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Traceability adoption in dry fish supply chain SMEs in India: exploring awareness, benefits, drivers and barriers

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Abstract. The illegal harvesting of seafood and the mislabelling of dry fish products have become more prominent in recent years. Traceability in the dry fish supply chain deserves research attention, especially among small and medium enterprises (SMEs) in a developing country like India. To implement the traceability system, it is necessary to identify the variables and their inter-relationships that influence traceability in a food supply chain. This research aims to identify the awareness, benefits, drivers, and barriers that affect traceability adoption in the dry fish supply chain. Data were collected from 226 dry fish supply chain stakeholders through a cross-sectional survey (both online and offline) in Kerala and Tamil Nadu, two central maritime states of India. A conceptual model is developed, and the inter-relationship among the factors underlying the traceability implementation is analysed through correlation matrices and multiple regression modelling. The results show that the Indian dry fish stakeholders moderately understand the traceability system. Product safety and quality are identified as the primary benefits of traceability, while quality concerns and food safety regulations are observed as primary drivers. The significant barriers are the cost of a traceability system, lack of a co-ordinator and lack of government support.

Keywords. Traceability; food safety; dry fish supply chain; Indian SME; multiple regression.

1. Introduction

India ranks second in the world in fish production, with 14.16 million metric tons produced during 2019–20 and provides livelihood to more than 28 million people [1]. Fisheries have become a significant socio-economic force in the Indian economy owing to their massive coastline of over 8,000 km and vast river network. However, fish are perishable and should be processed within a couple of hours of being caught because no handling or processing can improve the quality of spoiled fish. Ahmad and Bhuimbar [2] assessed that for one ton of fish consumed, an equivalent volume is disposed of either as waste or a low-value product. In India, the consumption of dried fish is about 32 percent of the total marine landings and about 17 percent of the total catch used to produce dry fish [3]. Sun drying is considered the most economical method for fish preservation [4] and an elective aspect of decreasing the actual post-harvest loss of bycatch and further improving value addition [5]. Salted and sun-dried fish products are most common in the country's coastal region, wherein the population is around 560 million. Several studies have evaluated the economics and marketing of dry fish production in India [4, 6]. Christian *et al* [7] analysed the business performance determinants of dry fish distribution during Covid-19. A few research articles are focussed on the types of fish used for drying [5], drying methods [8], and the yield of dried fish [3]. Pradhan *et al* [9] conducted a study on an SME-based dry fish supply chain that focuses on the social well-being of dried fish workers.

The illegal harvesting of seafood and the mislabelling of dry fish products have become more prominent in recent years [10, 11]. Typically, seafood products change hands 6 to 10 times before reaching the consumer. Since most fishing vessels lack adequate records, the primary challenge is identifying the first receiver in the seafood supply chain [12]. A survey of the authenticity of fresh and processed fish from the domestic market showed that 22 percent of seafood samples in India are mislabelled [13]. Food and Drug Administration found the presence of salmonella in sampling strips of frozen fish products exported from India and recalled them [14]. Traceability in the dry fish supply chain deserves research attention, as food scandals and scares worldwide have reduced consumer confidence. Numerous incidents like misinterpreting food characteristics, food adulteration, and recently the Covid-19 pandemic spread incidents in the food supply chain have shaken consumer's trust [15, 16]. Traceability is recognized as a mechanism for quality and safety, reducing the overall cost and improving the sustainability of the food product since it

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reduces recall [17]. The consumer's increased demand for complete visibility of food quality and history along the supply chain also supported traceability adoption in the food supply chain. However, most of India's dry fish supply chain stakeholders are Small and Medium Enterprises (SMEs), have very poor affordability, and often rely mainly on paper documentation at the distributors and wholesalers level [18]. Bharda *et al* [3] identified that SMEs in the dry fish supply chain make less profit due to poor product quality, safety and hygienic conditions and lack of market access. Adopting the traceability system is one of the main factors that significantly influence the quality of the SME food sector [19]. A recent survey by Rao *et al* [14] identified a low awareness of the importance of food traceability, especially among India's micro and small-scale food industries. Hence, awareness, benefits, drivers, and barriers must be explored to implement a traceability system in the dry fish supply chain. Literature has yet to provide evidence of a published work that identifies and explores the awareness, benefits, drivers and barriers to traceability adoption in dry fish supply chain SMEs in India. This research aims to understand the awareness, benefits, drivers, and barriers to effectively implementing the traceability system in dry fish SMEs in India.

The research objectives are as follows:

- To identify the awareness, benefits, drivers and barriers that affect the traceability adoption in the dry fish supply chain.
- To develop a conceptual model that formally states the relationship among perceived benefits, drivers, barriers and awareness to implement the traceability system.
- To test the conceptual model using the data gathered from 226 stakeholders in India's dry fish supply chain.
- To present the results and research implications.

The rest of this paper is organized as follows. Section 2 narrates the literature review. Section 3 presents the conceptual model and hypotheses. The illustration of the dry fish supply chain and the survey methods employed in this research are highlighted in section 4. The result and discussion are reported in section 5. Finally, in section 6 the conclusions and areas of further research are discussed.

2. Literature review

Donnelly and Karlsen [20] identified the critical points for traceability during the production of wet and dried salted fish and its practical challenges. To implement the food traceability system, it is necessary to identify the drivers and their inter-relationships that impact traceability in the value chain [21]. The recent literature on traceability adoption in the food supply chain is shown in table 1. Among the reviewed articles, it is observed that Agri-food products have received significant attention, followed by fishery products. Also, most studies tend to identify and summarise the barriers [12, 22–26] to implementing the food traceability system. Research about the awareness of food traceability [27–31] also has received considerable attention. It is noted that the drivers [12, 23, 32] and benefits [23, 33] of the traceability system have yet to receive much attention. From table 1, it is clear that none of the previous literature has paid attention to the Indian dry fish SMEs' awareness, benefits, drivers and barriers and their intention to implement it.

From the published literature, the identified benefits, drivers and barriers of food traceability are listed below in tables 2, 3 and 4, respectively.

Table 1. Recent studies on the traceability adoption in the food supply chain.

	Traceability adoption					
References	Awareness	Benefits	Barriers	Drivers	Product	Country
[22]			☐		Agri-food	Indonesia
[27]	☐				Agri-food	Sri Lanka
[24]		☐			Fish	Norway
[23]		☐	☐	☐	Agri food	Italy
[28]	☐				Agri-food	China
[29]	☐				Cheese	Brazil
[32]				☐	Agri-food	India
[12]			☐	☐	Fish	Indonesia
[30]	☐				Meat	Malaysia
[24]			☐		Fish	America
[25]			☐		Ice cream	Africa
[26]			☐		Fish	Romania
[31]	☐				Drinks	UK

Table 2. Benefits of food traceability identified from the literature

Benefits	References
Business benefits of implementing effective traceability system	
Improve product safety [A_1]	[34, 35]
Improve product quality [A_2]	[34, 36]
Identify product characteristics [A_3]	[35]
Increase access to overseas markets [A_4]	[37]
Attract new customers [A_5]	[18, 38]
Differentiate your products from others [A_6]	[39]
Increase profit [A_7]	[38]
Increase the ability to retain existing customers [A_8]	[35]
Reduce customer complaints [A_9]	[40]
Reduce liability claims and lawsuits[A_{10}]	[31]
Reduce the cost of product recall [A_{11}]	[41]
Enable rapid recall of food product [A_{12}]	[34]
Reduce the probability of product recall [A_{13}]	[31]

Table 3. Drivers of food traceability identified from the literature.

Drivers	References
Drivers of implementing effective traceability system	
Quality concern [B1]	[34, 35, 37, 46, 47]
Safety concern [B2]	[34, 35, 37]
Food safety regulation [B3]	[19, 35, 44]
Technological advancements [B4]	[35]
Reccall expenses [B5]	[34]
Gaining competitive advantage [B6]	[41, 45]
Suppliers/consumers request [B7]	[37]
Product information [B8]	[35]

The benefits of traceability include improved food safety and quality [34–36], which differentiate traceable products from others [18, 39]. Traceability increases the profit by retaining the existing customer and attracting new customers [18, 38] and reduces the cost associated with a product recall.

Also, regarding the drivers of food traceability, the most noticeable drivers are quality and safety concerns [34, 35, 37], food regulation [19, 35, 44] and getting competitive advantages [41, 45].

Furthermore, high costs of application of the traceability system [26, 34], lack of unified standards [39, 41, 42], privacy and security concerns [24, 43], lack of infrastructure [26, 42], uncertainty about the future benefits [26, 42], limited awareness of traceability and its benefits [31, 35], lack of support from the government [19, 37], and lack of a traceability coordinator [12, 45] are the commonly listed barriers to traceability systems from the various literature.

Table 4. Barriers of food traceability identified from the literature.

Barriers	References
Barriers of implementing effective traceability system	
High costs of the traceability system [C1]	[26, 34]
No unified standards in the markets [C2]	[39, 41, 42]
Privacy and security concerns [C3]	[24, 43]
Information limitation [C4]	[31]
Capacity[infrastructure] limitation [C5]	[26, 42]
Uncertainty about the future benefits [C6]	[26, 42]
Reluctance to change [C7]	[26]
Limited awareness of traceability and its benefits [C8]	[31, 35]
Inadequate Practices [C9]	[19]
Lack of support from government [C10]	[19, 37]
Lack of a coordinator for traceability practices [C11]	[12, 45, 56]

3. Theoretical framework and hypotheses development

A conceptual model that formally states the relationship among the perceived benefits, drivers, barriers and awareness to implement the traceability system is shown in figure 1.

3.1 *Perceived benefits and intention to implement the traceability system*

The rational choice theory states that firms are rational actors, and before decision-making and taking action, they evaluate the costs and benefits of a process [38]. Previous studies show that perceived benefits influence attitudes and behavioural intentions [48]. Furthermore, empirical research proposed the constructive outcome of perceived benefits on intention toward online self-exposure. The above arguments exhibit how perceived benefits influence preferences and function in different contexts. Thus it is

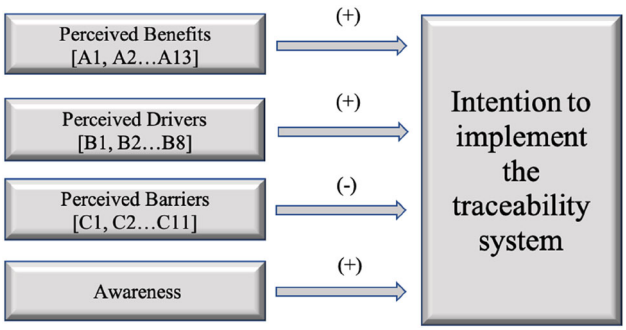

Figure 1. The proposed research framework states the relation among benefits, drivers, barriers and awareness.

postulated that H1, the higher the perceived benefits of a traceability system, the higher their readiness to implement it.

H_1: Perceived benefit will have a positive influence on the intention to implement the traceability system.

3.2 *Perceived drivers and intention to implement the traceability system*

Drivers are factors that cause a system to be the way it is or guide decisions around a system [31]. The perceived drivers can positively influence an organization's ability to execute a new practice and promote a new initiative [50]. Furthermore, the identification of the drivers assists the food industries in assessing their initiatives to implement a traceability system [51]. Thus the following hypothesis is developed.

H_2: Perceived drivers will have a positive influence on the intention to implement the traceability system.

3.3 *Perceived barriers and intention to implement the traceability system*

Implementing traceability in the food supply chain is challenging due to many barriers. Perceived barriers have a significant relationship with entrepreneurial intention. Sandhu *et al* [52] identified that perceived barriers have a negative impact on entrepreneurial inclination. The study between perceived barriers and a firm's intention reveals that based on anticipated barriers, people who wish to start their businesses decide to wait to start it anymore or even postpone until they can manage these barriers [53]. Doern [54] reported that perceived barriers could hinder, postpone and even slow down the process of realizing growth intentions. Therefore, it is hypothesized that:

H3: Perceived barriers will have a negative influence on the intention to the traceability system.

3.4 *Awareness of traceability and intention to implement it*

Awareness is the degree to which a target population is cognizant of innovation and frames a general perception of what it entails. Identifying food traceability awareness among stakeholders is essential, and lack of awareness is one of the significant negative factors towards improved traceability [27]. Awareness about traceability is a precondition for deciding it [55]. In addition, if a stakeholder is aware of the problems and precautions to take, they are more likely to have a favourable attitude toward using protective technologies. Thus, awareness is an antecedent

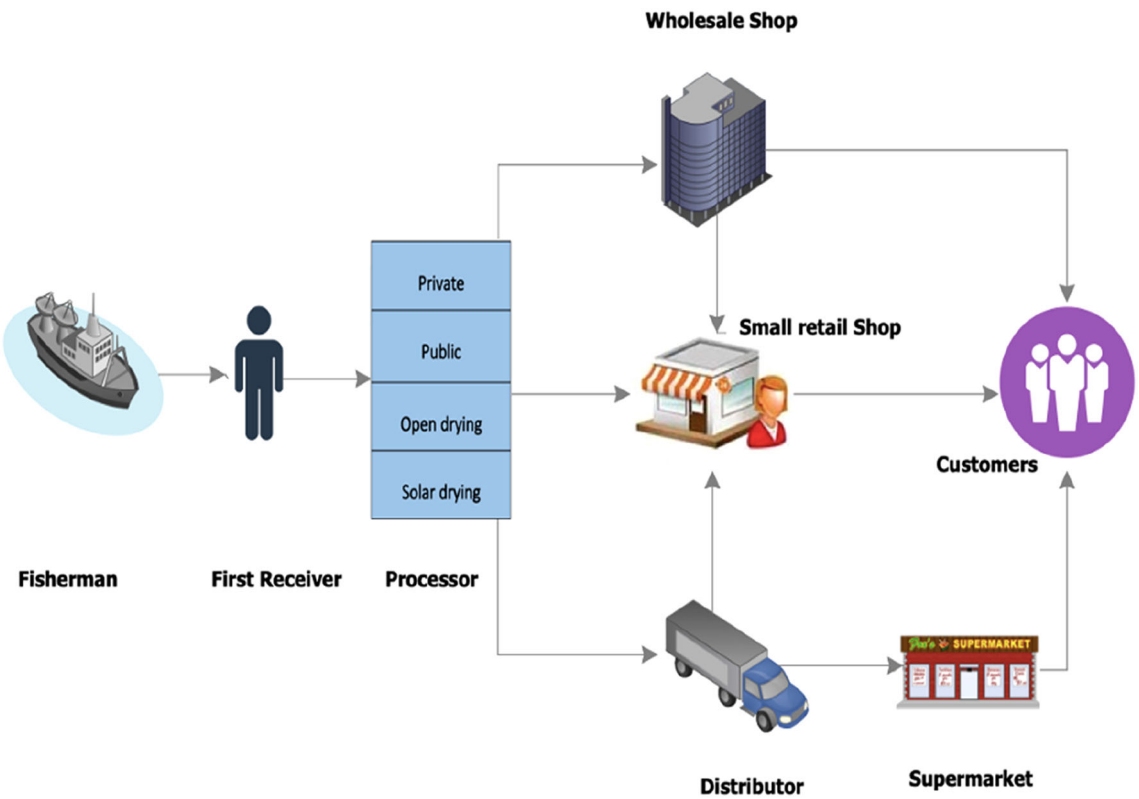

Figure 2. Illustration of dry fish supply chain in two major Indian states.

Table 5. Demographic data of survey respondents.

Variables	Categories	Frequencies	Percentage
Gender	Male	192	84.96
	Female	34	15.04
Age	Under 20	4	1.77
	20–35	96	42.48
	36–50	70	30.97
	51–65	50	22.12
	66 or older	6	2.65
Educational Background	Elementary School	65	28.76
	High School	130	57.52
	Diploma	2	0.88
	Undergraduate (i.e. Bachelor)	6	2.65
	Postgraduate (i.e. Master)	5	2.21
	Doctoral or equivalent	18	7.96
Demographic data excluding Customers and Government employees			
No. of employee	1 to 5	132	94.29
	6 to 50	8	5.71
	51 to 100	0	0.00
Year of establishment	Less than 3 years	19	13.57
	3 to 5 years	86	61.43
	6 to 10 years	35	25.00
	Graeter than 10 years		
Status of firm	Locally owned	82	58.57
	Partnership	58	41.43
Export status	Yes	0	0.00
	No	140	100.00
Yearly turnover	< or = Rs. 25 lakh	135	96.43
	> Rs. 25 lakh, < or = Rs 5 crore	5	3.57
	> Rs. 5 crore, < Rs 10 crore	0	0.00

for the attitude formation stage of innovation diffusion. Based on the statements mentioned above, the following hypothesis is developed.

H_4: There is a significant positive relationship between traceability awareness and intention to implement it.

4. Methodology

The food supply chain possesses unique characteristics of products and processes, whose data recording and information flow are essential for all the stakeholders to ensure transparency of the products [35]. Data were collected through a cross-sectional survey (both online and offline) administered in Kerala and Tamil Nadu, two central maritime states of India, to a sample of 226 stakeholders in the dry fish supply chain network shown in figure 2. It starts with the fisherman carrying their fish to the first receiver, who acts as a delivery agent between the fisherman and the processor. The processor is responsible for storing, processing, preserving, and subjecting them to steps that deem the dry fish healthy and fit for consumption. The processor also ensures that the dried fish are packaged into separate boxes based on the features such as variety, size, shelf life and processing methods. Open or sun drying is one of the world's oldest and most widely practiced methods [57]. Meanwhile, more than 50 percent of the time can be saved by using solar drying methods [58]. Although most of the fish processors belong to the private sector, by identifying the potential of dry fish products, the government of Kerala initiated dry fish processing and marketing units under the brand name "DRISH Kerala". Furthermore, to ensure safety and quality ICAR-Central Institute of Fisheries Technology (CIFT), Cochin has developed low-cost and energy-efficient solar dryers for the hygienic drying of fish. The wholesaler/retailer/distributor collects the dry fish from the processor and makes the products available to customers.

The demographic data are shown in table 5. The sample covered fishermen (15.5% of the sample), first receivers (7.1%), processors (12.4%), distributors (10.6%), wholesale and retail shops (16.4%), government agencies (10.2%) and finally, consumers (27.8%). This research employs a survey strategy as it is found to be the best method to gather information from a population such as SMEs in India, which is too large to observe

directly [31]. The authors identified awareness levels, benefits, drivers, and barriers to adopting a traceability system in Indian dry fish SMEs through the extensive literature review. As the initial step, a preliminary survey questionnaire in English is prepared and further, to minimize any colloquialism wording and maintain a high degree of consistency of the original questionnaire, a back-translation technique [61] was employed to translate the questionnaire into Malayalam and Tamil, two Indian languages. Second, the scale items included in the questionnaire, their relevance, wording and directions, and the format were refined based on comments from researchers and practitioners. Third, to further assess and refine the survey instrument, it was pre-tested through a pilot study among 21 dry fish stakeholders in Kerala and Tamil Nadu. The pilot survey was carried out in November/December 2019. The expert's comments were incorporated into the final version of the questionnaire.

The survey is conducted in two parts; online and offline mode. The study managed an online survey for government employees and customers, and 750 questionnaires were sent via e-mail. The initial mailing and three follow-ups from February 20 2019-January 31, 2021 (Delayed due to Covid-19) generated 106 usable responses, yielding a relatively high response rate of about 14.13 percent. For other stakeholders, an offline, face-to-face survey is conducted due to their need for more technical knowledge and infrastructure to respond. Furthermore, Szolnoki and Hoffmann [61], recommended that face-to-face surveys deliver the most representative result and are structured, flexible and adaptable. The total number of responses received through offline mode is 120. The main questions included are related to the topic of this paper and are reported below. It should be noted that some background questions are asked at the beginning of the survey to understand whether the stakeholders (except government agencies and customers) belong to a small and medium sector. Also, to identify the dry fish supply chain shown in figure 2, two questions are included for each stakeholder: "Who are your direct/immediate customers?" and "Who are your direct/tier1 suppliers? To understand the level of awareness of the traceability system, we included two questions for the stakeholders following Mattevi and Jones [31], as shown in table 6. Furthermore, the respondents were asked to rate the benefits, drivers, and barriers that impact implementing the traceability in the Indian dry fish SMEs on a 5- point Likert scale.

Data were statistically analysed using IBM SPSS version 20. In order to enhance the robustness of the results, correlation matrices are generated for the traceability system's perceived benefits, drivers and barriers. Furthermore, multiple regression modelling was used to assess the effect of these variables for the intention to implement the dry fish traceability system.

Table 6. Questionnaire to understand the level of awareness of the traceability system.

Are you familiar with the word "traceability" of a dried fish product? (Tick ✔ one)
☐ Know very well
☐ Know well
☐ Know
☐ Some information
☐ No Information
[IF YES] Which of the element below best describe the concept of traceability of a fish product? (Tick ✔ one or multiple choices)
☐ Tracking (Follow downstream path of a product)
☐Tracing (Determine the origin of a product)
☐ Safety control
☐ Quality control
☐ Information (capture, and/or store, and/or transmit)

5. Results and discussion

A correlation matrix enables reproducing (and confirming) a study's results or conducting secondary analyses. The correlations among the perceived benefits, drivers and barriers were examined individually, and the results are shown in the correlation matrices (tables 7, 8 and 9). Prior to this, the scales of measurement for the variables were tested using a Cronbach reliability test. They were 0.9720, 0.9840 and 0.9680 for the benefits, drivers, and barriers, respectively, indicating a high level of reliability. From table 7, it is identified that the perceived traceability benefits "increase profit and attract new customers" ($r = 0.420$, $p = 0.00$), "reduce liability claims and lawsuits and reduce customer complaints" ($r = 0.433$, $p = 0.00$), "reduce the probability of occurrence of product recall and reduce liability claims and lawsuits" ($r = 0.441$, $p = 0.00$), and "increase the ability to retain existing customers and increase profit ($r = 0.423$, $p = 0.00$) have a high positive correlation. Similarly, table 8 shows that the traceability drivers "reduced recall expenses and technological advancements" have a very high correlation value ($r=0.725$, $p=0.00$). This finding aligns with Karlsen *et al* [49], who assert that better product documentation and lower recall costs result from a willingness to invest in the technology. Table 9 indicates that barriers "inadequate practices and reluctance to change" ($r = 0.504$, $p = 0.00$) and "uncertainty about the future benefits and reluctance to change" ($r = 0.445$, $p = 0.00$) are strongly correlated. When multiple independent variables exist in a regression, the regression coefficient β shows how much the dependent variable is expected to change when one of those independent variables changes while the other independent variables stay constant. The R-squared value (R^2) of the regression is the fraction of the change in the dependent variable that is accounted for by independent variables. The t-value is used in regression to determine whether the response and predictor variables

Table 7. Correlation matrix (for the perceived benefits for traceability implementation in dry fish SME).

		Pearson correlation coefficients and significance levels (listed top to bottom in each cell)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Improve product safety	1												
2	Improve product quality	**.299****	1											
		0												
3	Identify product characteristics	**.329****	**.337****	1										
		0	0											
4	Increase access to overseas markets	**.207****	**.159***	**.408****	1									
		0.006	0.038	0										
5	Attract new customers	0.08	−0.056	0.063	**.342****	1								
		0.296	0.465	0.412	0									
6	Differentiate your products from others	**.218****	−0.018	−0.011	0.147	**.326****	1							
		0.004	0.819	0.883	0.054	0								
7	Increase profit	0.131	−0.032	0.046	**.328****	**.420****	**.367****	1						
		0.086	0.675	0.552	0	0	0							
8	Increase the ability to retain existing customers	**.161***	**.181***	**.231****	**.275****	**.249****	**.275****	**.423****	1					
		0.035	0.017	0.002	0	0.001	0	0						
9	Reduce customer complaints	**.267****	**.217****	**.303****	**.382****	**.240****	**.164***	**.372****	**.306****	1				
		0	0.004	0	0	0.001	0.032	0	0					
10	Reduce liability claims and lawsuits	**.151***	0.126	**.202****	**.358****	**.329****	**.190***	**.391****	**.322****	**.433****	1			
		0.048	0.099	0.008	0	0	0.013	0	0	0				
11	Reduce the cost of product recall	**.247****	**.166***	**.315****	**.413****	**.194***	0.127	**.196***	**.357****	**.291****	**.297****	1		
		0.001	0.029	0	0	0.011	0.098	0.01	0	0	0			
		172	172	172	172	172	172	172	172	172	172	172		
12	Enable rapid recall of food product	**.288****	0.145	**.276****	**.264****	**.167***	**.170***	**.284****	0.12	**.174***	**.300****	**.387****	1	
		0	0.058	0	0	0.028	0.026	0	0.118	0.023	0	0		
13	Reduce the probability of occurrence of product recall	**.307****	0.083	0.062	**.179***	**.175***	**.325****	**.373****	**.278****	**.343****	**.441****	**.303****	**.359****	1
		0	0.277	0.422	0.019	0.022	0	0	0	0	0	0	0	

*Significant at the p = 0.05 level. ** Significant at the p = 0.01 level

Table 8. Correlation matrix (for the perceived drivers for traceability implementation in dry fish SME).

Pearson correlation coefficients and significance levels (listed top to bottom in each cell)									
		1	2	3	4	5	6	7	8
1	Quality concern	1							
2	Safety concern	**.452****	1						
		0							
3	Food safety regulation	**.335****	**.448****	1					
		0	0						
4	Technological advancements	**.424****	**.395****	**.445****	1				
		0	0	0					
5	Reduced recall expenses	**.360****	**.314****	**.324****	**.725****	1			
		0	0	0	0				
6	To obtain competitive advantage	**.250****	**.171***	**.269****	**.369****	**.301****	1		
		0.001	0.025	0	0	0			
7	Suppliers/consumers request	**.208****	**.410****	0.149	**.266****	**.287****	0.09	1	
		0.006	0	0.052	0	0	0.243		
8	Product information	**.327****	**.495****	**.413****	**.394****	**.353****	**.331****	**.405****	1
		0	0	0	0	0	0	0	

*Significant at the p = 0.05 level. ** Significant at the p = 0.01 level

Table 9. Correlation matrix (for the perceived barriers for traceability implementation in dry fish SME).

Pearson correlation coefficients and significance levels (listed top to bottom in each cell)												
		1	2	3	4	5	6	7	8	9	10	11
1	High costs of application of the traceability system	1										
2	No unified standards in the markets	**.206****	1									
		0.007										
3	Privacy and security concerns	**.209****	**.296****	1								
		0.006	0									
4	Information limitation	0.133	**.408****	**.402****	1							
		0.083	0	0								
5	Capacity[infrastructure] limitation	0.081	**.202****	-0.075	**.268****	1						
		0.29	0.008	0.327	0							
6	Uncertainty about the future benefits	0.067	**.297****	**.228****	**.267****	**.371****	1					
		0.383	0	0.003	0	0						
7	Reluctance to change	**.182***	**.340****	**.383****	**.355****	**.239****	**.445****	1				
		0.017	0	0	0	0.002	0					
8	limited awareness of traceability and its benefits	0.122	**.352****	**.166***	**.347****	**.359****	**.267****	**.369****	1			
		0.111	0	0.03	0	0	0	0				
9	Inadequate Practices	**.190***	**.297****	**.199****	**.326****	**.245****	**.356****	**.504****	0.142	1		
		0.012	0	0.009	0	0.001	0	0	0.063			
10	Lack of support from government	− 0.003	**.315****	0.041	**.207****	**.161***	**.286****	**.356****	**.315****	**.272****	1	
		0.964	0	0.594	0.006	0.035	0	0	0	0		
11	Lack of a coordinator for traceability practices	.150*	**.220****	0.127	**.260****	**.357****	**.319****	**.358****	**.225****	**.389****	**.387****	1
		0.05	0.004	0.097	0.001	0	0	0	0.003	0	0	

* Significant at the p = 0.05 level. ** Significant at the p = 0.01 level

have a linear correlation. In the structural model, R^2 values of 0.75, 0.50, or 0.25 for endogenous latent variables can be explained as substantial, moderate, or weak, respectively. Critical t-values for a two-tailed test are 2.58 (significance level is equal to 1 percent), 1.96 (significance level is equal to 5 percent), and 1.65 (significance level is equal to 10 percent). The correlation matrix of perceived benefits, drivers and barriers are shown in tables 7, 8 and 9,

Table 10. Regression results, Hypothesis 1-3.

	Intention to implement the traceability system		
	R^2 = 0.808		
H1: Benefits of traceability	**F=55.69 (000)**		
	Standard β	t	Significance
Improve product safety	**0.597****	**9.021**	**0.000**
Improve product quality	**0.275****	**3.233**	**0.001**
Identify product characteristics	0.012	0.279	0.781
Increase access to overseas markets	−0.001	−0.021	0.983
Attract new customers	**0.521****	**8.445**	**0.000**
Differentiate your products from others	**0.501****	**8.287**	**0.008**
Increase profit	0.175	2.536	0.221
Increase the ability to retain existing customers	0.009	0.188	0.451
Reduce customer complaints	0.111	1.343	0.181
Reduce liability claims and lawsuits	0.010	0.267	0.790
Reduce the cost of product recall	0.227	6.889	0.120
Enable rapid recall of food product	0.010	0.250	0.103
Reduce the probability of occurrence of product recall	−0.131	−1.535	0.127
	R^2 = 0.631		
H2: Drivers of traceability	**F=32.68(000)**		
	Standard β	t	Significance
Quality concern	**0.588****	**8.942**	**0.000**
Safety concern	**0.245***	**1.871**	**0.023**
Food safety regulation	**0.404***	**5.986**	**0.028**
Technological advancements	0.031	0.277	0.782
Reduced reccall expenses	0.071	0.646	0.519
To obtain competitive advantage	**0.337****	**4.437**	**0.000**
Suppliers/consumers request	0.065	0.781	0.436
Product information	0.050	0.546	0.586
	R^2 = 0.473		
H3: Barriers of traceability	**F=13.148(.001)**		
	Standard β	t	Significance
High costs of application of the traceability system	**−0.343***	**−4.597**	**0.012**
No unified standards in the markets	−0.012	−0.179	0.858
Privacy and security concerns	0.02	0.296	0.768
Information limitation	−0.063	−0.888	0.376
Capacity[infrastructure] limitation	**−0.402****	**−5.303**	**0.000**
Uncertainty about the future benefits	0.009	0.148	0.883
Reluctance to change	0.021	0.285	0.776
limited awareness of traceability and its benefits	**−0.604****	**−8.482**	**0.000**
Inadequate Practices	−0.102	−1.507	0.134
Lack of support from government	**−0.514****	**−7.65**	**0.000**
Lack of a coordinator for traceability practices	**−0.216****	**−3.001**	**0.003**
	R^2 = 0.765		
H4: Awareness of traceability	**F= 47.76(.000)**		
	Standard β	t	Significance
	0.604**	**9.887**	**0.000**

* Significant at the p = 0.05 level. ** Significant at the p = 0.01 level

respectively. The regression models had significant ($p < 0.05$) F-values, as shown in table 10.

Hypothesis 1 holds that perceived benefit will positively influence the intention to implement the traceability system. The results in table 10 provide support for this hypothesis. The results are solid for the benefits of the traceability system, with the model R-squared implying that the independent variables explain 80.8 percent of the variation in intention to implement the traceability system. Examining the individual model results yields some additional insights. The benefits such as improved product safety [A1] (β = 0.597, t = 9.021, P = 0.000), quality [A2] (β = 0.275, t = 3.223, P = 0.001), attracting new customers [A5] (β = 0.521, t = 8.445, P = 0.000) and differentiate your

products from others [A6] (β = 0.501, t = 8.287, P = 0.008) have a significant positive impact on the intention to implement the traceability system. Contrarily, apart from the benefits outlined above, none of the other factors significantly affect the implementation of the traceability system. The result of reducing the cost of product recall [A11] (β = 0.227, t = 6.889, P = 0.120) is found to be less significant. While the authors expected this variable positively impacts the intention to implement the traceability system, the results suggest otherwise. One possible explanation is that most stakeholders in India believe that the recall cost includes the notification cost of the recall, the cost of shipping the recalled product and the cost of holding the recalled product is relatively high. In our survey, most dry fish supply chain stakeholders are small and medium sectors, market a limited quantity of products, and deal with few recalls. Memon *et al* [59] reported that a minor product recall would not affect the profit and sales of firms.

Hypothesis 2 argues that perceived drivers will positively influence the intention to implement the traceability system. The results in table 10 support this hypothesis. The model R^2 implies that the independent variables explain 63.1 percent of the variation in the intention to implement the traceability system. The traceability drivers such as quality concern [B1] (β = 0.588, t = 98.942, P = 0.000), safety concern [B2] (β = 0.245, t = 1.871, P = 0.023), food safety regulation [B3] (β = 0.404, t = 5.986, P = 0.028) and to obtain competitive advantage [B6] (β = 0.337, t = 4.437, P = 0.000) have a profoundly favourable effect on the decision to implement the traceability system. The results agree with the findings of Pant *et al* [34] that traceability is primarily considered a tool for food safety and quality by offering a mechanism for recall and confirmation of food authenticity. Several nations over the past few years have established specific regulations or policies for domestic products and implemented mandatory regulations for food traceability systems, excluding India Dandage *et al* [19]. India must cooperate with these nations and adhere to their established standards in order to export goods to those countries where a traceability system is required and get competitive advantages.

Hypothesis 3 holds that perceived barriers will negatively influence the intention to adopt the traceability system. The results in table 10 support this hypothesis, albeit not as strongly as for Hypotheses 1 and 2. High cost[C1] (β= −0.343, t= −4.597, P=0.012), capacity limitation[C5] (β= −0.402, t= −5.303, P=0.000), limited awareness[C8] (β= −0.604, t= −8.482, P=0.000), lack of government support[C10] (β= −0.514, t= −7.65, P=0.000) and lack of a coordinator[C11] (β= −0.216, t= −3.001, P=0.003) are the independent variables with a significant, negative impact on the intention to dry fish traceability system implementation and all other barriers have no significance. Not surprisingly, as the stakeholders believe that financial support for building capacity or infrastructure development by the government is inevitable, lack of government support has a high negative β value (β = −0.514). Furthermore, while the authors expected the lack of a coordinator for traceability practices to have little impact on implementing the dry fish traceability system, the result was surprising. The regression models yield some interesting insights. In India, most dry fish supply chain members are located in coastal area and prone to low literacy and technical knowledge levels. Therefore, they need support from external sources to provide training and support services and work closely with the supply chain team. The results validated the findings by Choi *et al* [60] say that to create the maximised system's profit and successful strategies, the interests of individual members, should be coordinated by a supply chain coordinator. Additionally, coordinating the traceability system positively impacts quality in food industry value chains since most entities act based on their activity and integration of these units is possible only through a coordinator [12].

Hypothesis 4 states a significant positive relationship between the level of traceability awareness and the intention to implement it. It is crucial to gauge stakeholders' awareness of food traceability, and a lack of awareness is one of the critical barriers to adopting traceability. Traceability awareness is a requirement before choosing it Blaauboer *et al* [55]. Indeed, the more knowledgeable a stakeholder is about issues and how to protect against them, the more likely they will develop a positive attitude toward using protective technologies. Therefore, awareness is a prerequisite for the innovation diffusion stage of attitude formation. The results in the table support this hypothesis, with the awareness of traceability explaining 76.5 percent of the variance in the implementation of the traceability system. The findings agreed with Samarasinghe *et al* [27] that poor awareness is a limiting factor for implementing a traceability system since a lack of awareness implies a lack of consciousness of something.

Finally, the overall result suggests that the main benefits are to improve product safety [A1], attract new customers [A5] and differentiate your products from others [A6]. The main traceability drivers are the quality concern [B1] and food safety regulation [B3]. The significant barriers are high cost[C1], limited awareness[C8], lack of government support [C10] and lack of a coordinator [C11]. To overcome the barriers, the Indian government must establish specific regulations or policies for food traceability and define the roles and responsibilities of stakeholders and regulators. The researchers and decision-makers must focus on developing an inexpensive traceability system to promote food traceability. The suggested recommendations can help to resolve the significant barriers and also helps to achieve the benefits of traceability implementation, such as food safety and quality.

6. Conclusion

Traceability in the dry fish supply chain deserves research attention, especially among small and medium enterprises(SMEs) in India. The extensive literature review identified the awareness levels, benefits, drivers, and barriers to adopting a traceability system in Indian dry fish SMEs. Also, a conceptual model that formally explains the impact of these variables to establish a dry fish traceability system was constructed. In order to test the model, data were collected through a cross-sectional survey of 226 stakeholders in the dried fish supply chain network from the central maritime Indian states of Kerala and Tamil Nadu and were statistically analysed using IBM SPSS version 20 software. Correlation matrices are developed for the traceability system's benefits, drivers, and barriers to enhance the robustness of the findings. Additionally, the impact of these variables on the decision to deploy the dry fish traceability system was evaluated using multiple regression modelling.

The findings revealed that barriers to implementing a traceability system in the dried fish industry are negatively correlated, while perceived benefits, drivers, and awareness are positively correlated. The benefits, such as improving product quality, attracting new customers and differentiating your products from others, have a significant positive impact on the intention to implement the traceability system. As far as the perceived driver's effect on the traceability system is considered, the leading elements are quality and safety concerns, food safety regulations, and to obtaining competitive advantages. Finally, the critical barriers to traceability are identified as high cost, capacity limitations, limited awareness, lack of government support and lack of a coordinator. From the survey, it is found that Indian dry fish stakeholders appear to have a moderate understanding of the definition and meaning of traceability as provided by the literature, like tracking, tracing, safety, and quality. A few minor contradictions remain, such as the low number of supply chain members who have chosen "information" as a concept associated with traceability.

The unique contribution of this research is that it developed a supply chain network for the SME dry fish sector in India. Furthermore, it provides information that may be considered by the government, programmers, and the fishing sector before making plans to create a traceability system for the supply chain of dry fish. This research can help to understand the various elements to implement traceability practices within dry fish SMEs and can be extended to any other food industry. Before developing a prototype of the traceability system for dry fish SMEs, this work offers several points to consider. Implementation of a dry fish traceability system will become a reality in the SME sector if these drivers and barriers are addressed adequately.

The following are the limitations of the present research. The findings and the business implications presented in this study are based on a sample size of 226 stakeholders in two states of India (Kerala and Tamil Nadu), which may restrict the generalisation of results. Therefore, future research can expand the sample size and improve representativeness from other coastal states. Notwithstanding its limitation, this study delivers a starting point for several future research streams. This research is limited to SME dry fish sector and may be extended to other food sectors such as fruit and vegetables, meat, live fish etc. Future research may utilise methodologies, such as interpretive structural modelling (ISM) and Decision making trial and evaluation laboratory (DEMATEL), to incorporate the direct effects of each driver and barrier to the adoption of traceability in the supply chain.

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Conflict 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.

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