

Contribution of components of Green Supply Chain Planning as a Green Supply Chain Performance measure-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 variables constituting the construct Green Supply Chain Planning 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 Planning and also for measuring the five variables that constitute the construct Green Supply Chain Planning. Further the paper establishes the correlation among these five variables. Finally this paper conducts Confirmatory Factor Analysis (CFA) to arrive at one factors (linear combination of five variables constituting the construct Green Supply Chain Planning) to aid in measuring the construct Green Supply Chain Planning. Finally the paper establishes the order of contribution of the five variables constituting the construct Green Supply Chain Planning.

Keywords – *Automobile, CFA, Green Supply Chain Performance, Green Supply Chain Planning, Green Supply Chain Practices, Indian, Manufacturing Sector, Pilot Study.*

I. INTRODUCTION

Green Supply Chain Planning has been identified as one of the ten Green Supply Chain Performance measures which is impacted by five Green Supply Chain Practices [5]. Accordingly, this paper identifies the variables constituting the construct Green Supply Chain Planning. Green Supply Chain Planning in turn is a sub-construct of the main construct Green Supply Chain Performance. Since Green Supply Chain Planning has been identified as being constituted of five variables, it is of interest to know how these five 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 five variables constituting the construct Green Supply Chain Planning. 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. RESEARCH QUESTIONS

The six 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 five variables constituting the construct Green Supply Chain Planning.

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

Research Question 3. To know the reliability of the questionnaire instrument for measuring the five variables constituting the construct Green Supply Chain Planning.

Research Question 4. How are the five variables constituting the construct Green Supply Chain Planning correlate?

Research Question 5. How many factors are retained by the five variables constituting the construct Green Supply Chain Planning?

Research Question 6. What is the order of contribution of the five variables constituting the construct Green Supply Chain Planning?

III. THE CONSTRUCT GREEN SUPPLY CHAIN PLANNING AND ITS FIVE COMPONENT VARIABLES USED IN THE STUDY

There are five variables that constitute the construct Green Supply Chain Planning. They are depicted in the Table 1 in their abbreviated form.

Table 1. The five variables constituting the construct Green Supply Chain Planning

| | | | | | |
|---|----------|----------|----------|----------|----------|
| The five variables constituting the construct Green Supply Chain Planning | GSCPLAN1 | GSCPLAN2 | GSCPLAN3 | GSCPLAN4 | GSCPLAN5 |
|---|----------|----------|----------|----------|----------|

IV. THE DESCRIPTIVE STATISTICS OF THE SCALED DATA ON GREEN SUPPLY CHAIN PLANNING

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 five variables constituting the construct Green Supply Chain Planning.

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

| Simple Statistics | | | | | | |
|-------------------|----|---------|---------|-----------|---------|---------|
| Variable | N | Mean | Std Dev | Sum | Minimum | Maximum |
| GSCPLAN1 | 50 | 4.02000 | 1.05926 | 201.00000 | 1.00000 | 5.00000 |
| GSCPLAN2 | 50 | 3.98000 | 1.03982 | 199.00000 | 1.00000 | 5.00000 |
| GSCPLAN3 | 50 | 4.02000 | 1.05926 | 201.00000 | 1.00000 | 5.00000 |
| GSCPLAN4 | 50 | 4.28000 | 0.67128 | 214.00000 | 2.00000 | 5.00000 |
| GSCPLAN5 | 50 | 4.30000 | 0.67763 | 215.00000 | 2.00000 | 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 planning is shown in the Table 3 as 0.953422 which is considered to be excellent [4].

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

| Cronbach Coefficient Alpha | |
|----------------------------|----------|
| Variables | Alpha |
| Raw | 0.947669 |
| Standardized | 0.953422 |

The reliability of the questionnaire for the five variables that constitute the construct Green Supply Chain Planning is shown in the Table 4. All the five variables in Table 4 have a reliability greater than 0.9 which is considered as excellent [4].

Table 4. Reliability of the individual five variables constituting the construct Green Supply Chain Planning

| Cronbach Coefficient Alpha with Deleted Variable | | | | |
|--|------------------------|----------|------------------------|----------|
| Deleted Variable | Raw Variables | | Standardized Variables | |
| | Correlation with Total | Alpha | Correlation with Total | Alpha |
| GSCPLAN1 | 0.952823 | 0.918411 | 0.921522 | 0.933585 |
| GSCPLAN2 | 0.929916 | 0.922689 | 0.896172 | 0.937994 |
| GSCPLAN3 | 0.952823 | 0.918411 | 0.921522 | 0.933585 |
| GSCPLAN4 | 0.819796 | 0.947530 | 0.853513 | 0.945314 |
| GSCPLAN5 | 0.727066 | 0.958704 | 0.763072 | 0.960427 |

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 Planning is shown in the Table 5. Since all the values of correlation coefficient range from a minimum value of around 0.6 to a maximum value above 0.9, it indicates that all the five variables that make up the construct Green Supply Chain Planning are oriented towards the goal of Green Supply Chain Planning in a unidirectional manner.

Table 5. Pearson's Correlation coefficient

| Pearson Correlation Coefficients, N = 50 Prob > r under H0: Rho=0 | | | | | |
|--|-------------------|-------------------|-------------------|-------------------|-------------------|
| | GSCPLAN1 | GSCPLAN 2 | GSCPLAN3 | GSCPLAN4 | GSCPLAN5 |
| GSCPLAN1 | 1.00000 <.0001 | 0.98238 <.0001 | 1.00000 <.0001 | 0.73819 <.0001 | 0.64540 <.0001 |
| GSCPLAN2 | 0.98238 <.0001 | 1.00000 | 0.98238 <.0001 | 0.70989 <.0001 | 0.61692 <.0001 |
| GSCPLAN3 | 1.00000 <.0001 | 0.98238 <.0001 | 1.00000 | 0.73819 <.0001 | 0.64540 <.0001 |
| GSCPLAN4 | 0.73819 <.0001 | 0.70989 <.0001 | 0.73819 <.0001 | 1.00000 | 0.97806 <.0001 |
| GSCPLAN5 | 0.64540 <.0001 | 0.61692 <.0001 | 0.64540 <.0001 | 0.97806 <.0001 | 1.00000 |

VII. FACTOR ANALYSIS

Using a statistical analysis software, SAS 9.2, Confirmatory Factor Analysis (CFA) was conducted on the construct Green Supply Chain Planning which consists of 5 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 = 5 Average = 1 | | | | |
|--|------------|------------|------------|------------|
| | Eigenvalue | Difference | Proportion | Cumulative |
| 1 | 4.22376778 | 3.48377430 | 0.8448 | 0.8448 |
| 2 | 0.73999348 | 0.71711246 | 0.1480 | 0.9928 |
| 3 | 0.02288103 | 0.00952332 | 0.0046 | 0.9973 |
| 4 | 0.01335771 | 0.01335771 | 0.0027 | 1.0000 |
| 5 | 0.00000000 | | 0.0000 | 1.0000 |

An Eigenvalue 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 4.22376778 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 the only factor as shown by the factor pattern of Table 7. The variance explained by the factor is 4.2237678.

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

| Factor Pattern | |
|----------------|---------|
| Variable | Factor1 |
| GASPLAN1 | 0.95681 |
| GASPLAN2 | 0.94109 |
| GASPLAN3 | 0.95681 |

| Factor Pattern | |
|----------------|---------|
| Variable | Factor1 |
| GASPLAN4 | 0.89905 |
| GASPLAN5 | 0.83597 |

The final communality estimates for the five variables constituting the construct Green Supply Chain Planning are shown in Table 8.

Table 8. The final communality estimates for Pollution Prevention

| Final Communality Estimates: Total = 4.223768 | | | | |
|---|------------|------------|------------|------------|
| GSCPLAN1 | GSCPLAN2 | GSCPLAN3 | GSCPLAN4 | GSCPLAN5 |
| 0.91548742 | 0.88565959 | 0.91548742 | 0.80828903 | 0.69884432 |

Communality estimates are indicative of how much of each variable is accounted for by the underlying factor 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 five variables GSCPLAN1, GSCPLAN2, GSCPLAN3, GSCPLAN4 and GSCPLAN5 in the construct Green Supply Chain Planning.

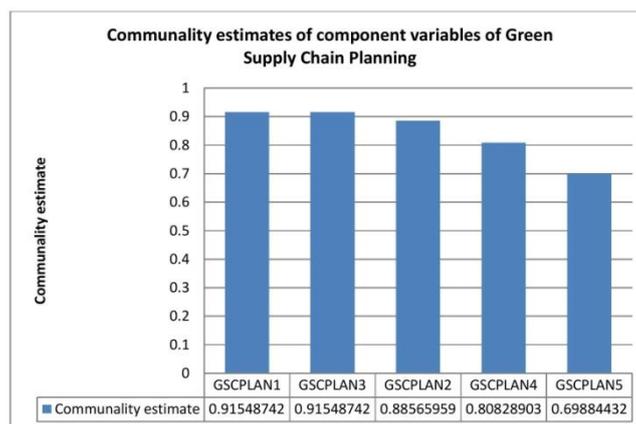


Figure 1. Contribution of the five components of Green Supply Chain Planning in descending order.

VIII. CONCLUSION

The aim of this paper was to study the contribution of the five variables constituting the construct Green Supply Chain Planning as a component measure of Green Supply Chain Performance. It was found that all the five variables in the study were strongly correlated with each of the other variables meaning that all the five variables involved are strongly oriented towards Green Supply Chain Planning. The reliability of the construct Green Supply Chain Planning was 0.953422 which is considered excellent. Also the reliability of the five variables constituting the construct Green Supply Chain Planning was above 0.9 which means that the questionnaire is reliable to measure each of the variables and also the construct Green Supply Chain Planning as a whole. Also the results of Confirmatory Factor Analysis reveal that one factor accounting for 4.2237678 variables is retained.

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