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Supply Chain Performance Measurement Practices of Indian Industries

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Abstract— In any industry, the supply chain performance plays a crucial role and it is vital in growth of the industry. Through this study, an attempt is made to find some insight to the supply chain performance measurement practices of Indian industries through an exploratory survey. The study reveals almost all the respondents (84%) felt that supply chain performance measurement system employed in their organisation has a clear purpose. Also, the study reveals that most supply chain performance measurement system provides high importance to quality measurements and includes both financial and non-financial indicators. The Multivariate analysis revealed three factors emerged from this study are 'Strategic Orientation' followed by 'Internal Focus' and 'Motivation and Control'. The study contributes to understanding the objectives of implementing supply chain performance measurement systems and metrics (measures) used in supply chain performance measurement systems.

Keywords— Supply chain performance, Indian supply chains, Performance management of supply chains, Supply chain performance measurement.

1.   Introduction

Supply chain performance is one of the most critical issues in various industries in today's competitive business environment [1]. In India, few surveys on supply chain management have been reported in literature [2], [3]. Indian industries made substantial progress since the 1990's after the liberalisation, though its supply chain management practices were restricted due to infrastructure deficiencies. It is therefore pertinent to understand the supply chain performance measurement practices of Indian industries. This is an exploratory study beginning with extensive literature review to understand the supply chain performance measurement practices in Indian

Industries followed by a questionnaire-based survey to investigate the current practices.

2.   Literature Review

Significant amount of research has been undertaken on supply chain performance management in the past two decades and published literature is available on the same [4]. New technologies and frameworks are enabling supply chains to collect, collate and share information among its partners thus facilitating integrated performance measurement systems [5].

2.1 Supply Chain Management: Indian Scenario

India embarked the policy of economic liberalisation two decades ago and since then Indian industries have been counted as global players. Along with the industrial progress and liberalisation, supply chain management has also gained significance and visibility over the last decade in India [6]. India is the fifth largest nation in terms of gross national product (GNP) and purchasing power parity (PPP). India is counted as one of the fastest growing markets in the world and is attributed with young entrepreneurial talents, cheap and skilled labour and rich in scientific and technological resources [7], [8]. However, global rankings comparing countries for ease of doing business have ranked India rather poorly over the years [8]. The reasons attributed for India's dismal performance in these global surveys are: uncertainty in government policies; infrastructural deficiencies; unsatisfactory corporate and financial management of both private and public-sector enterprises; undependable quality; inadequate customer orientation; and negligible investment on

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R&D [8]–[11]. Supply chain management becomes a challenging task for Indian businesses in such a scenario where expectations, opportunities and demands are high, but performance restricted by deficiencies mentioned . For many Indian companies, fostering trust between supply chain partners (service providers, suppliers etc.) and proceeding with appropriate performance measurement systems has been a new area with challenges [12].

A survey conducted by Sahay, Cavale, & Mohan (2003) [13] reveals that almost one third of Indian companies have no supply chain strategy even though the corporate recognition of the importance of supply chain is increasing with a rapid speed. Of the companies surveyed, demand management and forecasting, customer service and inventory management ranked high in the priority scale of metrics of measures. Another survey of supply chain management practices of Indian automobile industries reveal that transportation and information management has predominant influence on the performance of supply chain in the Indian context[9]. In terms of management tools employed, total quality management (TQM), and just in time (JIT) topped the list [13]. Outsourcing is an increasing trend due to many reasons with transportation as the most outsourced activity. The reasons for outsourcing are strategic reasons (26 %), process effectiveness (24 %), lower cost (27 %), lack of internal capability (11 %) and investment reasons (12 %) [13]. Majority of Indian companies examined have a weak alignment of supply chain strategy with business strategy. Information technology can act as a strong enabler for aligning supply chain to meet organisational strategy and achieve breakthrough in organisational effectiveness [8]. Based on a survey of Indian industries, Rahman (2004) [14] states that internet is being increasingly being used for integrating supply chains specifically in the areas of transportation, purchasing and order processing.

Ref. [6] based on a questionnaire-based survey states that there are significant differences in supply chain practices between industry sectors. Companies in the auto sector significantly differ from those in the other sectors in the adoption of supply chain management practices though engineering and auto sectors have some similarities in certain aspects of supply chain management. The

major stakeholder exercises some power or influence over the other entities of the supply chain. If this domination is effectively used by top managers for information sharing and initiatives in better supply chain management practices, overall supply chain effectiveness and customer satisfaction can improve significantly for Indian Companies [6], [15].

2.2 Supply chain performance measurement in Indian industries

Focus on performance measurement of supply chains is increasing, especially in the last decade, as companies have understood that for competing in continuously changing environment, it is necessary to monitor and understand the firm's performances in a supply chain context [16]–[18]. Measurement has been recognized as a crucial element to improve business performance and also use it as a vehicle for organisational transformation [19]. Indian industries, in general, were comfortable with department wise performance measurement systems and practices but slow to implement supply chain wide performance measures due to their hesitation in trusting their supply chain partners [12]. Another reason attributed is the rigid functional based organisational structure present in many Indian companies make it difficult to adapt to supply chain wide PMSs [20]. However, this trend is gradually changing, and supply chains are more and more implementing supply chain wide performance measures. Top managers started realising that supply chain integration is possible only with appropriate supply chain performance measurement, feedback and control mechanism. Many organisations have aligned their departmental metrics with the overall supply chain objective to meet the business objective [12], [21]. However, to achieve the full benefit of supply chain management practices, there is a need to streamline processes for supply chain integration and an appropriate supply chain performance measurement system will facilitate that [22].

Based on a study of Indian automobile industry [9][9], Indian supply chains are predominantly using financial measures and productivity based performance measures. The supply chain performance measurement system focus remains on productivity and cost related aspects. Even the cost

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and productivity measures remain confined to organisational boundaries. Ref.[12] [12] proposes an India-specific supply chain that focus on infrastructure, technology deployment and partnerships. Ref. [9], proposed a 'measure set' with their interdependency for performance measurement of Indian automobile supply chains which emphasises cost and productivity as tangible measures and communication, learning and trust as intangible measures. Modification and adaptability required for employing existing frameworks such as SMART (strategic measurement analysis and reporting technique), PMQ (performance measurement questionnaire) and supply chain performance measurement system frame work proposed by Ref. [23], for the Indian context has been recommended by Ref. [9].

3.   Objective

The objective of the study is to understand performance measurement practices and preferences of supply chains of Indian industries. The study is therefore exploratory in nature. A survey is conducted to find the nature of supply chain practices and provide a good understanding and insight of the issues and opportunities in this area. The survey is not intended to offer any final or conclusive solution to the existing issues and challenges.

4.   Methodology

A questionnaire-based survey is conducted to analyse the following in the Indian supply chain scenario:

   i.   Identify objectives of using supply chain performance measurement system in the organisation

   ii.   Supply chain performance measurement frameworks employed

   iii.   Methods and tools used in supply chain performance measurement system

   iv.   Important metrics / groups (categories) measured

In order to understand the factors from the list of variables, factor analysis has been performed. This analysis helps in separating the variables that are highly correlated into meaning full factors. Results

of the survey revealed significant insights into the performance measurement practices of Indian supply chains. This paper presents the important insights gained through the survey.

An extensive literature review of related literature and inputs from expert opinion is used to develop the survey questionnaire. The survey questionnaire consisting of 61 questions is divided into sections as given below to obtain the required information:

   i.   Section 1: Information about the industry profile and the participant

   ii.   Section 2: Objectives of using supply chain performance measurement systemin the organisation

   iii.   Section 3: supply chain Performance measurement frameworks employed

   iv.   Section 4: Methods and Tools in supply chain performance measurement system

   v.   Section 5: Metrics/Groups (Categories) Measured

The survey questionnaire is designed in such a way to elicit responses from respondents in a truthful, non-threatening way. All the questions are of single dimension, but answers can (in most cases) accommodate multiple choices and variability in responses. The questions are grouped together as Sections to make the respondent easier to comprehend the questions and answer. Explanation of technical terms are included in the questions to avoid misinterpretations. The questionnaire was sent to 250 supply chain and logistics practitioners and 29 responses were received. 25 responses were considered for study after excluding inadequate and incomplete responses.
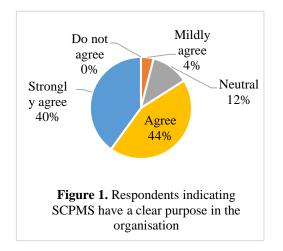
5.   Results and Discussion

The survey provided pertinent insights to the supply chain performance measurement practices of Indian industries. The respondents were supply chain and logistics practitioners from a variety of industries the details of which are provided at Table 1. The designation of the respondents included Assistant Manager, Associate Professor, Business Owner, Business Process Consultant, Director, Founder & Principal Consultant, Managing Director, Research Analyst, SAP Consultant,

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Software Dev Analyst, Manager and Production engineer.

Table 1. Industry Sector Profile of Survey Respondents

Industry Sector	Number of Respondents
Manufacturer / Assembler	7
IT Services	4
Services (other than IT)	7
Logistics	5

5.1 Objectives of using supply chain performance measurement system in the organisation

Respondents were asked about the purpose and objectives of using supply chain performance measurement system in their respective organisation. Most of the respondents (84%) indicated that the supply chain performance measurement system employed in their organisation has a clear purpose. The details of the respondents indicating existence of clear purpose for supply chain performance measurement system is presented at Figure 1.

Figure 1. Respondents indicating SCPMS have a clear purpose in the organisation

A set of fifteen questions were administered to understand the objectives of using supply chain performance measurement system in their respective organisation. The objectives of the supply chain performance measurement system indicated based on the survey are placed at Table 2. Table 2 also indicate the percentage of respondents strongly agreeing and the rank based on the percentage of positive responses. The comparative

responses on the question of objectives and purposes of supply chain performance measurement system is graphically represented at Figure 2.

Table 2. The objectives of the supply chain performance measurement system as indicated by Survey
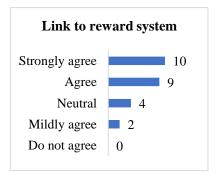
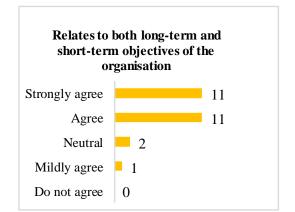| Objective of supply chain performance measurement system	% of Respondents Agree/ Strongly Support	Rank
Link to reward systems	76 %	7
Providing a fast Feedback	82 %	5
Relates to performance improvement, not just monitoring	92 %	1
Reinforces firm's strategy	76 %	8
Relates to both long-term and short-term objectives of the organisation	88 %	2
Matches the firm's organization culture	76 %	9
Consistent with the firm's existing recognition and reward system	64 %	12
Focuses on what is important to customers	80 %	6
Focuses on what the competition/ competitor is doing	40 %	13
Leads to identification and elimination of waste	86 %	3
Helps accelerate organisational learning	76 %	10
Acts as a strong communication tool	84 %	4
Acts as a vehicle for organisational change	36 %	14
Evaluate groups not individuals for performance to schedule	72 %	11

The analysis indicates that the three most commonly attributed objectives of supply chain performance measurement system in the Indian context, based on the survey are:
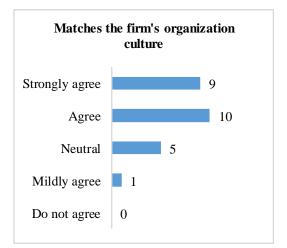
i.   Relates to performance improvement, not just monitoring

ii.   Relates to both long-term and short-term objectives of the organisation

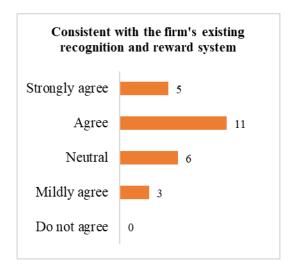iii. Leads to identification and elimination of waste (0perational wastes)

Many respondents also indicated that the supply chain performance measurement system acts as a strong communication tool and provides a fast feedback to the decision makers. Customer focus, linking to the reward system, reinforcing the firm's strategy and helping to accelerate organisational learning are the other stated objectives and purposes of supply chain performance measurement system.

Relates to both long-term and short-term objectives of the organisation

Strongly agree	11
Agree	11
Neutral	2
Mildly agree	1
Do not agree	0

Link to reward system

Strongly agree	10
Agree	9
Neutral	4
Mildly agree	2
Do not agree	0

Matches the firm's organization culture

Strongly agree	9
Agree	10
Neutral	5
Mildly agree	1
Do not agree	0

Reinforces the firm's strategy

Strongly agree	9
Agree	10
Neutral	4
Mildly agree	2
Do not agree	0

Consistent with the firm's existing recognition and reward system

Strongly agree	5
Agree	11
Neutral	6
Mildly agree	3
Do not agree	0

Focuses on what is important to customers

Strongly agree — 14
Agree — 6
Neutral — 3
Mildly agree — 1
Do not agree — 1

Focuses on what the competition is doing

Strongly agree — 7
Agree — 3
Neutral — 0
Mildly agree — 15
Do not agree — 0

Leads to identification and elimination of waste

Strongly agree — 12
Agree — 7
Neutral — 3
Mildly agree — 3
Do not agree — 0

Helps accelerate organisational learning

Strongly agree — 8
Agree — 11
Neutral — 2
Mildly agree — 4
Do not agree — 0

Acts as a strong communication tool

Strongly agree — 11
Agree — 10
Neutral — 1
Mildly agree — 3
Do not agree — 0

Acts as a vehicle for organisational change

Strongly agree — 2
Agree — 7
Neutral — 6
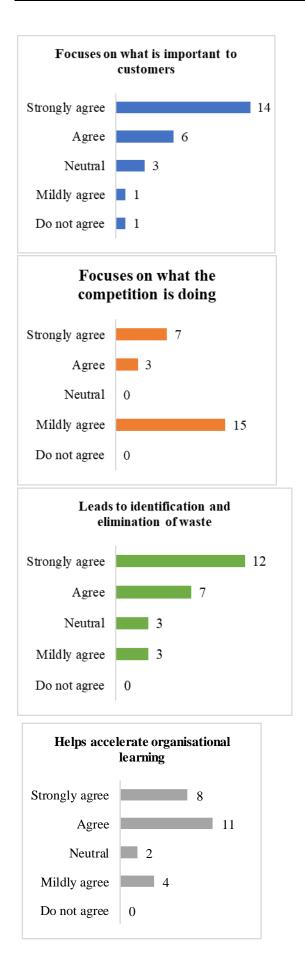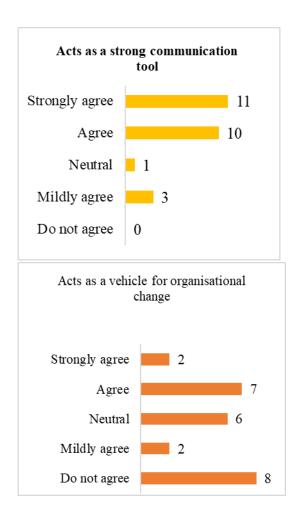Mildly agree — 2
Do not agree — 8

Figure 2. Objectives and Purpose of supply chain performance measurement system in Indian Industries
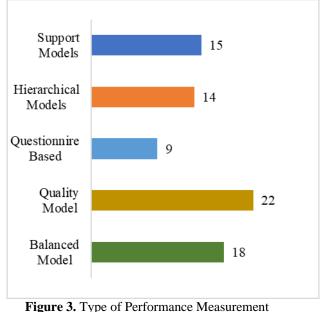
5.2 Performance measurement frameworks employed

A set of five questions were asked to understand the type of performance measurement frameworks employed in their respective supply chains. The types of performance measurement frameworks were defined as under:

i.   Balanced Model: Balanced models will have the presence of both financial and non-financial indicators. Some examples are Performance Measurement Matrix, Balanced Scorecard (BSC), Performance Prism (PP) [12].

ii. Quality Model: These are frameworks in which a great importance is attributed to quality. An example is Business Excellence Model [14].

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iii.   Questionnaire based Model: These are frameworks based on questionnaire. The Performance Measurement Questionnaire (PMQ) and TOPP System [15] are examples.

iv.   Hierarchical Models: SCPM models that are strictly hierarchical (or strictly vertical), characterised by cost and non-cost performance on different levels of aggregation are classified as hierarchical models. Frameworks where there is a clear hierarchy of indicators are: Performance Pyramid; Advanced Manufacturing Business Implementation Tool for Europe (AMBITE); the European Network for Advanced Performance Study (ENAPS) approach; and Integrated Dynamic Performance Measurement System (IDPMS).

v.   Support Models. Frameworks that do not build a performance measurement system but help in the identification of the factors that influence performance indicator are classified as support models. Examples of these models are: Quantitative Model for Performance Measurement System (QMPMS) and Model for Predictive Performance Measurement System (MPPMS) [16].
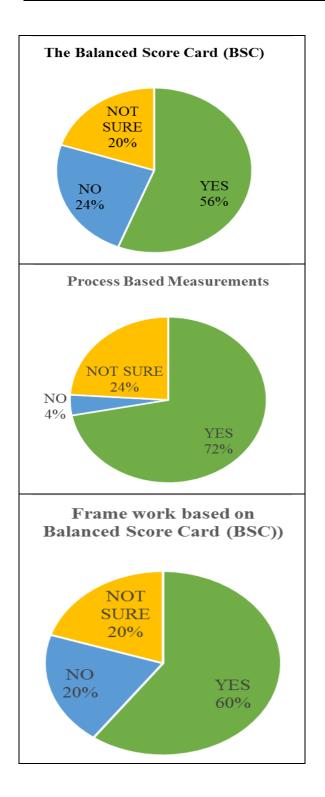
The analysis indicates that 'Quality' based models are most widely used followed by 'Balanced Models' and 'Support Models'. The 'Questionnaire' based models are the least used. The study therefore reveals that most supply chain performance measurement system provide high importance to quality measurements and includes both financial and non-financial indicators. The survey result is summarised in Figure 3.

Figure 3. Type of Performance Measurement Framework Employed

5.3 Methods and tools employed

Performance measurement frameworks for supply chain use different types of frameworks and tools as part of it. Some of the most commonly used tools and frameworks are the balanced score card (BSC), frameworks based on BSC or modified BSC, performance pyramid (PP), SCOR model, fuzzy set approach, process-based tools, economic value added (EVA) etc. Respondents were asked about the type of framework used in their supply chain performance measurement system. Response to these questions indicated that 20% to 52% of the respondents are not aware of the type of tools used in their respective supply chain performance measurement systems. Process based measurement tools and economic value-added EVA based tools topped the list followed by BSC based frameworks. The survey results are shown at Figure 4.
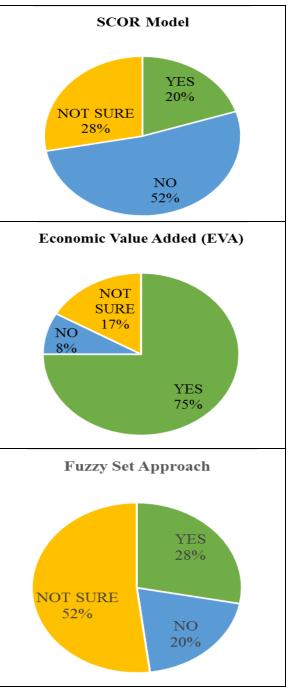
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The Balanced Score Card (BSC)

Process Based Measurements

Frame work based on Balanced Score Card (BSC))

SCOR Model

Economic Value Added (EVA)

Fuzzy Set Approach

Figure 4. Methods and Tools Employed in supply chain performance measurement system Metrics and groups (categories) measured

There was a set of 24 questions to understand the metrics and groups of entities that are part of the supply chain performance measurement systems. These questions revealed what exactly are the measures or group of measures which are significant to the respective organisations and are included in the supply chain performance measurement systems. The list of measures and their rankings are placed at Table 3. The survey

indicates the top five metrics being most commonly measured as follows:

  i.   Order fulfilment performance

  ii.   Quality of services

  iii. Delivery Performance

  iv.   Customer Satisfaction

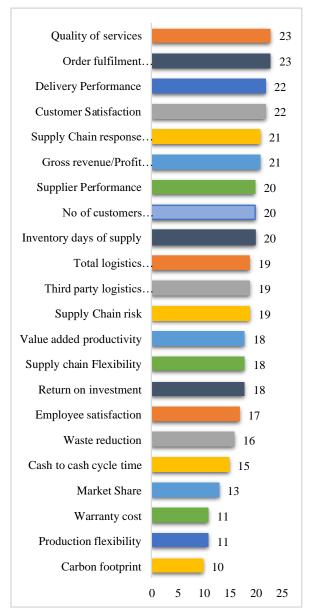 v.   Supply Chain response time

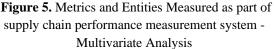**Table 3.** The Metrics and Groups Measured as part of supply chain performance measurement system

Metrics / Entities included in supply chain performance measurement system	Number of Firms Using the Measure	Rank
Delivery Performance	22	3
Order fulfilment performance	23	1
Supply Chain response time	21	5
Production flexibility	11	20
Total logistics management cost	19	10
Value added productivity	18	13
Warranty cost	11	19
Cash to cash cycle time	15	17
Inventory days of supply	20	9
Return on investment	18	15
Gross revenue/Profit before tax	21	6
Waste reduction	16	16
Carbon footprint	10	21
Market Share	13	18
Number of customers retained/Customer loyalty	20	8
Customer Satisfaction	22	4
Quality of services	23	2
Third party logistics provider's performance	19	11
Supply chain Flexibility	18	14
Supply Chain risk	19	12
Employee satisfaction	17	16
Supplier Performance	20	7

The graphical representation of the entities measured with number of positive responses is placed at Figure 5.

Survey questionnaire consisted of fifteen questions related to supply chain performance measurement system planning, implementation and use at the respondent's organization. These fifteen variables were asked in a six-point Likert type scale ranging from strongly disagree to strongly agree. Multivariate analysis is a suitable method to understand the factors from the list of variables. Factor analysis has been performed and the results analysed.

Figure 5. Metrics and Entities Measured as part of supply chain performance measurement system - Multivariate Analysis

The KMO test reveals that the sample is adequate (.731) and the Bartlett's Test of Sphericity also shows significant (p<0.000) which mean all the

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fifteen variables are highly correlated and Factor analysis has to be applied in order to take out the factors from the variables which will be uncorrelated. The KMO and Bartlett's Test result is placed at Table 4.

Table 4. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.731
Bartlett's Test of Sphericity	Approx. Chi-Square	261.594
	df	105
	Sig.	0.000

5.4 Variance explained

Table 5 shows the total variance explained by all the variables. Three factors were emerged based on eigen value (>1) and factor 1 alone explains 52% of variance and in total 69% of variance explained by these three factors.

5.5 Rotated component matrix

Varimax procedure is applied to find out the variables contributing under each factor. The Rotated Component Matrix is placed at Table 6 and Component Transformation Matrix is placed at Table 7. Principal Component Analysis is used as the extraction method and Varimax with Kaiser Normalization for rotation. A cut of point of 0.63 is taken and the variables that emerged for these factors are listed below:

Factor 1 - Strategic Orientation

Variables are: i. supply chain performance measurement system reinforces the firm's strategy: ii. Relates to both long-term and short-term objectives of the organisation; iii. Matches the firm's organization culture; iv. Focuses on what is important to customers and v. Focuses on what the competition is doing.

Factor 2 – Internal Focus

Variables are: i. supply chain performance measurement system leads to identification and elimination of waste; ii. Acts as a vehicle for organisational change; iii. Helps accelerate organisational learning; iv Evaluate groups not individuals for performance to schedule.

Factor 3- Motivation and Control

Variables are: i. supply chain performance measurement system as a clear purpose: ii. Makes a link to reward systems and iii. Relates to performance improvement not just monitoring.

The first factor that emerged from factor analysis is 'Strategic Orientation' followed by 'Internal Focus' and 'Motivation and control'. This analysis helps in separating the variables that are highly correlated into meaningful factors.

'Strategic Orientation' helps supply chain to achieve a specific, worthy end goal and objectives. The performance measures in Indian supply chains, therefore, facilitate to set direction, focus efforts, define the processes and provide consistence. A significant impact of implementing PMS in organizations is that individuals who are part of organizations respond to measures.

'**Internal Focus'** imply that measures implemented in their organization send people strong messages about what matters and what response is expected from them. The right measures then not only offer a means of tracking whether objectives are being implemented, but also a means of communicating objectives and encouraging its implementation.

The **'Motivation and Control'** factor indicates PMS usage to establish performance related reward mechanism and thereby facilitating a feedback and control mechanism in the organisation. Relating PMSs to people and teams make people responsible for that function and imply employee action for performance improvements.

Table 5. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.879	52.529	52.529	7.879	52.529	52.529	4.439	29.593	29.593
2	1.324	8.829	61.357	1.324	8.829	61.357	2.996	19.971	49.564
3	1.171	7.810	69.167	1.171	7.810	69.167	2.940	19.603	69.167
4	.904	6.027	75.194						
5	.794	5.291	80.486						
6	.685	4.568	85.054						
7	.645	4.298	89.351						
8	.541	3.605	92.956						
9	.343	2.284	95.240						
10	.271	1.808	97.048						
11	.156	1.037	98.085						
12	.126	.837	98.922						
13	.069	.462	99.385						
14	.050	.333	99.718						
15	.042	.282	100.000						

Extraction Method: Principal Component Analysis.

Table 6. Rotated Component Matrix[a]

Variable	Component		
	1	2	3
VAR00001	.059	.206	.743
VAR00002	.363	-.002	.780
VAR00003	.627	.113	.416
VAR00004	.243	.324	.661
VAR00005	.695	.278	.244
VAR00006	.811	.202	.294
VAR00007	.642	.323	.335
VAR00008	.522	.337	.499
VAR00009	.842	.269	.089
VAR00010	.815	.251	.224
VAR00011	.578	.631	-.098
VAR00012	.209	.808	.392
VAR00013	.377	.450	.558
VAR00014	.255	.732	.334
VAR00015	.261	.758	.133

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

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Table 7. Component Transformation Matrix

Component	1	2	3
1	.692	.521	.499
2	-.592	.016	.806
3	-.412	.853	-.320

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

6.   Conclusion and Limitations

The exploratory survey-based research provided an insight to the performance measurement practices of Indian supply chains. The respondents were practitioners from a cross section of the industry with manufacturing companies (30%) leading, followed by logistics companies (17 %) and IT services (17 %). However, it is observed that there are lot of similarities in the survey responses irrespective of the industry sector. Majority of the respondents agreed that there is clarity in the objectives of SCPMs implemented in their enterprise. The study gave clarity in understanding the objectives of implementing supply chain performance measurement systems and metrics (measures) used in supply chain performance measurement systems. The first factor that emerged from factor analysis is 'Strategic Orientation' followed by 'Internal Focus' and 'Motivation and Control'. This analysis helps in separating the variables that are highly correlated into meaningful factors.

The present study indicates a departure from previous surveys on Indian supply chains[9], [12], [13] that Indian supply chains started expanding to supply chain wide PMSs from department wise PMSs. Many organisations started using balanced measures in addition to financial performance measures. The industry sectoral differences are diminishing in supply chain wide performance measures.

The limitation of the study is that the sample size is relatively small and is not representing many industry sectors. Some of the respondents appear to be not aware of the supply chain wide performance measurement practices in their organisation, instead they responded based on their knowledge of their department wise performance measurement practices. The study was exploratory in nature to gather preliminary understanding.

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