Predictive Analysis of Variables Related with the Adoption of Quality Control Practices by the Shrimp Freezing Plants

M.K.Kandoran, S.Balasubramaniam, Mary Thomas, R.Thiagarajan and A.K.K.Nair
Central Institute of Fisheries Technology, Cochin - 682 029, India

This paper analyses the differential characteristics and adoption of quality control practices among the shrimp freezing plants in India. The mean adoption quotient scores calculated for the three categories of freezing units viz., Quality Control and Inspection in Approved Units, In-process Quality Control and combined samples, were found to be quite high (79.20%, 83.99% and 80.92%). The regression analysis of the combined sample revealed that the four variables viz. the number of years of functioning as shrimp freezing plant, ice production capacity, number of technical personnel and number of years of experience of the senior technologist were found to have significant influence on the extent of adoption of quality control practices.

Quality control in seafoods aims to produce better quality end products. Due to its importance, the Export Inspection Council of India had introduced various inspection systems from time to time and at present, the inspection systems viz, Quality Control and Inspection in Approved units (QCIA) and In-process Quality Control (IPQC) are in operation among the shrimp freezing plants. This research paper presents the extent of adoption of quality control practices by the shrimp freezing plants in India, the differential adoption among the QCIA and IPQC freezing plants, and the variables influencing the adoption of quality control practices.

Materials and Methods

The study was conducted among the shrimp freezing plants in the various maritime states of India and structured mailed questionnaires were used to collect the data. Seventy freezing plants comprising of 45 QCIA and 25 IPQC plants from nine maritime states had responded and they constituted the sample for this study. The term 'combined sample' refers to these 70 shrimp freezing plants.

In order to determine the extent of adoption of quality control practices, 13 quality control practices which could directly or indirectly influence the quality of the final product were considered in the study after excluding the practices adopted/not adopted by all the freezing plants. Based on the CIFT recommendations for adoption (Mathen, 1979; Thomas, 1979; Kaul et al., 1989), the percentage of actual adoption was determined for each selected practice and accordingly, scores were assigned in the range of 0 to 3.

The extent of adoption of quality control practices by a freezing plant was measured by using the adoption quotient formula and it was calculated based on the ratio of actual score obtained to the maximum possible score for all the 13 practices and expressed in percentage. Eleven independent variables measured quantitatively were considered for determining their extent of association and influnce on the adoption of quality control practices.

Results and Discussion

The means and standard deviations of the eleven quantitative characteristics of the freezing plants studied are given in Table 1. A perusal of these characteristics revealed that these freezing plants in general had

Table 1. *Characteristics of shrimp freezing plants*

Characteristics	Combined sample (n:70)		QCIA (n:45)		IPQC (n:25)		't'
	Mean	SD	Mean	SD	Mean	SD	
Number of years as shrimp processing plant	12.100	6.055	11.956	6.470	12.360	5.345	0.263
Number of marine products processed	6.057	3.729	5.089	3.295	7.800	3.894	3.089**
Production capacity (tonnes/day)	8.648	5.304	7.064	3.697	11.500	6.532	3.638**
Cold storage capacity (tonnes)	121.985	108.965	96.333	57.152	168.160	157.140	2.768**
Ice production capacity (tonnes/day)	11.564	16.960	9.833	17.600	14.680	15.600	1.149
Number of technical personnel	3.142	1.851	2.800	1.618	3.760	2.107	2.132*
Number of trained technical personnel	1.600	1.108	1.356	1.209	2.040	0.735	2.575*
Maximum number of training programmes attended by a technologist	1.500	1.411	1.200	1.014	2.040	1.837	2.102*
Number of years of experience of the senior technologist	9.871	6.439	11.111	6.492	7.640	5.821	2.222*
Number of male workers in the factory	15.871	16.138	14.133	14.796	19.000	18.209	1.213
Number of female workers in the factory	38.514	34.178	32.200	29.765	49.880	39.048	2.126*

** Significant at 1 per cent level; * significant at 5 per cent level

the necessary infrastructural facilities for freezing, qualified personnel, and other resources to undertake the processing operations. It is seen that out of the 11 variables, there were significant differences between the QCIA and IPQC freezing plants only in respect of eight variables.

Of these eight significant variables, IPQC freezing plants had higher mean values in respect of seven variables as seen in Table 1. Thus, these results reveal that the IPQC plants were better equipped and well placed than the QCIA plants in terms of manpower and material resources, facilities, and qualified personnel to supervise the various processing operations and analyses.

The qualitative characteristics of the freezing plants studied are given in Table 2. It is seen from Table 2 that of the six qualitative variables, QCIA and IPQC plants had differed significantly only in respect of three variables such as the marine products processed, defects rectified in the raw materials and educational levels of technical personnel. It is also evident that the majority of IPQC plants were located in the West Coast, had processed not only prawns but also other marine products and employed more numbers of post-graduates as technical personnel.

Table 2. *Qualitative characteristics of shrimp freezing plants*

Qualitative characteristics	Combined sample (n:70) No.	%	QCIA (n:45) No.	%	IPQC (n:25) No.	%	λ^2
Location of units							
a) East coast	22	31.43	17	37.78	5	20.00	2.3614
b) West coast	48	68.57	28	62.22	20	80.00	
Products processed							
a) Only prawns	17	24.29	16	35.56	1	4.00	
b) Prawns & other products	53	75.71	29	64.44	24	96.00	8.6989**
Types of freezing							
a) Block frozen	47	67.14	33	73.33	14	56.00	
b) IQF	1	1.43	-	-	1	4.00	3.4056
c) Both	22	31.43	12	26.67	10	40.00	
Defects rectified in raw materials while processing							
a) Defect free materials	29	41.43	22	48.89	7	28.00	
b) 1-2 defects	28	40.00	17	37.78	11	44.00	31.5513**
c) 3-4 defects	13	18.57	6	13.33	7	28.00	
Educational levels of technicians							
a) SSLC	14	20.00	13	28.89	1	4.00	
b) Graduates	28	40.00	20	44.44	8	32.00	11.2000**
c) Post-graduates	28	40.00	12	26.67	16	64.00	
Literature on processing							
a) Not available in the factory	20	28.57	16	35.56	4	16.00	
b) 1-3 publications	35	50.00	22	48.89	13	52.00	4.2020
c) 4-6 publications	15	21.43	7	15.55	8	32.00	

**Significant at 1 per cent level

Further, the results in Table 2 revealed that 48.89 per cent of the QCIA plants and 28 per cent of the IPQC plants had purchased the defect-free raw materials. It is seen that 51.11 per cent of the QCIA plants and 72 per cent of the IPQC plants had purchased and rectified the defects seen in the raw materials while processing in their premises.

Table 3 presents the extent of adoption of the selected quality control practices by the various categories of freezing plants in terms of their mean adoption scores which could vary from 0 to 3 for each practice.

Table 3. *Extent of adoption of quality control practices by the shrimp freezing plants*

Quality control practices	Combined sample (n:70)		QCIA (n:45)		IPQC (n:25)		't'
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	
Testing the suitability of water for processing	2.16	1.15	2.00	1.22	2.44	0.96	1.549
Hygienic production, storage and handling of ice	2.27	0.87	2.11	0.93	2.56	0.65	2.129*
Proper icing of the incoming raw materials	2.20	0.79	1.91	0.76	2.72	0.54	4.678**
Quality of raw materials received	1.84	0.88	1.86	0.89	1.80	0.86	0.302
Adequate chlorination of water for washing raw materials	2.90	0.39	2.84	0.47	3.00	0	1.634
Use of recommended cleaning schedule in the plant	2.41	0.65	2.24	0.67	2.72	0.45	3.123**
Drainage and waste disposal facilities in the plant	2.87	0.41	2.88	0.43	2.84	0.37	0.471
Rodent and fly control measures in the plant	2.31	0.71	2.11	0.74	2.68	0.47	3.442**
Time taken for loading the trays in the freezer after setting	2.13	0.82	2.31	0.73	1.80	0.86	2.618*
Excess weight added to compensate the drip loss	2.14	0.73	2.28	0.62	1.88	0.83	2.322*
Adequacy of freezing time	2.96	0.27	2.97	0.14	2.92	0.40	0.871
Appropriate cold storage temperature	2.84	0.47	2.82	0.53	2.88	0.33	0.490
Worker's hygiene and sanitary facilities	2.51	0.58	2.51	0.58	2.52	0.58	0.061
Overall Adoption Quotient	80.92	7.18	79.20	7.62	83.99	5.14	2.809**
Range	58.974-92.307		58.974-92.307		71.794-92.307		

* Significant at 5 per cent level; ** significant at 1 per cent level

It is seen that among all the three categories of the freezing plants, the extent of adoption was fairly high in respect of the 13 quality control practices. But, it is observed that the mean adoption scores were slightly lower on the practice - 'quality of raw materials received' for all the categories of freezing plants (1.84, 1.86 and 1.80) due to some problems in the raw materials supplied by the pre-processing centres eventhough they were easily rectified while processing. On proper icing of incoming raw materials, it is seen that the QCIA plants were found to have lesser mean adoption score (1.91) and this might be due to the location of the few QCIA

Table 4. *Correlation analyses between the adoption quotient scores and the independent variables*

Var. Code	Independent variables	Correlation coefficients (r) Combined sample (n:70)	QCIA (n:45)	IPQC (n:25)
X_1	Number of years as shrimp processing plant	0.175	0.227	0.005
X_2	Number of marine products processed	0.220	0.166	0.031
X_3	Production capacity (tonnes/day)	0.209	0.089	0.121
X_4	Cold storage capacity (tonnes)	0.307*	0.285	0.287
X_5	Ice production capacity (tonnes/day)	0.281*	0.265	0.221
X_6	Number of technical personnel	0.269*	0.146	0.360
X_7	Number of trained technical personnel	0.204	0.094	0.233
X_8	Maximum number of training programmes attended by a technologist	0.115	0.083	-0.054
X_9	Number of years of experience of the senior technologist	-0.139	-0.143	0.188
X_{10}	Number of male workers in the factory	0.265*	0.307*	0.099
X_{11}	Number of female workers in the factory	0.305*	0.311*	0.144

*Significant at 0.05 level of probability

plants far away from the landing and pre-processing centres.

The 't' values in Table 3 reveal that there were significant differences between the QCIA and IPQC plants only with reference to six practices. Of these six practices, the IPQC plants had higher mean values over QCIA plants in respect of four practices such as the hygienic production, storage and handling of ice, proper icing of the incoming raw materials, use of the recommended cleaning schedule and adoption of the rodent and fly control measures in the plant. But, in the other two practices viz, the time taken for loading the trays in the freezer after setting and excess weight added to compensate the drip loss, the QCIA plants had higher mean adoption values.

The mean adoption quotient scores calculated for the three categories of freezing units (80.92%, 79.20% and 83.99%) were found to be quite high. It is seen that when QCIA and IPQC plants were compared in terms of their mean adoption quotient scores, the IPQC plants had higher overall

Table 5. *Multiple regression analyses between the adoption quotient scores and the independent variables*

Var. Code	Independent variables	Combined sample (n:70)		QCIA (n:45)		IPQC (n:25)	
		Partial Reg. coefft.	SE	Partial Reg. coefft.	SE	Partial Reg. coefft.	SE
X_1	Number of years as shrimp processing plant	0.321*	0.149	0.350	0.209	0.124	0.332
X_2	Number of marine products processed	0.246	0.243	0.505	0.326	-0.302	0.613
X_3	Production capacity (tonnes/day)	-0.316	0.238	-0.238	0.379	-0.026	0.406
X_4	Cold storage capacity (tonnes)	0.005	0.010	0.005	0.026	0.003	0.011
X_5	Ice production capacity (tonnes/day)	0.112*	0.051	0.111	0.063	0.107	0.127
X_6	Number of technical personnel	1.536*	0.585	1.931	1.145	1.127	0.807
X_7	Number of trained technical personnel	-0.869	0.965	-2.597	1.686	0.947	1.761
X_8	Maximum no. of training programmes attended by a technologist	0.728	0.623	1.939	1.408	0.196	0.931
X_9	No. of years of experience of the senior technologist	-0.270*	0.133	-0.389	0.198	-0.026	0.237
X_{10}	No. of male workers in the factory	0.072	0.083	0.080	0.116	0.038	0.166
X_{11}	No. of female workers in the factory	0.021	0.050	0.055	0.069	0.001	0.129
	R^2	0.329		0.377		0.295	
	F	2.588**		1.813		0.495	

*Significant at 5 per cent level; ** significant at 1 percent level

adoption (83.99%) than the QCIA plants (79.20%) and here, the mean difference were significant.

The correlation coefficients calculated between the eleven independent variables and the adoption quotient scores of shrimp freezing plants are given in Table 4.

It is seen that among the QCIA plants, two variables such as the number of male workers and number of female workers were found to have significant and positive correlation with the extent of adoption of quality control practices. This is because, the adoption of several quality control practices required more number of skilled male and female workers, and hence, these variables might have had significant and positive relationship with the adoption quotient scores.

Among the IPQC plants, none of the variables listed had significant correlation with the extent of adoption. This might be due to the overall in-built quality system in the IPQC plants through the supporting

facilities in the self-inspection system. The results on the combined sample of freezing plants revealed that the five variables viz. cold storage capacity, ice production capacity, number of technical personnel, number of male workers and number of female workers were found to have significant and positive relationship with the extent of adoption of quality control practices. Hence, these five variables are important and they would have to be adequately taken into account by all the shrimp freezing plants to ensure the quality of the frozen shrimp products.

The results of the multiple regression analyses between the adoption quotient scores of three categories of freezing plants and the independent variables are presented in Table 5.

It is seen that for the QCIA and IPQC categories, only 37.7% and 29.5% of the variation in the adoption had been explained by the 11 variables when they were considered together in the regression analyses and the F values were not significant. Without categorising the freezing units as QCIA or IPQC units, when they were considered as one combined sample, the F value was found to be highly significant (R^2 = 0.329). Further, among the eleven variables, three variables namely, number of years of functioning as shrimp freezing plants, ice production capacity and number of technical personnel had significantly and positively influenced the extent of adoption and the variable, number of years of experience of the technologist, had significantly and negatively influenced the extent of adoption. It might be due to the situational constraints under which senior technologists had operated. The prediction equation derived from the analysis is as follows:

$$Y = 72.506 + 0.321\ X_1 + 0.246\ X_2 - 0.316\ X_3 + 0.005\ X_4 + 0.112\ X_5 + 1.536\ X_6 - 0.869\ X_7 + 0.728\ X_8 - 0.270\ X_9 + 0.072\ X_{10} + 0.021\ X_{11}$$

Thus, the study revealed the differential characteristics and the high level of adoption of the quality control practices among the shrimp freezing plants. Since the number of years of functioning of the plant, ice production capacity, number of technical personnel and experience of the technologist were found to have significant influence on the extent of adoption of quality control practices, the future quality control strategies would have to incorporate appropriate motivational and resource utilisation techniques.

Referenes

Kaul, P.N., Iyer, H.K. & Kandoran, M.K. (1989) *Fish.Technol.* **26**, 62

Mathen, C. (1979) in *Quality Control in Fish Processing*, CIFT, Cochin

Thomas, F. (1979) in *Quality control in Fish Processing*, CIFT, Cochin.