The International Landscape: Towards a low carbon society

Dr. Ernesto DR Santibanez Gonzalez

santibanez.ernesto@gmail.com

Universidad de Talca – Chile

Universidade Federal do Sul da Bahia - Brazil

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Agenda

- Supply chain management (SCM) – traditional network problem
- Decision making process – modelling characteristics
- SCM – integrating some practical issues
- SCM – alternative modelling approach
- Challenges/opportunities
- Extensions and conclusions

When was the last time we (as a world) face a problem like climate change and sustainability related issues?

Multicultural

Multidisciplinary

Multiple-industry sectors

Multiple-countries

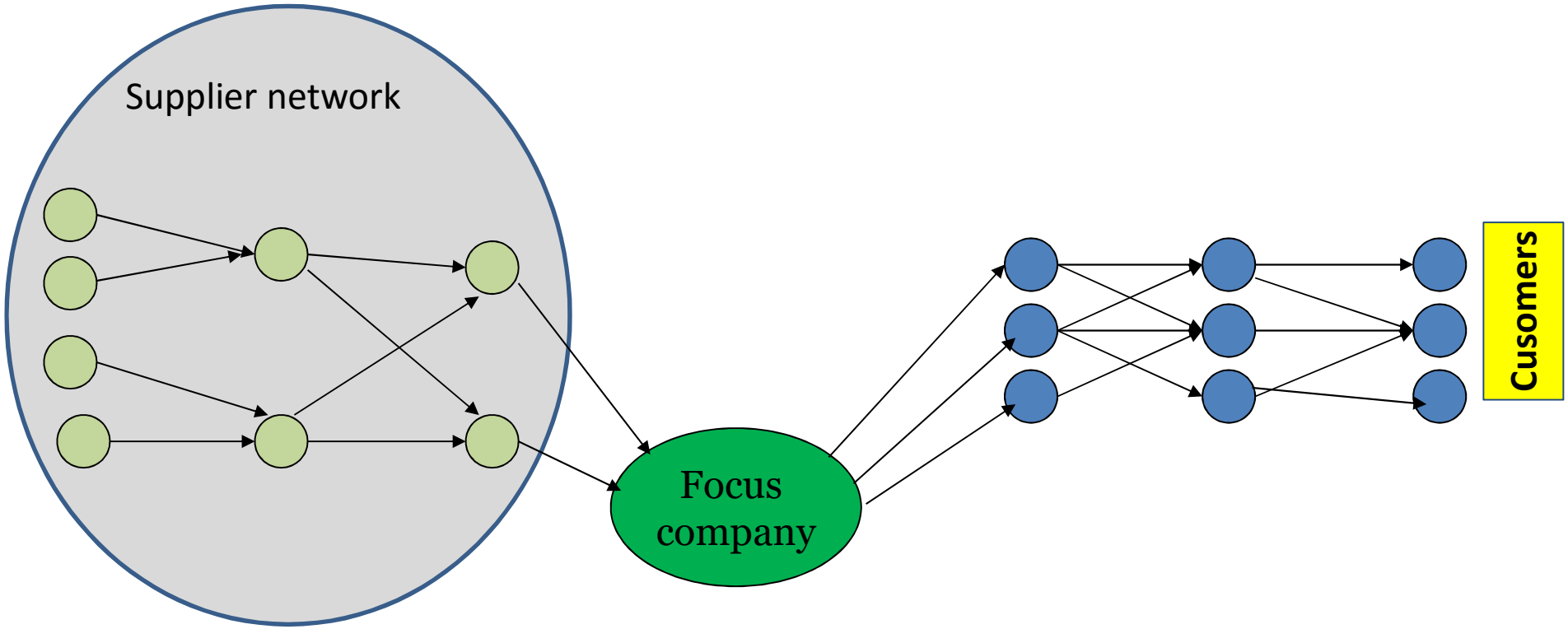
Supply chain management (SCM) - design

Classical

(Basic) Network Design and Management Supply Chain (SC) problem

- Facilities to be opened/closed/expanded;
- Flow of products between different (types) facilities, including customers
- Fulfill a customer demand for products, minimizing investments (fixed costs), transportation, production/operating costs

Food Supply Chain – simple structure representation



Why we need to study Food SC? Is it really a complex problem?

- Compared with this???
- It looks very simple network

Supply chain - Practical viewpoint

Supply chain comprised

- Different organizations, each of one with their own decision maker (or a team of), with their own objectives, costs, revenues, etc

A MILP Model - Sustainable supply chain network design problem (**SSCND)**

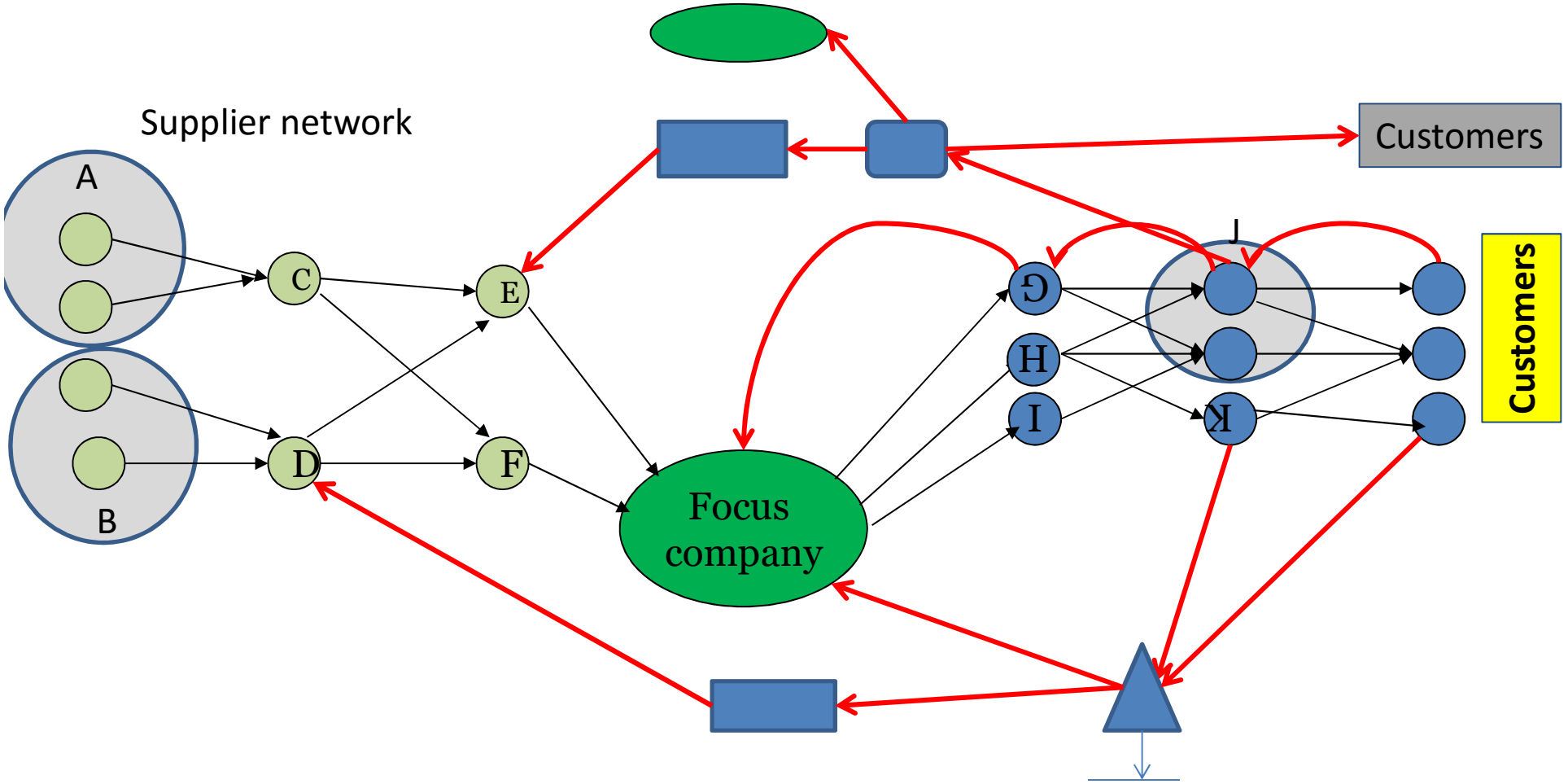
Sustainable supply chain network design problem

- Step by step
  - Economic and environmental issues
  - Social – still working

Characteristics of the supply chain network

- Multi-stage network (8 levels)
- Multi-period
- Multi-product
- Reverse flow (partially)

SC – forward and backward structure (cont.)



Solution layers

Decision support systems (software)

Tecnology to support decisión (hardware)

Mathematical Models and methods

Sustainable-based decisión making problems (i.e., Food Supply Chain)

Solution layers - approaches

Type of decisión making support	*Mathematical approach*	*Tecnology support (hardware, devices)*	*Decision support systems*
Descriptive	*Most of tools* *LCA-based*	*Remote sensing* *Drones-based*	*Commercial packages- tailored* *Customized solutions*
Predictive	*Artificial intelligence - based* *Classical forecasting models/methods*	*?*	*Commercial packages (i.e., SAS R)* *Free packages (i.e., Weka, Scilab)* *Customized solutions*
Prescriptive	*Zoo of models and methods* *System optimization referred approach*	*?*	*MP-based commercial packages (ILOG, CPLEX, GAMS, SAS…)* *Free packages* *Customized solutions*

Solution layers – winery industry

Type of decisión making support	Mathematical approach	Technology support	Decision support systems
Descriptive	Most of tools **LCA-based** • Carbon emissions • Water footprint • Energy footprint	**Remote sensing** Drones-based • Soil humidity (Deep) • Temperature • Leaves humidity • Sun exposure	
Predictive	Artificial intelligence - base Classical forecasti models/methods		
Prescriptive	Zoo of models and methods System optimization referred approach		

- *What is the environmental impact of one kg of coffee (espresso) produced in Guatemala?*
- *What is the environmental impact of one cup of coffee (espresso 50ml) consumed in UK?*

Solution layers - approaches

Type of decisión making support	***Mathematical approach***	***Tecnology support (hardware, devices)***	***Decision support systems***
Descriptive	*Most of tools* *LCA-based*	*Remote sensing* *Drones-based*	*Commercial packages- tailored* *Customized solutions*
Predictive	*Artificial intelligence - based* *Classical forecasting models/methods*	*?*	*Commercial packages (i.e., SAS R)* *Free packages (i.e., Weka, Scilab)* *Customized solutions*
Prescriptive	*Zoo of models and methods* ***System optimization referred approach*** • *Linear programming* • *Mixed Integer Linear programming* • *Non-linear integer programming* • *Stochastic linear programming*	*?*	*MP-based commercial packages (ILOG, CPLEX, GAMS, SAS…)* *Free packages* *Customized solutions*

Types of mathematical problems – frequently addressed

Transportation and Distribution – vehicle routing-based problems

Location/network design problems

Scheduling and production planning problems

ZOO – mining industry

Mathematical Models – Mixed- Integer Linear Programming Model

- Set:
  - Planning horizon
  - Mines,
  - Extraction fronts,
  - Crushing plants,
  - Processing plants,
  - Wasting stockyards,
  - Pelleting plants
  - Product stockyards
  - Train loading terminals
- Ports,
- Clients
- In process products and final products,
- Quality of final products,
- Levels or stages.

Characteristics – decision making process

Central Decision Making (team or just one person)

Take the decision about how will be the structure of the supply chain (strategic, tactical, operational) and how will operate

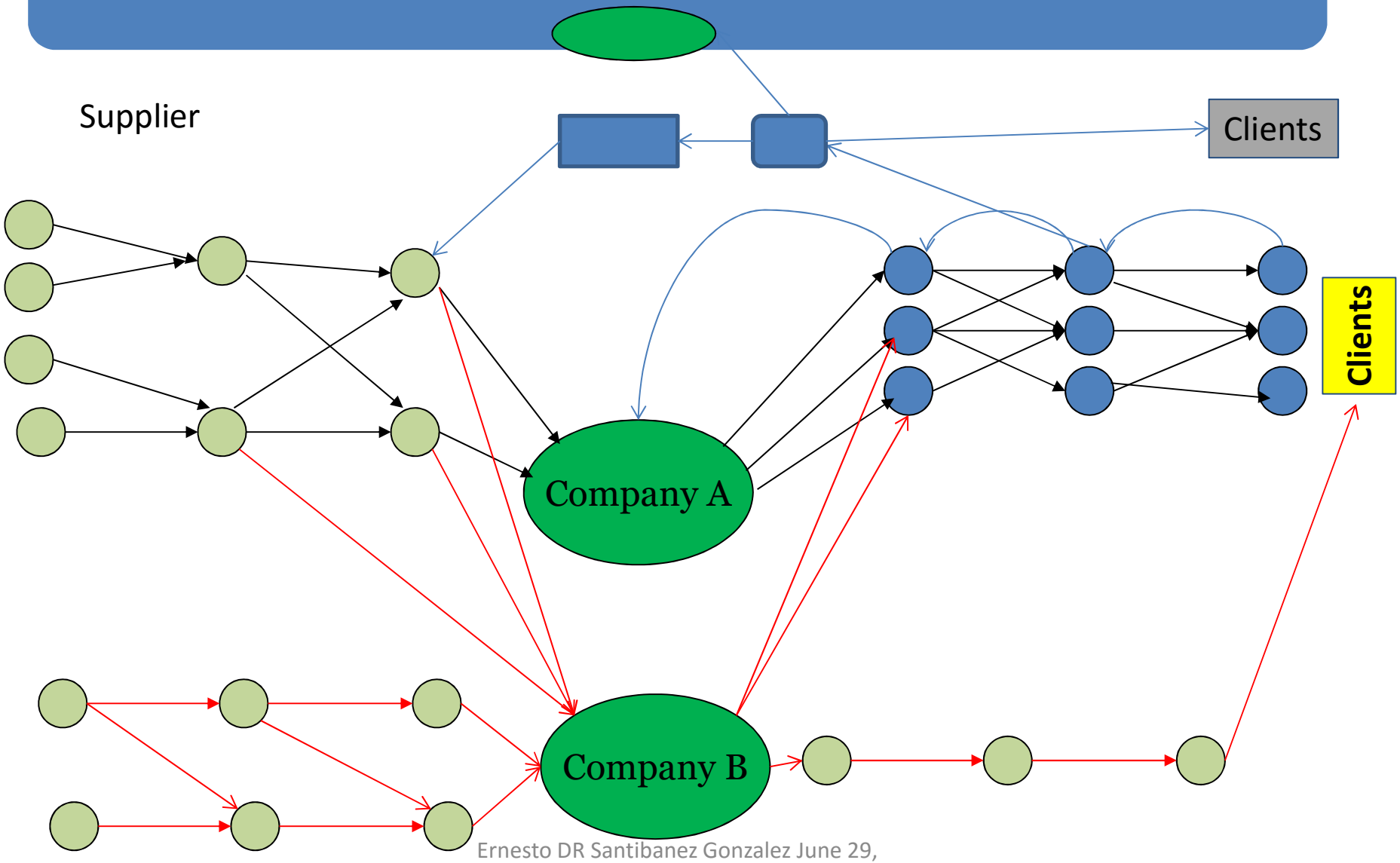
SC – some review papers

- Sustainable SC
  - Brandenburg et al. (2014), Quantitative models for sustainable supply chain management: Developments and directions, EJOR, 233(2) 299-312.
- Mining sector
  - Pimentel, Gonzalez and Barbosa (2015), Decision-support models for Sustainable Mining Networks: fundamentals and challenges, Journal of Cleaner Production,

Majority of research on supply chain network design models

- *Math prog approaches*
- *Centralized decision making process (system optimization)*

SC – Structure -> real scenario



What happens in this real scenario - GAP

- A supply chain that comprises of a group of companies/firms **which are exclusively dedicated to one supply chain does not exist.**
- Indeed, different supply chains **may involve common parties**, particularly when they are targeting the same or relevant markets. In other words, ***one firm could be involved in multiple supply chains at the same time***.
- **This supplier will allocate and balance its capacity between two (or more) supply chains to maximize its own profit rather than maximize any supply chain's profit**. In fact, supply chains are interconnected by these common partners to form a supply network.
- For example, **Wal-Mart, K-Mart and Target are competing for slightly different markets** (Graff, 2006) **and the competition among them is usually considered as competition among three supply chains** represented by Wal-Mart, Target, and K-Mart. However, **many of Wal-Mart's suppliers** provide products to K-Mart and Target as well. Hence, Wal-Mart, Target, and K-Mart compete not only for the customers in the demand market, but also for the supply resources.

What happens in this real scenario

- The underlying behaviour of suppliers, manufacturers, distributors and retailers is supposed to compete in a non-cooperative manner to service the demand of the customers. ***Each decision maker individually wishes to find optimal shipments given the ones of other competitors;***
- The consumer, who is the ultimate user for the product in the supply chain, located at the bottom tier of the supply chain ***agrees to the prices charged by distributors for the product if the associated business deal is done***.

Thank you!

Second World War???

Ernesto DR Santibanez Gonzalez June 29, 2017, Manchester, UK

Conclusion: What happens…

- **Real world** – **companies compete (collaborate)** – and the traditional system optimization approach fails…for example, one company can not agree with the volume of products to transport or produce, and it would like to increase the volume because production costs should decrease, and then returns for this company will increase? Or more simple, company does not agree to deliver to a particular customer or even open a facility at a particular place?
- New models to address the sustainable problems in particular food supply chain
- New and cheaper devices for collecting gathering data
- Decision support systems are needed