

**Ecosystem Aware
Global Supply Chain Management**

International Conference on
Stochastic Systems and Applications

**Green Supply Chain Design: An
Ecosystem Approach**

Meet the Present needs without compromising the Future

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**Ecosystem Aware
Global Supply Chain Management**

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Sustainable Development

“Development that meets the needs of the present without compromising the ability of future generations to meet their needs.”

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The Triple Bottom Line

Managing economic growth while reducing the use of resources and pace of emissions growth



- The triple bottom line is made up of "**social, economic and environmental**" the "people, planet, profit". The phrase was coined by John Elkington in 1995
- Quantitative models to evaluate and compare are needed
- Optimize: Best compromise between needs and resources

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Greenhouse Gas Emissions: Carbon Foot print

- Gases that trap heat in the atmosphere are called greenhouse gases: Carbon Dioxide (CO₂), Methane (CH₄); Nitrous Oxide (N₂O); Fluorinated Gases, etc
- “Carbon Footprint” refers to the total amount of carbon dioxide (CO₂) and other greenhouse gases emitted over the entire lifecycle of a product or service.

GHG Estimation and Reduction: Supply Chain Approach

Holistic analysis of end-to-end supply chain can lead to better reduction in emissions

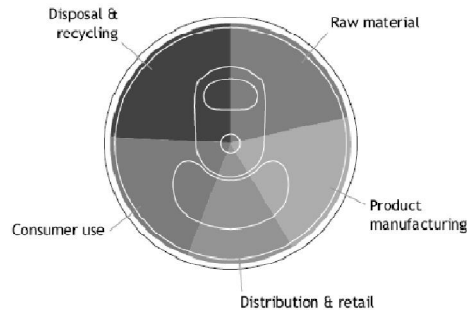
- In UK, One can buy a rose grown in Netherlands or from Kenya.
- 12,000 roses from Kenya emit 2,200 Kg CO₂, whereas those from Dutch emit 35,000 Kg CO₂.
 - Flower from Netherlands travels less miles than from Kenya.
 - Kenya grows the roses in Natural weather. In Netherlands, it require artificial light, heat and cooling over the 8 -12 week growing cycle.
- Potatoes are stored in artificially humidified warehouses which increases the water content, weight and value. If potatoes with lower water content are preferred, we save on energy bill and less frying emissions

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The Carbon Supply Chain for Cola

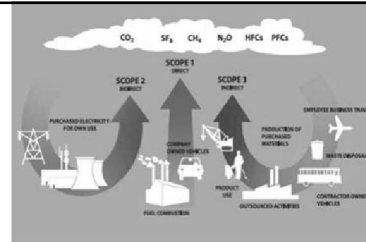


Total carbon footprint of the can of cola (illustrative)



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Three Scopes in GHG Protocol



- **Scope 1:** Direct emissions occur “from sources that are owned or controlled by the reporting entity” (industrial & on-site energy production)
- **Scope 2:** Indirect emissions from “activities of the reporting entity but occur at sources owned or controlled by another entity”(electricity)
- **Scope 3:** all other emissions associated with a company’s activities that are not included in Scopes 1 or 2, such as
 - Employee travel
 - Extraction and processing of raw materials and transport to company
 - Shipment of products to distribution centers, retailers, and customers
 - Product disposal.

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Two Popular Green methodologies

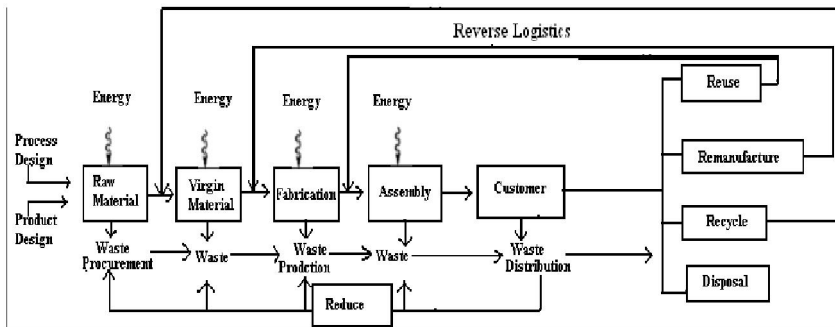
Cradle to Cradle Protocol

Carbon Trading

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A Green Sustainable Supply Chain Cradle to Cradle Protocol

A sustainable supply chain uses environmentally friendly inputs & transforms them into *outputs that can be reclaimed and re-used* at the end of their life-cycle.



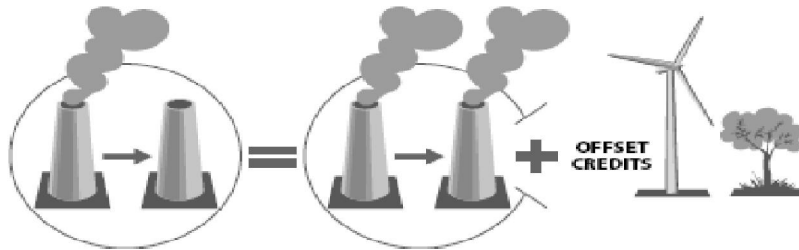
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The Basic Principle of Emissions Trading

- **Cap and Trade:** Emissions can be traded
 - The cost of emission reduction differs from firm to firm.
 - This creates a market opportunity.
 - The firm X can reduce more than *its emissions cap* and can sell its extra reduction units to another firm Y at a cost lower than the cost of emissions reduction for firm Y. X & Y can be in different continents
- **Carbon Offset:** The carbon credits can be offset against a qualifying carbon-reduction project: renewable-power generation, energy efficiency projects, forestry and industrial-waste remediation.
- The aim is to reduce the emissions into the atmosphere does not matter about the location

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Basic Assumption Behind Carbon Emission Trading Schemes



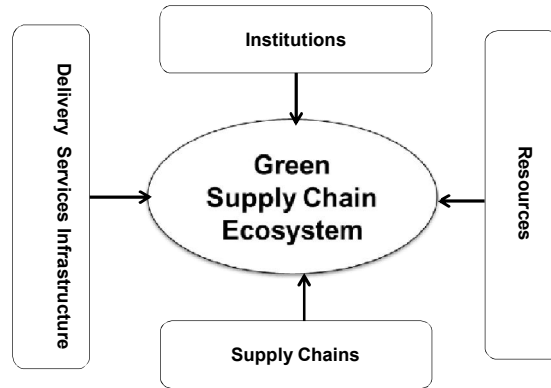
- What matters for the climate is the overall greenhouse gas concentrations in the atmosphere and it is a problem of quantity, so it doesn't matter where emissions are reduced as long as they are reduced'
- Most carbon offset projects are located in the global South.

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The Green Supply Chain Ecosystem

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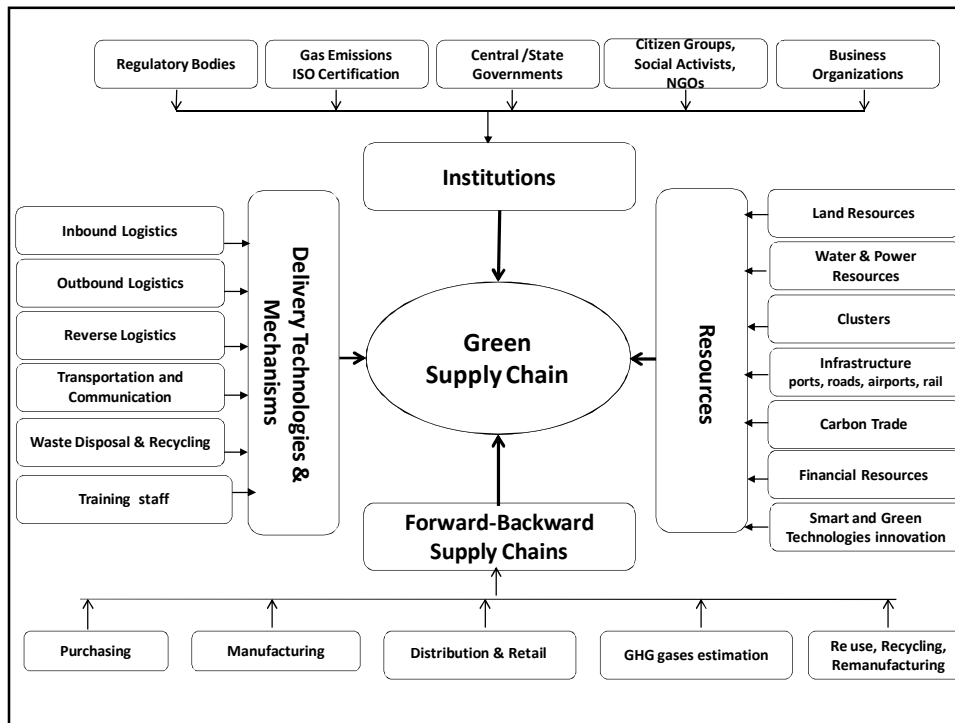
The Green Supply Chain Ecosystem



Co-Evolution, Risk Propagation

The Ecosystem Framework for GSCN

- Forward-Backward Supply chains
- Governmental & Social Institutions
- Resources including Human, Natural, Financial and Industrial (Clusters)
- Delivery Services



Green Business Processes

Ecosystem Aware Global Supply Chain Management

- Green Procurement : Acquisition of products and services that minimize environmental impacts over their life cycle of manufacturing, transportation, use and recycling or disposal.
- Green Manufacturing: Production processes using efficient inputs, energy-efficient technologies that generate little waste or pollution & have low environmental impact
- In-bound Logistics : Freight Consolidation, The transport mode selection. Rail and barge use energy more efficiently than road haulage or air cargo
- Outbound logistics : Criteria for green logistics such as Fewer shipments, less handling, shorter movements, more direct routes, and better space utilization tradeoff with delivery time, responsiveness, quality and cost.

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Resources

- Industries influence the environment in the eight major stress categories: **use of raw materials, energy, water, land, atmospheric emissions, water effluents, production of solid waste, and other releases.**
- Use of land in competition with other activities, such as agriculture; Use of virgin land (forests, wetlands and coastal), biodiversity loss.
- Massive use of non-renewable natural resources, Pollution during the transportation and manufacturing ; Consumption of water and pollution of water reserves; Generation of waste ; High energy consumption in product making & usage
- Cradle to Grave or Cradle to Cradle protocols

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Institutions Role in the Green Supply Chain

- Environmental legislations : Clean Air Act, the Clean Water Act, the Toxic Substances Act, Comprehensive Environmental Response, Compensation, and Liability Act were adopted in several countries.
- Legislation on products, energy usage motivate GSN research
- ISO 14000 series provide guidelines and standards towards ecologically sustainable business practices
- The price of emissions can include taxes, tax credits, and subsidies directly related to emissions and indirect emissions pricing such as fuel charges.

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Reverse Logistics

- Reverse logistics is the process of retrieving the product from the end consumer and includes collection, sorting, re-processing, redistribution, and disposal.
- Reverse logistics competency that does not exist in most OEMs or 3PLs. Outsourcing is common.
- The stronger the pooling ability held by the third party over the manufacturer in reverse logistics, the more suitable it is for the third party to manage the reverse supply chain.

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GRIP Framework

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Performance

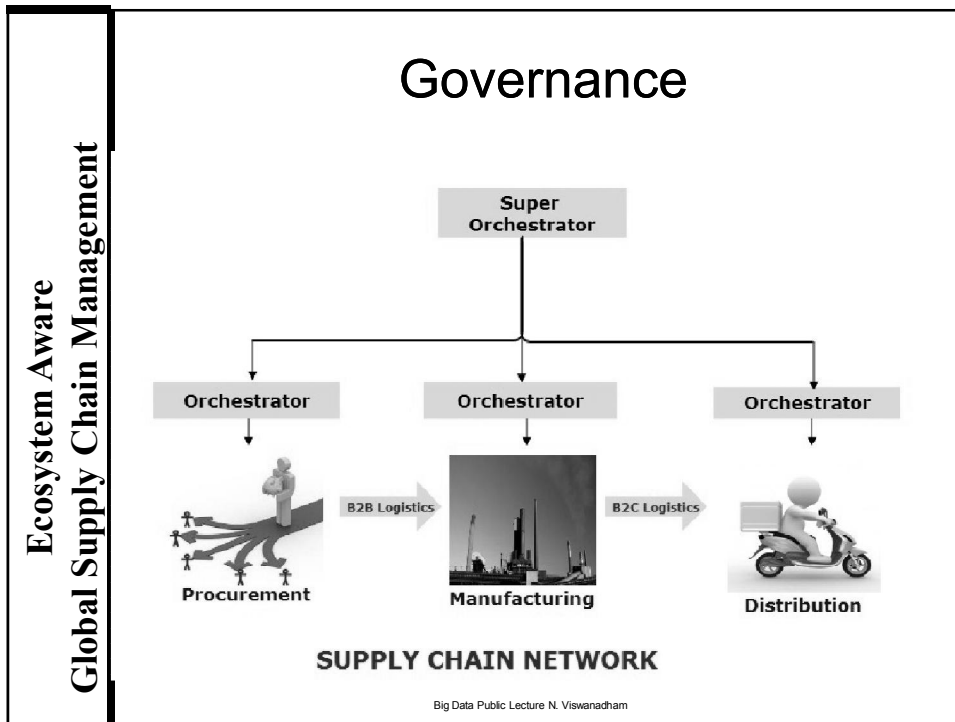
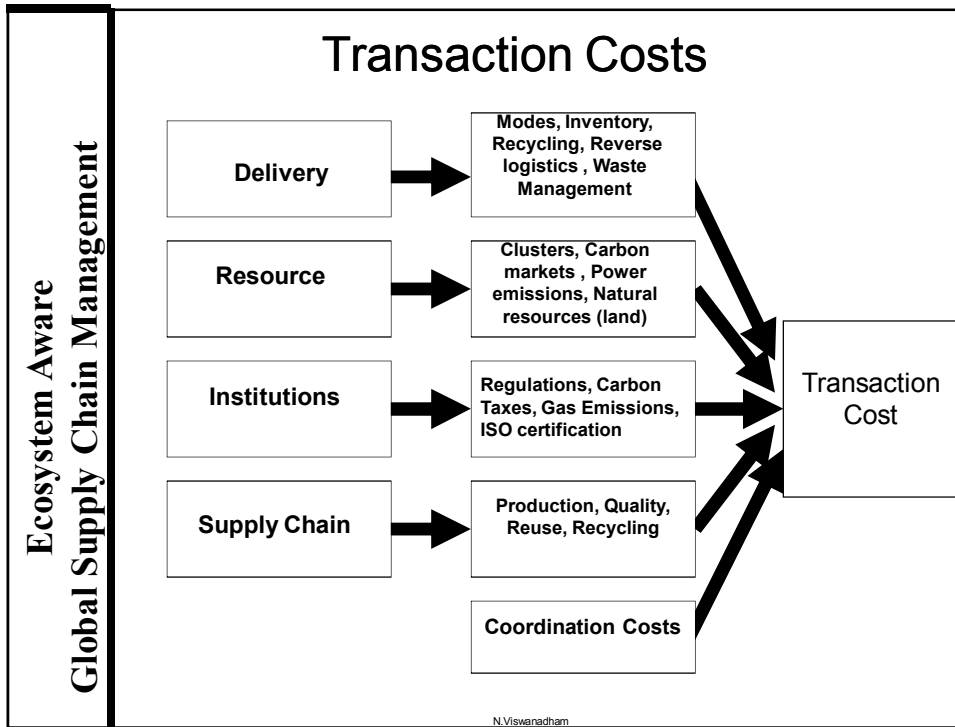
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Enablers and Green Supply Chain Performance

	Value Chain	Delivery	Institutions	Resources
Enablers	Re Innovations, Carbon Trading GHG, Resource minimization	Green Transport Mode , Reverse Logistics ,Smart Warehousing Carbon Trade	Green Regulations Emission Caps, ISO14000	Water, Power , Cradle to Cradle protocol ,Carbon markets
GHG gases	Low if product refurbished, High Otherwise	Low	Low	Low
Cost	High Product Design Cost, Low Production Cost	High Transportation & Inventory Costs	Cost of regulation, High Environ safety	Low Costs due to recycling

- Production and consumption costs include costs of inputs such as labor and capital and do not fully reflect the cost of using environmental resources.

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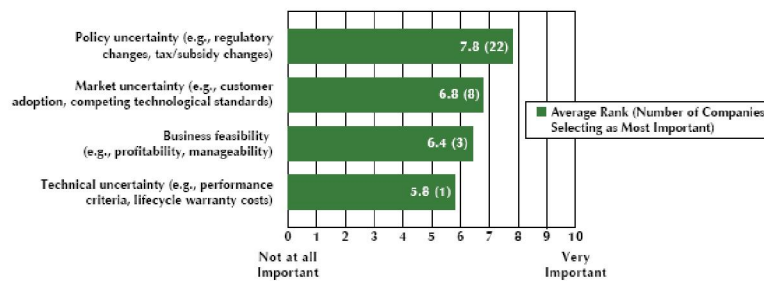


Risk

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Risk

- Companies need to understand how global warming could impact their supply chain; assessing potential climate-related vulnerabilities such as new rainfall patterns, increased storm activity, higher prices for natural resources, and potential political instability and energy insecurity.



Source: Center Survey (2011).

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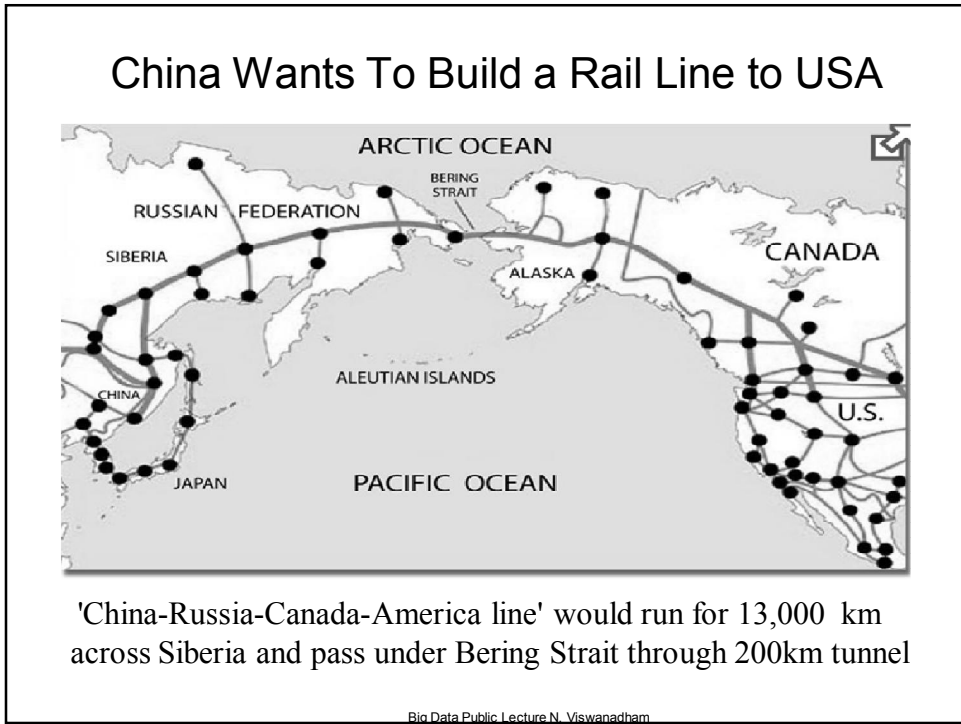
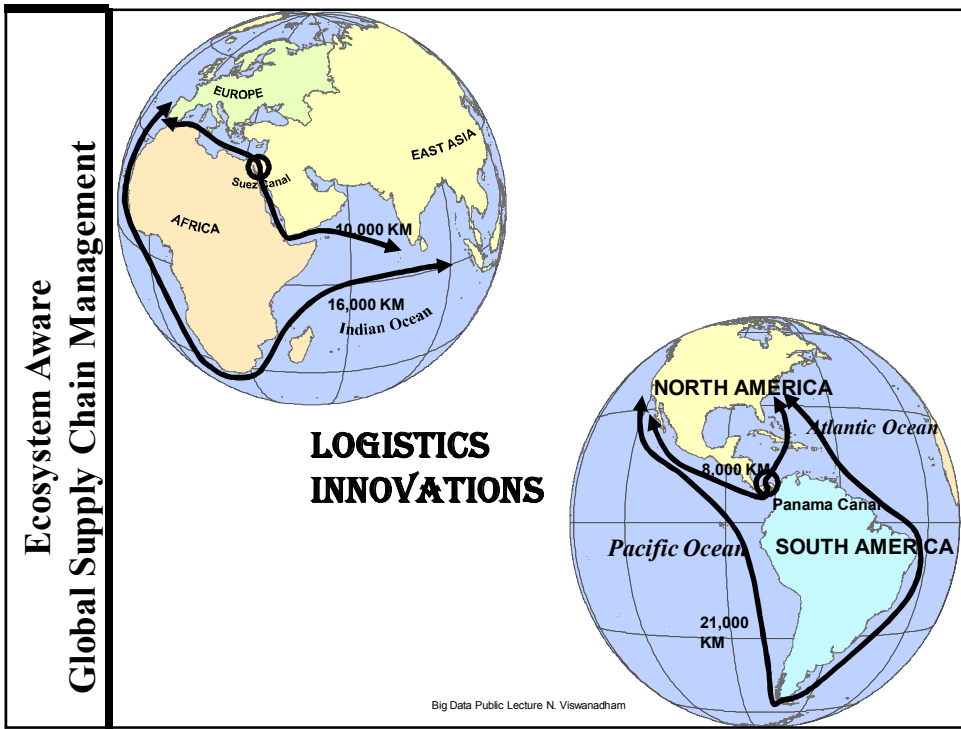
Policy and Market Uncertainties

- Many companies (65%) named government policy uncertainty as the biggest risk.
- Sectors, such as electricity, are regulated both at the federal and **state levels; policies often vary state-by-state.**
- **National priorities shift with elections.** President Clinton's clean car initiative meaning fuel efficiency, safety & less emissions, gave way to a hydrogen fuel initiative of President Bush. President Obama is focusing on electric cars.
- **Market acceptance.** Will customers pay more for electric cars and other highly fuel-efficient vehicles? The answer may change depending on fuel prices, the state of the economy, government policies.

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Innovations

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The Procurement Process: Data Based Decision Making

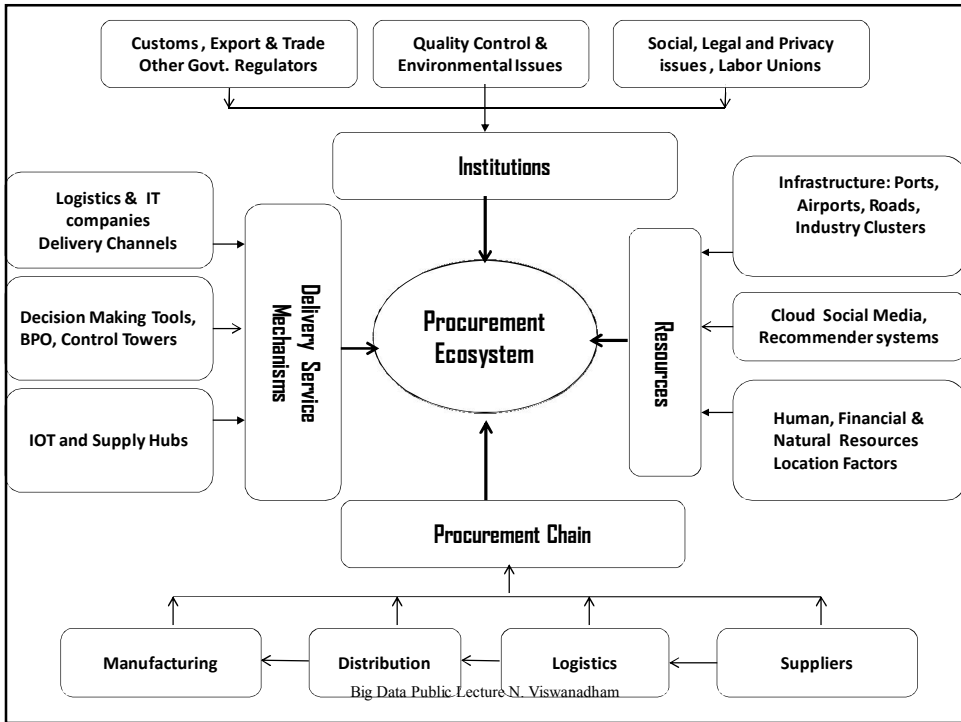
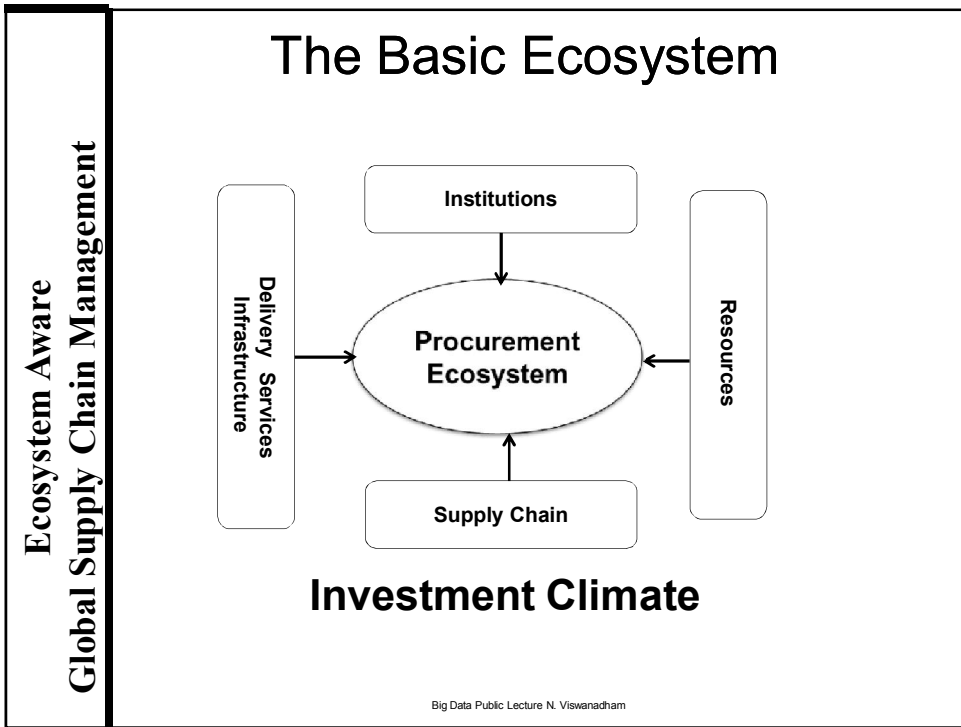
Green Supply Chain Design

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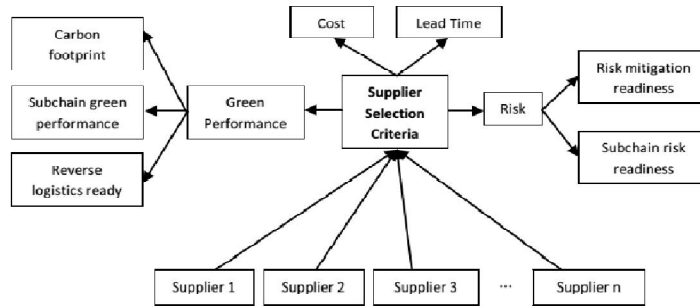
B2B Procurement

- Strong ties with Trusted suppliers
- Total landed cost
- Focus on supplier ecosystem not just product price & quality

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Combined Performance Risk based Supplier Selection in the Ecosystem Framework



One can use various optimization methods including AHP, Genetic Algorithms, Evolutionary methods to solve the supplier selection problem with both numerical as well as textual data

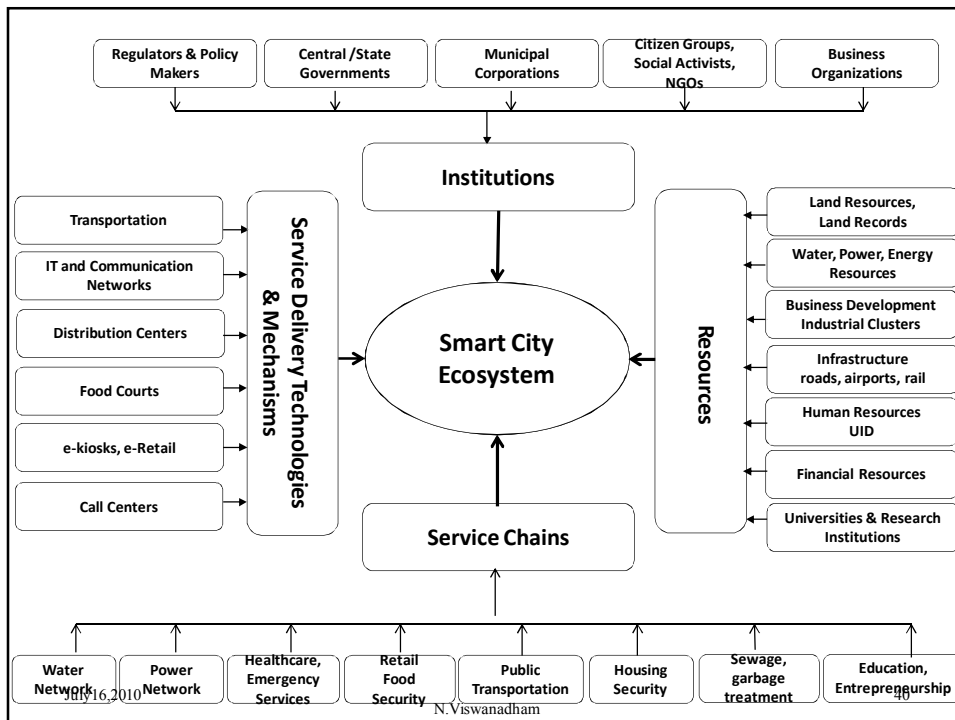
The Smart City Ecosystem

Smart City

Design of Smart Villages

- The ‘smart ’ concept is in the policy arena recently
- A **City** is a bundle of dozens of services delivered effectively and efficiently to the residents and businesses.
- New designs, technologies and management models should be used to upgrade the existing services such as Power, Water, Buildings, Retail, Health care, etc.
- City performance depends on hard infrastructure (physical capital), and increasingly on the availability and quality of knowledge, communication & social infrastructure (intellectual capital and social capital).

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Conclusions

- Green supply chain design is a complex exercise with risks of non compliance from partners
- Totally green products may not be a feasible proposition & requires collaborative developments across all partners.
- A feasible green solution that is a balance between resource use, carbon foot print, customer acceptance & Profitability.
- Theory development needs Integration of Social networks, Machine learning, Optimization, Game theory with SCNs.
- We can design a green city or a green region by considering the city or region as a bundle of services.

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