Management Practice

2. Operations and systems

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MPiE

Course

Literature for the course:

Eisner, Howard. *Essentials of project and systems engineering management*. John Wiley & Sons, 2008.

Learning objective for this session:

- Able to define operation management
- Able to relate systems to management
- Able to complete Porter’s value chain
- Able to draw a simple supply graph

Operation management

Management was shown to **add value**, but we can further split the concept of management and explore the different aspects.

Operations management **optimises planning, organisation and supervision in production and manufacturing**.

It is **delivery-focused**, ensuring that an organization successfully turns inputs to outputs in an effective manner.

Source: MIT Sloan School of Management

Operation management definition

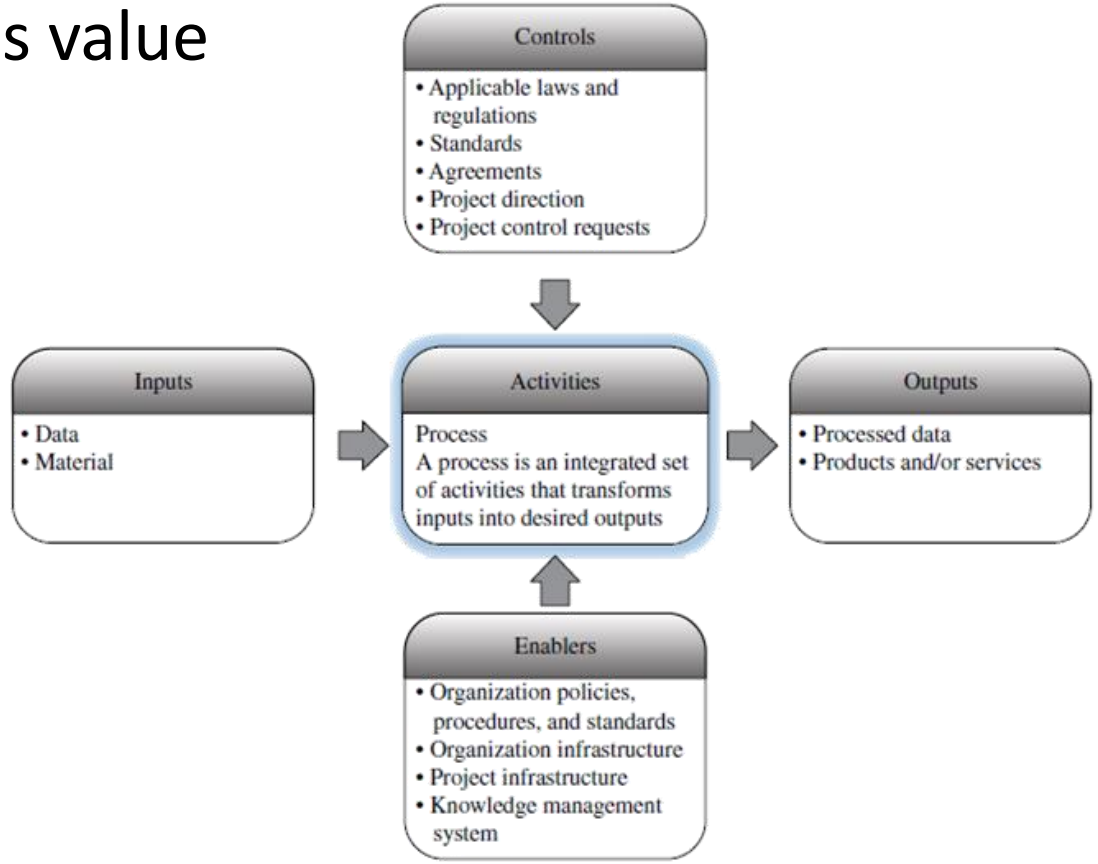
- This is the management of **processes that create value** for a company and its customers. These processes transform inputs - such as materials, energy, services and people - into goods and services (outputs).

Core functional activities	*Internet service provider (ISP)*	*Fast food chain*	*International aid charity*	*Furniture manufacturer*
Marketing and sales	Promote services to users and get registrations Sell advertising space	Advertise on TV Devise promotional materials	Develop funding contracts Mail out appeals for donations	Advertise in magazines Determine pricing policy Sell to stores
Product/service development	Devise new services and commission new information content	Design hamburgers, pizzas, etc. Design décor for restaurants	Develop new appeals campaigns Design new assistance programmes	Design new furniture Coordinate with fashionable colours
Operations	Maintain hardware, software and content Implement new links and services	Make burgers, pizzas etc. Serve customers Clear away Maintain equipment	Give service to the beneficiaries of the charity	Make components Assemble furniture

Source: FT.com; Slack, Nigel, Stuart Chambers, and Robert Johnston. *Operations management*. Pearson education, 2010.

The input–process–output (IPO) diagram

Process that creates value



Source: INCOSE Systems Engineering Handbook, version 3 .

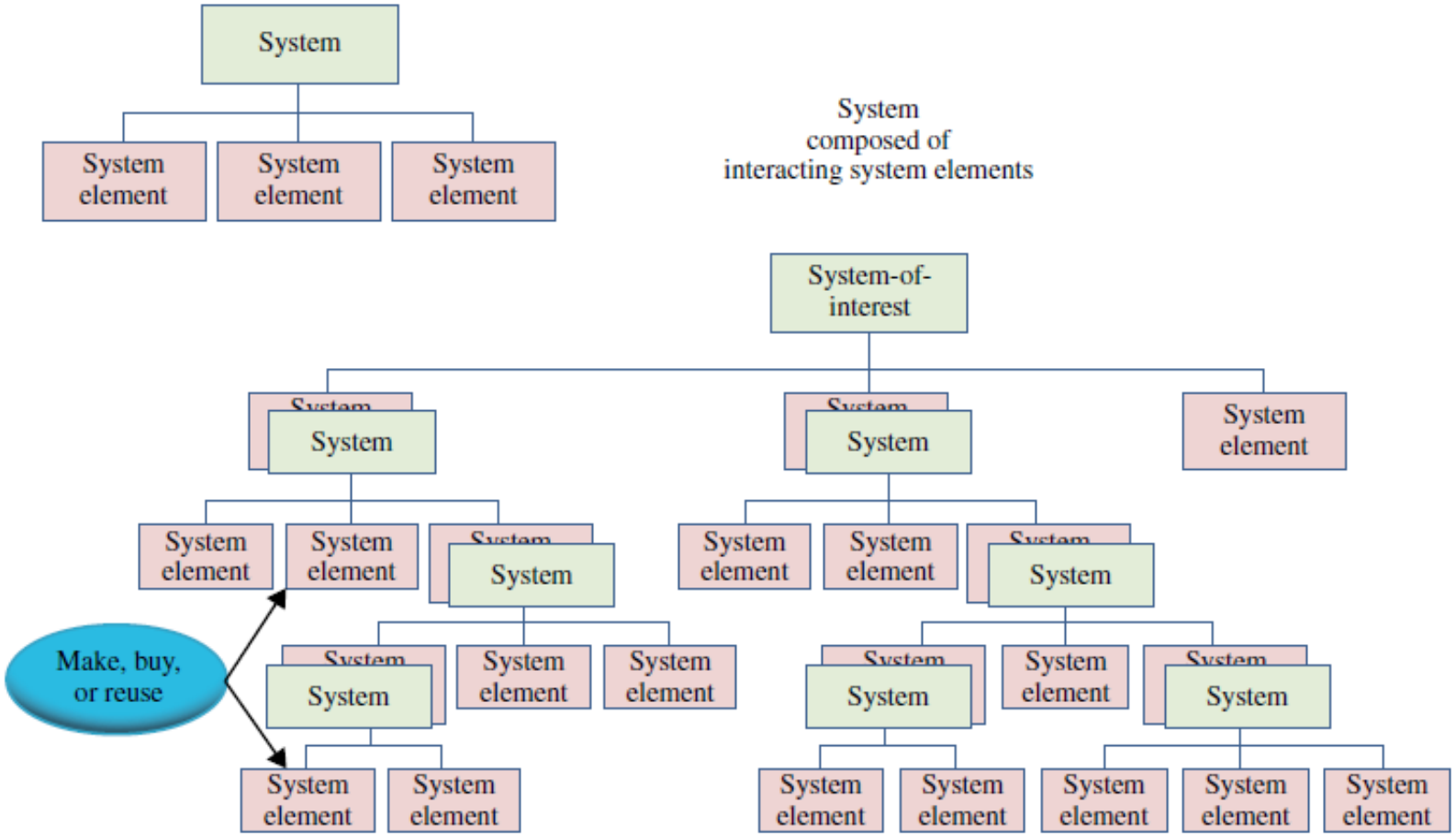
Systems

- Systems are **man-made, created and utilized** to provide products or services in defined environments for the benefit of users and other stakeholders.

- An attribute of a system (or system element) is an **observable characteristic or property of the system** (or system element).

Source: INCOSE Systems Engineering Handbook, version 3 .

Hierarchy within a system



Source: INCOSE Systems Engineering Handbook, version 3 .

System of systems (SoS)

A system of systems is a system of interest whose elements are **managerially and/or operationally independent systems**.

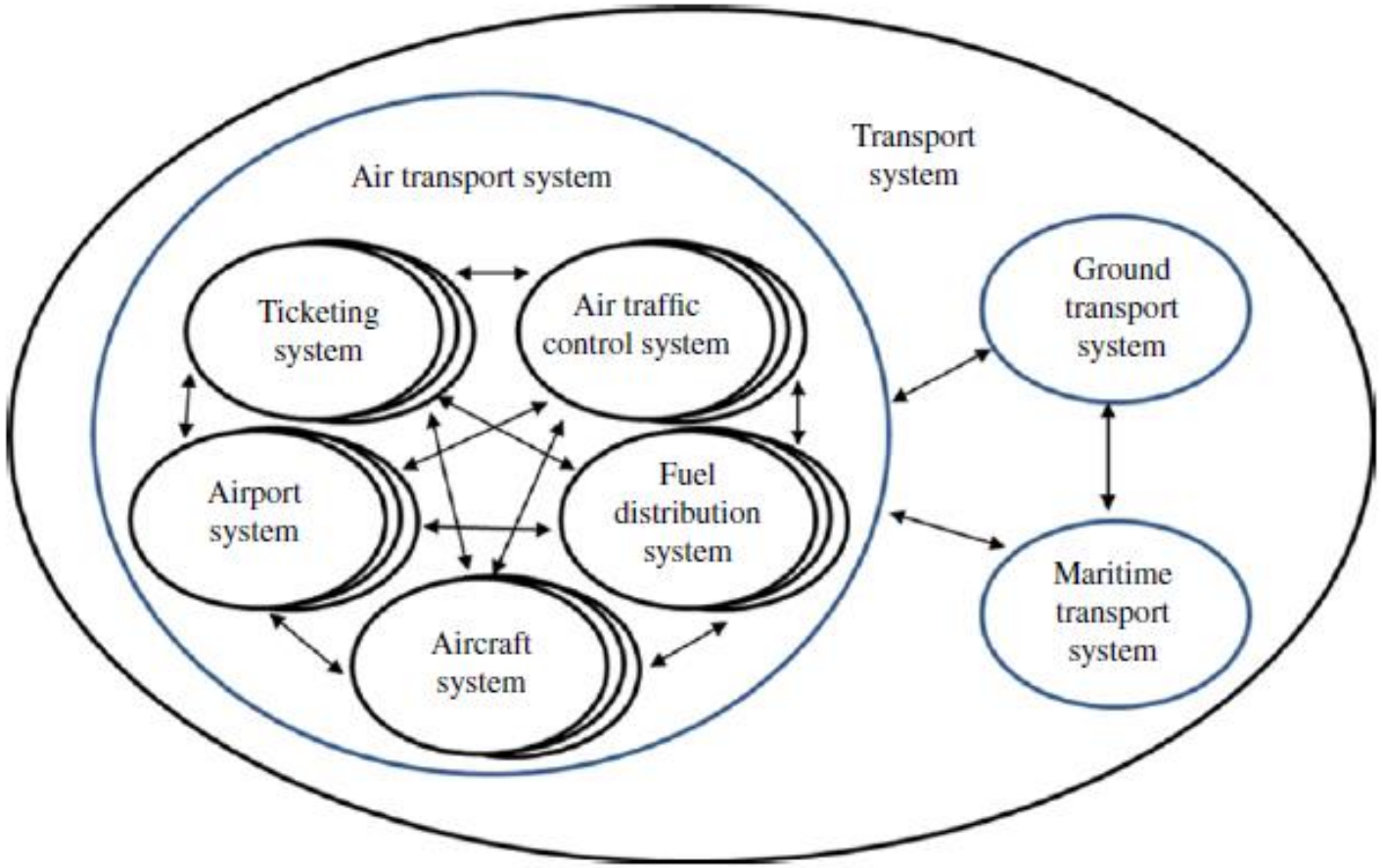
These interoperating and/or integrated collections of constituent systems usually produce results unachievable by the individual systems alone.

The following (Maier's) characteristics can be useful when deciding if a particular System of interest can better be understood as an SoS :

- Operational independence of constituent systems
- Managerial independence of constituent systems
- Geographical distribution
- Emergent behaviour
- Evolutionary development processes

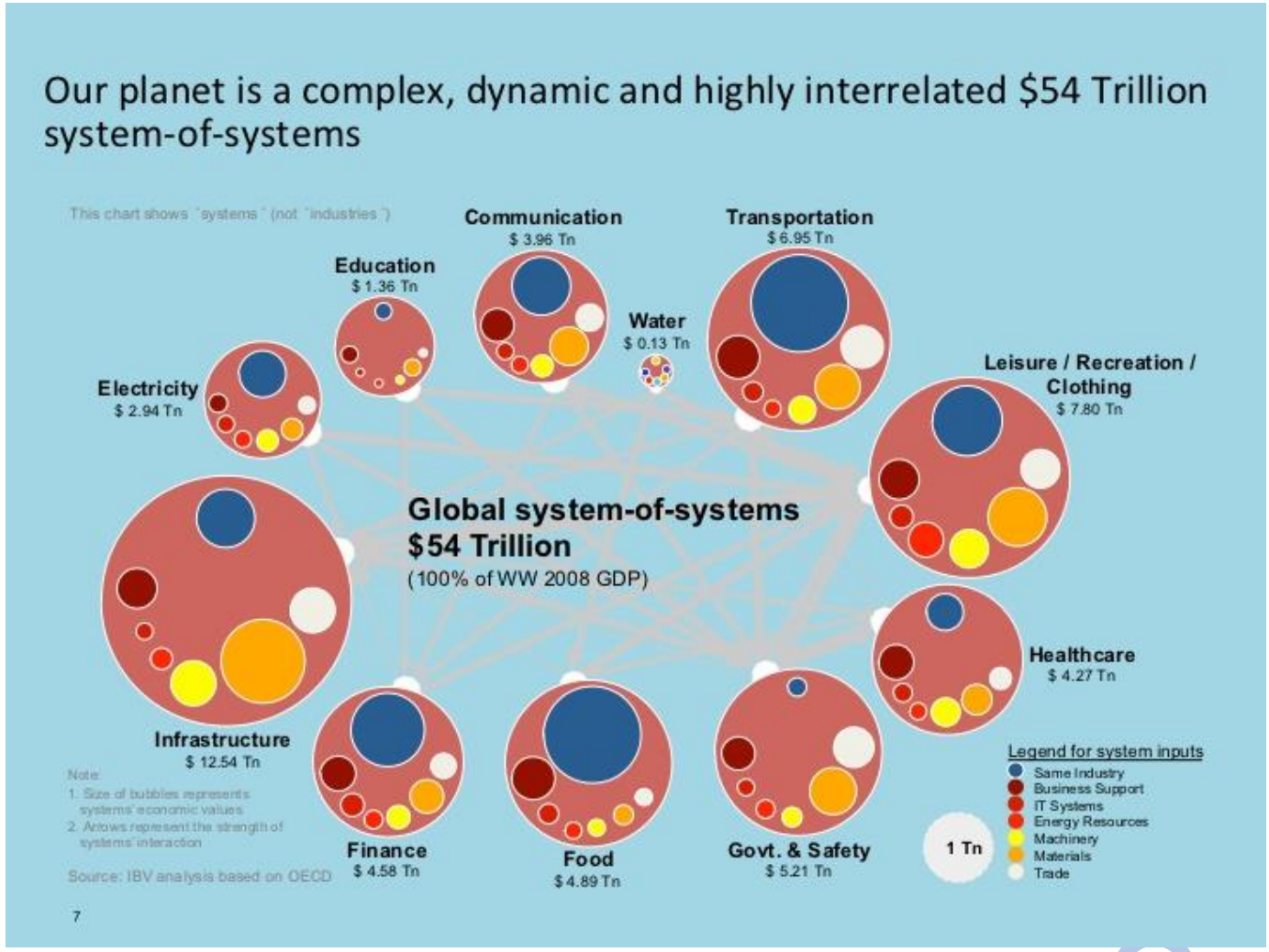
Source: Maier, 1998

System of systems example



Source: INCOSE Systems Engineering Handbook, version 3 .

World as system of systems



System of systems

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- Managerial independence of constituent systems
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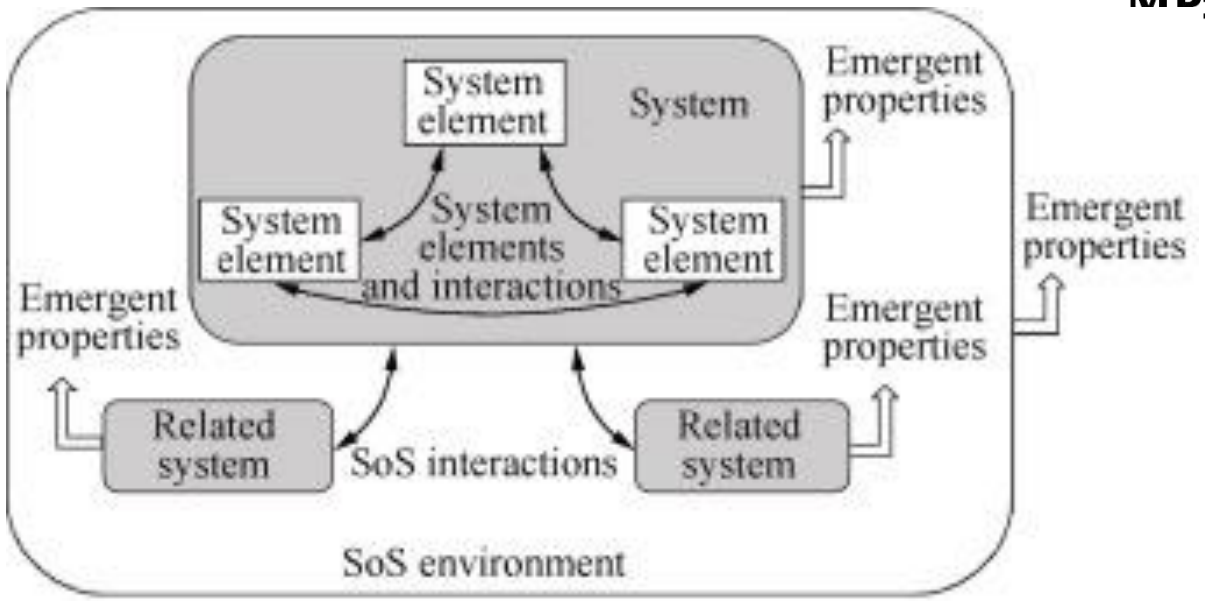


Draw a system of systems example

Source: //doi.org/10.1016/j.cja.2016.01.002

System of systems (SoS)

- The SoS usually exhibits **complex behaviours**, often created by the existence of the Maier's characteristics.
- The complex system can't just be understood by its parts alone, because the **emergent properties** that we really care about disappear when we examine the parts in isolation.
- A fundamentally different approach is required to understand the whole in context through **iterative exploration** and adaptation.
- Linear, procedural methods for sorting through complicatedness ("systematic activity") and holistic, non-linear, iterative methods for harnessing complexity ("systemic" or systems thinking and analysis—always required when dealing with SoS).

Source: INCOSE Systems Engineering Handbook, version 3 .

Operational management

- In this sense an operation is a **system of functions that transforms** inputs into outputs of greater “value”.
- The process takes place along a **value chain**.
- The value chain can be regarded as a **complete transformation model overlaid by the necessary support functions**.
- Functions that do not add value should be **eliminated**.
- Operations management consist of the design, operation an improvement of this system in this context.

Porter’s value chain

Value chain is a tool designed to systematically divide a company into its “**strategically relevant**” activities, analyse their behaviour and interaction, and determine their importance in the implementation of business strategies.

In Porter’s model the value chain activities can be divided in two categories:

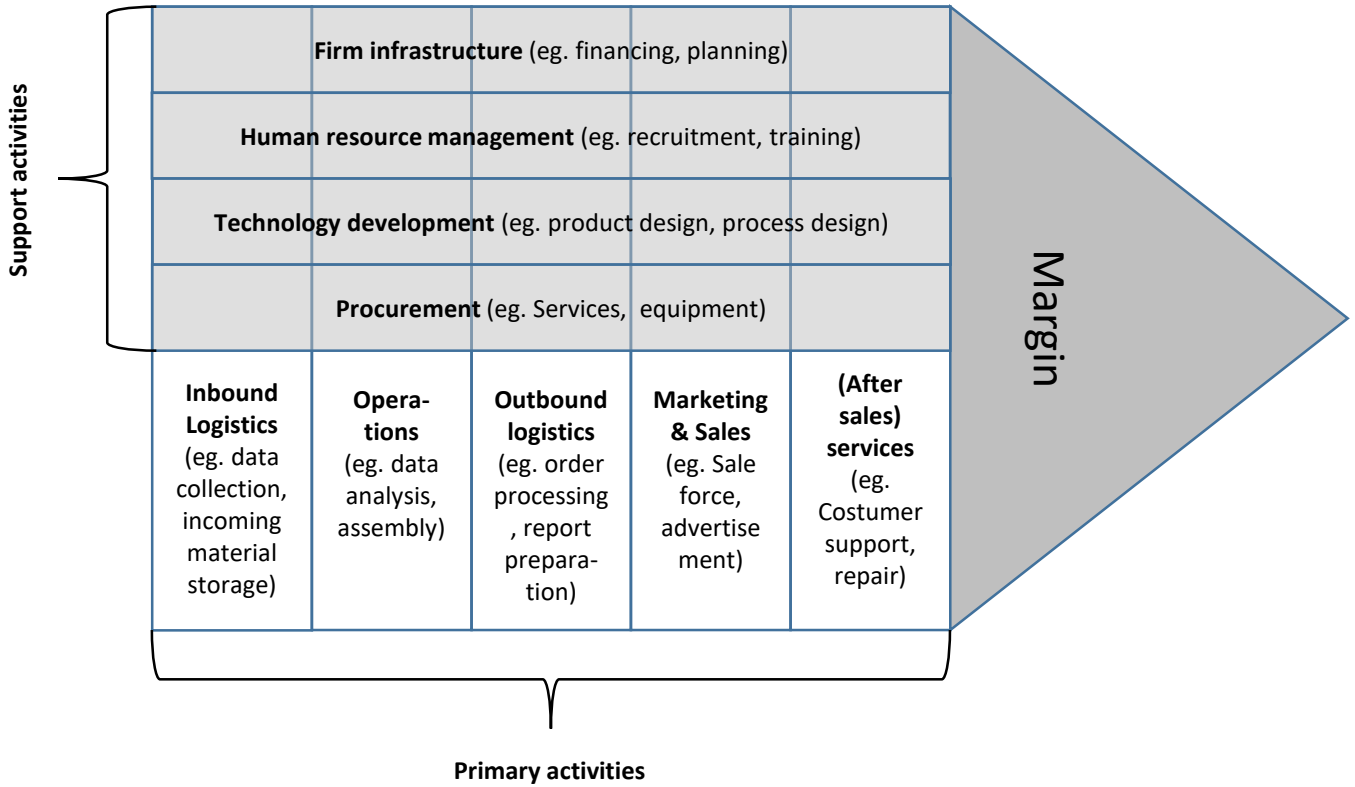
1. Primary activities
2. Support activities

The **primary activities** are those related to the **physical creation and delivery** of the product to the customer.

The **support activities** are involved in the procurement and management of the resources needed by the primary activities to operate.

Source: Porter, 1985; Edgar Arias, Sustainable Innovation Management

Porter's value chain

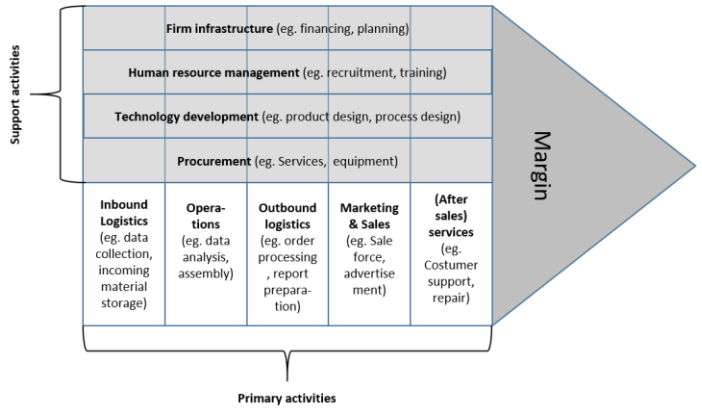


Source: Porter, 1985; Edgar Arias, Sustainable Innovation Management

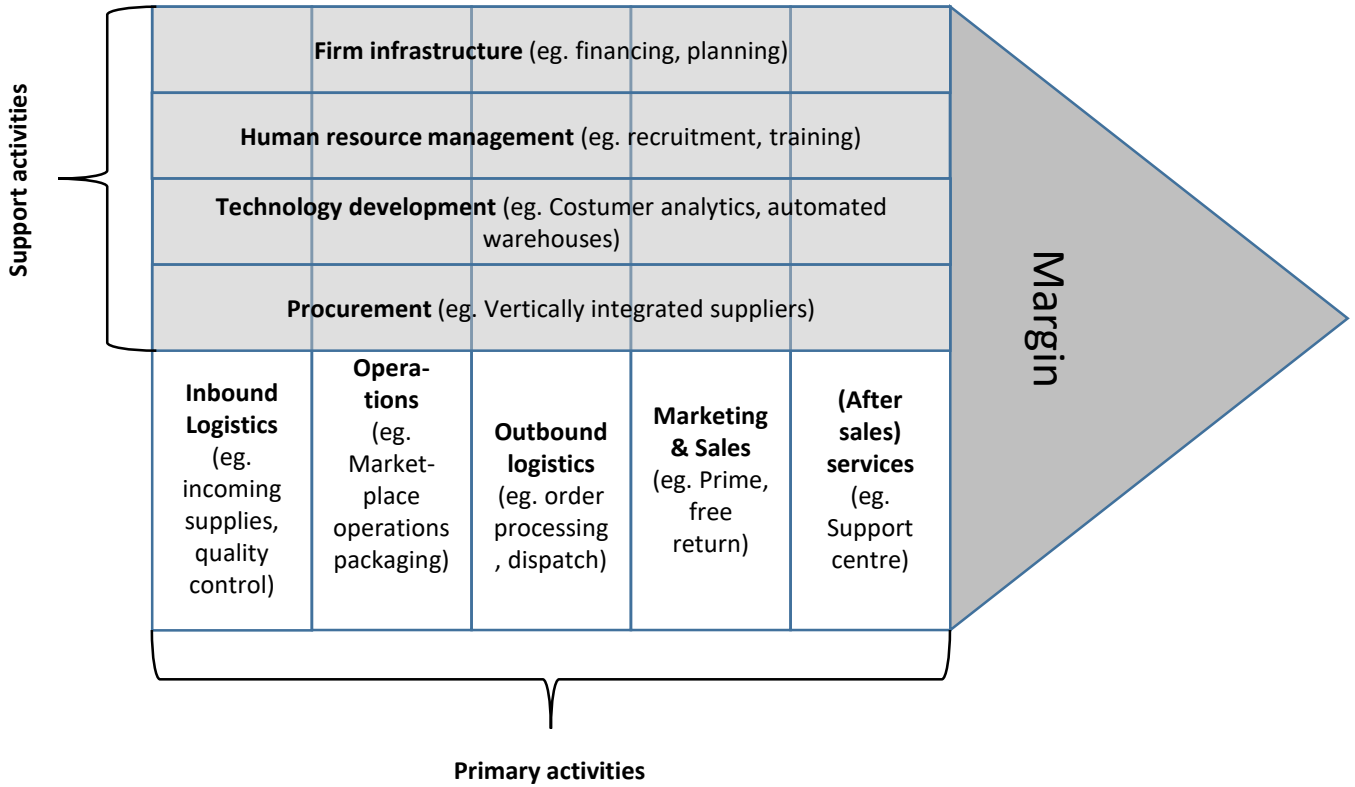
Value chain in application

- What would be the value chain for Amazon (marketplace)?

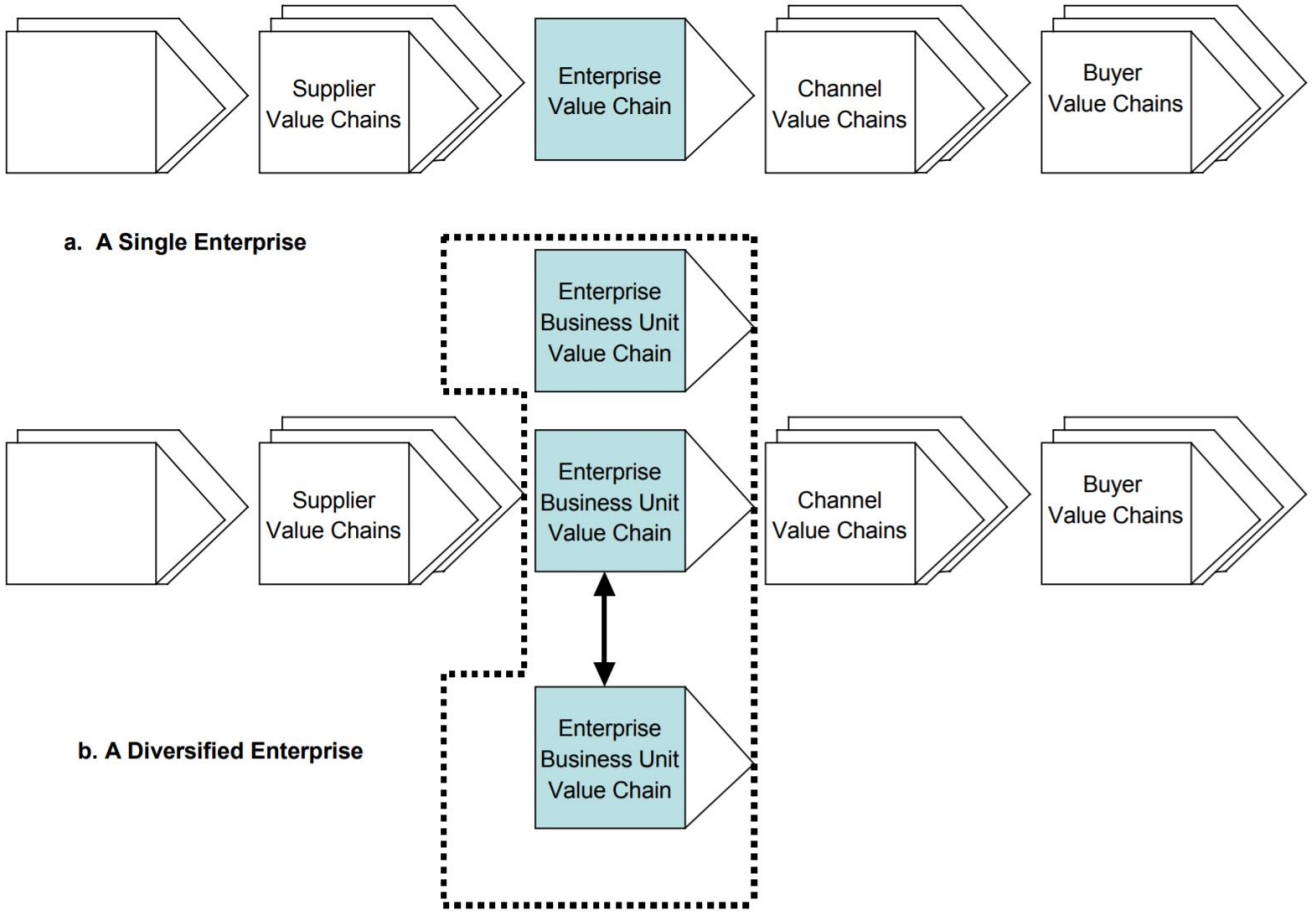
- Discuss and write down your value chain (5 mins).



Value chain


Support activities
Firm infrastructure (eg. financing, planning)
Human resource management (eg. recruitment, training)
Technology development (eg. Costumer analytics, automated warehouses)
Procurement (eg. Vertically integrated suppliers)
Inbound Logistics (eg. incoming supplies, quality control)
Opera-tions (eg. Market-place operations packaging)
Outbound logistics (eg. order processing , dispatch)
Marketing & Sales (eg. Prime, free return)
(After sales) services (eg. Support centre)
Margin
Primary activities

Value chain as a network



Source: Nyamekye, K. Axiomatic Design Approach for Designing Re-configurable C4isr Systems (2007)

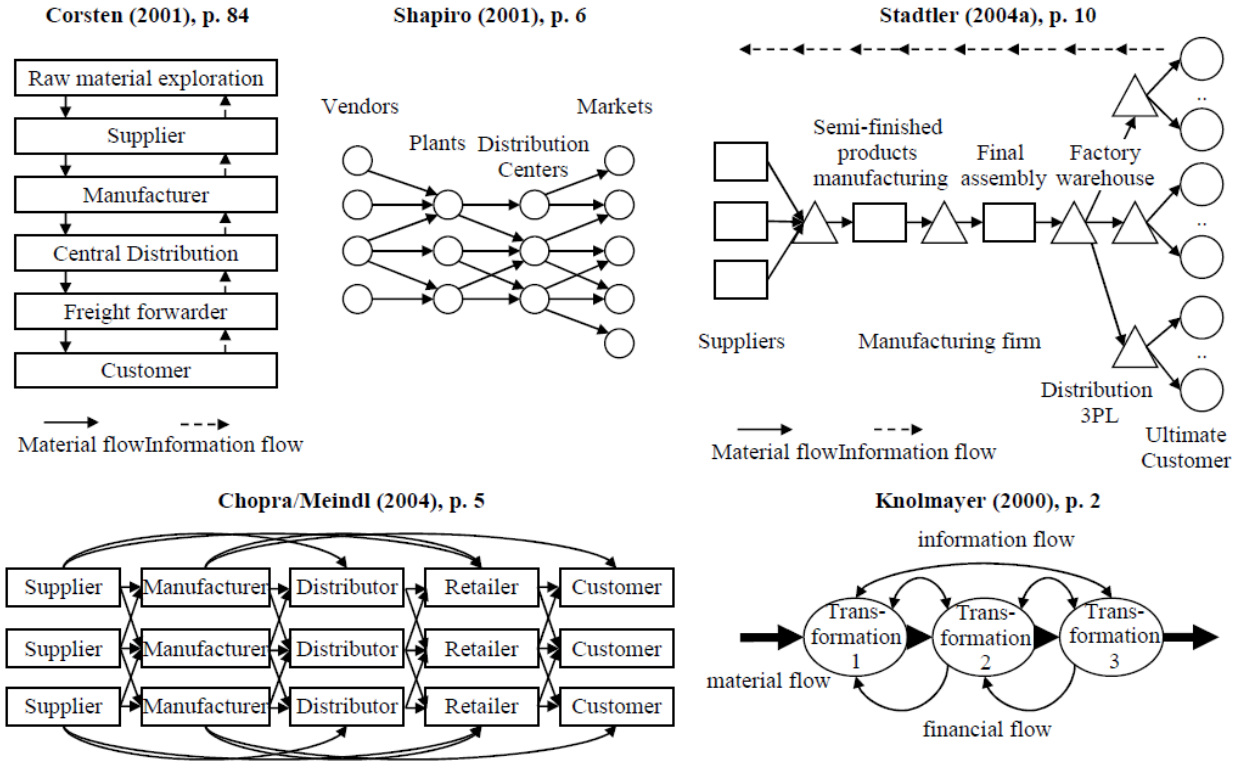
Value chain to supply chain

- Porter's value chain was a basis for the development of the **supply chain**.
- Compared to the company-internal focus of Porter's value chain, the supply chain extends the scope towards **intra-company** material and information flows from raw materials to the end consumer reflected in the definition of Christopher (1992):

A supply chain is a network of organizations that are involved through upstream and downstream linkages in different processes and activities that produces value in the form of products and services in the hand of the ultimate consumer.

Source: Kannegiesser (2008)

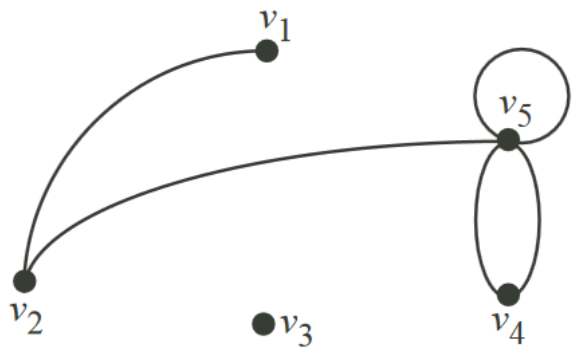
Capturing the supply chain



Source: Kannegiesser (2008)

Supply chain as graph

A graph is formed by vertices and edges connecting the vertices.



Better is to state a graph is a pair of sets (*V, E*), where *V* is the set of vertices and *E* is the set of edges.

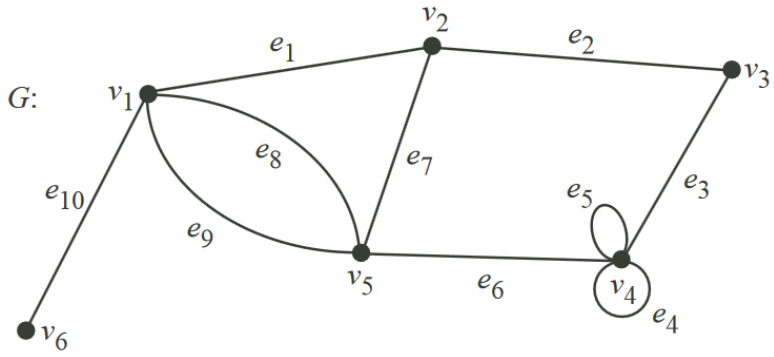
$$V = \{v_1, \dots, v_5\}$$

$$E = \{(v_1, v_2), (v_2, v_5), (v_5, v_5), (v_4, v_5), (v_5, v_4), \} = \{e_1, \dots, e_5\}$$

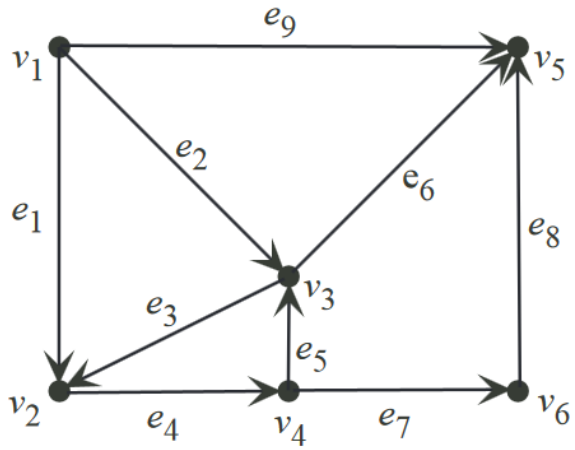
Source: Kannegiesser (2008)

Walk and directed graph

A walk in the graph *G = (V, E)* is a finite sequence which consists of alternating vertices and edges of *G.*



A directed graph can be used to capture characteristics of the supply chain



The two vertices *u* and *v* are end vertices of the edge (*u, v*), so an edge (*v, v*) is a loop.

Closeness centrality

- The value of representing supply chains as graphs, or networks, rather than as flat structures and relational databases has benefits for analysis.
- Interpreting supply chains as graphs produces new opportunities to investigate **structural characteristics and transitive links of complex relations.**
- **Closeness centrality** can be used to evaluate the flow of materials through a supply chains.
- Product platforms with **smaller** distances are connected to shorter supply chains and are thus have a **reduced risk** for encountering distortion in physical and information flows.

Source: Carstens et al (2017); //doi.org/10.1016/j.susmat.2016.10.002

Closeness centrality

Closeness centrality (*C*) measures a vertex's (or nodes's) centrality in a graph. It is the total vertices count *N* (minus one for the vertex itself) divided by the sum of the length of the shortest paths between the vertex and all other vertices in the graph or distance *d*(*y, x*), as

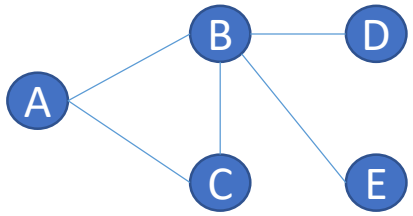
$$C(x) = \frac{N - 1}{\sum_y d(x, y)}$$

with $x \neq y$ and *d(i,j)* being the shortest path between vertices *i* and *j*

Source: Carstens et al (2017)

Closeness centrality (normalised)

$N = 5$



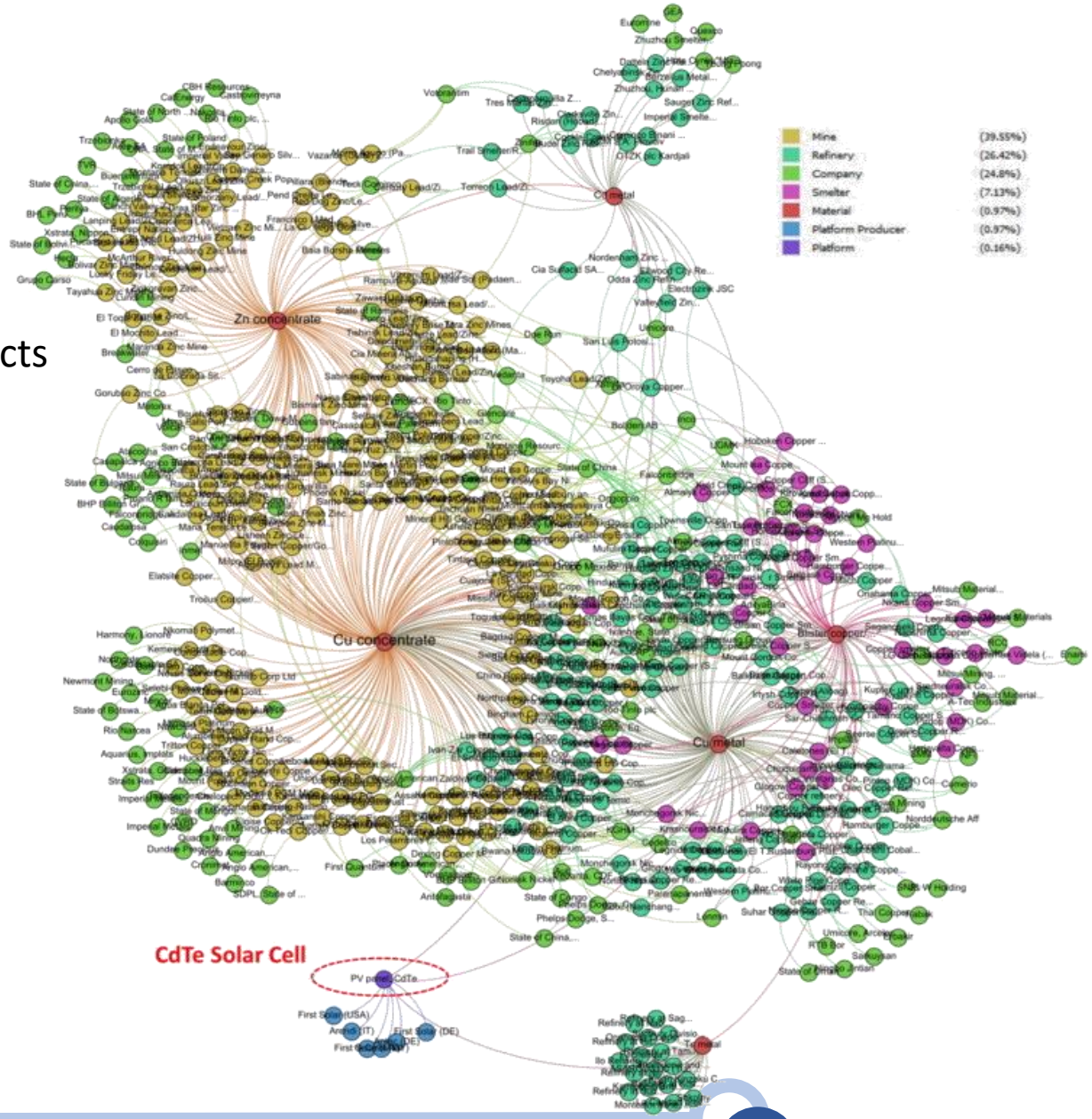
$V = \{v_1, \dots, v_5\} = \{A, \dots, D\}$

	A	B	C	D	E	$\sum_{k-1}^{N} d(v_i, v_k)$	$C(v_i) = \frac{N-1}{\sum_{k-1}^{N} d(v_i, vk)}$
A	0	1	1	2	2	6	.67
B	1	0	1	1	1	4	1
C	1	1	0	2	2	6	.67
D	2	1	2	0	2	7	.57
E	2	1	2	2	0	7	.57

Supply chain graph

Relationships mapped between material and products

(i) cadmium telluride solar cell
(ii) a germanium solar cell
(iii) a turbine blade
(iv) a lead acid battery
(v) a hard drive (HD) magnet



Source: doi.org/10.1016/j.susmat.2016.10.002

Factors influencing supply chain

SUMMARY OF RISKS

Type of risk	Source
Supply Risks	Disruption of supply, inventory, schedules, and technology access; price escalation; quality issues; technology uncertainty; product complexity; frequency of material design changes
Operational Risks	Breakdown of operations; inadequate manufacturing or processing capability; high levels of process variations; changes in technology; changes in operating exposure
Demand Risks	New product introductions; variations in demand (fads, seasonality, and new product introductions by competitors); chaos in the system (the Bullwhip Effect on demand distortion and amplification)
Security Risks	Information systems security; infrastructure security; freight breaches from terrorism, vandalism, crime, and sabotage
Macro Risks	Economic shifts in wage rates, interest rates, exchange rates, and prices
Policy Risks	Actions of national governments like quota restrictions or sanctions
Competitive Risks	Lack of history about competitor activities and moves
Resource Risks	Unanticipated resource requirements

Source: Manuj et al, Global supply chain risk management strategies, 2008

Risk in the extended supply chain

Source: Manuj et al, Global supply chain risk management strategies, 2008

Supply chain risk

- When a firm takes a traditional, cost minimization approach to supply chain strategy, it often increases its risk of failure or increases its overall cost.
- Traditional solutions remain optimal as long as nothing changes, but they are extremely fragile to exceptions, failure, or changes in cost.
- Vinod Singhal at Georgia Tech's DuPree College of Business found **that supply chain glitches negatively impacted stock prices** by nearly 20% and it was the biggest factor for stock prices.
- For example, the chance that materials don't arrive in time threatens to disrupt service or increase cost on a daily basis.

Source: Kilgore, 2004

Supply chain risk - mitigation

- Identify where a large proportion of operating activities are tied up in a single location, organization, or flow. A graph that includes all supply chain vertices from source to customer can help identify **centralised risk**.
- Filter out **high-contingency risks**.
- Estimate the **probability** of each risk materializing. Economic forecasters and industry watchdogs can be good sources for macro economic plans, interest or labour rates, and union negotiation issues
- Assess the **impact** associated with each risk.
- Evaluate the **cost** of spreading the risk.

Source: Kilgore, 2004

Next lecture

- We will go further with supply management in the next lecture.

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Questions?

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