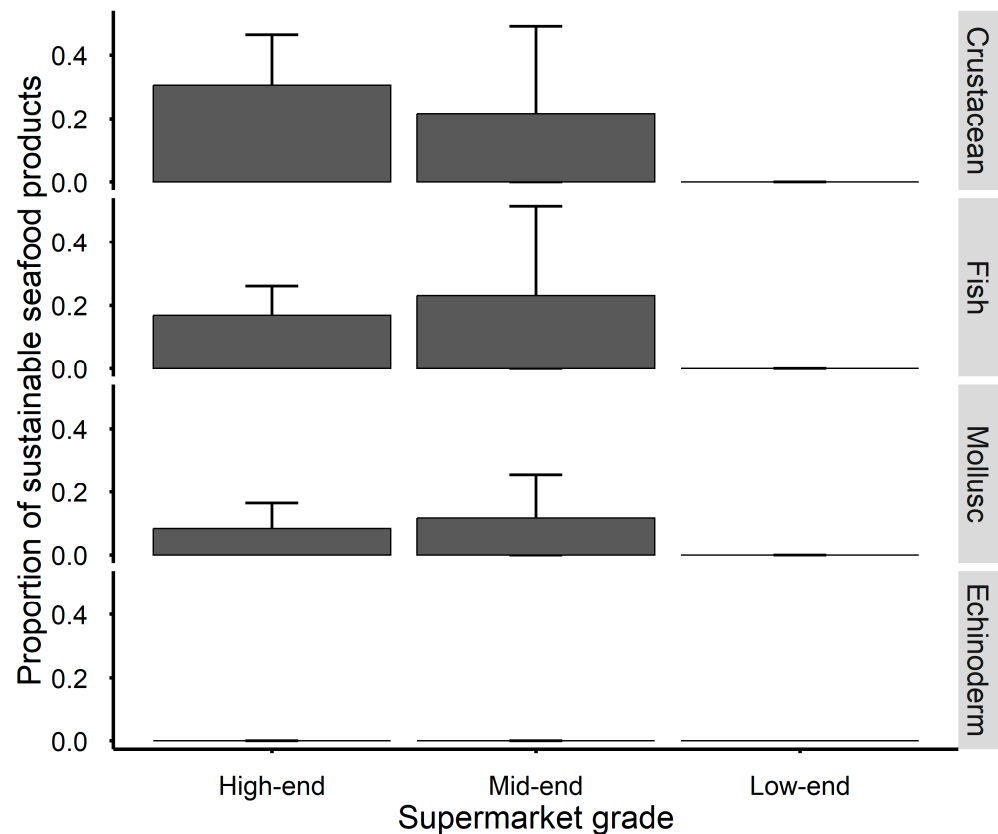


Figure 2. Proportions of sustainable seafood products (those with certified ecolabels, see main text) across the three grades of supermarkets in Hong Kong for crustacean, fish, mollusc and echinoderm products. Bars are mean + 1 SD, $n = 1-7$ shops for supermarket grades ($n = 3-7$ shops for proportions in mid- and high-end supermarkets).

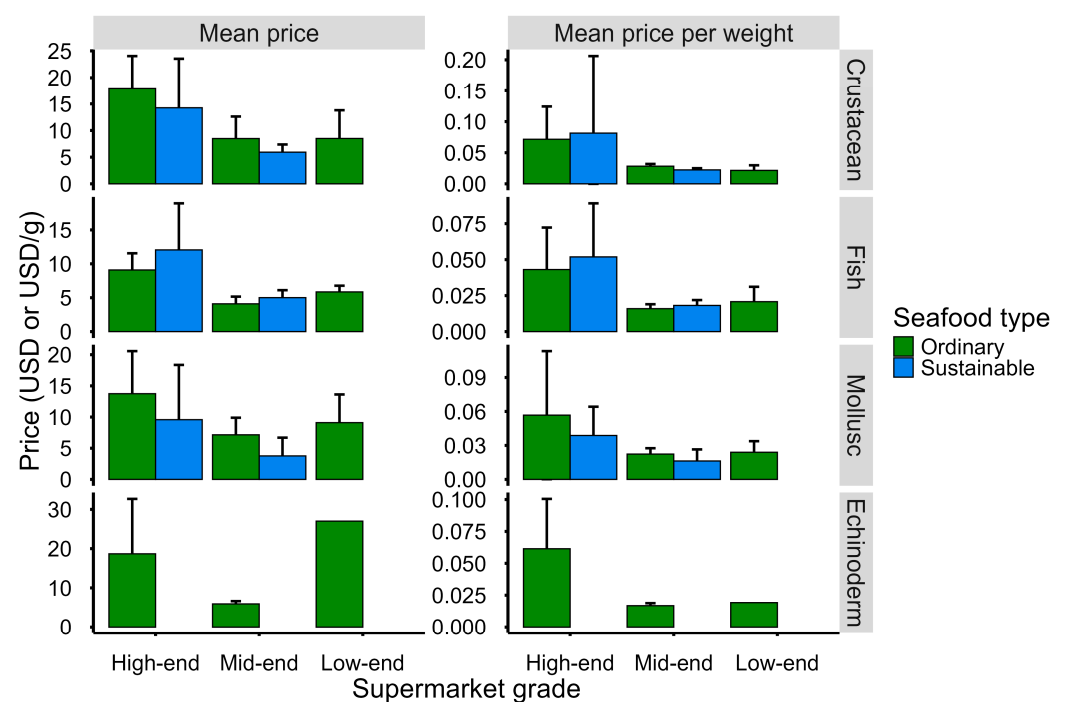


Figure 3. Mean prices (left panel) and mean prices per weight (right panel) of sustainable (blue) and ordinary (green) seafood products (those with or without certified ecolabels, see main text) across the three grades of supermarkets in Hong Kong for crustacean, fish, mollusc and echinoderm products (in USD). Bars are mean + 1 SD, $n = 1-7$ shops for all supermarket grades ($n = 3-7$ shops in mid- and high-end supermarkets). Note differences in y-axes.

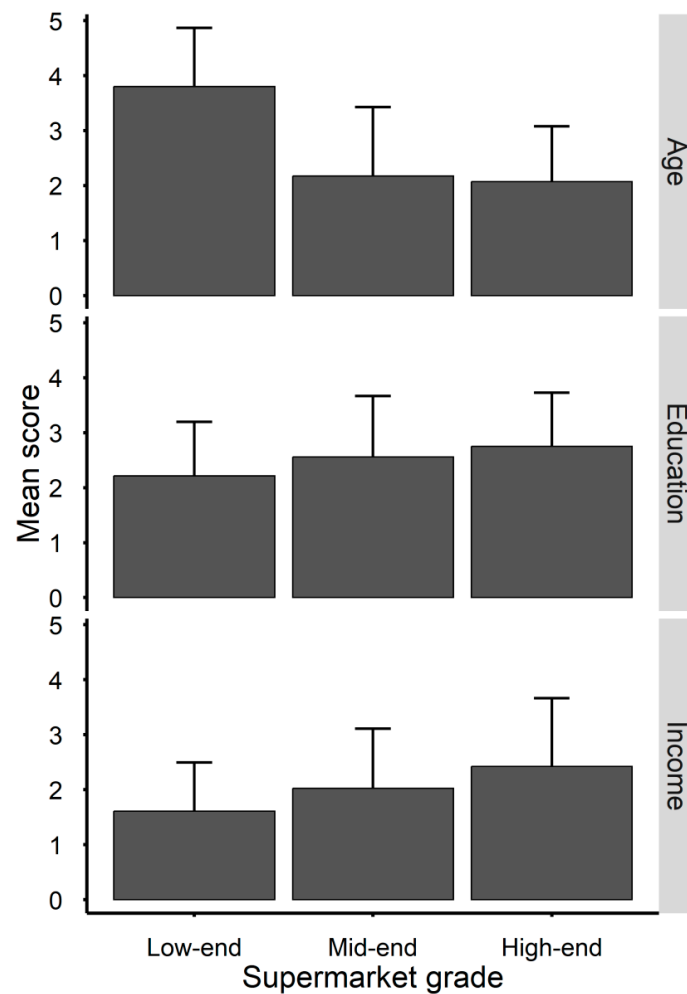


Figure 4. Demographic traits of consumers across the three grades of supermarkets in Hong Kong (age, education and income levels, see Supplementary Information for score definitions). Bars are mean + 1 SD, $n = 115, 120$ and 180 for low-, mid- and high-end supermarkets, respectively.

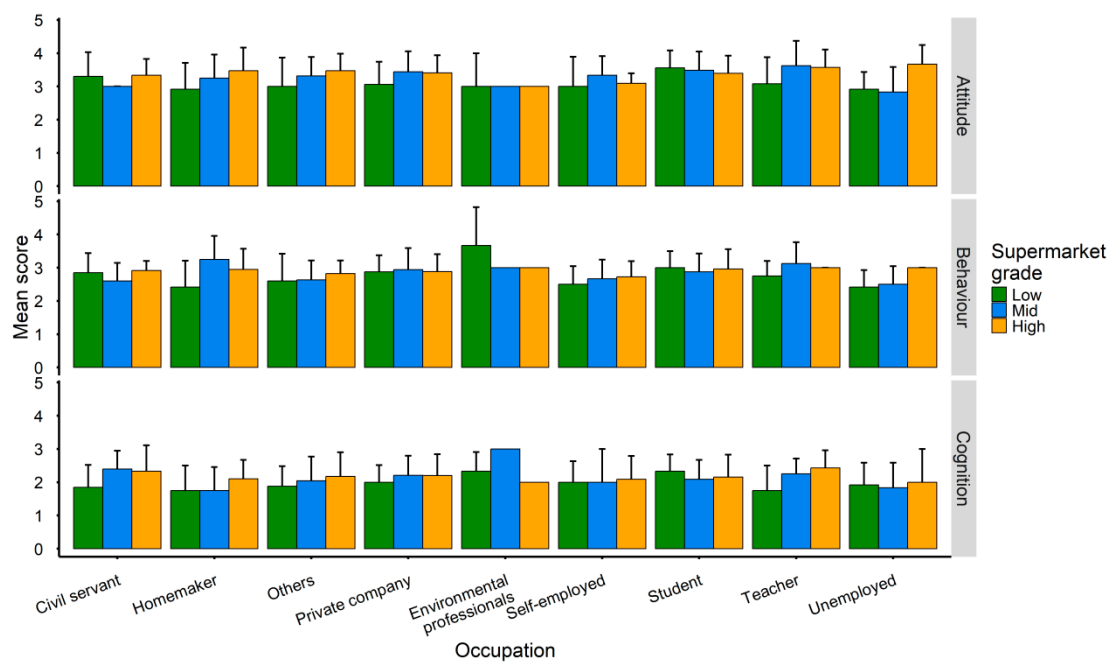


Figure 5. Variations in consumers' cognition (bottom panel), behaviour (middle panel) and attitude scores (top panel) towards sustainable seafood in Hong Kong's supermarkets, against the three grades

of supermarkets (low-, mid- and high-end) and occupations of the consumers. Bars are mean + 1 SD, $n = 15$ on average for each occupation in each grade of supermarket, ranging from 1 (environmental professional in mid- and high-end supermarkets) to 59 (consumers working for private companies in high-end supermarkets). Occupations with $n < 5$ in any supermarket grades were excluded from the analyses (environmental professionals, unemployed and self-employed consumers).

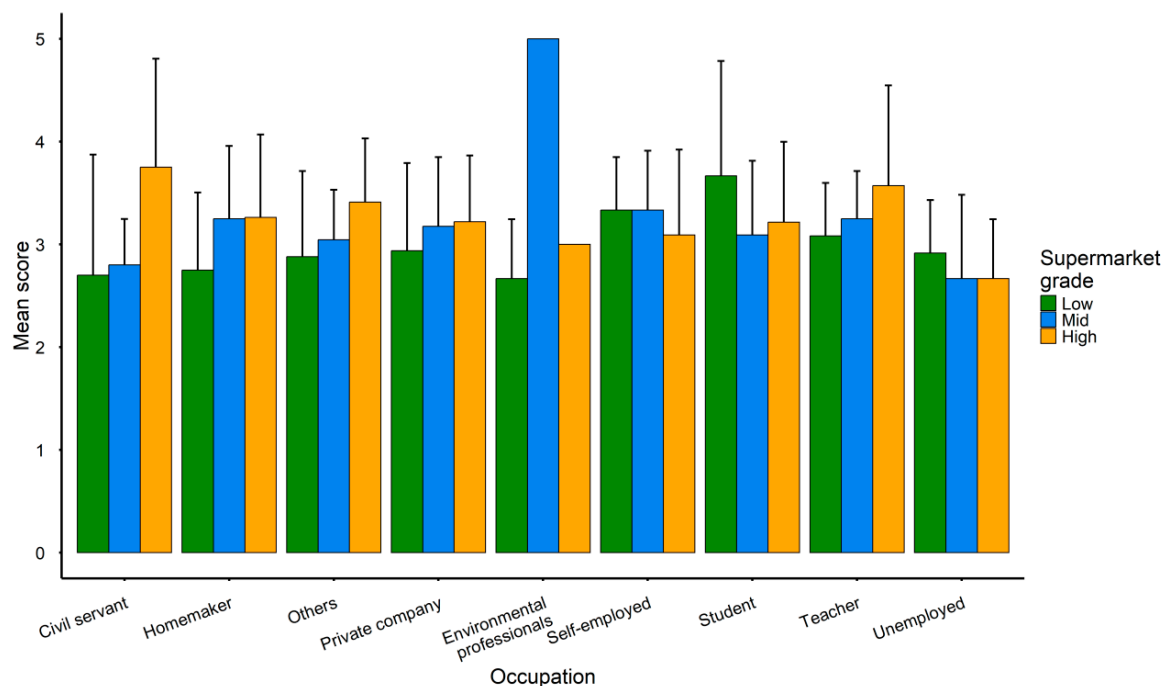


Figure 6. Variations in consumers' knowledge on ecolabel of sustainable seafood in Hong Kong's supermarkets, against the three grades of supermarkets (low-, mid- and high-end) and occupations of the consumers. Bars are mean + 1 SD, $n = 15$ on average for each occupation in each grade of supermarket, ranging from 1 (environmental professional in mid- and high-end supermarkets) to 59 (consumers working for private companies in high-end supermarkets). Occupations with $n < 5$ in any supermarket grades were excluded from the analyses (environmental professionals, unemployed and self-employed consumers).

Table 2. Analyses of deviance on the generalised linear models (with ordinal responses) used to investigate how cognition, attitude, behaviour and knowledge on ecolabel of the consumers varied with supermarket grade (low-, mid- and high-ends), occupation of the consumers (student, homemaker, teacher, civil servant, private company and others; environmental professionals, self-employed and unemployed were excluded from the analyses due to their low sample size in one of the supermarket grades, $n < 5$) and their interaction. Numbers are chi-squared statistics with significance levels labelled by * (<0.05), ** (<0.01) and *** (<0.001). For significant factors, *post-hoc* Tukey's tests were further performed, and the results are listed in ascending order (in terms of the mean response). In case of significant interaction, *post-hoc* tests were performed on the interaction but not the main effects. "/" in the *post-hoc* results means that no statistically significant subgroups were identified, despite the factor was significant in the main test. "NA" means that no *post-hoc* tests were done.

Source of Variations	Consumer Trait			
	Cognition	Attitude	Behaviour	Knowledge on Ecolabel
Grade	$\chi^2_2 = 258.9^{***}$	$\chi^2_2 = 79.5^{***}$	$\chi^2_2 = 59.8^{***}$	$\chi^2_2 = 91.8^{***}$
Occupation	$\chi^2_5 = 14.4^*$	$\chi^2_5 = 129.4^{***}$	$\chi^2_5 = 167.3^{***}$	$\chi^2_5 = 347.9^{***}$
Grade $\times$ Occupation	$\chi^2_{10} = 8.5$	$\chi^2_{10} = 11.5$	$\chi^2_{10} = 14.8$	$\chi^2_{10} = 27.0^{**}$

Table 2. Cont.

Source of Variations	Consumer Trait			
	Cognition	Attitude	Behaviour	Knowledge on Ecolabel
	<i>Post-hoc Tukey's tests</i>			
Grade	Low ≤ Mid ≤ High	Low ≤ Mid ≤ High	/	/
Occupation	/	/	/	/
				Student:
				/
				Homemaker:
				/
				Teacher:
				/
Grade × Occupation	NA	NA	NA	Civil servant:
				Low ≤ Mid ≤ High
				Private company:
				/
				Others:
				Low ≤ Mid ≤ High

4. Discussion

4.1. Availability of Sustainable Seafood Across Supermarket Grades

All low-end supermarkets surveyed in this study did not provide ecolabelled seafood with MSC, ASC or BAP, which were only available in mid- and high-end supermarkets. This pattern was observed regardless of the supermarket's location across the territory. For instance, low-end supermarkets located in both Kennedy Town and Tuen Mun did not offer sustainable seafood, while mid-end supermarkets offered sustainable seafood regardless of whether they were located in Causeway Bay, Tuen Mun or Tai Kok Tsui (see Figure S1 for locations). There are three potential reasons why low-end supermarkets did not offer sustainable seafood.

Firstly, consumers in low-end supermarkets had lower scores for attitude and cognition towards sustainable seafood (Figure 5 and Table S4), suggesting lower demand and thereby less incentive for retailers to procure such products. Differences in consumers' demographic composition across supermarket grades, especially age, may further explain this pattern. Consumer age was generally higher in low- as compared to mid- and high-end supermarkets (Table S4). Given that the sustainable seafood movement in Hong Kong began in 2007 (as led by WWF-Hong Kong) and expanded to the catering sector (hotels and restaurants) only from 2010 onward [78], elderly consumers who are less exposed to new information could be less aware of and supportive towards sustainable seafood [71].

Secondly, consumers in low-end supermarkets tend to be more price sensitive, and considerations of sustainability play only a minor role in their purchasing decisions [71]. This pattern is also reflected in consumer feedback on acceptable price differences between sustainable and ordinary seafood (Question 8, Table S4), highlighting the strong price sensitivity among consumers in low-end supermarkets. Sustainable products are often mistakenly perceived as being more expensive than ordinary ones, thereby discouraging purchase among price-sensitive consumers [79]. This low incentive may then feed back to retailers, resulting in less sourcing of sustainable products for sale.

Finally, mid- and high-end supermarkets are more likely to implement strategies to improve their ESG performance. The mid- and high-end supermarkets surveyed in this study often outline campaigns to source or promote sustainably produced goods, and to monitor suppliers and business partners for compliance with sustainability standards [80].

Many go beyond these compliances by collaborating with environmental NGOs to enhance public awareness [71]. At present, city'super, PARKnSHOP, and DFI Retail Group—the parent company of Wellcome—are members of WWF-Hong Kong's Sustainable Seafood Business Membership Programme, which was launched in 2022 (see Figure S2). The proactive approach by mid- and high-end supermarkets to sustainable sourcing appears to align with consumer expectations. Consumers in these supermarkets demonstrate greater cognition of and willingness to purchase sustainable products, which in turn motivates retailers to offer more sustainable options. As such, consumer awareness and corporate strategy jointly shape the landscape of sustainable seafood across supermarkets in Hong Kong.

The landscape highlights, however, a critical issue of green consumption inequality in Hong Kong. Consumers of low-end supermarkets are structurally excluded from making sustainable choices. This 'retail barrier' means that sustainability information and certified products do not penetrate these communities, regardless of the consumers' latent environmental interest [81]. Consequently, sustainable consumption is tied to both supermarket accessibility and socio-economic status, potentially reinforcing the cognitive and behavioural gap between different social strata.

4.2. The Supply of Sustainable Seafood Products in Hong Kong Supermarkets

The overall proportion of sustainable seafood in mid- and high-end supermarkets, however, remains low in Hong Kong (an average of 17%) when compared to other major cities in Europe and Asia, where such proportion averages at 64% and 55% respectively (proportions obtained from online supermarkets in these regions, [82,83]). This is also partly attributable to the spatial barrier that Hong Kong is not located near major areas of sustainable seafood harvesting, and therefore, retailers may face greater logistical and cost-related challenges in sourcing sustainable products; some seafood types sold in local supermarkets are not readily available as sustainable options. In particular, for echinoderms (primarily sea cucumbers), none of the available products were certified as sustainably harvested among all surveyed supermarkets. Among the three ecolabels (MSC, ASC, and BAP), only the MSC provides certification for echinoderm species [84]. The other two, ASC and BAP, do not offer sustainability certification for this taxon.

4.3. Cognitive-Behavioural Discrepancy

Although consumers in high-end supermarkets exhibited the highest score of attitude and cognition towards sustainable seafood, and stronger abilities to identify ecolabels compared to those in mid- and low-end supermarkets, their actual purchasing behaviour exhibited less differentiation (Table S4). Indeed, perceived behavioural control can weaken the link between attitude and purchasing behaviour. Following the Theory of Planned Behaviour [67], attitude and cognition levels do not always translate into purchasing decisions due to the limited benefits (supply of seafood over the long-term) but high costs (perceived to be more expensive) associated with choosing sustainable over ordinary products [85,86]. Across all supermarkets, 57% of respondents perceived that sustainable seafood should be more expensive than ordinary seafood (and were willing to pay a positive price premium). This perception is, however, not always true: while ecolabelled fish products were more expensive than ordinary ones, sustainable molluscan and crustacean products were similarly priced or even cheaper in terms of price per unit weight (see Table 1, and also Table S5 in Supplementary Information). In addition, consumers in high-end supermarkets were more tolerant of the premium for sustainable seafood, and so cost-related concerns are unlikely to be the primary barrier for these consumers. As

such, we argue that pricing alone may not sufficiently explain the observed behavioural discrepancy. A more plausible explanation may lie in the perceived credibility of ecolabels.

Information related to seafood sustainability, such as harvesting methods and production processes, is often inaccessible or complicated to consumers [21]. Such information is conveyed primarily through ecolabels, which have been suggested to play a key role in encouraging sustainable seafood consumption [87,88]. However, ecolabels face two key challenges: the controversy over greenwashing and the lack of transparency and product traceability, both of which have eroded consumer trust in certification schemes [89,90]. Consumers in high-end supermarkets, who tend to have higher education levels, are more likely to be exposed to information on sustainability (e.g., through formal curriculum) and/or possess greater environmental awareness [91,92]. They are thus more likely to encounter critical discourse, question the legitimacy of ecolabels, and even abstain from purchasing based on labels.

4.4. Interactions Between Supermarkets and Consumers in Promoting Sustainable Seafood

Both consumers and supermarkets are, therefore, key stakeholders in promoting sustainable seafood. Education level and age of consumers are important demographic factors that positively influenced their attitude, cognition, behaviour, or knowledge level on sustainable seafood across different grades of supermarkets. Supermarkets themselves also play a positive, albeit insignificant, role in increasing consumers' attitude and acceptable premium. Specifically, one notable finding from the SEM analysis is that supermarket grade does not exert a significant direct influence on consumers' acceptable premium, nor does it override individual cognition. This suggests that the premium acceptable is primarily an individual-level decision driven by demographic characteristics rather than the retail environment [93]. Specifically, the positive correlation of education on premium acceptance highlights that an individual's environmental literacy is a prerequisite for consumers to value sustainable products [94]. This insignificance of supermarket grade must also be interpreted through the lens of green consumption inequality. In low-end supermarkets, the total absence of ecolabelled products constitutes a structural barrier, beyond mere accessibility; the systematic absence of certified seafood in broader market channels may fundamentally hinder the public's ability to acquire and trust certification information—consumers may develop skepticism towards the validity of labels or ignore these market cues altogether due to a lack of familiarity and knowledge structure [95].

Despite these barriers, supermarkets can still influence the consumption landscape. The positive, though insignificant, influence of supermarket grade on cognition could be attributed to more promotion and/or advertisement of sustainable products in high-end supermarkets, for instance, through separate sales zones, posters, more conspicuous labelling, or booths promoting particular types of environmentally friendly products (Figures S2 and S3, Supplementary Information). These strategies often make product information explicit, including harvesting methods, environmental footprints, price and quality, which may then raise consumers' interest, cognition and eventually encourage purchasing decisions [96]. In summary, while a well-designed educational environment by supermarkets can improve consumer attitudes, individual demographic traits remain the most definitive factors governing attitudes and behaviour.

4.5. Recommendations

Based on our results, there are three potential strategies to promote sustainable seafood in Hong Kong supermarkets. Firstly, it is important for retailers to leverage the price advantages of sustainable products, particularly for molluscan and crustacean products, which this study found to be price-competitive or even cheaper than ordinary items (in

contrast to the prevailing notion that sustainability always carries a high cost). This strategy is expected to be more effective in mid-end supermarkets, where consumers have lower WTP compared to those in high-end supermarkets. In high-end supermarkets where consumers have higher incomes, however, there is a greater potential to market premium sustainable seafood products, and thus retailers should increase the availability and variety of sustainable choices.

Secondly, the role of signage and ecolabels as a means of environmental communication should be maximised. Studies have shown that visual attention plays a critical role in encouraging purchase behaviour [93,97]. Retail displays, such as shelf layout, the number and position of facings, packaging design, and signage, allow for strategic placement of sustainability information [98,99]. It is, therefore, recommended that supermarkets implement choice architecture by positioning sustainability-related messages in locations that naturally draw consumer attention, such as near price tags, or enhance their visual salience through the use of colour, icons, or point-of-sale advertisements. Such measures may increase the visibility of ecolabels, reduce the cognitive load on consumers, and facilitate quick decision-making, ultimately improving consumer awareness and engagement with sustainable seafood options.

Finally, future strategies should focus not only on enhancing the transparency and standardisation of ecolabelling schemes to alleviate greenwashing concerns [89] but also on improving public communication regarding the standards and implications of certification, especially within high-end market sectors [91]. For certification bodies, digital tracing tools, such as QR codes linking to detailed supply chain data, should be adopted to enhance the verifiability and credibility of ecolabels [21]. For supermarkets, posters and signage could be considered to increase the visibility of ecolabels and provide a concise summary on sustainability information, thereby reducing the cognitive burden on consumers and facilitating the transition from awareness to purchasing behaviour [99].

5. Conclusions

This study highlights a strong disparity in sustainable seafood availability and consumer awareness across different supermarket tiers in Hong Kong. By integrating market data with consumer traits, we demonstrated that the lack of sustainable options in low-end supermarkets created a structural barrier to responsible consumption, while higher cognition and willingness to pay effectively translated into behaviour among those with access to certified products. This suggests that the hurdles to sustainable consumption include both behavioural discrepancy and structural exclusion that prevent informed choices in broader retail channels. The findings emphasise that promoting sustainable seafood requires more than public education; in fact, such promotion necessitates a coordinated effort from retailers to equalise access and from certification bodies to enhance transparency. Looking forward, education for both consumers and retailers is key to mainstream sustainable seafood in Hong Kong [100]. Our research establishes a transferable study framework for other major retailers, catering industries, or fresh markets to assess broader patterns of sustainable consumption and to develop targeted retail strategies for the sustainable seafood market in Hong Kong.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su18052642/s1>, Figure S1: Distribution of the surveyed supermarkets in Hong Kong. In total 21 shops of various supermarkets were selected across the territory: four in Tuen Mun, three in Admiralty, one in Causeway Bay, one in Kowloon Tong, two in Mei Foo, five in Sham Shui Po, two in Tsim Sha Tsui, and three near Kennedy Town (see Table S2 for detail locations); Figure S2. Example collaboration between an NGO (WWF-Hong Kong) and a high-end supermarket in promoting sustainable seafood (in one of the surveyed city's super supermarkets). A plaque with

sustainable seafood label and production methods, in both English and Chinese, was established to introduce the product; Figure S3. Examples of ecolabelled seafood products during the market surveys in high- (upper panel) and mid-end (lower panel) supermarkets. No ecolabelled seafood were found in low-end supermarkets. Table S1: Examples of ecolabels for sustainable seafood, their sources of production and website links for relevant standards; Table S2: Locations of the surveyed supermarkets. In the “Grade” column, “L” = “Low-end”; “M” = “Mid-end” and “H” = “High-end”. Survey dates are expressed in dd.mm.yyyy. For each supermarket, three shops were haphazardly selected within residential or urban areas in Hong Kong for the questionnaire survey ($\sum n = 3 \text{ (grades)} \times 2 - 3 \text{ (supermarkets)} \times 3 \text{ (shops)} = 21$). Market survey column denotes the shops sampled for frozen seafood surveys, in addition to questionnaire surveys; Table S3. Reliability analyses (in terms of Cronbach’s alpha) of the questionnaire questions used to investigate consumer traits on sustainable seafood in Hong Kong supermarkets. Reliability was measured for questions related to attitude, behaviour and in combination of the two dimensions; Table S4. Distributions of responses (in terms of percentages) of respondents surveyed in each of the low-, mid- and high-end supermarkets, for Question 1 and Questions 8 to 16 of the questionnaire (see Part II of this Supplementary Information for the questionnaire); Table S5. Price per unit weight of selected sustainable and ordinary frozen seafood products of the same category in high- and mid-end supermarkets. Sample size ranges from 1–12 for each average price (1–12 for ordinary and 1–3 for sustainable seafood). The type of ecolabel is also indicated for each product category. For “Clam” category in the mid-end supermarkets, the sustainable (ASC) average price includes both raw (0.08 HKD/g) and boiled (17.5 HKD/g) clams.

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Informed Consent Statement: All participants were fully informed of the study’s purpose, data collection and usage, and consented to participate in the survey by completing the questionnaire.

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