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# Micro Variables Identification for SUPPLY Chain Management Practices in Context of Flexible System in Indian Gas Industry

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**Abstract**

Present paper recognizes a set of micro variables for the Supply Chain Management (SCM) practices in context of flexible system (FS) practices and groups them into different categories for gas industry in India. Grounded on a detailed literature analysis, twenty-four micro variables were recognized and a structured questionnaire was created and distributed to middle level managers to senior level managers from various sectors of Indian gas industry. In total 309 valid replies were obtained on a five point Likert scale ranging from unimportant to most vital. Statistical analysis was used to create the reliability and validity of the questionnaire. Factor analysis identified five factors of SCM practices in context of FS Practices. Further, descriptive statistics was used to find their importance in Indian gas context. Present work would help practitioners and Indian gas managers for understanding the importance of these variables and their role in SCM practices in relations of FS practices.

**Keywords:** Flexible System Practices, Indian Oil and Gas Industries, Supply Chain Management (SCM), Total quality Management (TQM)

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## 1. Introduction

The three segments in gas sector are upstream segment, midstream segment and downstream segment. Among these the upstream segment primarily includes companies that are involved in production activities and exploration. The midstream segment comprises of companies in storage and transportation, and the downstream segment includes of players that are involved in petroleum products refinement, processing and marketing. This would reflect into growing energy needs India many times in future. In a supply chain, upstream suppliers and downstream distributors are linked to serve its customers. For profits maximization, the firm must maximize benefits and minimize costs along the supply-chain. The concept of SCM issues and its relationship with in information technology has been studied (Shahrzad, et al., 2013)7.

The flexibility to adapt to changing market needs and develop Innovative products in current competitive environment is vital for success (Nigel and Slack, 2005)1. Flexibility of an organization and its capability to reply to new consumer's needs governs the competitiveness of it in the market. Organizations re-organized to work efficiently to generate a diverse portfolio of services or products in spite of large quantities of a limited product portfolio.

## 2. Literature Survey

Today flexible system means a system to produce reasonably valued customized products of high quality that can be quickly sent to customers. Some authors define flexibility as "ability of the manufacturing system to cope with the alterations effectively" (Buzacott and Gupta, 1989)2. According to him, "Manufacturing systems that are flexible can utilize the flexibility as an adaptive response to unpredictable conditions." The study conducted by (Buzacott and Mandelbaum, 1990)8 considered flexibility as mandatory in a "process or system so that it is able to respond adjustment in the system's environment or a conversion in the decision maker's opinion of reality".

## 3. Flexible System

According to Saxena and Wadhwa (2009)5, as complexity and competition have increased, flexibility-based SCM has appeared as an increasingly important issue for companies. Rao and Wadhwa (2000)6 have stressed on design flexibility and manufacturing flexibility and advocated that product flexibility could

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often be more efficiently derived as design. Zhang et al., (2003) proposed another framework for the flexibilities. According to Saxena and Wadhwa (2009), as complexity and competition have increased, flexibility-based SCM has developed as an increasingly vital issue for companies. They have included some other flexibility which is related to human being also. The seven components in a flexible system is proposed by Prakash (2011)9 are volume flexibility, manufacturing flexibility, labour flexibility, material handling flexibility, machine flexibility, routing flexibility, and mix flexibility. Their studies are related to the competence and customer satisfaction by analysing the relationships among the different flexibilities.

## 4. Flexible Approach

The framework for flexibility, which was introduced by Nilsson and Nordah, (1995) shows the notions of, output flexibility, which is found in the relationship between the company and its customers, and input flexibility, which is found in the relationship between the company and its suppliers. Flexibility in manufacturing organization means the "ability to cope with changes and variations in market place.

Enterprise flexibility means producing choices at many stages in the enterprise, evolving ways and means of change across the variety of choices, and providing freedom of choice at various actors in the enterprise to create this change happen with least efforts and time (Sushil, 2000)10. This flexibility in the production processes has become very crucial for an organization to remain competitive and profitable.

## 5. SCM

Supply chain networks as the network which provides a specific product or product group following the chain discussed by (Hertz, 2001) from raw material to the final consumer. A quality-SCM framework proposed by Robinson (2004) that can be used to place prior work in outlook, as well as identify three specific opportunities for future SCQM research. The concept SCM identified by Min and Mentzer (2004)12 as including agreed goals and vision, information sharing, risk and award sharing, cooperation, process integration, long-term relationship and agreed supply chain leadership.

## 6. SCM Program

SCM is a concept that is gaining in popularity and importance by (Dag, D. and Stevenson, 2010) brings some clarification to the thought of SCM by discovering some of the more prevalent SCM definitions, frameworks. The management of the supply chain and the roles of various actors involved differ from industry to industry and company to company by (Rajendra et al., 2011)14 present's main activities of supply chain and the step-by-step approach for understanding a complete picture of supply chain.

## 7. SCM Practices

The contest for firms today is to take a SCM initiative and apply it effectively as the future shall see a competition among supply chains. Gunasekaran, et al. (2001) explored that SCM needs to be assessed for its performance in order to evolve an efficient and effective supply chain.Suhong (2005) develops, conceptualizes and validates six dimensions of SCM practices (customer relationship, quality, strategic supplier partnership, internal lean practices, information sharing, information and postponement). They need to emphasis on SCM practices that have impact on improving SCM activities and eventually performances (Arawati, 2011).

## 8. Gas Sector: An Overview

Gas as organizations is part of an industry in which effective customers relations are mostly incremental and focus on process up-gradation. Damiebi et al. (2010) did an empirical study and recognized that some critical success factors in mega production projects can be applied to deep-water gas projects. Mehdi Sheikh (2012)22 identified the key success factors of the upstream area of gas industry due to global attentions to limited natural resources and significance of efficiency in the gas value chain. Wan Mahmood et.al. (2009)21 integrates the overall business strategy in upstream operations that contain of work management, performance management and asset management.

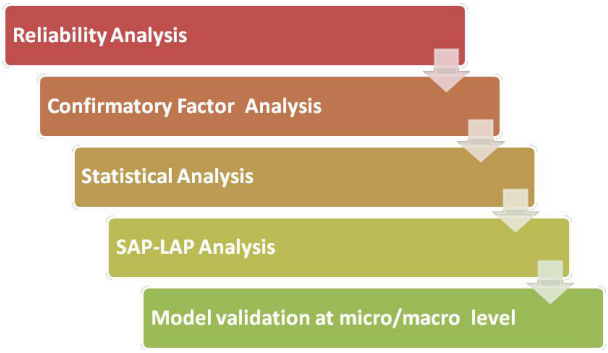


**Figure 1.** Methodology for analysis at micro level.

## 9. Methodology for the Micro Study

The micro study variables were considered on the basis of primary data and interview of the concerned person in the selected industry. The quantitative and qualitative data have been collected

through questionnaire, interview and observation techniques. Literature review and industry expert's opinions helped to form connection among variables and managed the conceptual framework to be tested through qualitative as well as quantitative methods. For testing the proposed framework, a questionnaire survey and a statistical tool (Refer Figure 1) were used. Synthesis of both research methods led to validating the conceptual framework and results in learning/ discussion.

## 10. Reliability Analysis

Reliability is concerned with the ability of an instrument to measure consistently. In order to calculate reliability, calculating alpha is a good practice in education research once multiple-item measures of a concept or construct are employed.

An alpha value of 0.7 or more specifies a reliable measurement instrument for data that are used for fundamental research. It should be noted that the reliability of a tool is closely related with its validity. An instrument cannot be valid unless it is reliable. However, the reliability of a tool does not depend on its validity (Nullay, 1994).

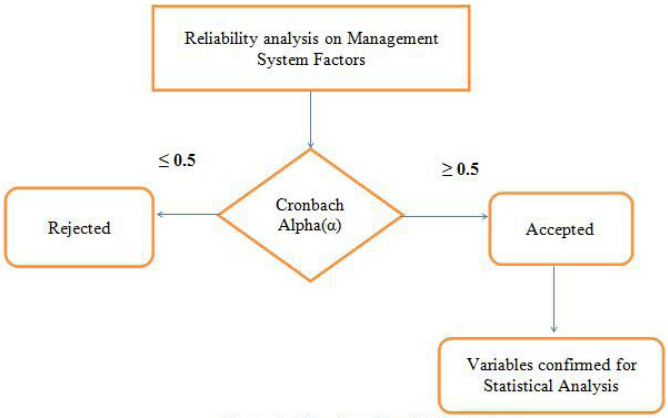


Figure 2: Flowchart for reliability analysis

It is likely to objectively measure the reliability of an instrument and in this study we describe the meaning of Cronbach's Alpha, the most widely used objective measure of reliability. Internal consistency describes the amount to which all the items in a test measure the same concept or construct and hence it is related to the inter-relatedness of the items within the test.

## 11. Confirmatory Factor Analysis (CFA)

Factor analysis addresses the problem of interrelationships between a big numbers of variables, and explains these variables in terms of their common underlying dimensions (Zhang et al., 2000). Scales were considered to have face validity (Neuman, 2003), and they do measure the key practices of management system activities performed within the research context. According to Hair et al. (2005), factor loadings more than 0.30 are measured as important; loadings of 0.40 are considered as more important, while loadings which are more than 0.50 are very significant. As such, a factor loading of 0.50 was used as the cutoff point (Hair et al., 2005).

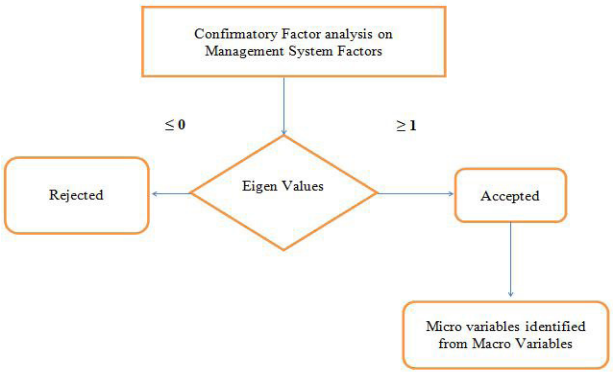


Figure 3: Flowchart for confirmatory factor analysis

Factor analysis is used to calculate construct validity. The main purpose of factor analysis is to recapitulate or condense the information into a smaller set of new composite dimensions (factors) without losing majority of information (Hair et al., 2005).

## 12. Statistical Analysis on Data

Statistics analysis on data is the study of to collect, organize, analyze, and interpret numerical information from data. It involves descriptive statistics comprising of several methods of organizing, picturing and summarizing information from data.

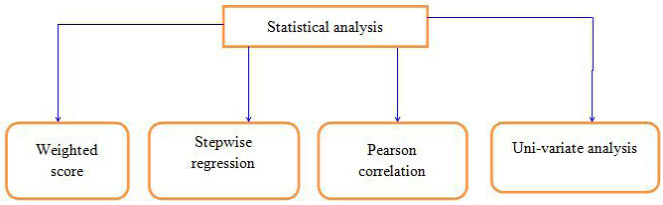


Figure 4: Steps in the statistical analysis

The questionnaires were sent to different levels of respondents in various departments of oil and gas industry. The data collected was scrutinized and incomplete questionnaires were discarded. The data was then entered in Microsoft Office (MS Excel) for tabulation with the help of computer software "Statistical Package for Social Sciences (SPSS-16) for testing of the collected data.

## 13. Result and Discussion

Reliability analysis is concerned with the capability of an instrument to measure consistently (Tavakol et. al., 2008). Hence reliability tests were conducted for the instrument, a low value of alpha could be due to a low number of questions, poor interrelatedness between items or heterogeneous constructs (Mohsen, 2011).

In the present reliability analysis, 340 filled in questionnaires were received from the industries out of which 31 were incomplete. Finally, 309 filled questionnaires were selected for analysis. It means that the response rate was 61.8 per cent, which is considered to be good in Indian context where industry institute linkages are not so strong. The questionnaire consist of 9 distinct parts for which reliability check was necessary. Internal consistency of the data was measured using reliability measurement. Cronbach's Alpha measures how well a set of key performance indicators (or variables) measures a single one-dimensional latent construct. It is a coefficient of reliability (or consistency). If the value of alpha is high, and then there is proof that the items are measuring the same underlying construct which means that they have reasonably good reliability. The values of Cronbach's Alpha obtained are given in Table 1.

**Table 1.** Cronbach-alpha (α) values

| S. No. | Questionnaire | Cronbach Alpha ( α ) |
|---|---|---|
| 1 | a1.1-a1.6 | Not Applicable |
| 2 | a2.1-a2.2 | Not Applicable |
| 3 | a3.1a3.6 | Not Applicable |
| 4 | b1.1-b1.10 | 0.67 |
| 5 | b2.1-b2.8 | 0.822 |
| 6 | b3.1-b3.6 | 0.812 |
| 7 | c1.1-c1.10 | 0.831 |
| 8 | c2.1-c2.11 | 0.759 |
| 9 | c3.1-c3.6 | 0.725 |

**Table 2.** Rotated component matrix factor loadings

| ITEMS | Factor 1: TQM Practices | Factor 2: FS Practices | Factor 3: SCM Program | Factor 4: SCM Practices |
|---|---|---|---|---|
| TQMTPM | 0.826 | | | |
| TQMTMW | 0.890 | | | |
| TQMEPE | 0.622 | | | |
| FSPIDT | | 0.668 | | |
| FSPSOP | | 0.840 | | |
| FSPFLX | | 0.774 | | |
| SCMECR | | | 0.865 | |
| SCMBDT | | | 0.752 | |
| SCMCBA | | | 0.744 | |
| CUSTRLP | | | | 0.815 |
| STATRLP | | | | 0.855 |

Note: i. Extraction method: principal component analysis
ii. Rotation Method: Varimax with Kaiser Normalization

A portion of the questionnaire was related to demographic nature of the respondents hence reliability coefficient calculation was not applicable to it. The reliability coefficients of the TQM program, principles and practices was found (α =0.67, 0.812 and 0.822) to be significant. The reliability coefficients of the variables of FS program, principles and practices was found (α =0.831, 0.759 and 0.725) to be significant. Also the reliability coefficients of the variables of SCM program, principles and practices was also found (α =0.873, 0.795 and 0.849) to be significant.

**Table 3.** Summary of confirmatory factor analysis for macro variable

| Macro variable | Micro variables confirmed by factor analysis | Excluded variables in factor analysis | Cumulative (per cent) of the variance |
|---|---|---|---|
| FS Practices | Interdepartmental task Forces Standard operating Procedures Flexible approach toward product, routing, volume and process | ---------- | 51.99 |
| SCM Program | Effective customer Relations Building trust Co management base activities | ---------- | 42.72 |
| SCM Practices | Customer relationship Strategic relationship | ---------- | 66.39 |

## 14. Concluding Remarks

This paper explains the design of the questionnaire, its validation and testing. A questionnaire is defined as a set of questions developed to advance the required information necessary for testing the formulated hypotheses. The research objectives and hypotheses were translated into specific research questions. The reliability analysis was done to find the Cronbach's alpha and the values come within the acceptable range (0.5) are considered for further analysis. Then the CFA was done to reduce the data in groups which are known as micro variables. The varimax rotation was carried out at macro and micro level and the values which are having Eigen values more than 1 are considered as the

micro variables of the study. The univarite analysis helps to link the relationship among the macro and micro variables in terms of mean.

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