

Contribution of components of Green Supply Chain Carbon Management in Green Supply Chain Performance measurement- A Pilot Empirical Study of the Indian Automobile Manufacturing Sector

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Abstract : This paper is one of the several extensions of the research works done by [5]. Green Supply Chain Practices have been known to have an impact on Green Supply Chain Performance [5]. This paper tests empirically through a pilot study of the Indian Automobile Manufacturing Sector, the contribution of the seven variables constituting the construct Green Supply Chain Carbon Management in Green Supply Chain Performance measurement. Also the paper establishes the reliability of the questionnaire instrument developed previously for measuring the construct Green Supply Chain Carbon Management and also for measuring the seven variables that constitute the construct Green Supply Chain Carbon management. Further the paper establishes the correlation among these seven variables. Finally this paper conducts Confirmatory Factor Analysis (CFA) to arrive at two factor (linear combination of seven variables constituting the construct Green Supply Chain Carbon Management) to aid in measuring the construct Green Supply Chain Carbon Management. Finally the paper establishes the order of contribution of the seven variables constituting the construct Green Supply Chain Carbon Management.

Keywords: Automobile, CFA, Green Supply Chain Carbon Management, Green Supply Chain Performance, Green Supply Chain Practices, Indian, Manufacturing Sector, Pilot Study.

I. Introduction

Green Supply Chain Carbon Management has been identified as one of the ten Green Supply Chain Performance measures which are impacted by five Green Supply Chain Practices [5]. Accordingly, this paper identifies the variables constituting the construct Green Supply Chain Carbon Management [5]. Green Supply Chain Carbon Management in turn is a sub-construct of the main construct Green Supply Chain Performance. Since Green Supply Chain Carbon Management has been identified as being constituted of seven variables, it is of interest to know how these seven variables fare in the pilot empirical study of the Indian automobile manufacturing sector by means of a questionnaire instrument [5]. It is also of interest to know the order of contribution of these seven variables constituting the construct Green Supply Chain Carbon Management. The 50 automobile manufacturing plants that were surveyed during the pilot empirical study are among the ones listed in [2]. The survey methodology was used in line with the findings of [3].

II. The Research Questions Addressed

The six research questions addressed are as follows:

Research Question 1. To have a feel of the responses of the Indian Automobile Manufacturing Sector pertaining to the seven variables constituting the construct Green Supply Chain Carbon Management.

Research Question 2. To know the reliability of the questionnaire instrument for measuring the construct Green Supply Chain Carbon Management.

Research Question 3. To know the reliability of the questionnaire instrument for measuring the seven variables constituting the construct Green Supply Chain Carbon Management.

Research Question 4. How are the seven variables constituting the construct Green Supply Chain Carbon Management correlated?

Research Question 5. How many factors are retained by the seven variables constituting the construct Green Supply Chain Carbon Management?

Research Question 6. What is the order of contribution of the seven variables constituting the construct Green Supply Chain Carbon Management?

III. The Construct Green Supply Chain Carbon Management And Its Seven Component Variables Used In The Study

There are seven variables that constitute the construct Green Supply Chain Carbon Management. They are depicted in Table 1 in their abbreviated form.

Table 1. The seven variables constituting the construct Green Supply Chain Carbon Management

The seven variables constituting the construct Green Supply Chain Carbon Management	GSCCM1	GSCCM2	GSCCM3	GSCCM4	GSCCM5	GSCCM6	GSCCM7
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IV. The Descriptive Statistics Of The Scaled Data On Green Supply Chain Carbon Management

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 [2]. The data collected revealed the following descriptive statistics of the seven variables constituting the construct Green Supply Chain Carbon Management.

Table 2. Descriptive Statistics of the data scaled by the questionnaire on Green Supply Chain Carbon Management

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
GSCCM1	50	4.42000	1.16216	221.00000	1.00000	5.00000
GSCCM2	50	4.50000	1.05463	225.00000	1.00000	5.00000
GSCCM3	50	4.72000	0.83397	236.00000	1.00000	5.00000
GSCCM4	50	3.36000	1.45350	168.00000	1.00000	5.00000
GSCCM5	50	3.36000	1.45350	168.00000	1.00000	5.00000
GSCCM6	50	2.40000	0.94761	120.00000	1.00000	5.00000
GSCCM7	50	2.48000	0.81416	124.00000	1.00000	5.00000

V. The Reliability Of The Instrument For The Variables And Construct Used

The reliability of the questionnaire instrument developed by [5] for the construct Green Supply Chain Carbon Management is shown in the Table 3 as 0.831687 which is considered to be a very good indicator of excellent internal consistency reliability [4].

Table 3. Reliability by Cronbach's Coefficient Alpha for the construct Green Supply Chain Carbon Management

Cronbach Coefficient Alpha	
Variables	Alpha
Raw	0.836164
Standardized	0.831687

The reliability of the questionnaire for the seven variables that constitute the construct Green Supply Chain Carbon Management is shown in Table 4. All the seven variables in Table 4 have a reliability ranging from 0.7 to greater than 0.9 but less than 1. Accordingly GSCCM1, GSCCM4, GSCCM5, GSCCM7 have acceptable internal consistency reliability and GSCCM2, GSCCM3 and GSCCM6 have very good internal consistency reliability [4].

Table 4. Reliability of the individual seven variables constituting the construct Green Supply Chain Carbon Management

Cronbach Coefficient Alpha with Deleted Variable				
Deleted Variable	Raw Variables		Standardized Variables	
	Correlation with Total	Alpha	Correlation with Total	Alpha
GSCCM1	0.647194	0.803931	0.676128	0.793032
GSCCM2	0.507975	0.825465	0.503205	0.820923
GSCCM3	0.398697	0.838699	0.401556	0.836465
GSCCM4	0.792466	0.775931	0.760133	0.778802
GSCCM5	0.792466	0.775931	0.760133	0.778802
GSCCM6	0.325599	0.848153	0.319145	0.848615
GSCCM7	0.697783	0.805739	0.671033	0.793881

VI. 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 Green Supply Chain Migration strategies is shown in Table 5. Since the values of correlation coefficient are positive, it indicates that all the seven variables that make up the construct Green Supply Chain Carbon

Management are oriented towards the goal of Green Supply Chain Carbon Management in a unidirectional manner. This is also an indicator of internal consistency reliability [4].

Table 5. Pearson's Correlation coefficient among the five variables of Green Supply Chain Carbon Management

Pearson Correlation Coefficients, N = 50 Prob > r under H0: Rho=0							
	GSCCM1	GSCCM2	GSCCM3	GSCCM4	GSCCM5	GSCCM6	GSCCM7
GSCCM1	1.00000	0.87417 <.0001	0.62917 <.0001	0.42817 0.0019	0.42817 0.0019	0.14084 0.3293	0.34338 0.0146
GSCCM2	0.87417 <.0001	1.00000	0.34805 0.0133	0.34615 0.0138	0.34615 0.0138	0.04084 0.7782	0.23768 0.0965
GSCCM3	0.62917 <.0001	0.34805 0.0133	1.00000	0.25321 0.0760	0.25321 0.0760	0.04132 0.7757	0.26209 0.0660
GSCCM4	0.42817 0.0019	0.34615 0.0138	0.25321 0.0760	1.00000	1.00000	0.36746 0.0087	0.74777 <.0001
GSCCM5	0.42817 0.0019	0.34615 0.0138	0.25321 0.0760	1.00000	1.00000	0.36746 0.0087	0.74777 <.0001
GSCCM6	0.14084 0.3293	0.04084 0.7782	0.04132 0.7757	0.36746 0.0087	0.36746 0.0087	1.00000	0.48672 0.0003
GSCCM7	0.34338 0.0146	0.23768 0.0965	0.26209 0.0660	0.74777 <.0001	0.74777 <.0001	0.48672 0.0003	1.00000

VII. Factor Analysis

Using statistical analysis software called SAS 9.2; Confirmatory Factor Analysis (CFA) was conducted on the construct Green Supply Chain Carbon Management which consists of seven variables. Principal Component 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 = 7 Average = 1				
	Eigenvalue	Difference	Proportion	Cumulative
1	3.62373796	2.01596270	0.5177	0.5177
2	1.60777527	0.86411532	0.2297	0.7474
3	0.74365994	0.06560204	0.1062	0.8536
4	0.67805791	0.39229650	0.0969	0.9505
5	0.28576140	0.22475388	0.0408	0.9913
6	0.06100752	0.06100752	0.0087	1.0000
7	0.00000000		0.0000	1.0000

An Eigen value indicate the relative importance of each factor in accounting for the particular set of variables being analysed. From Table 6 it is clear that the first factor can explain 3.62373796 variables. The second factor can explain 1.60777527 variables. No other factor in Table 6 can explain at least one variable. Hence two factors will be retained by MINEIGEN criterion as the only two factor as shown by the factor pattern of Table 7. The variance explained by the by the two factors is 3.6237380 and 1.6077753 respectively.

Table7. Factor pattern obtained for the two factors retained by MINEIGEN criterion

Factor Pattern		
	Factor1	Factor2
GSCCM1	0.75106	0.60970
GSCCM2	0.63094	0.61053
GSCCM3	0.52046	0.50730
GSCCM4	0.88184	-0.32549
GSCCM5	0.88184	-0.32549
GSCCM6	0.45265	-0.49051
GSCCM7	0.79406	-0.39175

The final communality estimates for the seven variables constituting the construct Green Supply Chain Carbon Management are shown in Table 8.

Table 8. The final communality estimates for Green Supply Chain Carbon Management

Final Communality Estimates: Total = 5.231513						
GSCCM1	GSCCM2	GSCCM3	GSCCM4	GSCCM5	GSCCM6	GSCCM7
0.93581433	0.77083251	0.52822606	0.88357913	0.88357913	0.44548390	0.78399817

Communality estimates are indicative of how much of each variable is accounted for by the underlying factors taken together. A high value of communality means that not much of the variable is left over after whatever the factors represent is taken into consideration. In short the communality estimates are indicative of the relative contribution of each of the variables in the construct. Accordingly Figure 1 shows in the descending order, the relative contribution of each of the seven variables of the construct Green Supply Chain Carbon Management as follows: GSCCM1, GSCCM4, GSCCM5, GSCCM7, GSCCM2, GSCCM3 and GSCCM6.

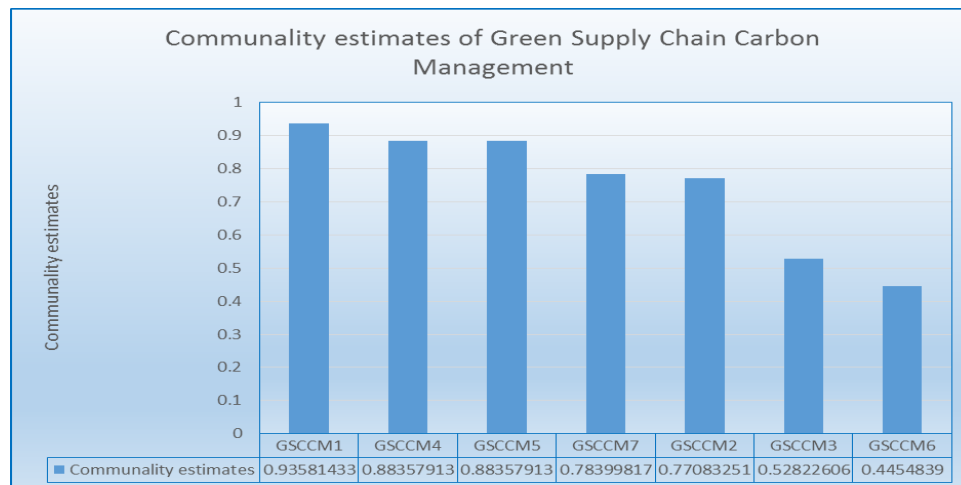


Figure 1. Contribution of the seven components of Green Supply Chain Carbon Management in descending order.

VIII. Conclusion

The aim of this paper was to study the contribution of the seven variables constituting the construct Green Supply Chain Carbon Management in Green Supply Chain Performance measurement. It was found that all the seven variables in the study were positively correlated with each of the other variables in varying degrees meaning that all the seven variables involved are oriented towards Green Supply Chain Carbon Management. The reliability of the construct Green Supply Chain Carbon Management was 0.831687 which is considered to be an indicator of very good internal consistency reliability. Also the reliability of the seven variables constituting the construct Green Supply Chain Carbon Management was between 0.7 and 0.8 in few cases and between 0.8 and 0.9 in other which means that the questionnaire is reliable to measure each of the variables and also the construct Green Supply Chain Carbon Management as a whole. Also the results of Confirmatory Factor Analysis reveal that two factor accounting for 3.6237380 variables and 1.6077753 variables are retained. Finally the contribution of the seven variables of the construct Green Supply Chain Carbon Management in descending order of their contribution in the construct is as follows: GSCCM1, GSCCM4, GSCCM5, GSCCM7, GSCCM2, GSCCM3 and GSCCM6.

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