

Study on performance measurement systems – Measures and Metrics

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Abstract- Significant research has been carried out so far in the field of performance measurement and management. Various authors have presented their findings based on their respective perspective of the topic. A wide variety of literature available makes the study of performance measures and metrics more difficult. The present study has made an attempt to dig into the literature to identify the importance of performance management, terminologies and various models in performance measurement system. Knowledge about types of measures, their purpose and tests on measures provides sufficient inputs while designing a performance measurement system.

Index Terms- Performance management, Performance measurement, Performance measures and metrics, Performance models

I. INTRODUCTION

Increasing competition, changing external demand as well as roles of business are forcing the enterprises to examine and improve their strategies and management systems (Michaela et al., 2012). Companies have understood that for competing in continuously changing environment, it is necessary to monitor and understand firm performances. Measurement has been recognized as a crucial element to improve business performance (Taticchi et al., 2010). In recent years, organizational performance measurement framework and factors have received much attention from researchers and practitioners (Gunasekaran et al., 2004).

According to Amlan et al.,(2004) performance measurement provides the means by which a company can assess whether its supply chain has improved or degraded. It is only by means of performance measurement that one can see how much one is behind or ahead of its competitors. In the last three decades, a variety of literature has been published in the area of performance measurement and management. Researchers and practioners initially concentrated on the business performance, definitions for measurement, measures and measurement system (Neely et al.,1995). Later studies were about developing comprehensive frameworks and models for measurement (Kaplan and Norton, 1992). Subsequently importance was given to developing and designing customised performance measurement systems with integrated models gaining prominence.

One of the problems with the performance measurement literature is that it is diverse. This means that individual authors have tended to focus on different aspects of performance measurement system design (Neely et al., 1995). A comparative analysis of some most widely cited performance measurement systems have been undertaken by G. P. Kurien and M.N. Qureshi and it indicates that validity of many of the measurement frameworks needs to be established through further study. Unfortunately these different approaches have led to numerous definitions of a performance measurement system, and there is little consensus regarding its main components and characteristics. The gap between what are wanted to be measured and what can be measured is the main reason for performance measurement being still so challenging (Michaela et al., 2012).

So the study aims to identify the major theories, models and frameworks in order to analyse best practices in performance management systems. A detailed study regarding the performance measures are also carried to facilitate knowledge regarding performance system design.

II. IMPORTANCE OF PERFORMANCE MANAGEMENT SYSTEMS

The famous sayings such as “You get what you measure”, “People perform the way they are measured”, highlight the importance of a proper performance management system. Thus performance management is an important aspect of a successful supply chain management. Even well-conceived competitive strategies cannot increase organizational success unless they are effectively implemented. Performance-measurement systems can play a key role in strategy implementation by helping to translate organizational strategy into desired behaviours and results, communicate expectations, monitor progress, provide feedback, and motivate employees

through performance-based rewards (Fleming et al., 2009). According to Amr Abu-Suleiman, importance of performance management systems can be summarised into the following categories:

- To drive organizational actions

Performance measures drive actions in two ways. First, monitored measures get high visibility within an organization, and people strive to achieve high performance with respect to these measures. Second, Measured metrics drive organizational actions by identifying areas of improvement. Once poor area is identified, managers can take corrective action to address such issues.

- As a framework for decision making

Measures provide a basis to evaluate alternatives and identify decision criteria. The structure of measurement systems drives decisions and action at the different levels in the firm.

- Provides closed loop control

An effective enterprise performance management system allows proper monitoring of business process. The feedback is used to compare actual progress to planned; facilitate benchmarking against industry best practices and to identify improvement opportunities. Meyer (2002) defines 7 purposes of performance measurement that takes place within the different levels of the companies. Performance measurement enables companies to look back and evaluate the past activities and look ahead and prepare for the forthcoming performance. Motivate and compensate, on the other hand are the purposes for the lower levels of the company. In larger and more complicated firms, measures are also expected

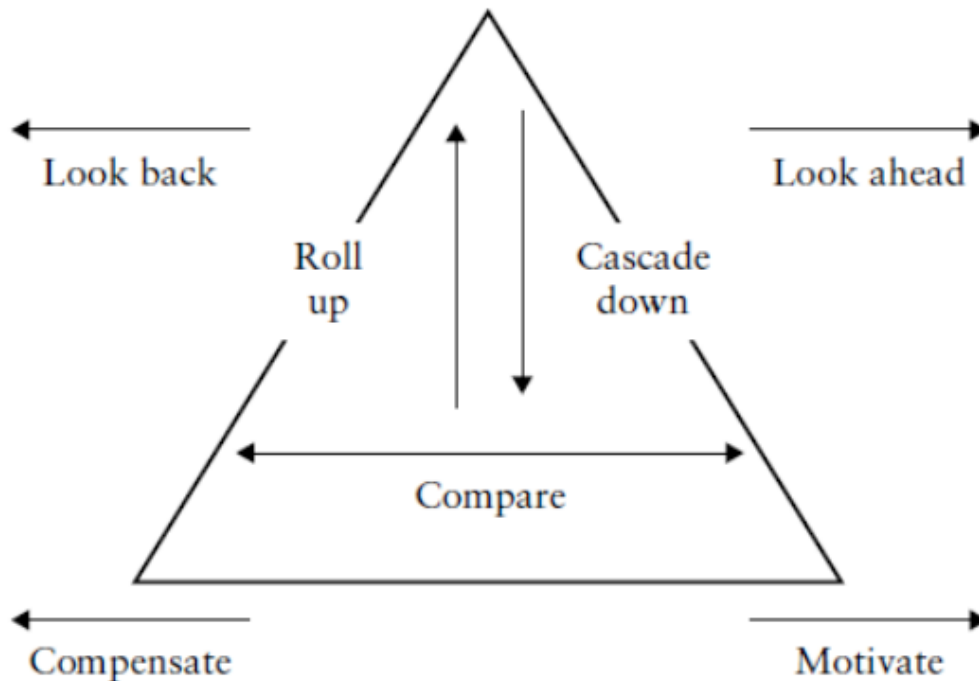


Figure 1: Seven purposes of performance measurement (Meyer 2002)

to roll up from the bottom to the top of the organization, to cascade down from top to bottom, and to facilitate performance comparisons across business and functional units.

III. TERMINOLOGY

According to Neely(1995) performance measurement is a topic which is often discussed but rarely defined. He defines performance measurement as the process of quantifying the efficiency and effectiveness of action. Effectiveness is the amount of meeting customers' needs and efficiency is rate of economically using corporation's resources in time of measuring a predetermined level of customers' satisfaction.

- A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of an action (Neely, 1995).
- A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions (Neely, 1994).

Performance Measurement and Evaluation: Definitions and Relationships (GAO/GGD-98-26), the U.S. General Accounting Office (GAO) cited in 'Performance based management handbook', 2001 provides the following definition:

Performance measurement is the ongoing monitoring and reporting of program accomplishments, particularly progress towards pre established goals. Performance measures may address the type or level of program activities conducted (process), the direct products and services delivered by a program (outputs), and/or the results of those products and services (outcomes).

IV. CLASSIFICATION OF PERFORMANCE MANAGEMENT LITERATURE

Different authors have classified the performance management literature based on their perspectives. According to Başar Öztayşi(2009), the studies about performance can be grouped into two. In the first group, the researches focus on models and frameworks about what to measure in other words, performance indicators. On the other hand, the second group focuses on analytical techniques and quantification of performance.

Table 1: Performance measurement models and evaluations (Öztayşi, 2009)

Models / Frameworks	Focus of the model	Individual Evaluations	Look Back	Look Ahead	Balanced Performance	Alignment with	Flexibility / Dynamism
Traditional Performance Measurement	Financial ratios	-	+	-	-	-	-
Time based performance measurement system. (Stalk, 1988)	Time based measurement of the processes	-	-	+	-	-	-
Time based Costing (Boons, 2002)	Time based costing of products	-	+	-	-	-	-
Theory of Constraints (TOC) and throughput accounting (Goldratt and Cox, 1992)	Efficiency, activities, inputs, inventory and money-time	-	+	+	+	-	-
Tableau de Bord (Eccles, 1991)	Corporate performance	+	+	+	+	+	□
Performance Pyramid (Wedman and Graham, 1998)	Identification of the performance improvement areas	-	-	-	+	-	-
Performance Prism (Kennerley and Neely, 2002)	Considers the perspectives: Shareholder satisfaction, strategies, processes, capabilities	+	+	□	□	+	□
Activity-Based Costing (Turney, 1991)	Costing of activities and resources	-	+	+	□	-	-
SMART System (Cross and Lynch, 1989)	Performance indicators for different levels of the company.	-	+	-	□	□	+
Performance Measurement Survey (Dixon et al, 1990)	Preparation for the prior performance improvement areas.	-	-	-	+	-	-
Performance Measurement Matrix (Keegan et al, 1989)	Groups the corporate performance indicators as financial, non-financial, exterior and interior.	-	+	-	-	-	□
Performance Measurement Framework for Service (Fitzgerald et al, 1991)	Analyzes the performance indicators with a cause and effect relation	-	+	+	□	□	□

Balanced Scorecard (Kaplan and Norton, 1992)	Defines a corporate performance system with financial, customer, process and learning and growth perspectives.	+	+	+	+	+	+
Macro Process Model (Brown, 1996)	Models the processes as inputs, production system, outputs, outcomes and goals.	-	+	-	□	-	-
Consistent performance management system (Flapper et. al. 1996)	Defines the steps for implementing performance measurement.	-	+	□	□	□	+
Cambridge Performance Measurement Process (Neely et al. 1997)	Design and tracing of the performance indicators	□	+	-	□	□	+
Quality Frameworks (Macey, 2001; Neely and Adams, 2001)	Standard and corporate performance	-	+	□	□	-	-

The present supply chain performance measurement frameworks can be classified into following three main models that are mentioned frequently by other scholars:

- result based (balanced scorecard) (Kaplan and Norton, 1992);
- hierarchical (decision making levels) (Gunasekaran et al., 2004) and
- process based (supply chain operations reference, SCOR model) frameworks (Supply Chain Council, 1996).

Kurien et.al,(2011) classified the literature related to SCPMS to two major orientations. They are: (i) Conceptual articles and (ii) Empirical articles. The conceptual works tend to focus on measurement constructs and prescriptive methodologies. Topics normally covered in conceptual articles are related to performance definition, theoretical evaluation criteria, models and issues with measures. The empirical works tend to focus more on performance content than on measurement process. Empirical articles include descriptive studies, methods, taxonomies, benchmarking and prescriptive performance improvement activities. Table 1. shows the evaluations of various models and frameworks. The symbols are used to define the properties of the models, “+” means that the model satisfies the property while “-” means that the property is not provided. The “□” sign symbolizes that the property is satisfied to some degree or the user is free to modify.

Many authors have classified PMS in different ways. A basic classification provided by Cagnazzo cited in Kurien et.al,(2011) consists of grouping PMS models into:

1. Balanced models;
2. Quality models;
3. Questionnaire-based models;
4. Hierarchical models; and
5. Support models.

V. COMMON FRAMEWORKS AND MODELS FOR PERFORMANCE MEASUREMENT

A number of frameworks and models for performance measurement have been developed, since 1980s (Bititci et al., 2000). All these frameworks and models have their own respective benefits and limitations. Kurien et.al,(2011) claims that empirical and theoretical validity of some of the frame works are established whereas information about others is not available. The following section familiarises a few widely cited measurement systems.

A. Balanced Score Card (BSC):

Since the introduction of Balanced scorecard by Kaplan and Norton in 1992, it has been widely recognised as the leading tool for performance management. Balanced scorecard shown in the figure below provides a quick and comprehensive view of the entire business process by using a set of balanced measures from four different perspectives. They are

- Customer perspective (How do customers see us?)
- Internal perspective (What must we excel at?)

- Innovation and learning perspective (Can we continue to improve and create value?)
- Financial perspective (How do we look to shareholders?)

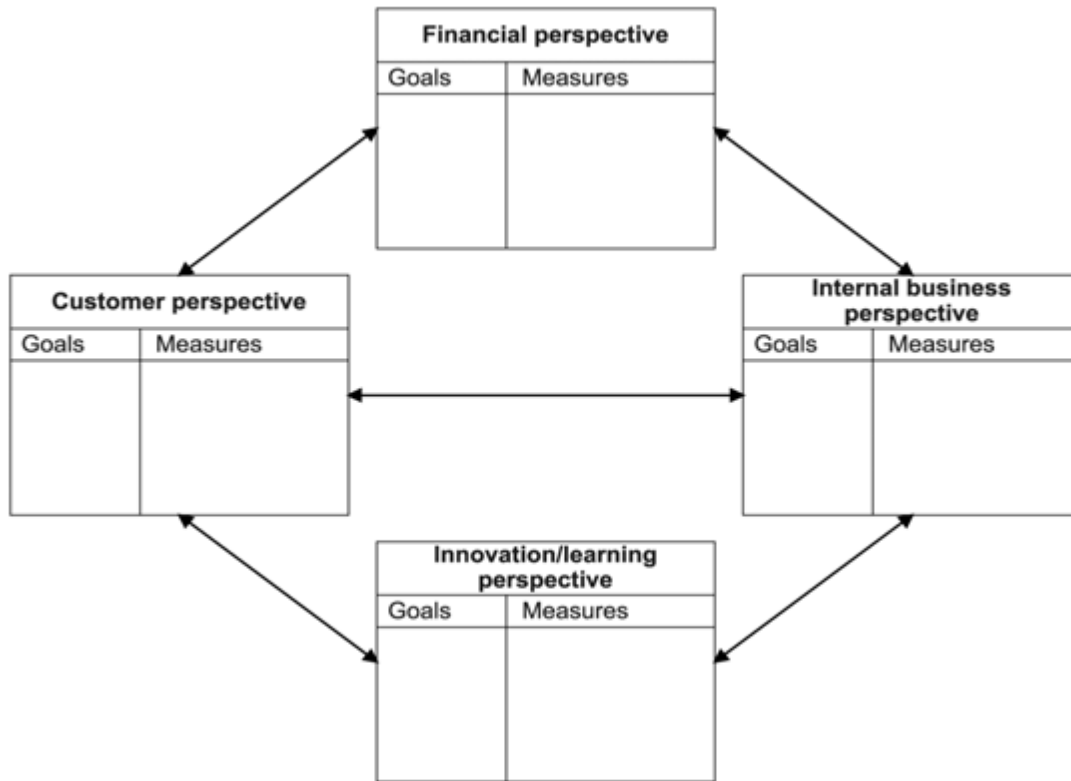


Figure 2. Balanced Score Card (Source: Adapted from Kaplan et.al, 1992)

With these perspectives in mind a manager can derive specific measures that are directly linked to the business strategy. Thus BSC provides a set of financial and non financial operational measures and helps the managers to identify a critical few measures that are most important to the business. The balanced score card guards against local optimisation thus providing insight whether an improvement is based on actual process improvement or by reducing the performance of other processes (Kaplan et.al, 1992).

B. Performance Prism:

The Performance Prism (PP) is one of the younger conceptual systems and is considered as a second-generation PM system (Michaela et al., 2012). The performance prism framework suggests that a PMS should be organised around five distinct but linked perspectives



Figure 3: Performance Prism (Adapted from Tangen, 2004)

of performance as shown in figure 3 (Neely et al., 2001).

- Stakeholder satisfaction (Who are the stakeholders and what do they want and need?)
- Strategies (What are the strategies we require to ensure the wants and needs of our stakeholders?)
- Processes (What are the processes we have to put in place in order to allow our strategies to be delivered?)
- Capabilities (The combination of people, practices, technology and infrastructure that together enable execution of the organisation’s business processes, both now and in the future, and what are the capabilities we require to operate our processes?)
- Stakeholder contributions (What do we want and need from stakeholders to maintain and develop those capabilities?)

According to performance prism the performance measurement need not be strictly derived from the strategy: instead, “strategies should be put in place to ensure the wants and needs of the stakeholders are satisfied” (Neely et.al.,2001). It is tool that helps management teams to think about vital questions and strategies to address them. (Michaela et.al. 2012). Although the performance prism extends beyond “traditional” performance measurement, it offers little about how the performance measures are going to be realised. Another weakness is that little or no consideration is given to the existing PMSs that companies may have in place (Medori et al., 2000), cited in Kurien et.al,(2011).

C. The Performance Pyramid:

Another important framework is performance pyramid proposed by Cross and Lynch (1992). The purpose of the performance pyramid (refer Figure 4) is to link an organisation’s strategy with its operations by translating objectives from the top down (based on customer priorities) and measures from the bottom up. This PMS includes four levels of objectives that address the organisation’s external effectiveness (left side of the pyramid) and its internal efficiency (right side of the pyramid). The development of a

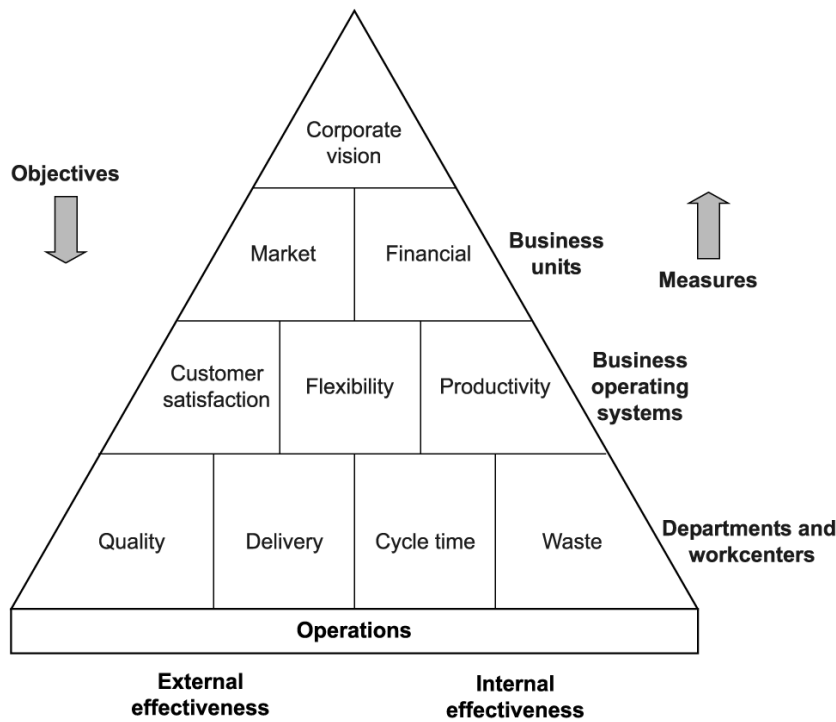


Figure 4. Performance Pyramid (Adapted fromTangen, 2004)

company’s performance pyramid starts with defining an overall corporate vision at the first level, which is then translated into individual business unit objectives. The second-level business units are short-term targets of cash flow and profitability and long-term goals of growth and market position (e.g. market, financial). The business operating system bridges the gap between top-level and day-to-day operational measures (e.g. customer satisfaction, flexibility, productivity). Finally, four key performance measures (quality, delivery, and cycle time, waste) are used at departments and work centres on a daily basis (Kurien et.al,2011).

The strengths of this framework are that it ties together the hierarchical view of business performance measurement with the business process view. It also makes explicit the difference between measures that are of interest to external parties-customer satisfaction, quality and delivery, and measures that are primarily of interest within the business productivity, cycle time and waste (Neely et.al, 2000).

D. The Supply-Chain Operations Reference (SCOR) Model:

The SCOR model was developed by the Supply-Chain Council (SCC) to assist firms in increasing the effectiveness of their SCs, and to provide a process-based approach to SCM (Kurien et.al, 2011). The Supply Chain Operations Reference (SCOR) model provides a unique framework that links performance metrics, processes, best practices, and people into a unified structure. The framework supports communication between supply chain partners and enhances the effectiveness of supply chain management, technology, and related supply chain improvement activities (SSC Council, 2010). The SCOR model was originally developed on five supply chain management processes - plan, source, make, deliver and return. Further the measures are grouped into five performance attributes: reliability, responsiveness, flexibility, cost and assets.

VI. MEASURES AND METRICS

Performance measures help us understand, analyse, control and improve what our organizations do. Commentators believe performance measures and metrics will facilitate a more open and transparent communication between people, leading to a cooperative supported work environment and hence improved organizational performance (Gunasekaran and Kobu, 2007). According to The Performance-Based Management Handbook, 2001 effective performance measures can let us know:

- How well we are doing,
- If we are meeting our goals,
- If our customers are satisfied,
- If our processes are in statistical control, and
- If and where improvements are necessary.

Gopal et.al, (2012) in review of supply chain measures and metrics claim that researchers have associated the supply chain performance with measures in the following diverse ways:

- qualitative or quantitative
- cost and non-cost;
- quality, cost, delivery and flexibility
- cost, quality, resource utilization, flexibility, visibility, trust and innovativeness
- resources, outputs and flexibility
- supply chain collaboration efficiency; coordination efficiency and configuration
- input, output and composite measures
- strategic, operational or tactical focus
- supply chain operations reference (SCOR) model (plan, source, make, deliver and return or customer satisfaction); whether they measure cost, time, quality, flexibility and innovativeness; and, whether they were quantitative or qualitative
- modelling the metrics of lean, agile and leagile supply chains
- key performance measures and metrics in supply chain
- scorecard approach
- tangible/intangible
- sustainability/green
- financial/non-financial

A .Types of Performance Measures:

The Performance-Based Management Handbook, 2001 has divided the performance measures into five general types. They are:

- Input Measures - Used to understand the human and capital resources used to produce the outputs and outcomes.
- Process Measures - Used to understand the intermediate steps in producing a product or service. In the area of training for example, a process measure could be the number of training courses completed as scheduled.
- Output Measures - Used to measure the product or service provided by the system or organization and delivered to customers. An example of a training output would be the number of people trained.
- Outcome Measures - Evaluate the expected, desired, or actual result(s) to which the outputs of the activities of a service or organization have an intended effect. For example, the outcome of safety training might be improved safety performance as reflected in a reduced number of injuries and illnesses in the workforce.
- Impact Measures - Measure the direct or indirect effects or consequences resulting from achieving program goals. An example of an impact is the comparison of actual program outcomes with estimates of the outcomes that would have occurred in the absence of the program.

Performance measures can also be categorized as leading, lagging, and/or behavioural. These types of measures are defined below:

- Lagging Measures - Measure performance after the fact. Injury and illness measures such the Lost Workday Case Rate and the Total Recordable Case Rate are examples of lagging measures commonly used to measure environment, safety and health performance.
- Leading Measures - Are more predictive of future performance and include measures such as near misses, procedural violations, or estimated cost based on highly correlated factors.
- Behavioural Measures - Measure the underlying culture or attitude of the personnel or organization being measured. Examples would include management walk-through, safety program implementation, or employee satisfaction questionnaires.

VII. TESTS FOR PERFORMANCE MEASURES

Once the performance measure types are identified and selected, it is to be tested to analyse the effectiveness of the measure. Even though a wide literature is available on the various requirements of performance measures a set of generic tests will help us to know what to look for in a performance measure and how to develop sound performance measure. Two important tests cited from The Performance-Based Management Handbook, 2001 is given below.

A. The SMART test:

SMART test provide a quick reference for determining the quality of a particular performance measure:

- S = Specific - Is the measure clear and focused to avoid misinterpretation? It should include measurement assumptions and definitions, and should be easily interpreted.
- M = Measurable - Can the measure be quantified and compared to other data? It should allow for meaningful statistical analysis. Avoid "yes/no" measures except in limited cases, such as start-up or systems-in-place situations.
- A = Attainable - Is the measure achievable, reasonable, and credible under conditions expected?
- R = Realistic - Does the measure fit into the organization's constraints? Is it cost-effective?
- T = Timely - Is measurement doable within the time frame given?

B. The Quality Check:

The following questions serve as a checklist to determine the quality of the performance measures that have been defined:

- Is the measurement objectively measurable?
- Does the measurement include a clear statement of the end results expected?
- Does the measure support customer requirements, including compliance issues where appropriate?
- Does the measure focus on the effectiveness and/or efficiency of the system being measured?
- Does the measure allow for meaningful trend or statistical analysis?
- Have appropriate industries or other external standards been applied?

VIII. CRITICISMS ON PERFORMANCE MEASUREMENT SYSTEMS

We have seen that a variety of models and frameworks were proposed and practiced in various organisational contexts. Even though each model has its own merits and features, they had to face criticisms from reviewers on various fronts. Some of the most observed shortcomings of performance measurement systems are listed below.

- Lack of systematic method for selecting measures
- Lack of a balanced approach
- Too many number of metrics and measures
- Lack of provision for benchmarking
- Lack of connection with organisation's mission and strategy.
- Failure in addressing the practicalities of measurement
- Lack of system thinking of measuring supply chain as a whole
- Lack of systematic method for prioritising measures

IX. SUGGESTIONS

- Creative efforts are needed to design new measures and new programs for assessing the performance of the supply chain as a whole as well as the performance of each organization that is a part of the supply chain (Gunasekaran et.al, 2004).
- Researchers should include and analyze safety-related measures in supply chains (Gopal et.al, 2012).
- Comparative analysis is needed of short vs long supply chains based on product life cycles (Gopal et.al, 2012).
- Composite models can be generated and be experienced in some case studies (Öztayşi et.al, 2009)
- Measures spanning entire SC do not exist; there is requirement to go beyond internal matrix and take an SC perspective (Kurien et.al, 2011).

- It is expected that future SCPMS will be incorporating technology, Operations Research techniques and heuristics in measurement frameworks (Kurien et.al, 2011).
- Future studies must address the business and environmental results of a green supply chain management performance measurement system and their impact within the organization, industry, and society at large (Hervani et. al, 2005).
- Research to explore how the conceptual frameworks can be translated and tailored to fulfil the unique measurement needs of a specific company, especially at the operational level, is needed (Michaela Striteska et.al, 2012).
- There is a need for longitudinal empirical studies that explores the relationship between the dynamic operating environment; Evolution of performance measures; Evolution of performance management and Evolution of organisational culture to create a better understanding of how one effects the other (Bititci et.al, 2000).

X. CONCLUSION

The relevance of effective performance measures in achieving sustained business progress in a dynamic environment cannot be understated. With this in mind significant amount of work has been carried out in the field of performance measurement and management in the last two decades. Literature indicates the existence of wide variety of measures and frameworks. Many of the works are theoretical models with less information on how to implement these models. The validity and practicality of most of these measures and metrics is yet to be determined. With the change of time business practices are also evolving to meet the changes in market demand and customer expectations. Accordingly the measures and measurement systems also need to evolve. The existing performance measurement models and systems are to be strengthened by including new dimensions and measures of the new age. The scope for incorporating suitable optimisation techniques to create integrated performance measurement and management systems is to be tested. While carrying on such advanced researches the ability of a performance measurement system to provide a quick snapshot of the business with relative easiness is to be maintained.

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