Contribution of Pollution Prevention as a Green Supply Chain Practice-A Pilot Empirical Study of the Indian Automobile Manufacturing Sector

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Abstract: *This paper tests empirically through a pilot study of the Indian Automobile Manufacturing Sector, the contribution of the variables constituting the construct Pollution Prevention in Green Supply Chain Practices. Also the paper establishes the reliability of the questionnaire instrument developed previously for measuring the construct Pollution Prevention and also for measuring the eleven variables that constitute the construct Pollution Prevention. Further the paper establishes the correlation among these eleven variables. Finally this paper conducts Confirmatory Factor Analysis (CFA) to arrive at one or more factors (linear combination of variables constituting the construct Pollution Prevention) to aid in measuring the construct Pollution Prevention.*

Keywords: *Automobile, CFA, Green Supply Chain Practice, Indian, Manufacturing Sector, Pilot Study, Pollution Prevention*

I. Introduction to Pollution Prevention and Green Supply Chain Practices

Pollution Prevention has been identified as one of the five green supply chain practices having an influence over ten green supply chain performance measures [13]. Accordingly, this paper identifies the variables constituting the construct Pollution Prevention. Pollution Prevention in turn is a sub-construct of the main construct Green Supply Chain Practices. Since pollution prevention has been identified as being constituted of eleven variables, it is of interest to know how these eleven variables fare in the pilot empirical study of the Indian automobile manufacturing sector by means of a questionnaire instrument [13]. The 50 automobile manufacturing plants that were surveyed during the pilot empirical study are all listed in [4]. The survey methodology was used in line with the findings of [5].

II. Research Questions

The four research questions identified are as follows:

Research Question 1.To have a feel of the responses of the Indian Automobile Manufacturing Sector pertaining to the eleven variables constituting the construct Pollution Prevention.

Research Question 2.To know the reliability of the questionnaire instrument for measuring the construct Pollution Prevention.

Research Question 3.To know the reliability of the questionnaire instrument for measuring the eleven variables constituting the construct Pollution Prevention.

Research Question 4. How are the eleven variables constituting the construct Pollution Prevention correlated?

Research Question 5. How many factors are retained by the eleven variables constituting the construct Pollution Prevention?

III. The Construct And Variables Used In The Study

There are eleven variables that constitute the construct Pollution Prevention. They are depicted in the Table 1 in their abbreviated form.

Table 1. The eleven variables constituting the construct Pollution Prevention

The eleven variables constituting the construct Pollution Prevention:	PP1	PP2	PP3	PP4	PP5	PP6	PP7	PP8	PP9	PP10	PP11

The Descriptive Statistics Of The Data Scaled

A five point balanced Likert scale was used to scale the data from respondents on whom a questionnaire was administered. The respondents were employees of Indian automobile manufacturing firms and /or their plants as mentioned in [4]. The data collected revealed the following descriptive statistics of the eleven variables constituting the construct Pollution Prevention.

Table 2. Descriptive Statistics of the data scaled by the questionnaire

Simple Descriptive Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
PP1	50	4.52000	0.93110	226.00000	1.00000	5.00000
PP2	50	4.52000	0.83885	226.00000	2.00000	5.00000
PP3	50	4.64000	0.69282	232.00000	2.00000	5.00000
PP4	50	4.46000	0.99406	223.00000	1.00000	5.00000
PP5	50	4.08000	0.89989	204.00000	1.00000	5.00000
PP6	50	4.72000	0.45356	236.00000	4.00000	5.00000
PP7	50	4.70000	0.50508	235.00000	3.00000	5.00000
PP8	50	4.10000	0.95298	205.00000	1.00000	5.00000
PP9	50	4.50000	0.86307	225.00000	2.00000	5.00000
PP10	50	4.46000	0.97332	223.00000	1.00000	5.00000
PP11	50	4.46000	0.99406	223.00000	1.00000	5.00000

The Reliability Of The Instrument For The Variables And Construct Used
The reliability of the questionnaire instrument developed by [13] for the construct Pollution Prevention is shown in the Table 3 as 0.981131 which is considered to be excellent [7].

Table 3. Reliability by Cronbach's Coefficient Alpha for the construct Pollution Prevention

Cronbach Coefficient Alpha	
Variables	Alpha
Raw	0.977275
Standardized	0.981131

The reliability of the questionnaire for the eleven variables that constitute the construct Pollution Prevention is shown in the Table 4. All the eleven variables in Table 4 have a reliability greater than 0.9 which is considered to be an excellent indicator of internal consistency reliability of the questionnaire survey instrument [7].

Table 4. Reliability of the individual eleven variables constituting the construct Pollution Prevention

Cronbach Coefficient Alpha with Deleted Variable				
Deleted Variable	Raw Variables		Standardized Variables	
	Correlation with Total	Alpha	Correlation with Total	Alpha
PP1	0.831980	0.976678	0.829560	0.981089
PP2	0.971565	0.972584	0.975582	0.977267
PP3	0.914364	0.974784	0.914247	0.978885
PP4	0.976525	0.972420	0.974491	0.977296
PP5	0.861459	0.975688	0.848837	0.980591
PP6	0.818127	0.978844	0.827354	0.981146
PP7	0.796954	0.978609	0.801437	0.981813
PP8	0.867196	0.975722	0.856023	0.980404
PP9	0.972789	0.972480	0.975359	0.977273
PP10	0.915005	0.974324	0.917089	0.978811
PP11	0.976525	0.972420	0.974491	0.977296

The Pearson's correlation coefficient among the variables used in the study
The Pearson's Correlation coefficient between different pairs of variables that constitute the construct Pollution Prevention is shown in the Table 5. Since all the values of correlation coefficient are around 0.7 and above, it indicates that all the eleven variables that make up the construct Pollution Prevention are oriented towards the goal of Pollution Prevention in a unidirectional manner. This is also an indicator of internal consistency reliability of the survey instrument ranging from acceptable to excellent [7]. Accordingly all the eleven variables are retained as there is also a strong support from existing literature in their favour [1], [2], [3], [6], [8], [9], [10], [11], [12] and [14].

Table 5. Pearson's Correlation coefficient

Pearson Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0											
	PP1	PP2	PP3	PP4	PP5	PP6	PP7	PP8	PP9	PP10	PP11
PP1	1.00000	0.77029 <.0001	0.77067 <.0001	0.83876 <.0001	0.68004 <.0001	0.69009 <.0001	0.68566 <.0001	0.72220 <.0001	0.83806 <.0001	0.83412 <.0001	0.83876 <.0001
PP2	0.77029 <.0001	1.00000	0.92564 <.0001	0.97994 <.0001	0.83593 <.0001	0.87325 <.0001	0.80923 <.0001	0.82714 <.0001	0.98659 <.0001	0.90084 <.0001	0.97994 <.0001
PP3	0.77067 <.0001	0.92564 <.0001	1.00000	0.95654 <.0001	0.80001 <.0001	0.84170 <.0001	0.67653 <.0001	0.76657 <.0001	0.92151 <.0001	0.76508 <.0001	0.95654 <.0001
PP4	0.83876 <.0001	0.97994 <.0001	0.95654 <.0001	1.00000	0.84777 <.0001	0.83468 <.0001	0.72759 <.0001	0.83372 <.0001	0.98716 <.0001	0.87367 <.0001	1.00000 <.0001
PP5	0.68004	0.83593	0.80001	0.84777	1.00000	0.60602	0.63760	0.96618	0.81457	0.79594	0.84777

Pearson Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0											
	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
PP6	0.69009	0.87325	0.84170	0.83468	0.60602	1.00000	0.78397	0.58548	0.88628	0.71378	0.83468
	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001
PP7	0.68566	0.80923	0.67653	0.72759	0.63760	0.78397	1.00000	0.69960	0.77247	0.90915	0.72759
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001
PP8	0.72220	0.82714	0.76657	0.83372	0.96618	0.58548	0.69960	1.00000	0.80641	0.85149	0.83372
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001
PP9	0.83806	0.98659	0.92151	0.98716	0.81457	0.88628	0.77247	0.80641	1.00000	0.88674	0.98716
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001
PP10	0.83412	0.90084	0.76508	0.87367	0.79594	0.71378	0.90915	0.85149	0.88674	1.00000	0.87367
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001
PP11	0.83876	0.97994	0.95654	1.00000	0.84777	0.83468	0.72759	0.83372	0.98716	0.87367	1.00000
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	

IV.   Factor Analysis

Using a statistical analysis software, SAS 9.2, Confirmatory Factor Analysis (CFA) was conducted on the construct Pollution Prevention which consists of 11 variables. Principal Components method was used as the initial factor method. Accordingly the Eigenvalues were obtained as shown in the Table 6.

Table 6. Eigen values obtained by using Principal Components Method as the initial factor method.

Eigenvalues of the Correlation Matrix: Total = 11 Average = 1				
	Eigenvalue	**Difference**	**Proportion**	**Cumulative**
1	9.28741522	8.65018820	0.8443	0.8443
2	0.63722703	0.12385130	0.0579	0.9022
3	0.51337573	0.17991884	0.0467	0.9489
4	0.33345689	0.20507633	0.0303	0.9792
5	0.12838056	0.05004244	0.0117	0.9909
6	0.07833812	0.05653166	0.0071	0.9980
7	0.02180645	0.02180645	0.0020	1.0000
8	0.00000000	0.00000000	0.0000	1.0000
9	0.00000000	0.00000000	0.0000	1.0000
10	0.00000000	0.00000000	0.0000	1.0000
11	0.00000000		0.0000	1.0000

From Table 6 it is clear that the first factor can explain 9.28741522 variables. Hence it is a desirable factor. No other factor in the Table 6 can explain at least one variable. Hence the first factor will be retained by MINEIGEN criterion as shown by the factor pattern of Table 7. The variance explained by the factor is 9.2874152.

Table7. Factor pattern obtained for the single factor retained by MINEIGEN criterion

Factor Pattern	
	Factor1
PP1	0.85799
PP2	0.98140
PP3	0.93170
PP4	0.98115
PP5	0.87512
PP6	0.85701
PP7	0.83138
PP8	0.88014
PP9	0.98129
PP10	0.93041
PP11	0.98115

The final communality estimates are shown in Table 8.

Table 8. The final communality estimates for Pollution Prevention

Final Communality Estimates: Total = 9.287415										
PP1	PP2	PP3	PP4	PP5	PP6	PP7	PP8	PP9	PP10	PP11
0.73615290	0.96314088	0.86806067	0.96265470	0.76584161	0.73447195	0.69119934	0.77464951	0.96293418	0.86565480	0.96265470

V.   Conclusion

The aim of this paper was to study the contribution of the eleven variables constituting the construct Pollution Prevention as a component of Green Supply Chain Practices. It was found that all the eleven variables in the study were strongly correlated with each of the other variables meaning that the variables are strongly

oriented towards pollution prevention. The reliability of the construct Pollution Prevention was 0.981131 which is considered good. Also the reliability of the eleven variables constituting the construct Pollution Prevention was above 0.9 which means that the questionnaire is reliable to measure each of the variables and also the construct Pollution Prevention as a whole. Also the results of Confirmatory Factor Analysis reveal that one factor accounting for 9.28 variables is retained.

Acknowledgements

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