

# Contribution of components of Green Supply Chain Execution-Supply Loops in Green Supply Chain Performance measurement

A Pilot Empirical Study of the Indian Automobile Manufacturing Sector

Mohd. Asif Gandhi

Assistant Professor (Mechanical Engineering)  
Department of Mechanical Engineering  
Anjuman-I-Islam's Kalsekar Technical Campus, School of Engineering and Technology  
Affiliated to University of Mumbai, New Panvel, India

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

**Index Terms**— Automobile, CFA, Green Supply Chain Execution-Supply Loops, Green Supply Chain Performance, Green Supply Chain Practice, Indian, Manufacturing Sector, Pilot Study.

## I. INTRODUCTION TO GREEN SUPPLY CHAIN EXECUTION-SUPPLY LOOPS

Green Supply Chain Execution-Supply Loops 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-Supply Loops [5]. Green Supply Chain Execution-Supply Loops in turn is a sub-construct of the main construct Green Supply Chain Performance. Since Green Supply Chain Execution-Supply Loops has been identified as being constituted of three variables, it is of interest to know how these three 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 three variables constituting the construct Green Supply Chain Execution-Supply Loops. 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 BY THIS STUDY

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 three variables constituting the construct Green Supply Chain Execution-Supply Loops.

Research Question 2. To know the reliability of the questionnaire instrument for measuring the construct Green Supply Chain Execution-Supply Loops.

Research Question 3. To know the reliability of the questionnaire instrument for measuring the three variables constituting the construct Green Supply Chain Execution-Supply Loops.

Research Question 4. How are the three variables constituting the construct Green Supply Chain Execution-Supply Loops correlated?

Research Question 5. How many factors are retained by the three variables constituting the construct Green Supply Chain Execution-Supply Loops?

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

## III. THE CONSTRUCT GREEN SUPPLY CHAIN EXECUTION-SUPPLY LOOPS AND ITS VARIABLES USED IN THE STUDY

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

Table 1. The three variables constituting the construct Green Supply Chain Execution-Supply Loops

The three variables constituting the construct Green Supply Chain Execution-Supply Loops	GSCEXSL1	GSCEXSL2	GSCEXSL3
--	----------	----------	----------

#### IV. DESCRIPTIVE STATISTICS OF THE SCALED DATA ON GREEN SUPPLY CHAIN EXECUTION-SUPPLY LOOPS

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 three variables constituting the construct Green Supply Chain Execution-Supply Loops as shown in Table 2.

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

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
GSCEXSL1	50	3.82000	1.11922	191.00000	1.00000	5.00000
GSCEXSL2	50	2.94000	1.03825	147.00000	1.00000	5.00000
GSCEXSL3	50	3.68000	1.07741	184.00000	2.00000	5.00000

#### V. THE RELIABILITY OF THE INSTRUMENT FOR THE CONSTRUCT GREEN SUPPLY CHAIN EXECUTION-SUPPLY LOOPS

The reliability of the questionnaire instrument developed by [5] for the construct Green Supply Chain Execution-Supply Loops is shown in the Table 3 as 0.722359 which is considered to be an acceptable indicator of internal consistency reliability [4].

Table 3. Reliability by Cronbach's Coefficient Alpha for the construct Green Supply Chain Execution-Supply Loops

Cronbach Coefficient Alpha	
Variables	Alpha
Raw	0.759859
Standardized	0.722359

The reliability of the questionnaire for the three variables that constitute the construct Green Supply Chain Execution-Supply Loops is shown in Table 4. All the three variables in Table 4 have a reliability greater than 0.7 but less than 0.9. The reliability of the variables GSCEXSL1 and GSCEXSL3 is between 0.7 and 0.8 indicating that it is an acceptable measure of internal consistency reliability [4] and the variable GSCEXSL2 has a reliability of 0.832352 which is considered as a good measure of internal consistency reliability [4]. So all the three variables are acceptable/good measures of reliability. Also all these three variables have got good support from existing literature [1]. Accordingly all the three variables have been retained.

Table 4. Reliability of the individual three variables constituting the construct Green Supply Chain Execution-Supply Loops

Cronbach Coefficient Alpha with Deleted Variable				
Deleted Variable	Raw Variables		Standardized Variables	
	Correlation with Total	Alpha	Correlation with Total	Alpha
GSCEXSL1	0.729141	0.823694	0.717058	0.723832
GSCEXSL2	0.717556	0.832000	0.721217	0.832352
GSCEXSL3	0.766158	0.755436	0.736889	0.755596

#### VI. 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-Supply Loops is shown in the Table 5. Since all the values of correlation coefficient are positive, it indicates that all the three variables have unidirectionality with the construct Green Supply Chain Execution-Supply Loops. This is again an indicator of internal consistency reliability. There is also strong support from existing literature in support of these three variables [1]. So they are retained. This is again an indicator of internal consistency reliability amongst the variables of Green Supply Chain Execution-Supply Loops.

Table 5. Pearson's Correlation coefficient among the three variables constituting the construct Green Supply Chain Execution-Supply Loops

Pearson Correlation Coefficients, N = 50 Prob >  r  under H0: Rho=0			
	GSCSL1	GSCSL2	GSCSL3
GSCSL1	1.00000	0.72705 0.8521	0.71285 <.0001
GSCSL2	0.72705 0.8521	1.00000	0.78240 0.0061
GSCSL3	0.71285 <.0001	0.78240 0.0061	1.00000

## VII. CONFIRMATORY FACTOR ANALYSIS OF THE CONSTRUCT GREEN SUPPLY CHAIN EXECUTION-SUPPLY LOOPS

Using a statistical analysis software, SAS 9.2, Confirmatory Factor Analysis (CFA) was conducted on the construct Green Supply Chain Execution-Supply Loops which consists of three 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 of Green Supply Chain Execution-Supply Loops by Principal Components Method as the initial factor method

Eigenvalues of the Correlation Matrix: Total = 3 Average = 1				
	Eigenvalue	Difference	Proportion	Cumulative
1	1.82041344	0.84293874	0.6068	0.6068
2	0.97747469	0.77536282	0.3258	0.9326
3	0.20211187		0.0674	1.0000

From Table 6 it is clear that the first factor can explain 1.82041344 variables. Hence it is a desirable factor. No other factor in the Table 6 can explain at least one variable. Hence the first will be retained by MINEIGEN criterion as shown by the factor pattern of Table 7. The variance explained by the first factor is 1.82041344.

Table 7. Factor pattern obtained for the single factor retained by MINEIGEN criterion.

Factor Pattern	
	Factor1
GSCSL1	0.83850
GSCSL2	-0.46915
GSCSL3	0.94723

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

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

Final Communality Estimates: Total = 1.820413		
GSCSL1	GSCSL2	GSCSL3
0.70307778	0.22009728	0.89723838

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 three variables of the construct Green Supply Chain Execution-Supply Loops as follows: GSCSL3, GSCSL1 and GSCSL2.

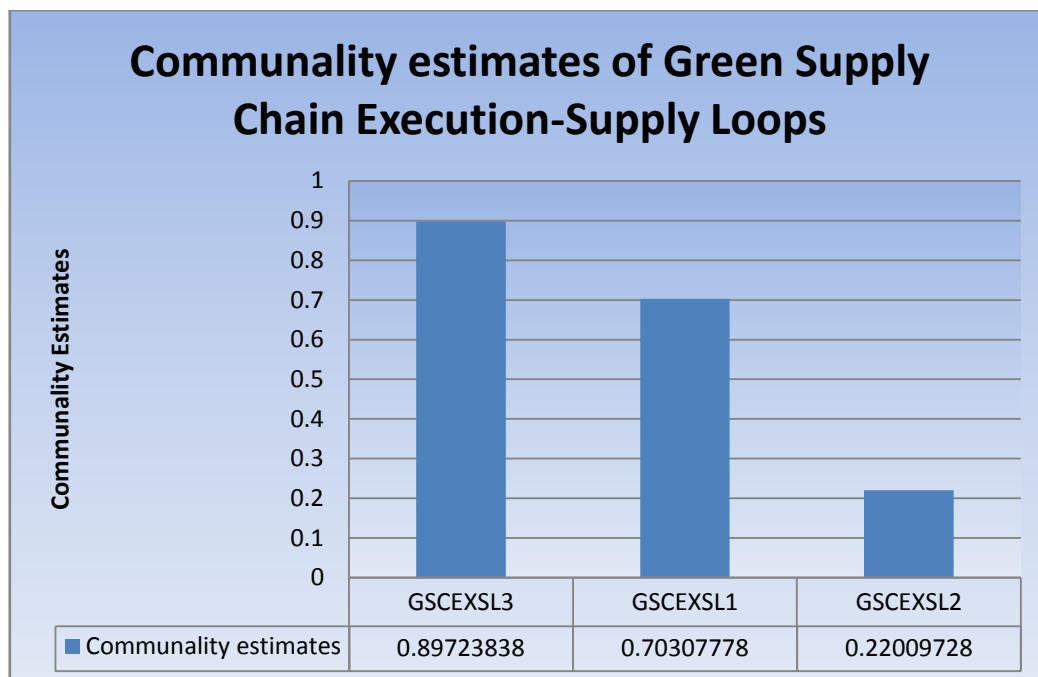


Figure 1. Order of contribution of the three components of Green Supply Chain Execution-Supply Loops

### VIII. CONCLUSION

The aim of this paper was to study the contribution of the seven variables constituting the construct Green Supply Chain Execution-Supply Loops in Green Supply Chain Performance measurement. It was found that all the three variables in the study were positively correlated with each of the other variables in varying degrees meaning that all the three variables involved are oriented towards Green Supply Execution-Supply Loops. The reliability of the construct Green Supply Chain Execution-Supply Loops was 0.7223590 which is considered to be an acceptable indicator of internal consistency reliability. Also the reliability of the two variables GSCSEXSL1 and GSCSEXSL3 constituting the construct Green Supply Chain Execution-Supply Loops was between 0.7 and 0.8 and the reliability of the variable GSCSEXSL2 was between 0.8 and 0.9 which is considered to be good indicator of reliability. This means that the questionnaire is reliable to measure each of the three variables and also the construct Green Supply Chain Execution-Supply Loops as a whole. Also the results of Confirmatory Factor Analysis reveal that one factor accounting for 1.8204134 variables is retained. Finally the contribution of the three variables of the construct Green Supply Chain Execution-Supply Loops in descending order of their contribution in the construct is as follows: GSCSEXSL3, GSCSEXSL1 and GSCSEXSL2.

### IX. ACKNOWLEDGMENT

I express my heartfelt thanks to Dr. Abdul Razak Honnutagi for permitting me to go ahead with my research work from NITIE, Mumbai though our institute was at its formative stage. Also I acknowledge the patience and support of my wife Yasmin Mohd. Asif Gandhi for bearing with me during my long research hours for years. I express my heartfelt thanks to my parents Mr. Indravadan Chimanlal Gandhi and Mrs. Sarmista Indravadan Gandhi for encouraging me and motivating me to complete my research work. I dedicate all my success to them.

### REFERENCES

- [1] Emmett, S. and Sood, V., Green Supply Chains – An Action Manifesto. John Wiles & Sons, 2010, 165-180.
- [2] Gandhi, M.A. “A Review of the Indian Automobile Manufacturing Sector”, IOSR Journal of Business and Management, vol 19, issue 3, Ver II, pp. 9-15, 2017.
- [3] Gandhi, M.A. and Sharma, S. “A Review of Research Methodologies Linking Green Supply Chain Practices and Green Supply Chain Performance”, International Journal of Supply Chain Management, vol 3, issue 4, 2014.
- [4] George D, Mallery M. “Using SPSS for Windows step by step: a simple guide and reference”, 2003.
- [5] Sharma, S., and Gandhi, M.A. “Exploring correlations in components of green supply chain practices and green supply chain performance”, Competitiveness Review, vol 26, issue 3, pp. 332-368, 2016.