

## Measuring The Effectiveness Of Green Supply Chain Management

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**Abstract:** This article aims to introduce the topic of environmental (green) supply chain management measuring performance and provide an overview of the different issues involved. The work draws on real-world examples, case studies, and other research on how to quantify environmental supply chain performance. This framework aims to bring together supply chain management, environmental management, as well as performance management. The discussion is structured around a systems framework that places emphasis on control system, inputs, tools, and outputs. This paper presents an integrative approach to the study, design, and evaluation of green supply chain management performance tools. The results also raise a number of open questions. There are many possible ways to classify the problems, but we only have one design. There is a dearth of literature in this area, but cutting-edge models and innovations can fill in the gaps. The work implies that these gaps exist & that much more research needs to be done in this area. A great resource for those working to integrate such systems into existing businesses and facilitate collaboration between companies. The paper also suggests numerous avenues for researchers to fill in knowledge gaps and create research agendas. This paper presents preliminary research into how a performance measurement system for green supply chain management could be designed. We go beyond the standard approach taken by most performance measurement systems by also considering the dynamics between different organizations and the external environment in which businesses operate.

**Keywords:** Performance measurement, Sustainability, Supply chain management, Emerging economy, Environmental management.

### Introduction:

Measuring performance in supply chains with multiple geographically dispersed vendors, manufacturers, distributors, and retailers is difficult because of the inability to attribute performance results to a single entity. Measuring performance in the context of other organizations is even more challenging than measuring performance within a single organization. Non-standardized information, poor technological integration, cultural and geographical differences, discrepancies in organizational policy, dearth of agreed upon metrics, or a lack of understanding the necessity for inter-organizational performance measurement are just some of the reasons why there are no systems to measure performance across organizations [1]. Green supply chain management performance appraisal, or GSCM/PM, is almost non-existent, and there are a number of reasons for this. One of these is

the difficulty of measuring performance in supply chains, which is compounded when multiple tiers within the supply chain are considered [2]. There are many reasons why GSCM/PM is essential alongside these challenges. The long-term environmental and social sustainability & competitive nature of organizations may depend on their ability to overcome these obstacles and adopt GSCM/PM [3].

Primary functions of GSCM/PM include economic rent reporting, improved management, and in-house analysis (considerate the business better & continuous improvement). These central concerns motivate researchers to create new methods of gauging company performance. Purpose and the connections between these metrics must be considered.

This paper begins with a discussion of supply chain management & performance measurement principles as a foundation upon which to build an approach to the many challenges that GSCM/PM faces [4]. Adding supply chain or inter-organizational dimensions to benchmark measurement principles expands the scope of the original discussion. Next, we'll introduce a few GSCM principles to set the stage for talking about GSCM/PM as well as environmental management systems (or GSCM/PMS) [5]. In this setting, metrics as well as measures, are defined. Finally, we conclude by addressing management and research concerns pertaining to GSCM/PM system management.

## **Supply chain performance measurement:**

### **I. Supply chain management:**

Management of the complex set of processes involved in getting a finished good into the hands of consumers is what supply chain management is all about. It's a crucial part of running a business. It entails everything from acquiring materials and components to putting finished goods together, putting them in storage, entering orders, keeping tabs on their progress, and sending them out to customers. Customers, internal company departments, third-party distributors, and wholesalers all figure into the supply chain structure of any given business (commercial or end-user) [6]. There may be a number of supply chains that a company is a part of at once. Global players spread across borders and time zones add another layer of complexity to management and coordination. Customer expectations, globalization, IT, government regulation, competition, and the environment are all factors in the organisational success of a supply chain.

### **II. Managing and evaluating performance:**

The field of measuring corporate performance and the ways in which it is applied continue to expand to include both mixed methods. The objectives of the company or the specifics of each strategic business unit will determine the types and levels of metrics used to evaluate performance. The return on investment, profitability, market share, and revenue growth are all examples of traditional financial metrics that businesses should use to gauge performance, but these metrics lack the strategic depth required to compete effectively in today's business climate. While some metrics, such as customer satisfaction and inventory performance (supply and turnover), are more strategic, others, such as response time, are more operational

[7]. The various measurement taxonomies are ultimately to blame for the difficulties in establishing standards for performance measurement. Taxonomic factors can include, but are not limited to: the type of management level being considered (strategic, tactical, or operational); the nature of the data being collected and reported; the nature of the organization's position in the supply chain; or the nature of the functions performed within the company (e.g., accounting, versus marketing or operations).

The system for measuring performance may be as unique as the organization or department it serves because it is based on the organization's core values and external conditions. The fundamentals of performance evaluation have been the subject of numerous studies. Research into performance measurement systems has led to several findings, including the following: systems as well as measures are best developed with a team approach, deriving from and linking to corporate strategy; products and processes must be included; measures should be dynamic & present at multiple levels; Some have argued that measurement should give way to performance management, in which the company creates a suitable infrastructure and learns how to effectively implement the changes suggested by the measurements [7].

Performance measurement is essential for any business to manage its operations successfully, and this work is at the heart of total quality management and continuous improvement initiatives. One of the many performance measurement applications is evaluating and comparing alternative systems to see which ones work best. It is common practice to use performance metrics in system design, planning, implementation, and ongoing evaluation.

### **III. The Measurement of Supply Chain Performance:**

Supply chain performance quantification has received little attention from the practitioner or research communities, despite considerable work on performance measurement and management of internal organizational operations.

Historically, cost and a combination of cost as well as customer responsiveness, have been the primary metrics of success for supply chain models, particularly those that account for multiple echelons of inventory management. The existing literature does provide some foundational understanding of supply chain performance measurement in its broadest sense. The evaluation of supplier performance and the investigation of suitable performance measures have received special focus. Most of these studies have also looked at the function of supplier performance measurement constructs and evaluated their efficacy [8]. Beamon and Chen (2001) go further by analysing the impact of multiple variables on supply chain performance and determining the nature of the connection between these variables and overall supply chain efficiency. The study's findings corroborate the importance of inventory system stock-out risk, demand probability distribution, and transportation time in determining supply chain efficiency.

When it comes to supply chain performance metrics, Gunasekaran et al. (2001) describe various sources and give an overview of how they are used. In an integrated model, the supply chain's four "basic links"—planning, sourcing, manufacturing, and delivering—are considered together, and the metrics necessary for their management are determined. While they didn't get into specific environmental metrics, they did note the need for more research on the broader metrics they covered. Foresight into current practice & future requirements in supply chain performance measurement, including issues relevant to our future discussion on GSCM/PM, are provided by Gunasekaran et al. (2004), authors of a more recent empirical study. Non-financial metrics are gaining more attention than financial ones, and additional & creative efforts are required to design new measures, all of which must be coordinated across the organization for successful implementation [9].

Concerns about implementing supply chain-wide performance measurement systems and tools are voiced by Brewer and Speh (2001) in various forms.

- Combating skepticism. Historically, SCM practices have been antagonistic. There needs to be more trust in data sharing, collecting, and monitoring. Misunderstanding due to a lack of context. Managers accustomed to working with internal processes may struggle with multi-organizational metrics.
- Control issues. Management and businesses would prefer to be judged on factors they can influence. Measures taken between companies are notoriously difficult to coordinate and oversee.
- The aims and purposes are varied. Organizations with varying missions and objectives will naturally advocate for varying solutions. Technologies of information. Supply chain performance data that isn't traditionally collected by corporate information systems.
- There aren't any industry-wide metrics for success. There might not be universally accepted standards for the appropriateness of various units, organizational approaches, presentation formats, etc.
- Problems with tying metrics to actual customer worth. It is becoming increasingly difficult to establish a connection to stakeholder value (which now includes consideration of environmental concerns). It is not always obvious who the customer actually is within a given supply chain.
- Making a decision about where to start. Since the boundaries between different parts of the supply chain are not always obvious, it is challenging to develop supply chain-wide performance.

Strong leadership, communication, and partnership programs across organizations are necessary to overcome these obstacles; however, it is evident that more cooperative stances are needed among organizations. After providing an overview of supply chain performance

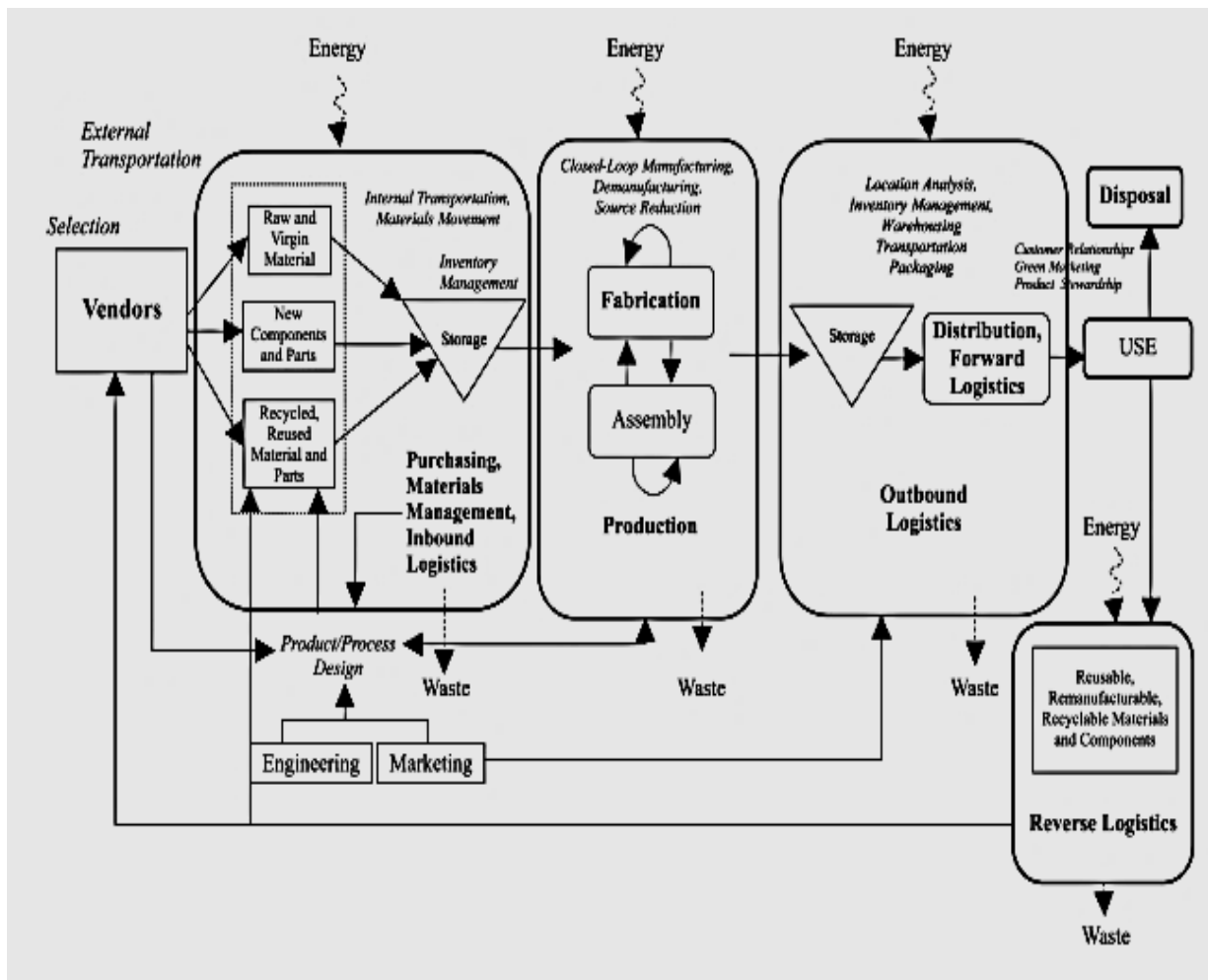
metrics, this section will introduce some of the challenges associated with green environmental supply chain management as well as performance measurement.

**Green supply chain management:**

Ecological sustainability has been used as a lens through which to examine management techniques in both tactical and strategic settings, and a wide range of combinations thereof have all been studied concerning the greening of supply chains (Bowen et al., 2001a). It makes sense that supply chain management is where the term "GSCM" is first defined. Supply chain management can be made more environmentally friendly by considering its impact on and connections to ecosystems. Both environmental concerns and internal competition can spark such behavior in businesses.

Green Supply Chain Management (GSCM) is defined in this paper as follows: Green Purchasing + Green Manufacturing + Materials Management + Green Distribution & Marketing + Reverse Logistics.

This GSCM equation is graphically represented in Figure 1, where "reverse logistics" "closes the loop" of a typical forward supply chain through activities such as material reuse, remanufacturing, and recycling. Wastes of any kind (energy, emissions, chemicals/hazards, and solids) should be avoided or reduced as much as possible. This diagram illustrates a single company's internal supply chain, key processes, and interdependencies. Green design (marketing and engineering), green procurement practices, total quality environmental management, environmentally friendly packaging and transportation, and the various product end-of-life practices defined by the "Re's" of reusability, repairability, refurbish ability, and manufacturability can all be seen throughout the supply chain. Extending this diagram further reveals a plethora of interconnected organizational relationships between the various nodes in the model, such as those between customers and their supply chains and those between suppliers and theirs.



**Figure 1: GSCM graph**

GSCM methods would greatly assist in fostering the growth of commercial ecologies. According to Korhonen and Niutanen's (2003) analysis of the flow of materials and energy in the Finnish forest industry, these flows are typical of industrial and economic systems overall. Only in the last two decades have the product-based systems perspective and the locally and regionally defined industrial ecosystem come into being. Both strategies aim to lessen the burden placed on natural resources and the environment by the material and energy demands of the industrial system. In this respect, Korhonen (2002) concurs that the sustainable natural ecosystem model is an excellent idea.

Sharing accountability for environmental performance between organizations is a key component of GSCM. A reduced environmental burden caused by industry should be a primary goal of GSCM, and the sharing of environmental responsibility should help get us there. Life cycle assessment, product stewardship, and the design for environment (DFE) principles are just some of the tools and philosophies that can help managers create supply chain environmental impact maps. Life cycle assessment is a systematic method to define and assess the full environmental burden of delivering a service. It also includes analysis of the impact of materials, products, and processes and the development of a data inventory. When



considering these factors of life cycle assessment, it is essential to measure and track GSCM performance using appropriate metrics. The proactive nature of the company's environmental approach is often cited as a predictor of GSCM implementation. In their article "Capabilities Appropriate for Green Supply," Bowen et al. (2001b) state that a proactive company's responsibility stance and a strategic supply chain and purchasing management approach are necessary to develop the capabilities necessary for green supply. When fully formed, supply chain management capabilities can facilitate the introduction of green supply, thereby facilitating the spread of environmentally responsible practices across the intricate web of industrial trade.

Hart (1995) and Sarkis & Kitazawa (2000) argue that organizational capabilities and pressures for GSCM introduction are related to total quality management, which can ease the introduction of smog prevention programs, and cross-functional management facilitates product stewardship, an essential part of GSCM. Total quality environmental management is a subset of the broader total quality management paradigm that similarly relies on data to make decisions and emphasizes constant growth through precise performance monitoring. Beamon (1999), in one of the few studies connecting GSCM components and performance measurement, proposes expanding the traditional evaluation structure of the supply chain to incorporate mechanisms for product recovery (reverse logistics) as well as the establishment & implementation of new performance measurement systems. However, not as much research has been done on measuring the environmental performance of supply chains as a whole.

#### **System for measuring the effectiveness of green supply chain management:**

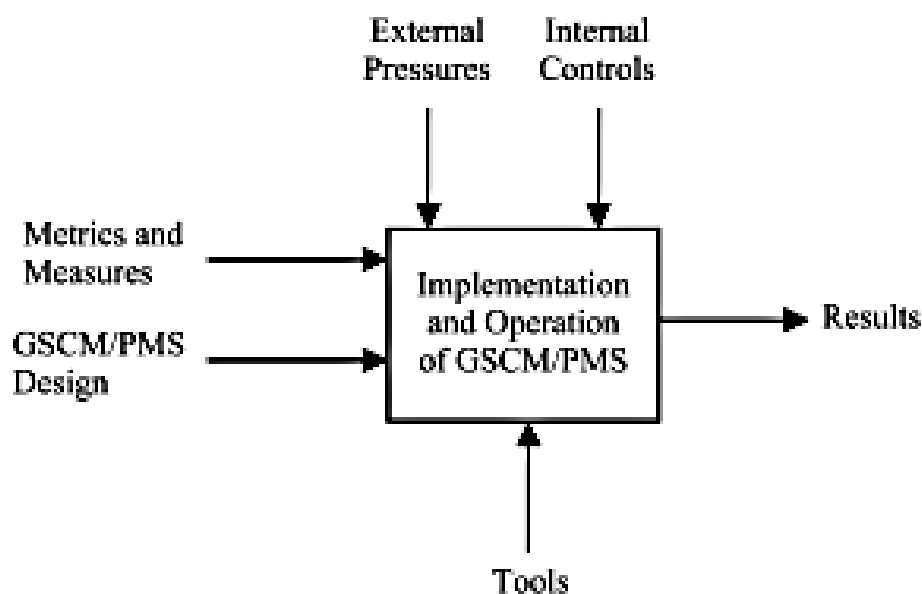
This paper significantly contributes by addressing problems with the GSCM/PMS (green supply chain performance measurement system). A systems model based on the single activity "Implementation and Operation of GSCM/PMS" is depicted in Figure 2, which will serve as a framework for the rest of our discussion. The primary constraints of this system's management are first discussed; these include both external pressures and internal controls and pressures. Next, we'll go over the system's essential inputs, which will cover topics such as the "metrics and measures" used in the system and how a GSCM/PMS will be built. Identifying "tools" that can be used in GSCM/PMS management is also possible. The outcomes of such a system are discussed in terms of the expected results.

#### **IV. Influences and constraints on a GSCM/PMS:**

Struggles within. Internal controls for GSCM/PMS are under significant pressure due to financial considerations. Needs are determined by waste streams, disposal costs, and the total amount of waste and excess that results from failing to recycle. Numerous legacy systems, data management systems, and connections to other performance systems (such as those based on ISO 9000:2000, total quality management, as well as other industry-specific standards) make up the vast network of internal controls. Costs, employee interest, and green program activity are all things that can be evaluated as part of the internal controls that

govern an organization. Whether or not a company decides to implement new, cutting-edge procedures depends on a variety of internal factors. Many of these novel practices' environmental and economic benefits are still to be determined. According to Florida et al. (2000), a company's adoption of environmental practices is significantly influenced by two organizational factors: organizational resources and capacity and organizational monitoring. Several studies have looked into how businesses adopt organizational innovations similar to these novel practices.

Much research has been done on the importance of "organizational capabilities" to organizational innovation and performance. Research like this suggests that differences in an organization's internal resources and procedures can affect its responsiveness to both changes in the internal or challenges. Organizational capabilities include available resources, the ability to think creatively, and internal checks and balances effectiveness. When we talk about a company's "resources and capacity," we're referring to things like their overall level of resources as well as any specialized environmental resource and capacity they may have. When we talk about a company's innovativeness, we're referring to its history and record of embracing and successfully implementing new and cutting-edge business methods. The term "organizational monitoring" is used to describe the processes by which businesses track their progress in strategic areas. Hemmelskamp (1999) adds that it's important to draw on internal and external information sources when developing environmentally friendly products. GSCM/PMS are required within this context, and their absence will severely restrict the ability to implement this sort of innovation within an organization and, increasingly, among them.



**Figure 2: GSCM/PMS flow & pressures**

Angel del Brio and Junquera have summed up the factors that affect how quickly communities adopt environmental innovations like GSCM/PMS (2003). The authors propose



that a number of factors, including constrained financial resources, the nature of the organization's structure, the lack of influence of the strategic adaptation competence against changes in the enterprises, the lack of environmental training and short-term orientation among managers, the dearth of environmental awareness and training among employees, and the nature of the environmental issue themselves, all contribute to the fact that small and medium-sized businesses are less likely to innovate in terms of environmental strategy. Larger organizations also face this challenge and must learn to overcome it (for references, see Sharma (2000) and Bansal and Roth (2000)). For environmental innovations to be implemented successfully, businesses need to create suitable internal structures. Environmental innovations are those that lessen the negative effects on the environment caused by traditional business practices (Clayton et al., 1999). Inventions with positive environmental impacts are driven both by environmental concerns and the desire to make a profit. Knowledge of product features, process and material features, and technological and market options must be combined in novel ways for an environmentally beneficial innovation to be implemented successfully.

The availability of large bodies of internal expertise inside firms can be a valuable resource for environmental innovations, as knowledge processes are central to environmental innovation. Both process and product innovations benefit from information gathered internally. For instance, a company's ability to construct green supply capabilities may depend critically on purchasing staff's technical abilities and skills. Organizations need the right frameworks to evaluate and implement external metrics. An organization also needs what's known as "internal absorptive capacity," or the ability to absorb new information and make necessary adjustments to its operations in response to unexpected events. To be sustainable, change must take root within organizations. The importance of GSCM performance management can be reaffirmed by giving it attention from upper management and providing for its measurement, assessment, & rewards at all levels. Using suggestion systems, promoting green practices within the company, and communicating the importance of doing so are all essential components of any successful process implementation. Factors from without. Many outside forces necessitate the development of GSCM/PMS and similar environmental innovations. External "stakeholders" and competitors are two broad categories that encompass many subcategories. Both governmental and commercial pressures contribute to the situation. Some of these stresses are more severe for some businesses and sectors than others. The problems with the company's legitimacy are the source of many of the outside worries and pressures.

### **Conclusions:**

It has been discussed how strategic as well as inter-organizational (supply chain) needs have been added to organizational performance measurement since the early days of operational silos. Organizations are now forced by competition to look beyond their own walls for answers about how to maintain a sustainable competitive advantage. Systems for managing performance across organizations are important. Considering environmental factors is a

natural extension of this broader competitiveness. Over the past few decades, pressure from stakeholders inside and outside an organization has led to a widespread shift toward taking environmental factors into account at every stage of the planning and implementation processes. This stress is felt all along the supply chain, and it's driving the recent uptick in its prevalence and interest. There needs to be at least some planning and conceptualization of performance measurement systems & their requirements to help with the introduction and implementation of GSCM. The main contribution of this paper is the introduction of various topics as well as concerns of GSCM/PMS, such as the various internal/external pressures, the types of metrics that need to be developed, prospective designs of GSCM/PMS, and the tools and results of a GSCM/PMS. Although many companies have not yet implemented such systems, doing so may be necessary for their long-term success in the face of increasing integration and mounting pressure.

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