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Contribution of Components of Green Supply Chain Execution-Logistics 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 twelve variables constituting the construct Green Supply Chain Execution-Logistics 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 Execution-Logistics and also for measuring the twelve variables that constitute the construct Green Supply Chain Execution-Logistics. Further the paper establishes the correlation among these twelve variables. Finally this paper conducts Confirmatory Factor Analysis (CFA) to arrive at three factor (linear combination of twelve variables constituting the construct Green Supply Chain Execution-Logistics) to aid in measuring the construct Green Supply Chain Execution-Logistics. Finally the paper establishes the order of contribution of the twelve variables constituting the construct Green Supply Chain Execution-Logistics.*

Keywords: *Automobile, CFA, Green Supply Chain Execution-Logistics, Green Supply Chain Performance, Green Supply Chain Practices, Indian, Manufacturing Sector, Pilot Study.*

I. Introduction

Green Supply Chain Execution-Logistics 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 Execution-Logistics [5]. Green Supply Chain Execution-Logistics in turn is a sub-construct of the main construct Green Supply Chain Performance. Since Green Supply Chain Execution-Logistics has been identified as being constituted of twelve variables, it is of interest to know how these twelve 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 twelve variables constituting the construct Green Supply Chain Execution-Logistics. 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 twelve variables constituting the construct Green Supply Chain Execution-Logistics. Research Question 2. To know the reliability of the questionnaire instrument for measuring the construct Green Supply Chain Execution-Logistics. Research Question 3. To know the reliability of the questionnaire instrument for measuring the twelve variables constituting the construct Green Supply Chain Execution-Logistics. Research Question 4. How are the twelve variables constituting the construct Green Supply Chain Execution-Logistics? Research Question 5. How many factors are retained by the twelve variables constituting the construct Green Supply Chain Execution-Logistics?

Research Question 6. What is the order of contribution of the twelve variables constituting the construct Green Supply Chain Execution-Logistics?

III. The Construct Green Supply Chain Carbon Execution-Logistics And Its Twelve Component Variables Used In The Study

There are twelve variables that constitute the construct Green Supply Chain Execution-Logistics. They are depicted in Table 1 in their abbreviated form.

Table 1. The seven variables constituting the construct Green Supply Chain Execution-Logistics

The twelve variables constituting the construct Green Supply Chain Execution-Logistics	GSCEXLOG1	GSCEXLOG2	GSCEXLOG3	GSCEXLOG4	GSCEXLOG5	GSCEXLOG6	GSCEXLOG7	GSCEXLOG8	GSCEXLOG9	GSCEXLOG10	GSCEXLOG11	GSCEXLOG12

IV. The Descriptive Statistics Of The Scaled Data On Green Supply Chain Execution-Logistics

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 twelve variables constituting the construct Green Supply Chain Execution-Logistics.

Table 2. Descriptive Statistics of the data scaled by the questionnaire on Green Supply Chain Execution-Logistics

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
GSCEXLOG1	50	3.56000	1.32727	178.00000	1.00000	5.00000
GSCEXLOG2	50	2.34000	1.00224	117.00000	1.00000	5.00000
GSCEXLOG3	50	4.42000	0.70247	221.00000	2.00000	5.00000
GSCEXLOG4	50	4.28000	0.67128	214.00000	2.00000	5.00000
GSCEXLOG5	50	4.50000	0.50508	225.00000	4.00000	5.00000
GSCEXLOG6	50	4.00000	1.03016	200.00000	2.00000	5.00000
GSCEXLOG7	50	4.00000	0.83299	200.00000	3.00000	5.00000
GSCEXLOG8	50	4.84000	0.37033	242.00000	4.00000	5.00000
GSCEXLOG9	50	4.74000	0.66425	237.00000	1.00000	5.00000
GSCEXLOG10	50	4.54000	0.78792	227.00000	2.00000	5.00000
GSCEXLOG11	50	4.56000	0.86094	228.00000	1.00000	5.00000
GSCEXLOG12	50	4.60000	0.69985	230.00000	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 Execution-Logistics is shown in the Table 3 as 0.817626 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	0.775143
Standardized	0.817626

The reliability of the questionnaire for the twelve variables that constitute the construct Green Supply Chain Execution-Logistics 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. The variables GSCEXLOG1, GSCEXLOG2, GSCEXLOG7, GSCEXLOG9, GSCEXLOG12 have their reliability between 0.7 and 0.8 which is considered to be a very good indicator of internal consistency reliability [4]. The variables GSCEXLOG3, GSCEXLOG4, GSCEXLOG5,

GSCEXLOG6, GSCEXLOG8, GSCEXLOG10, GSCEXLOG11 have their reliabilities between 0.7 and 0.8 which is considered to be an acceptable measure of internal consistency reliability [4].

Table 4. Reliability of the variables constituting the construct Green Supply Chain Execution-Logistics

Cronbach Coefficient Alpha with Deleted Variable				
Deleted Variable	Raw Variables		Standardized Variables	
	Correlation with Total	Alpha	Correlation with Total	Alpha
GSCEXLOG1	0.556139	0.745488	0.511389	0.800505
GSCEXLOG2	0.366652	0.848567	0.426242	0.872194
GSCEXLOG3	0.709386	0.732131	0.761078	0.777953
GSCEXLOG4	0.796436	0.725593	0.807071	0.773627
GSCEXLOG5	0.642553	0.748082	0.629683	0.790015
GSCEXLOG6	0.624186	0.731793	0.661633	0.787122
GSCEXLOG7	0.545461	0.744880	0.490643	0.802310
GSCEXLOG8	0.477047	0.763719	0.543171	0.797721
GSCEXLOG9	0.292585	0.770607	0.353161	0.814003
GSCEXLOG10	0.484733	0.752139	0.557437	0.796463
GSCEXLOG11	0.523109	0.747010	0.568229	0.795508
GSCEXLOG12	0.333814	0.767157	0.332160	0.815749

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 Execution-Logistics is shown in Table 5. Since all the values of correlation coefficient are positive, it indicates that all the twelve variables that make up the construct Green Supply Chain Execution-Logistics are oriented towards the goal of Green Supply Chain Execution-Logistics in a unidirectional manner. This is also an indicator of internal consistency reliability.

Table 5. Pearson's Correlation coefficient among the twelve variables of Green Supply Chain Execution-Logistics

Pearson Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0												
	GLog1	GLog2	GLog3	GLog4	GLog5	GLog6	GLog7	GLog8	GLog9	GLog10	GLog11	GLog12
GSCEXLOG1	1.00000	0.25283 0.0765	0.22414 0.1176	0.46178 0.0007	0.36532 0.0091	0.26867 0.0592	0.55377 <.0001	0.10297 0.4767	0.01667 0.9085	0.17329 0.2288	0.39863 0.0041	0.46577 0.0007
GSCEXLOG2	0.25283 0.0765	1.00000	0.23595 0.0990	0.20506 0.1531	0.06047 0.6765	0.25696 0.0716	0.07333 0.6128	0.40029 0.0040	0.63088 <.0001	0.59905 <.0001	0.48533 0.0004	0.55863 <.0001
GSCEXLOG3	0.22414 0.1176	0.23595 0.0990	1.00000	0.87076 <.0001	0.83404 <.0001	0.81784 <.0001	0.59290 <.0001	0.57738 <.0001	0.19506 0.1746	0.39305 0.0047	0.37928 0.0066	0.01660 0.9089
GSCEXLOG4	0.46178 0.0007	0.20506 0.1531	0.87076 <.0001	1.00000	0.66212 <.0001	0.64926 <.0001	0.62045 <.0001	0.51227 0.0001	0.12083 0.4032	0.55717 <.0001	0.46471 0.0007	0.19983 0.1641
GSCEXLOG5	0.36532 0.0091	0.06047 0.6765	0.83404 <.0001	0.66212 <.0001	1.00000	0.82369 <.0001	0.82462 <.0001	0.43644 0.0015	0.09124 0.5286	0.02564 0.8597	0.04693 0.7462	0.11547 0.4246
GSCEXLOG6	0.26867 0.0592	0.25696 0.0716	0.81784 <.0001	0.64926 <.0001	0.82369 <.0001	1.00000	0.78482 <.0001	0.21398 0.1357	0.35789 0.0107	0.27657 0.0519	0.20709 0.1490	0.02831 0.8453
GSCEXLOG7	0.55377 <.0001	0.07333 0.6128	0.59290 <.0001	0.62045 <.0001	0.82462 <.0001	0.78482 <.0001	1.00000	0.00000 1.0000	0.03688 0.7993	0.03109 0.8303	0.11383 0.4312	0.14003 0.3321
GSCEXLOG8	0.10297 0.4767	0.40029 0.0040	0.57738 <.0001	0.51227 0.0001	0.43644 0.0015	0.21398 0.1357	0.00000 1.0000	1.00000	0.49114 0.0003	0.58191 <.0001	0.54280 <.0001	0.37796 0.0068
GSCEXLOG9	0.01667 0.9085	0.63088 <.0001	0.19506 0.1746	0.12083 0.4032	0.09124 0.5286	0.35789 0.0107	0.03688 0.7993	0.49114 0.0003	1.00000	0.74166 <.0001	0.50960 0.0002	0.47412 0.0005
GSCEXLOG10	0.17329 0.2288	0.59905 <.0001	0.39305 0.0047	0.55717 <.0001	0.02564 0.8597	0.27657 0.0519	0.03109 0.8303	0.58191 <.0001	0.74166 <.0001	1.00000	0.77860 <.0001	0.62176 <.0001
GSCEXLOG11	0.39863 0.0041	0.48533 0.0004	0.37928 0.0066	0.46471 0.0007	0.04693 0.7462	0.20709 0.1490	0.11383 0.4312	0.54280 <.0001	0.50960 0.0002	0.77860 <.0001	1.00000	0.85354 <.0001
GSCEXLOG12	0.46577 0.0007	0.55863 <.0001	0.01660 0.9089	0.19983 0.1641	0.11547 0.4246	0.02831 0.8453	0.14003 0.3321	0.37796 0.0068	0.47412 0.0005	0.62176 <.0001	0.85354 <.0001	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 Execution-Logistics which consists of twelve 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 = 12 Average = 1				
	Eigenvalue	Difference	Proportion	Cumulative
1	5.19305456	1.96093937	0.4328	0.4328
2	3.23211519	1.77312315	0.2693	0.7021
3	1.45899204	0.60437001	0.1216	0.8237
4	0.85462203	0.33443492	0.0712	0.8949
5	0.52018710	0.05607042	0.0433	0.9382
6	0.46411668	0.18720429	0.0387	0.9769
7	0.27691239	0.27691239	0.0231	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	0.00000000	0.0000	1.0000
12	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 5.19305456 variables. The second factor can explain 3.23211519 variables. The third factor can explain 1.45899204 variables. No other factor in Table 6 can explain at least one variable. Hence three factors will be retained by MINEIGEN criterion as the only factors as shown by the factor pattern of Table 7. The variance explained by the by the three factors is 5.19305456, 3.23211519 and 1.45899204 respectively.

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

Factor Pattern			
	Factor1	Factor2	Factor3
GSCEXLOG1	0.44794	0.22271	0.83868
GSCEXLOG2	-0.50762	0.54188	0.42232
GSCEXLOG3	0.83492	0.39161	-0.21125
GSCEXLOG4	0.84399	0.29172	0.10332
GSCEXLOG5	0.67675	0.65694	-0.13237
GSCEXLOG6	0.74548	0.48050	-0.23021
GSCEXLOG7	0.52019	0.75703	0.12438
GSCEXLOG8	0.68700	-0.25460	-0.18252
GSCEXLOG9	0.56085	-0.52466	-0.30879
GSCEXLOG10	0.72750	-0.55395	-0.02650
GSCEXLOG11	0.69347	-0.56277	0.31139
GSCEXLOG12	0.49426	-0.67174	0.45785

The final communality estimates for the twelve variables constituting the construct Green Supply Chain Execution-Logistics are shown in Table 8.

Table 8. The final communality estimates for Green Supply Chain Execution-Logistics

Final Communality Estimates: Total = 9.884162											
GSCEXLOG1	GSCEXLOG2	GSCEXLOG3	GSCEXLOG4	GSCEXLOG5	GSCEXLOG6	GSCEXLOG7	GSCEXLOG8	GSCEXLOG9	GSCEXLOG10	GSCEXLOG11	GSCEXLOG12
0.95363851	0.72966520	0.89507784	0.80809189	0.90707967	0.83961467	0.85916216	0.57011320	0.68518029	0.83682041	0.89457007	0.90514790

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 twelve variables of the construct Green Supply Chain Execution-Logistics as follows: GSCEXLOG1, GSCEXLOG5, GSCEXLOG12, GSCEXLOG3, GSCEXLOG11, GSCEXLOG7, GSCEXLOG6, GSCEXLOG10, GSCEXLOG4, GSCEXLOG2, GSCEXLOG9 and GSCEXLOG8.

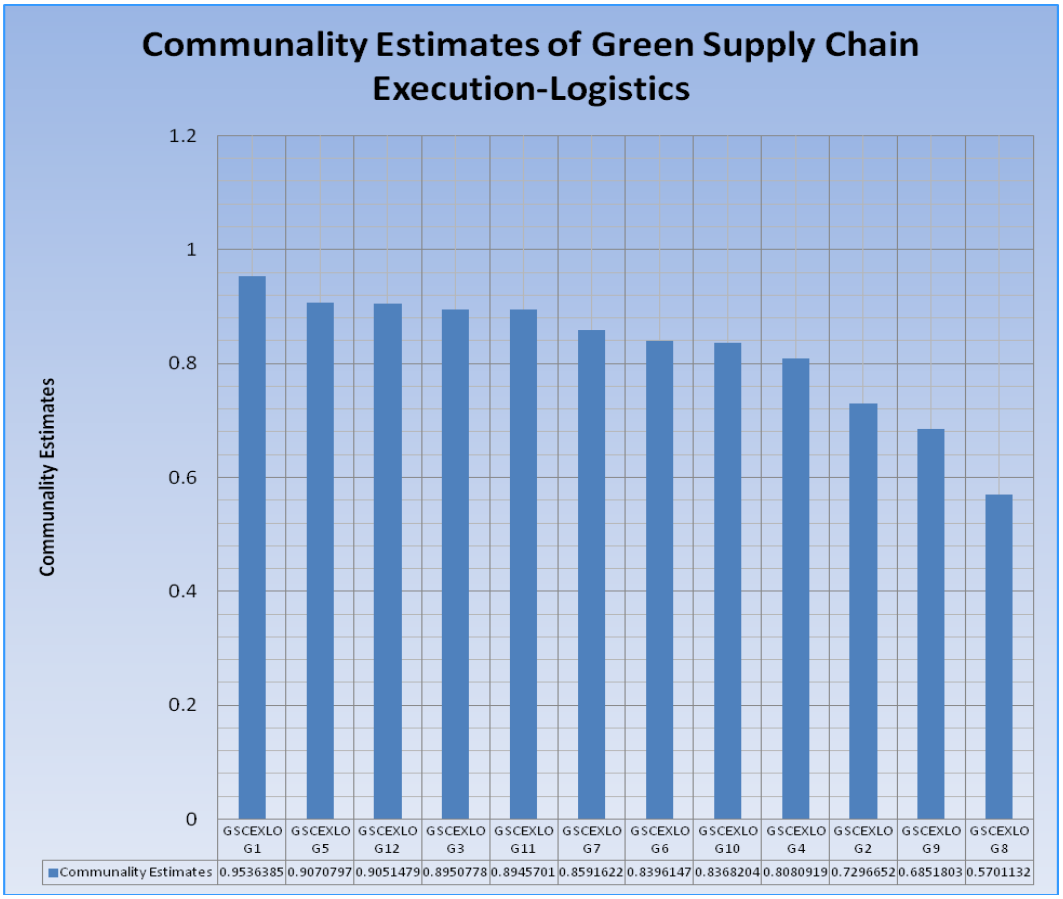

Figure 1. Contribution of the twelve components of Green Supply Chain Execution-Logistics in descending order.

VIII. Conclusion

The aim of this paper was to study the contribution of the twelve variables constituting the construct Green Supply Chain Execution-Logistics in Green Supply Chain Performance measurement. It was found that all the twelve variables in the study were positively correlated with each of the other variables in varying degrees meaning that all the twelve variables involved are oriented towards Green Supply Chain Execution-Logistics. The reliability of the construct Green Supply Chain Execution-Logistics was 0.817626 which is considered to be an indicator of very good internal consistency reliability. All the twelve variables in Table 4 have a reliability ranging from above 0.7 to greater than 0.9 but less than 1. The variables GSCEXLOG1, GSCEXLOG2, GSCEXLOG7, GSCEXLOG9, GSCEXLOG12 have their reliability between 0.8 and 0.9 which is considered to be a very good indicator of internal consistency reliability. The variables GSCEXLOG3, GSCEXLOG4, GSCEXLOG5, GSCEXLOG6, GSCEXLOG8, GSCEXLOG10, GSCEXLOG11 have their reliabilities between 0.7 and 0.8 which is considered to be an acceptable measure of internal consistency reliability [4]. Finally the contribution of the twelve variables of the construct Green Supply Chain Execution-Logistics in descending order of their contribution in the construct is as follows: GSCEXLOG1, GSCEXLOG5, GSCEXLOG12, GSCEXLOG3, GSCEXLOG11, GSCEXLOG7, GSCEXLOG6, GSCEXLOG10, GSCEXLOG4, GSCEXLOG2, GSCEXLOG9 and GSCEXLOG8.

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