

## IMPACT OF SEA POLLUTION DUE TO X-PRESS PEARL SHIP DISASTER ON SEAFOOD CONSUMPTION PATTERNS OF SRI LANKANS

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**ABSTRACT:** Fish and shellfish are mainly considered seafood; are the best source of protein and have distinct flavours and aromas. Seafood consumption patterns of Sri Lankans mainly depend on socioeconomic conditions, health status, food habits and consumer attitudes. Marine pollution is one of the biggest threats to the seafood industry and its consumption pattern. This work was carried out to determine the factors that influence on seafood consumption patterns of Sri Lankans. The 700 respondents were collected from all the 25 districts of the country through the structured online questionnaire after three months of disaster. The highest preference was represented by the tuna fish species and the lowest was given to the bivalve and seaweeds at 43.2% and 0.41% respectively. The higher nutritional quality, and unique organoleptic characteristics were identified as the major reasons for consumption. Sea pollution was significantly influencing the seafood consumption pattern changes in Sri Lankans, and there was a significant relationship between consumer awareness of sea pollution and socioeconomic factors including age, gender, region, educational status and occupation ( $p < 0.05$ , chi-square test). It was revealed as the X-press pearl ship disaster significantly ( $p < 0.05$ , chi-square test) impacted the reducing the seafood consumption pattern of Sri Lankans and its varied with the socioeconomic factors. However, the consumption of freshwater food fish species has significantly increased. Also, sea pollution has negatively impacted brackish-water food species' consumption and survival. It indicated the requirement and implementation of stronger legislation policies for preventing the occurrence of sea pollution, ensuring the survival of marine and brackish-water species and production of hazardous-free seafood products.

**Keywords:** Sea pollution in Sri Lanka, X-press pearl ship disaster, Marine fish species

### 1. INTRODUCTION

Seafood has been played a key role in the human diet; recommended to be taken more frequently as a nutrient-rich food source with widespread availability and as the cheapest protein source (Cardoso *et al.*, 2016). Seafood which refers to any sort of marine life is an important part of a balanced and healthy diet because of its high nutritional value and the higher bioavailability of essential amino-acid and some minerals. In general, nutritional guidelines recommend eating one to two meals of fatty fish per week (Cardoso *et al.*, 2016). Many cuisines around the world use seafood as a major protein source, particularly in coastal areas. It is common knowledge that the global production of fish and fisheries is around 154 million tons per year, with 18.5 kg per capita (Can, Günlü, and Can, 2015) and increased to 20.5 kg per capita (Fisheries statistics – 2020). Marine fisheries of Sri Lanka are divided into two categories: coastal and offshore/deep-sea fisheries. Sri Lanka is an Asian country that has a significantly high average annual per capita seafood consumption, at 45.4 g/day (Fisheries statistics – 2020). According to the Ministry of Fisheries and Aquatic Resources Development, per capita consumption of fish and other marine products grew from 44 to 46.7 kg in the year 2017. Due to being a multi-religious and multi-ethnic country, numerous religious and cultural biases and prejudices of Sri Lanka restrict animal meat consumption, while fish

and other marine species are widely recognized and hence in high demand. However, the lack of in-depth understanding of the seafood preferences and habits of the Sri Lanka population, as well as the underlying dynamics, is a severe impediment that must be addressed (Naik, Murthy, and Anjanayappa, 2017).

As an island in the Indian Ocean, Sri Lanka has a higher possibility to expand the wide range of seafood industry. The ocean area of Sri Lanka is rich with a higher concentration of marine resources. Sri Lanka has a very large exclusive economic zone of 517, 000 km<sup>2</sup>. The entire 1770 km of coastline of Sri Lanka also has valuable potential for the seafood sector with 158,000 ha of brackish water areas (lagoon and estuaries). Also, a high number (45) major brackish water and estuaries covering 158, 000 ha and 520, 000 ha of water bodies are available for aquaculture practices in Sri Lanka (Naik, Murthy, and Anjanayappa, 2017). The seafood consumption preference and pattern of people depend on several factors including socioeconomic background, the personal health status of consumers, general food consumption pattern, and the number of attitudinal dimensions. Some studies also have shown that taste, age, health/ nutrition, and convenience also affect seafood consumption behaviour (Erdoğan, Mol, and Coşansu, 2011). Also, the price of seafood, availability, production of the country, government regulations, quality of seafood, and sea pollution are considerable factors that affect usual consumption patterns.

Sea pollution is caused by the entering of chemicals, agricultural waste, residential waste, noise, or the spread of invasive species to the water and has detrimental impacts. In general, marine pollution has various effects on human health, ecosystem health, recreational water quality, and economic viability (Cole, 1979). Mechanical, saprogenic, eutrophication, toxicity, mutagenic, and carcinogenic are some of the terms used to describe the effects of certain pollutants (Fartoosi, 2013). The fire and sinking of the X-Press Pearl cargo ship on the off coast of Colombo in May 2021 have reported many environmental and livelihood consequences that are still being examined. Estimated data have exhibited that 5.6% of total fishing households of Sri Lanka were directly impacted due to the relatively localized impact. The environmental impact caused by the X-press pearl ship disaster is still significant due to accumulating heavy metals, hazardous chemicals, oil spills, microplastic particles, etc. The consequences of the chemical spill have yet to be determined. Long-term effects on the ecology and the livelihoods of coastal fishermen will be obvious if an oil spill occurs. However, there was a lack of data and research activities have been conducted or didn't publish yet.

Furthermore, the seafood consumption pattern and buying patterns in Sri Lanka can be influenced significantly due to this disaster. Therefore, this survey is mainly focused on the impact of sea pollution on seafood consumption patterns in Sri Lanka. This is based on a comprehensive survey of the seafood consumption preferences and habits of the Sri Lankan population, and it aims precisely at socio-economic factors including age, gender, educational status, regional district, and occupation and awareness about sea pollution. The relationship between those aspects is evaluated in this survey.

## **2. MATERIALS AND METHODS**

### **2.1. Data Collection**

Primary data was acquired by an online questionnaire completed by 700 randomly selected persons in the 25 districts of the country, and the population represented multi-ethnic and multicultural social groups. The minimal sample size for this study was established using the following assumptions: The 91% predicted seafood consumption rate based on pre-tested questionnaires; a 5% sampling error; and a 95% confidence level. Data were collected starting

in September and ending in October 2021. The questionnaire was pre-tested on customers before the start of the field research to see if any adjustments were needed.

The online questionnaire was designed to provide a comprehensive assessment of seafood preference and consumption patterns among the individual consumers of the Sri Lankan population. The questionnaire consisted of four different sections included: socio-economic details, usual seafood consumption patterns, the impact of sea pollution on seafood consumption, and the impact of socioeconomic and environmental pollution on the seafood industry as sections 1-4 respectively. The alignment and the scales of the questionnaire that underlie the characterization of their options were designed according to the guidelines elaborated in Ridolfi, 2014.

## **2.2. Conduction of the Survey**

Web online media was used to distribute the questionnaire throughout the country. Only after answering all of the questions in the previous section might respondents move on to the following section. This programming detail ensured that no questions remained unanswered.

## **2.3. Data Analysis**

The information gathered during the consumption survey was immediately saved in a Google Docs spreadsheet, which displayed a line for each responder with numerous columns. The first column contained the date and time when the relevant questionnaire was completed and the remaining fields contained the varied responses. This spreadsheet was converted to an Excel spreadsheet in order to thoroughly evaluate the data. Any contradiction resulted in the removal of the entire questionnaire of that respondent as a general requirement for maximum survey reliability. The remainder of the questions were deemed valid.

## **2.4. Statistical Analysis**

The possible relationship/s between variables were expressed with bar charts and pie charts; the Pearson correlation coefficients were used to examine the linear relationship between the socioeconomic factors such as age of the subject, gender, regional district, educational status, and occupation and consumer awareness of sea pollution by dividing the covariance by each standard deviations of two variables. The impact of sea pollution on seafood consumption patterns were tested by using the Chi-square test. In this survey, the change in seafood consumption patterns with the impact of sea pollution was considered the dependent variable. Cross-tabulation is a popular method for displaying and analysing the relationship between two or more categorical variables. In a matrix format, it shows the frequency distribution of the variables. The relationship between each dependent and independent variable considered in this study was investigated using scatter diagrams and bar charts.

# **3. RESULTS AND DISCUSSION**

## **3.1. Usual Seafood Consumption Pattern**

The 700 valid questionnaires were received and 18 were rejected under the online survey on “Impact of sea pollution due to X-press pearl ship disaster on seafood consumption patterns of Sri Lankans”. The usual seafood consumption pattern of people mainly varied on several factors which can be derived from socioeconomic factors. The individual preference of selected respondents, 43.2%, 28.9%, and 25.1% respondents has shown as the highest preference, moderate like, and extremely like respectively. The major reasons for the seafood consumption pattern of The Sri Lankans have been identified as high nutritional value, unique taste, better mouth-feel, physiological reasons, and some other factors.

The results have shown that the high nutritious value of seafood was the major reason for consuming seafood due to having a greater percentage of respondents 42.8%. The unique taste of seafood, better mouth-feel, and physiological reasons such as pregnancy and several diseases were identified as other significant reasons which were impacted seafood consumption in public. According to the survey, the most consumable seafood species were tuna, mackerel, herrings, sprats, and shrimps such as 15.38%, 13.87%, 10.57%, 13.06%, and 12.435% respectively; while clams, mussels, oysters and seaweed have shown the least consumption among all respondents. Purchasing place has also impacted seafood consumption, the majority of respondents buy seafood from street vendors, fish markets (Lellama), and supermarkets such as 26.53%, 24.95%, and 21.68% respectively.

### 3.2. Consumer Awareness of Sea Pollution

This survey was mainly focused on determining the impact of the X-press pearl ship disaster which was the most recent vast sea pollution incidence on fish consumption of Sri Lankans. The informational sources take place an important role in awareness and perception regarding sea pollution. The survey revealed as 38.4% of respondents have selected mass media (television and radio) as the prominent informational sources. Social media was the second most significant informational source receiving 30.9%. The newspapers, government announcements, and research articles were also significant at 14.6%, 9.9%, and 5.8% respectively.

It was shown that socioeconomic factors play an important role in consumer awareness of sea pollution which is summarized in Table 01. The age ranges from 25 – 44 and 15 – 24 have shown the highest awareness regarding sea pollution at 47.65% and 43.4% respectively and, below 15 years and above 60 years of age have shown the least awareness (*p-value* 0.047). There was a significant relationship between gender and consumer awareness of sea pollution at a 95% confidence level (*p-value* 0.031). Due to having a greater chi-square calculated value (155.012) than the chi-square critical value (36.415) at a 95% confidence level, there was a significant association between regional districts and consumer awareness of sea pollution. It indicates the varied consumer awareness among all 25 districts in Sri Lanka, although the majority of the people have an awareness of recent sea pollution incidence. Respondents from Gampaha, Colombo, Kalutara, and Hambanthota districts have the greatest awareness than other districts and as a percentage, it was higher than 95% in those districts. Respondents from Mulathiv, Kilinochchi, and Vavuniya have shown the least awareness.

Table 01: Consumer awareness of sea pollution with socioeconomic subgroups

Socioeconomic subgroups	N	%	Awareness on sea pollution (%)		p - value
			Yes	No	
All Respondents	700				
Age					
Below 15 years	96	13.70	1.12	0.00	0.047
15 – 24 years	197	28.10	43.40	0.30	
25 – 44 years	173	24.70	47.65	0.30	
45 – 60 years	128	18.30	5.60	0.00	
Above 60 years	106	15.20	0.44	0.00	
Gender					
Female	378	54.00	54.86	0.76	0.031
Male	322	46.00	43.38	1.00	
Educational Status					
Below GCE (O/L)	103	14.70	2.27	1.10	0.016
Up to GCE (O/L)	133	19.00	3.43	1.05	
Up to GCE (A/L)	219	31.30	41.01	0.96	
Graduate or above	245	35.00	51.50	0.80	

Occupation					
Student	98	14.00	50.68	0.00	
Employed (Government sector)	197	28.14	23.40	0.20	0.023
Employed (Private sector)	134	19.14	13.40	0.00	
Self – Employed	105	15.00	0.16	0.00	
Unemployed	166	23.70	5.60	1.40	

(If chi-square test value  $p < 0.05$ , there is a significant relationship)

The identified major reason for the awareness variation among districts would be their life experiences. Generally, respondents from Gampaha, Colombo, Kalutara, and Hambanthota districts have well-experienced knowledge about sea pollution because they are always close to the sea area. When it comes to the X-press pearl ship disaster, people who live in Negombo, Colombo, Kalutara, and Galle, regions have much knowledge about how it influenced the sea area. Hence, the respondents in those regions have shown a greater awareness than others.

Along with the statistical analysis, the educational background of the public can be considered a prominent factor that affects consumer awareness of sea pollution. The graduate or above educational category has shown the highest awareness (51.5%) while the below GCE (O/L) category has the least awareness (2.27%). It indicates that there was a significant relationship between the educational status of people and awareness of sea pollution ( $p$ -value 0.016) at a 95% confidence level and that the undergraduates have a greater awareness of sea pollution because they usually take information from different sources regarding the awareness as books/ magazines, internet, scientific researches. Also, there was a significant relationship between occupation and awareness of sea pollution ( $p$ -value 0.023) at a 95% confidence level. The student has the highest awareness (50.68%) while the self-employed category has the least awareness (0.16%).

### 3.3. Impact of Sea Pollution on Seafood Consumption Patterns

Table 02 shows the variation in seafood consumption due to sea pollution according to different socioeconomic factors such as age, gender, educational status, occupation, and regional districts.

According to the derived values related to the age of respondents, there was a significant relationship between the seafood consumption patterns with age ( $p$ -value 0.041). The awareness of sea pollution may cause a decline in seafood consumption. Respondents in 15 – 24 years and 25 – 44 years have shown a higher decline in seafood consumption being “Totally stopped” their seafood consumption at 4.14% and 5.22% respectively. Also, the majority of participants were undergraduates and employees. Generally, they have much knowledge about sea pollution and its impact on marine species as well as human health.

When considering gender, the highest percentage of respondents of both females and males 18.07% and 14.45% respectively; has shown a slight reduction in seafood consumption. However, there were no changes in seafood consumption has been shown with the least percentage of both female (7.09%) and male (9.36%) respondents. Hence, there was a significant association between declining seafood consumption the gender ( $p$ -value 0.022) since both female and male respondents have shown a greater awareness of sea pollution as identified earlier.

A greater chi-square calculated value (133.145) than the chi-square critical value (133.045) at a 95% confidence level has shown that there was a significant association between regional districts and seafood consumption reduction due to sea pollution. People who live in all 25 districts have reduced their seafood consumption due to recent sea pollution incidents (X-

press Pearl ship disaster). Respondents from Gampaha, Colombo, Kalutara, Galle, and Hambantota districts have shown a greater reduction percentage than other districts who may be having well-experienced knowledge and life experiences about sea pollution.

According to the educational status, the graduates or above have shown the highest percentage as 10.91% for occasionally consumed and 17.99% for slightly reduced. All the educational categories have totally stopped their seafood consumption due to sea pollution was significant. Since the p-value is lesser than the significant level (p-value 0.036), the alternative hypothesis was accepted while the null hypothesis was rejected which indicates that there was a significant relationship between declining seafood consumption with the educational status. Generally, awareness and educational status of individual people can be considered as a major reason for reducing seafood consumption due to sea pollution according to this study. Occupation also affects seafood reduction due to sea pollution. The student category has shown the highest percentage for “slightly reduced” and “totally stopped” seafood consumption having 17.95% and 4.74% respectively. A significant relationship between occupation and seafood consumption reduction due to sea pollution at a 95% confidence level can be identified ( $p$ -value 0.028).

#### **3.4. Impact of X-press Pearl Ship Disaster on Marine Species and Seafood Consumption Pattern**

The most recent sea pollution incidence; The X-press pearl ship disaster, caused severe damage to the Southern, West, North-West, South-East, and some part of the eastern coastal area of the country. Also, highly impacted the West, South-west, and Southern Sea area and many marine species. Those sea areas have been directly exposed to hazardous chemicals and synthetic plastic pebbles; some of them have already accumulated in the ocean and raising concerns that they may poison marine life. Moreover, hundreds of thousands of small plastic pellets have already washed up on surrounding beaches. Furthermore, the hundred tonnes of engine fuel trapped in the sunk hull, which was leaked into the water. Due to these kinds of pollutants, marine species were impacted and killed. Hence, burning wounds on the skin, swollen bodies, plastic pebbles accumulated in the gills, and skin colour changes happened to marine species. Therefore, many people were inspired to reduce their seafood consumption, because of the risk of the possibility of transferring those chemicals and pollutants to human bodies through the seafood. Thus, seafood consumption was noticeably reduced, and there was a significant relationship between declining seafood consumption due to the X-press pearl ship disaster ( $p$ -value 0.027).

#### **3.5. Impact of X-press Pearl Ship Disaster on Brackish Water Species Consumption**

The salinity changes of brackish water, changes in the reproduction cycle, damage to fish eggs and their juvenile, and damage to gills, skin, and eyes of brackish water species occurred due to the impact of sea pollution due to the X-press pearl ship disaster (*Nishshanka., et al 2022*). There was a significant relationship between the decline of brackish water species consumption and seafood consumption. Some respondents refused the consumption of brackish water fish and its crustacean species too.

#### **3.6. Impact of X-press Pearl Ship Disaster on Seaweed Consumption Pattern**

Seaweed consumption is less popular among Sri Lankans and has reported less demand compared to other fish species due to their unpleasant organoleptic properties are not comply with Sri Lankans cuisines. There was no significant relationship between the decline in seafood consumption with the impact on seaweed consumption ( $p$ -value 0.583).

### 3.7. Impact of Seafood Consumption Pattern and Change in Consumption of Freshwater Species

13.77% of respondents have reduced their consumption of seafood, and positively impacted the consumption of freshwater species (12.86%). 10.71% of people have shown no changing behaviour of consumption of both two species. A greater chi-square calculated value (392.045) than the chi-square critical value (26.296) at a 95% confidence level has shown that there was a significant association between the impact on seafood consumption pattern and change in consumption of freshwater species which indicates the overall freshwater consumption is considerably influenced by the reduction of seafood consumption due to sea pollution.

Table 02: Variation of seafood consumption with socioeconomic subgroups due to sea pollution

Socioeconomic Subgroups	N	%	Seafood Consumption (%)					p-Value
			Moderately consumed	No change	Occasionally consumed	Slightly reduced	Totally stopped	
All Respondents	700							
Age								
Below 15 years	96	13.70	0.32	0.32	0.20	0.16	0.16	
15 – 24 years	197	28.10	9.44	8.68	10.63	16.12	4.14	
25 – 44 years	173	24.70	9.44	5.41	9.63	14.09	5.22	0.041
45 – 60 years	128	18.30	0.64	2.03	0.88	1.79	0.28	
Above 60 years	106	15.20	0.08	0.00	0.00	0.36	0.00	
Gender								
Female	378	54.00	11.86	7.09	12.30	18.07	6.21	0.022
Male	322	46.00	8.04	9.36	9.04	14.45	3.58	
Educational Status								
Below GCE (O/L)	103	14.70	0.52	0.40	0.76	0.20	0.40	
Up to GCE (O/L)	133	19.00	0.44	0.80	1.04	0.76	0.40	0.036
Up to GCE (A/L)	219	31.30	8.92	7.64	8.64	13.58	3.15	
Graduate or above	245	35.00	10.03	7.60	10.91	17.99	5.85	
Occupation								
Student	98	14.00	10.35	8.32	10.75	17.95	4.74	
Employed (Government sector)	197	28.14	3.70	4.14	6.37	7.09	2.11	
Employed (Private sector)	134	19.14	3.07	1.91	1.39	5.26	1.95	0.028
Self – Employed	105	15.00	1.19	0.96	1.87	0.56	0.40	
Unemployed	166	23.7	1.43	1.12	0.96	1.47	0.60	

(If chi-square test value  $p < 0.05$ , there is a significant relationship)

#### 4. CONCLUSION

The current study shows that the most consumable seafood varieties were tuna, mackerel, and herrings' species, while clams, mussels, oysters, and seaweed have shown the least consumption. This survey was mainly focused on the X-press pearl ship disaster which was the most recent vast sea pollution incidence in Sri Lanka. Socioeconomic factors play an important role in consumer awareness of sea pollution in order to influence seafood consumption patterns. Hence, there was a significant relationship between consumer awareness of sea pollution with age, gender, educational status, and occupation ( $p$ -value: 0.047, 0.031, 0.016, and 0.023 respectively). The respondents thought the x-press pearl ship disaster caused severe damage to the marine environment and biodiversity including the accumulation of hazardous chemicals, plastic pallets, and fuels. Hence, burning wounds on the skin, swollen bodies, plastic pebbles in gills, and colour changes happened to marine species. There was a significant relationship between declining seafood consumption with the impact of marine species by sea pollution ( $p$ -value: 0.027). Moreover, there was a significant relationship between the decline in seafood consumption with the impact of brackish water species by sea pollution ( $p$ -value: 0.017) and it indicates that most people (13.77%) have reduced their consumption of seafood and a significant number of people (12.86%) have increased their consumption behaviour of freshwater species. There is a significant relationship between sea pollution and the seafood consumption pattern of Sri Lankans.

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