مقاله پاورپوینت ارائه شده در همایش

Performance Measurement for Green Supply Chain Management

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What is it ?

In supply chains with multiple vendors, manufacturers, distributors and retailers, whether regionally or globally dispersed, performance measurement is challenging because it is difficult to attribute performance results to one particular entity within the chain.

Supply Chain Management (SCM)

What is SCM?

Supply chain management is the coordination and management of a complex network of activities involved in delivering a finished product to the end user or customer.

A company's supply chain structure consists of external suppliers, internal functions of the company, and external distributors, as well as customers (commercial or end-user).

The successful management of a supply chain is also influenced by customer expectations, globalization, information technology, government regulation, competition, and the environment.

Some Principles of Performance Measurement

From (Nanni et al. 1990; Kaplan and Norton 1980's; Sink and Tuttle 1989; Gunasekaran et al. 2001):

- Measures may be Tangible and Intangible
- Balance among them
- Measures should be dynamic
- Measures should be at multiple levels
- Don't use too many
- Should be appropriate for your problem.
- Measures should be developed with a team approach
- Measures should be derived from strategy
- Measures should be developed for activities and processes

Linking the Supply Chain and Performance Measurement

Supply chain models have typically focused on performance measures such:

- cost and a combination of cost and customer responsiveness.
- supplier performance evaluation and appropriate performance measures
- performance metrics across the supply chain
- successful implementation requires organization-wide coordination
- to monitor performance each metric must take a supply chain perspective
- each entity in the supply chain should be measured and improved with common goals
- non-financial metrics are gaining more attention then financial ones
- additional and creative efforts are needed to design new measures.

GREEN SUPPLY CHAIN MANAGEMENT (GSCM)

Several research studying management practices in both operational and strategic contexts include:

- Ecological sustainability as a framework (Sarkis & Rasheed 1995; Klassen & McLaughlin 1996; King & Lenox, 2001)
- Greening of supply chains within various contexts including in product design (Allenby 1993; Gupta 1995)
- Process design (Porter & Van der Linde 1995a; Klassen & McLaughin 1996)
- Manufacturing practices (Winsemius & Guntram 1992)
- Purchasing (Handfield, et al., 2002) and a broad mixture of these elements (Bowen, et al., 2001a).

What is Green Supply Chain Management?

Adding the "green" component to supply chain management involves addressing the influence and relationships of supply chain management to the natural environment.

Question really is what is Supply Chain Management?

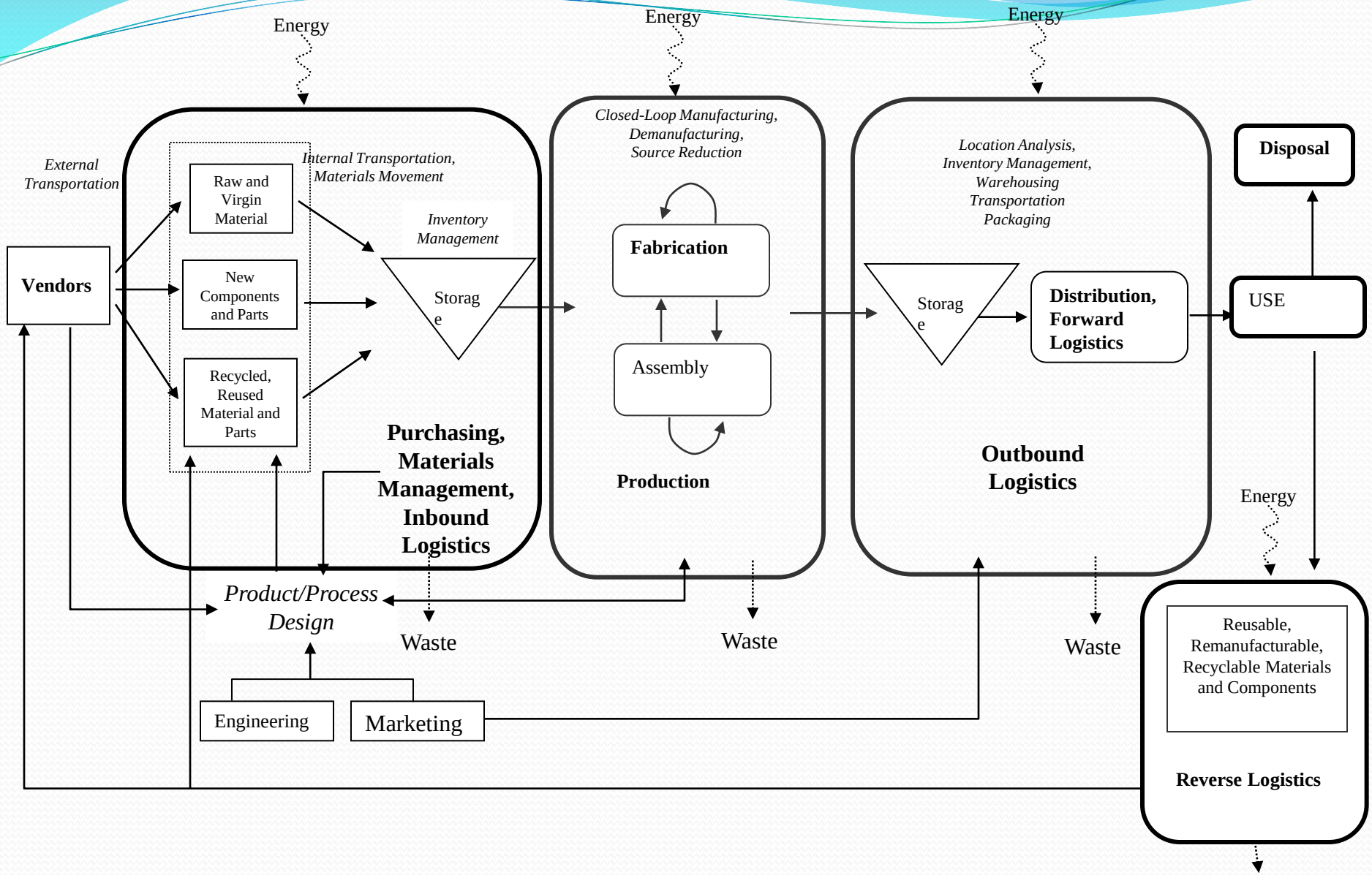
Green = Natural Environment (may = money too).

GSCM = Green Purchasing + Green Manufacturing/Materials Management + Green Distribution/Marketing + Reverse Logistics

What is Green Supply Chain Management?

Figure 1

describes this GSCM equation graphically, where reverse logistics “closes the loop” of a typical forward supply chain and includes reuse, remanufacturing, and/or recycling of materials into new materials or other products with value in the marketplace.


Energy
Energy
Energy
External Transportation
Vendors
Raw and Virgin Material
New Components and Parts
Recycled, Reused Material and Parts
Internal Transportation, Materials Movement
Inventory Management
Storag e
Purchasing, Materials Management, Inbound Logistics
Closed-Loop Manufacturing, Demanufacturing, Source Reduction
Fabrication
Assembly
Production
Location Analysis, Inventory Management, Warehousing Transportation Packaging
Storag e
Distribution, Forward Logistics
Outbound Logistics
Disposal
USE
Energy
Product/Process Design
Waste
Waste
Waste
Engineering
Marketing
Reusable, Remanufacturable, Recyclable Materials and Components
Reverse Logistics

GREEN SUPPLY CHAIN MANAGEMENT

A major element within GSCM is concerned with inter-organizationally sharing responsibility for various aspects of environmental performance.

GSCM should promote the sharing of environmental responsibility and lend itself to achieving a reduced environmental burden caused by industry.

Several techniques exist to help managers map the environmental impacts along supply chains, such as the life cycle assessment, product stewardship, and design for environment (DFE) principles, which are also complementary tools and philosophies for each other.

Performance Measurement within the Environmental Context

- Practically: ISO 14031 are the performance measurement guidelines. Total Quality Environmental Management requires environmental performance elements (like TQM).
- Research: Descriptive research on performance measures in environmental situations is still early. Relationship of organizational environmental and other organizational performance research is plentiful and growing.

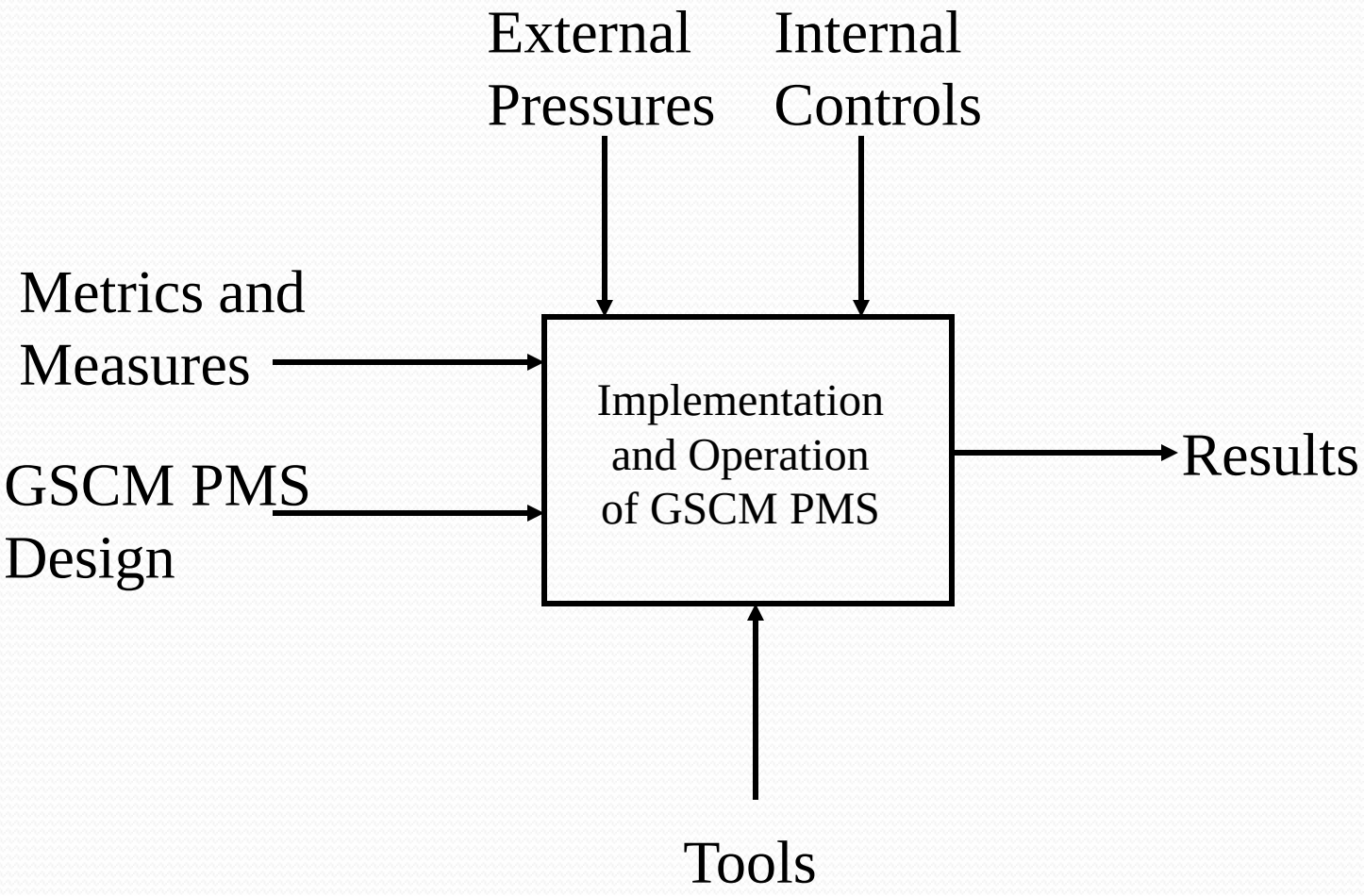
Roles of Performance Measurement in GSCM

- Supplier Selection
- Supplier Monitoring
- Product Design Selection and Improvement
- Continuous Improvement of Processes
- Monitoring Internal Processes
- Product Performance
- Life Cycle Analysis
- Customer Management Performance
- Logistics Design

Some Previous Works in Performance Measurement in GSCM

1. Bowen et al. (2001) – Green Supply and Firm Performance
2. Theyel (2001) – Customer – Supplier relationships and environmental performance
3. Faruk et al. (2001) – Environmental Matrix scoring across supply chain.
4. Handfield et al. (2002) – Supplier Assessment and AHP
5. Nagel (2003) – Development of Performance Measures (ratios) for evaluating supplier environmental performance.
6. Harris (2003) – Business value perspective of Strategic Sourcing and environmental issues.
7. Zhu et al. (in progress) – GSCM practices and relationships to various types of performance.

GSCM/PM Flow & Pressures



What Factors Influence a Firm's Adoption of Environmental Practices?

- Many studies focus on the role of "organizational capabilities" in both organizational innovation and organizational performance (e.g. Cohen & Levinthal 1990; Teece & Pisano 1994; Winter 1987).

- Organizational Capabilities Include Factors such as:

- **Organizational Resources** (refer to overall level of resources and specialized environmental resources and capacities possessed by firms.)
- **Organizational Innovativeness** (refers to firm's previous commitment and track record in implementing advanced organizational practices.)
- **Organizational Monitoring systems** (refers to the methods by which organizations measure, analyze, and monitor their performance in key dimensions).

External Pressures

- *There are a number of sources of external pressures for GSCM/PMS and other environmental innovations.*

- EXAMPLES
  - Product Take-back
  - Life Cycle Analysis
  - Compliance
  - Liability
  - Business Continuity
  - Benchmarking
  - Customer Relationships
  - Inter-organizational IT/Data/Management systems
  - European Union's Impact on the Environment of Electrical and Electronic Equipment (EEE) Directive and Integrated Product Policy (IPP) initiative

Internal Controls

- Pressures for internal controls for GSCM/PMS are largely cost and profit driven. Waste streams, costs for disposal, and the overall waste and excess from not recycling drive the needs. Internal controls are numerous, and include:

- Legacy Systems
- Data Management
- Linkage to other performance systems
- Environmental Programs (Reactive/Proactive)
- Employee Interest and Activity
- Costs

Performance Measure Taxonomies

Overall, difficulties in developing standards for performance measurement are traced to the various measurement taxonomies such as:

- Level of Management (Strategic, Tactical, Operational)
- Tangible/Intangible
- Location Along Supply Chain
- Internal/External
- Functional/Cross-functional
- Overall? Many possible dimensions.

Metrics & Measures

- Environmental performance indicators are core requirements of a GSCM/PMS when evaluating the environmental performance of activities, processes, hardware and services. Environmental performance indicators are described in ISO 14031

- The next two slides provide a list of selected metrics of environmental performance from the Toxics Release Inventory and the Global Reporting Initiative ranging from air emissions to energy recovery and recycling.

Environmental Measures and Metrics

Selected Metrics of Environmental Performance used by TRI and GRI

- Fugitive non-point air emissions
- Stack or point air emissions
- Discharges to receiving streams and water bodies
- Underground injection on-site
- Releases to land on-site
- Discharges to publicly owned treatment works
- Other off-site transfers
- On-site and off-site energy recovery
- On-site and off-site recycling
- On-site or off-site treatment

Measures and Metrics-Continued

Selected Metrics of Environmental Performance used by TRI and GRI

- Non-Production releases
- Source Reduction Activities
- Spill and Leak Prevention
- Inventory Control
- Raw Material Modification
- Process Modifications
- Cleaning and Decreasing
- Surface Preparation and Finishing
- Product Modifications
- Pollution Prevention Opportunity Audits
- Materials Balances Audits

Measures and Metrics-Continued

- Employee and Participative Management
- Publicly available missions and values statement(s)
- Management systems pertaining to social and environmental performance
- Magnitude and nature of penalties for non-compliance.
- Number, volume, and nature of accidental or non-routine releases to land, air, and water
- Costs associated with environmental compliance
- Environmental liabilities under applicable laws and regulations
- Site remediation costs under applicable laws and regulations
- Major awards received
- Total energy use
- Total electricity use.
- Total fuel use.

Measures and Metrics-Continued

- Total water use.
- Habitat improvements and damages due to enterprise operations.
- Quantity of non-product output returned to process or market by recycling or reuse
- Major environmental, social, and economic impacts associated with the life cycle of products and services.
- Formal, written commitments requiring an evaluation of life cycle impacts.
- Programs or procedures to prevent or minimize potentially adverse impacts of products and services.
- Procedures to assist product and service designers to create products or services with reduced adverse life cycle impact.
- What makes these different for GSCM?

Designing a GSCM/PMS

Design issues and implementation issues must be addressed by the organization. When designing the GSCM/PMS, top management should address the following questions:

- What are the goals of the GSCM/PMS?
- How does the GSCM/PMS fit within the strategy of the supply chain?
- How should GSCM/PMS be designed?
- How should external stakeholder concerns and preferences be integrated?
- What metrics levels and decomposition should be included?
- Who should design the measures?

Designing a GSCM/PMS-Continued

Design issues and implementation issues must be addressed by the organization. When designing the GSCM/PMS, top management should address the following questions:

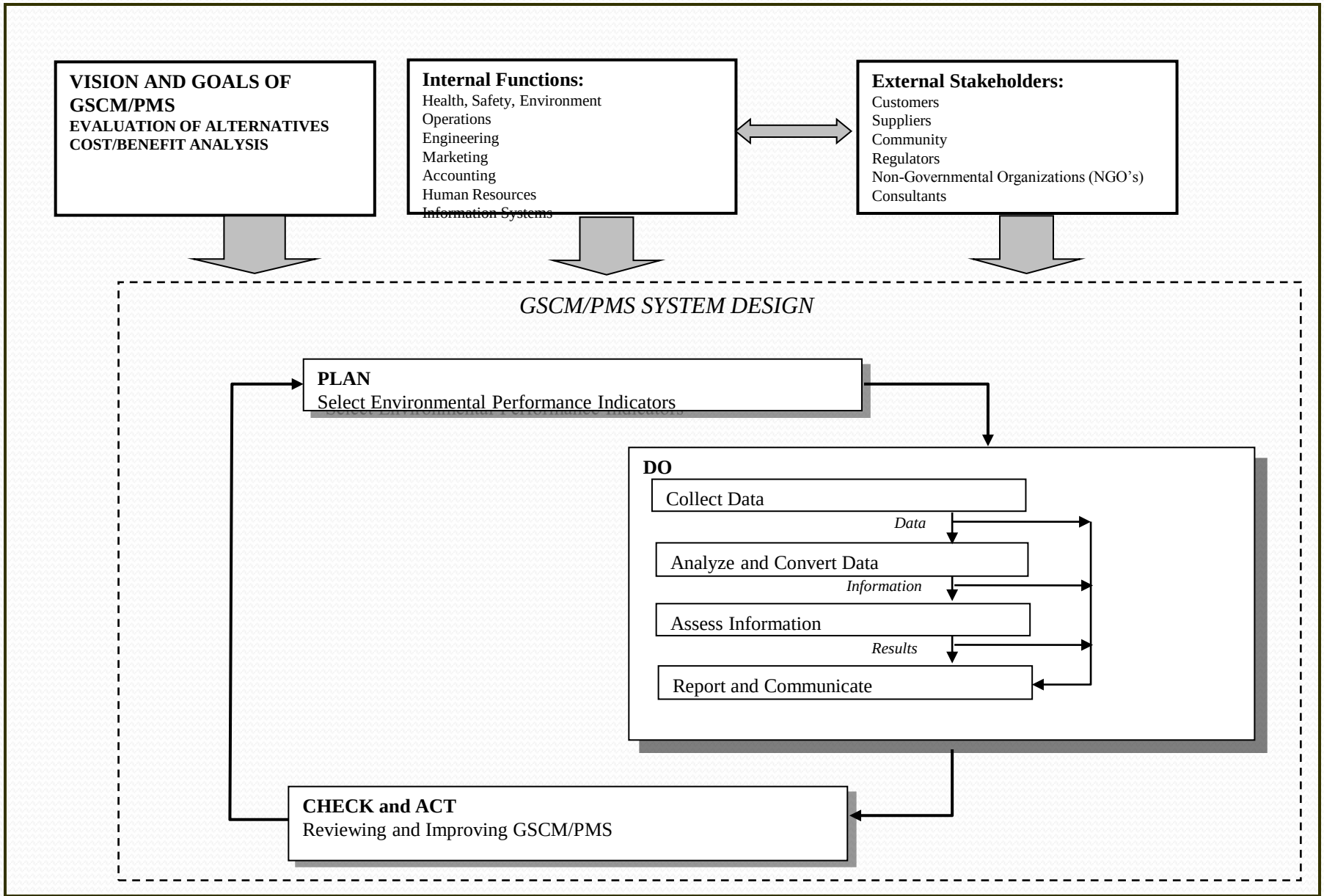
- Who should monitor the measures?
- How should information generated by system be used and disseminated?
- How should information be linked up to other internal and external performance measurement systems, environmental management systems and other information systems (e.g. enterprise resource planning systems)?
- What are relationships between GSCM measures and organizational measures (e.g. customer satisfaction)?

Design Issues

How to design GSCM performance measurement systems?

- These may be inter-organizational systems
- What metrics to include, levels and decomposition?
- Who should design them?
- Who should monitor them?
- How should info be used?
- How should they be linked up to other internal and external performance measurement systems and EMS.
- What are relationships between GSCM measures and organizational measures (customer satisfaction)

Design of a performance measurement system (ISO-14031)



Operation and Implementation Issues

- GSCM PMS implementation
  - Are they being implemented? How?
  - What is the adoption rate?
  - Do they work?
  - What makes them work? Not work?
  - Who is involved in implementation?
  - What element in supply chain do they address?
  - What type of management support is needed?
  - What are costs?

Tools Issues

- Performance Measurement Tools

  - Are current toolsets adequate? Do tools exist?
    - Analytical hierarchy process
    - Activity-Based Costing
    - Design for Environment Analysis
    - Balanced Scorecard
    - MCDM
    - Weighted Matrices
    - Spider and Control Charts
    - Life cycle analysis type tools
    - Ecological supply chain analysis
    - Data Envelopment Analysis
  - What alterations have to be made for GSCM? Elements of GSCM?

Results of GSCM/PMS

- Results or Outputs of GSCM/PMS may serve numerous purposes including:

  - External Communications
  - Companies Improvements
  - Regulatory Compliance.

Results of GSCM/PMS-Continued

- For external communications, companies will have metrics as well as longitudinal data to benchmark and show performance and improvement over time in both environmental awareness and actions.

- The GSCM/PMS data may also be used internally for assessing improvements in waste elimination, recovery, recycling, cost containment, elimination of extra processing time (including energy and raw materials), and other key measures of waste.

- Regulatory compliance with local, regional, national and international laws is another use of the performance measurement system data.

SUMMARY AND CONCLUSIONS

-Competitive forces have caused organizations to look externally to determine how to sustain long term competitive advantage.

-Inter-organizational performance management systems play a role. Part of this broadened focus of competitiveness necessarily begins to focus on the natural environment.

-Stakeholders (internal and external) over the last few decades have caused organizations to explicitly consider the environment in their strategic and operational planning and execution. This pressure has extended across the supply chain and is responsible for the increased growth and interest in GSCM.

-To aid GSCM implementation and introduction, there is a need to at least plan for and conceptualize performance measurement systems and their requirements.

Results

- Are the results of a GSCM PMS measurable?
- Are GSCM PMS making a difference?
- Will they make a difference?
- What do they work for, what don't they work so well for?

Issues for Future Research

(1) inter-organizational agreement on performance management and measurement

(2) managing the entire supply chain beyond the single dyadic relationship (with numerous questions that need to be answer such as: Who is in charge? Who decides? How important is it? Global issues? What should be the baseline? Do industry differences exist – e.g. chemical versus electronics?)

(3) tools needed for further GSCM/PMS enhancement and development

(4) linkages to product stewardship, life cycle analysis and design for the environment

(5) development of data and information with respect to GSCM

(6) adequacy of the tools and management of supply chain management for incorporating environmental management dimensions and

(7) roles of new technologies including information technology.