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Session 11:
Logistical Drivers and Metrics
35E00750 Logistics Systems and Analytics

Dr. Tri M. Tran

Assistant Professor of Operations Management
University of Groningen
https://www.rug.nl/staff/tri.tran/

Learning objectives

1. Describe key financial metrics of supply chain performance

2. Identify the logistical drivers of supply chain performance

3. Define the key performance metrics for logistical drivers

4. Understand what makes "good" metrics

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Financial metrics of (supply chain) performance

Why financial metrics?

"An increasing number of CFOs view the supply chain as making a crucial difference in their ability to achieve corporate objectives. **But aligning supply chain strategy to business strategy continues to be a slow process that often misses the mark**. Part of the problem lays within supply chain professional who need to put themselves in their CFO's shoes and ask themselves, *how can I speak the CFO's language?*"

- Scott David, CFO, UPS

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See the big picture!

- **Operations manager's concerns**
  - Matching supply with demand
  - Increasing customer service
  - Quality
  - Cost
  - Speed
  - Flexibility
  - Raw materials, manufacturing, order processing, and logistics operations

- **Board members' concerns**
  - Profitability
  - Shareholder (firm) value
  - Market share and growth
  - New product
  - Brand image and reputation
  - Competitors

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Key financial metrics (1/3)

- **Return on assets (ROA)** measures the return earned on each dollar/euro invested by the firm in assets

$$\textbf{ROA} = \frac{\textbf{Earnings before interest}}{\textbf{Average Total Assets}}$$

$$= \frac{\textbf{Net Income} + \left[\textbf{Interest Expense} \times (1 - \textbf{Tax Rate})\right]}{\textbf{Average Total Assets}}$$

- From a shareholder perspective, return on equity (ROE) is the main summary measure of a firm's performance

$$\textbf{ROE} = \frac{\textbf{Net Income}}{\textbf{Average Shareholder Equity}}$$

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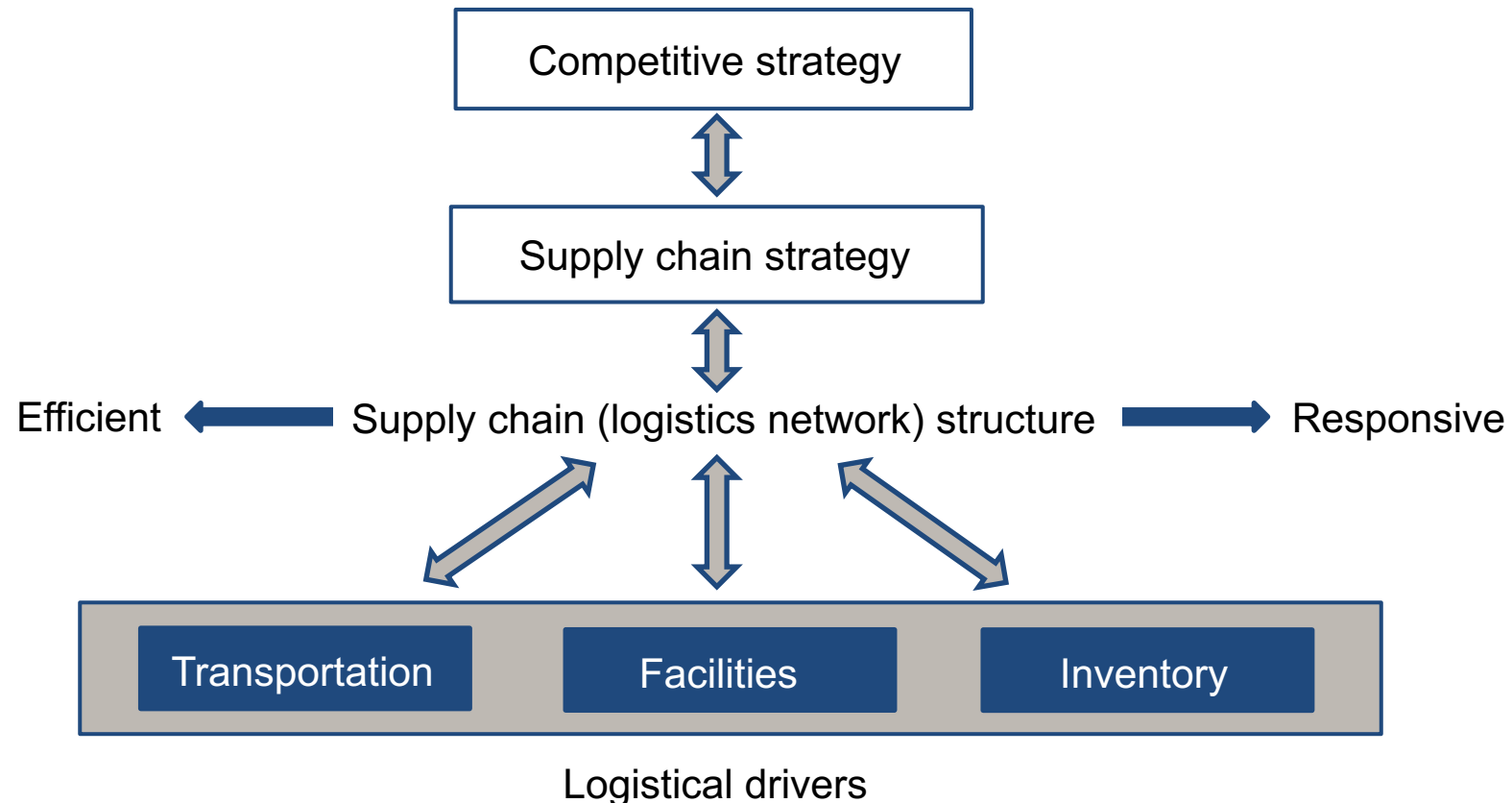
Key financial metrics (2/3)
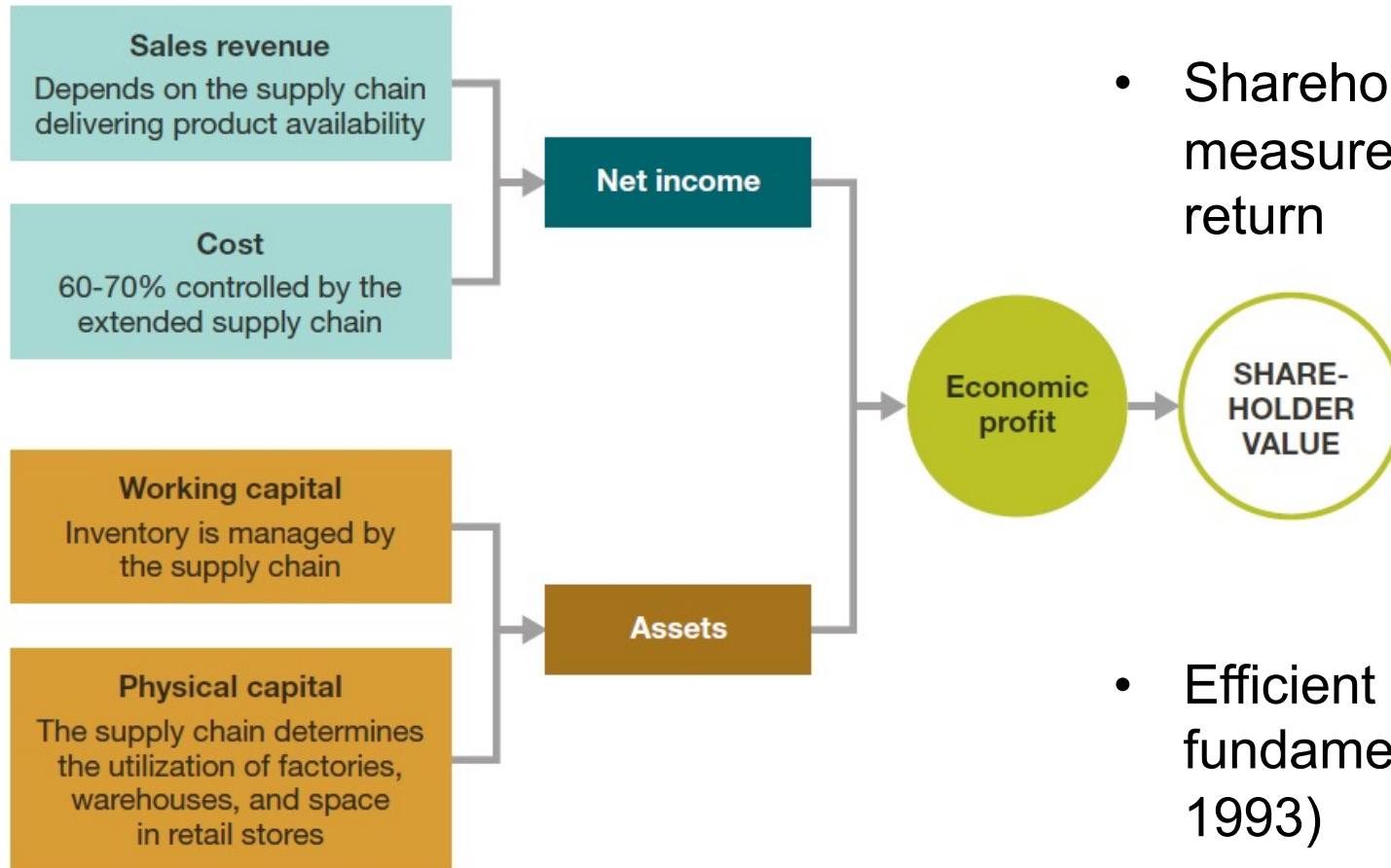
- Shareholder value (or wealth) can be measured by abnormal stock price return

- Efficient market hypothesis (EMH) as fundamental theory (Fama, 1970; 1993)

Source: Stank (2019)

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Key financial metrics (3/3)

- **There are now important measures, however, that are not explicitly part of a firm's financial statements**
  - Markdowns: discounts required to convince customers to by excess inventory
  - Lost sales: represent customer sales that did not materialize because of the absence of products the customer wanted to buy

- **Both reduce net income and arguably represent the biggest impact of supply chain performance on the financial performance of a firm**

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Logistical drivers for supply chain performance

Logistical drivers of SC performance

Competitive strategy

Supply chain strategy

Efficient ← Supply chain (logistics network) structure → Responsive

Transportation · Facilities · Inventory

Logistical drivers

Logistical drivers: Facilities

- **The physical locations in the supply chain network where the product is stored, assembled, or fabricated**

- **Role in the supply chain**
  - Production sites and storage sites
  - Increase responsiveness by increasing the number of facilities, making them more flexible, or increasing capacity

- **<u>Honda</u> responded to the downturn of 2008 by making facilities more flexible**

Logistical drivers: Inventory

- **All raw materials, work in process, and finished goods within a supply chain**

- **Role in the supply chain**
  - Match between supply and demand
  - Exploit economies of scale
  - Reduce costs
  - Improve product availability
  - Affect assets, costs, responsiveness, material flow time

- **Amazon attempts to provide a wide variety of books making the balance of responsiveness and efficiency**

Logistical drivers: Transportation

- **Moving inventory from point to point in the supply chain**

- **Role in the supply chain**
  - Moves inventory between stages in the supply chain
  - Affects responsiveness and efficiency
  - Faster transportation allows greater responsiveness but lower efficiency
  - Also affects inventory and facilities
  - Allows a firm to adjust the location of its facilities and inventory

- **With FedEx, Blue Nile offers free shipping for overnight delivery**

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Blue Nile

Blue Nile vs. Tiffany

- **Blue Nile**
  - Established in 1999
  - Offered high-quality diamonds at outstanding prices
  - Lower inventory and warehousing costs
  - Had only a single warehouse in the US
  - Offered a 30-day money-back guarantee
  - Offered free international shipping

- **Tiffany**
  - Established in 1837
  - 275 stores and outlets
  - "D" items through its website
  - High-end products via stores
  - Both make (60%) and buy
  - Had a retail service center in New Jersey, replenishing its retail stores
  - Had a customer fulfillment center for processing direct-to-customer orders

Class discussion

1. What are some key success factors in diamond retailing? How do Blue Nile and Tiffany compare on those dimensions?

2. Blue Nile carries many stone priced at $2500 or higher, while almost 60% of the products sold from the Tiffany website are priced around $200. Which of these product categories is better suited to the online channel?

3. Which of the two companies do you think was best structured to deal with weak economic times?

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Key metrics of the logistical drivers

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Why metrics for supply chains?

The right metrics can help answer the following key questions for business "journey":

1. **Where do we want to go?**
   - Metrics are valuable for the strategic or tactical direction of a firm

2. **How do we get there?**
   - Metrics quantify goals and objectives, providing actionable targets

3. **How do we know when we've arrived?**
   - Metrics can indicate where you are on the journey to success

Source: Davis and Novak (2012)

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Facility-related metrics

- **Capacity**
  - The maximum amount a facility can process
  - Excess capacity – responsive but costly
  - Little excess capacity – more efficient but less responsive
- **Utilization**
  - Fraction of capacity that is currently being used in the facility
- **Processing/setup/down/idle time**
  - (Fraction of) time that the facility was processing/setup/down/idle
- **Quality losses**
  - Fraction of production lost as a result of defects

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Inventory-related metrics

- **C2C cycle time**
  - Inventories, account payables and receivables
- **Average inventory**
  - Average amount of inventory carried (units, days of demand, etc.)
- **Inventory returns**
  - The ratio of average inventory to either the cost of goods sold or sales
- **Average replenishment batch size**
  - Average amount in each replenishment order
- **Average safety inventory**
  - Average amount of inventory on hand when a replenishment order arrives

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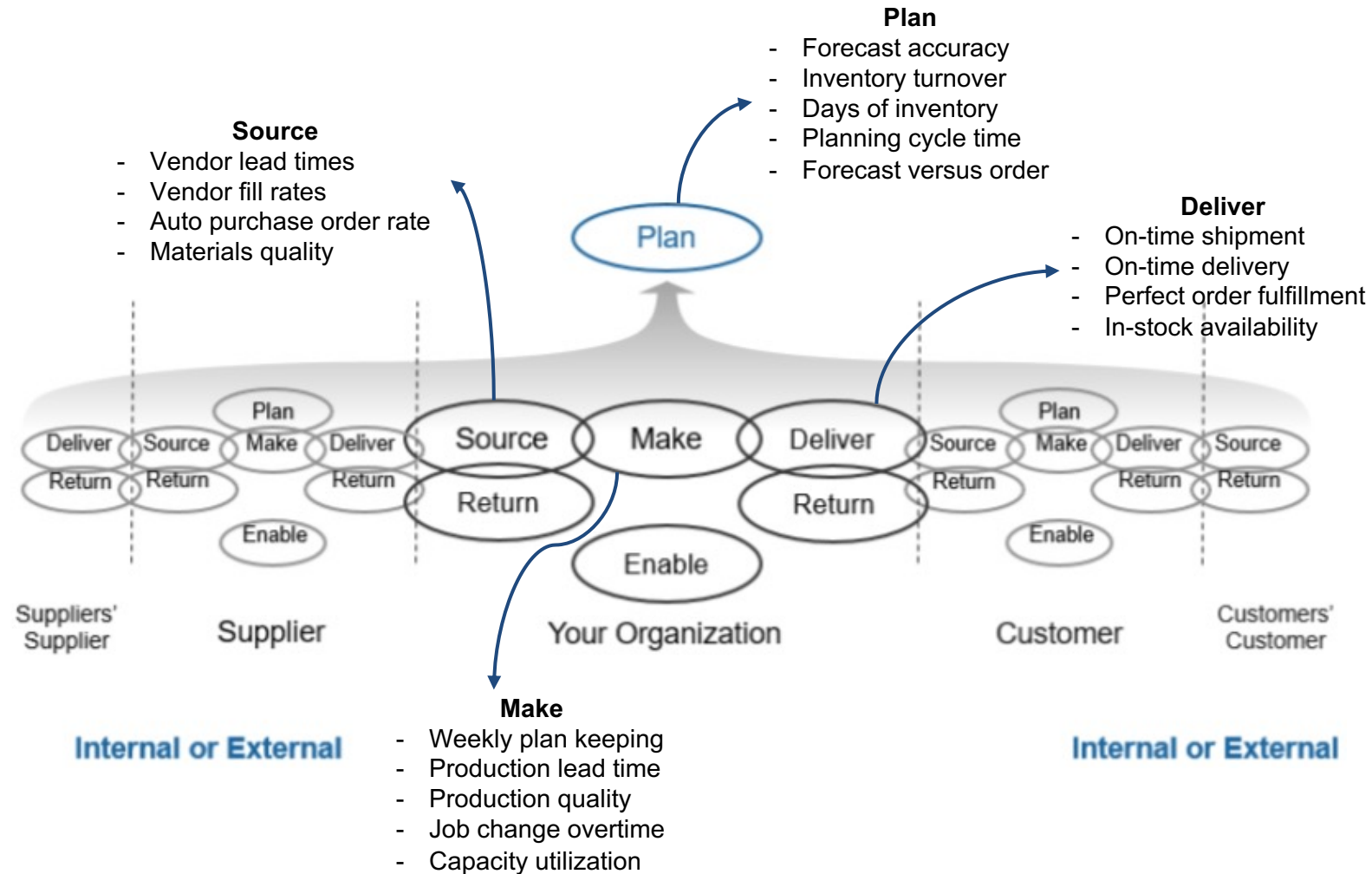# Transportation-related metrics

- **Average inbound (outbound) transportation cost**
  - Cost of bringing (sending) products into (out of) a facility
- **Average incoming (outbound) shipment size**
  - Average number of units or dollars in (on) each incoming (outbound) shipment at a facility
- **Average inbound (outbound) transportation cost per shipment**
  - Average transportation cost of each incoming (outgoing) delivery
- **Fraction transported by mode**
  - Fraction of transportation (in units of dollars) using each mode of transportation

What makes "good" metrics

What makes a good metric?

- **Well-defined from a standard source (e.g., SCOR)**
- **Related to one another**
- **Widely disseminated to the organization**
- **Related to organizational objectives**
- **Actionable**
- **Tested before they are implemented**
- **Organized, so that top metrics are supported by lower-level metrics**
- **Timely and accurate**

Source: Davis and Novak (2012)

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SCOR model

Plan
- Forecast accuracy
- Inventory turnover
- Days of inventory
- Planning cycle time
- Forecast versus order

Source
- Vendor lead times
- Vendor fill rates
- Auto purchase order rate
- Materials quality

Deliver
- On-time shipment
- On-time delivery
- Perfect order fulfillment
- In-stock availability

Make
- Weekly plan keeping
- Production lead time
- Production quality
- Job change overtime
- Capacity utilization

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Delegation flow concept

The more metrics you try to follow and control, the more likely you'll neglect something

The recommended number of metrics is five plus or minus two
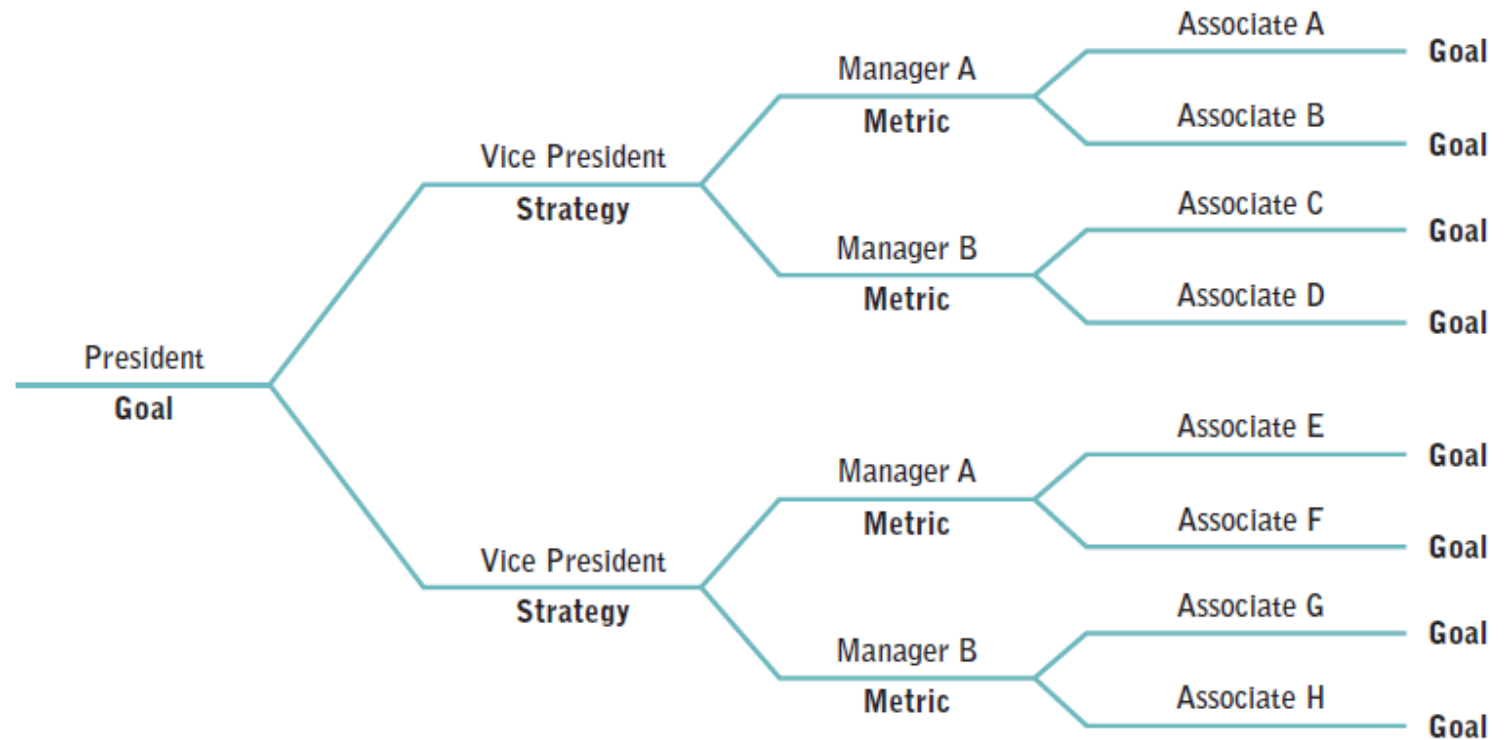
Decision-making under uncertainty

Slides adopted from the course Business Analytics 2 by Dr. Vilkkumaa and Dr. Liesiö

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Decision-making under uncertainty

A decision problem under uncertainty is characterized by:

- <u>States of nature</u>: Possible future events
  - Should be mutually exclusive and collectively exhaustive
  - The DM cannot control/select which of them occurs

- <u>Decision alternatives</u>: Different possible strategies the decision maker (DM) can employ

- <u>Resulting payoffs</u>: Capture the **outcome** associated with each decision alternative in each state of nature

> - **mutually exclusive:** not overlapping
> - **collectively exhaustive:** combined, they cover everything

Decision trees

Decision node (square):

- Each path corresponds to a decision alternative

Chance/uncertainty node (circle)

- Each path corresponds to a state of nature and has a probability (sum to one)

Decisions and chance events are displayed in logical temporal sequence from left to right

Consequences are specified with a single performance measure and listed at the right end of the tree

- E.g., profit, cost, revenue, utility
- Path-dependent consequences can be readily handled
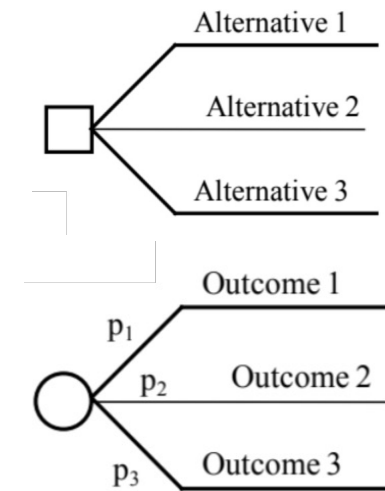
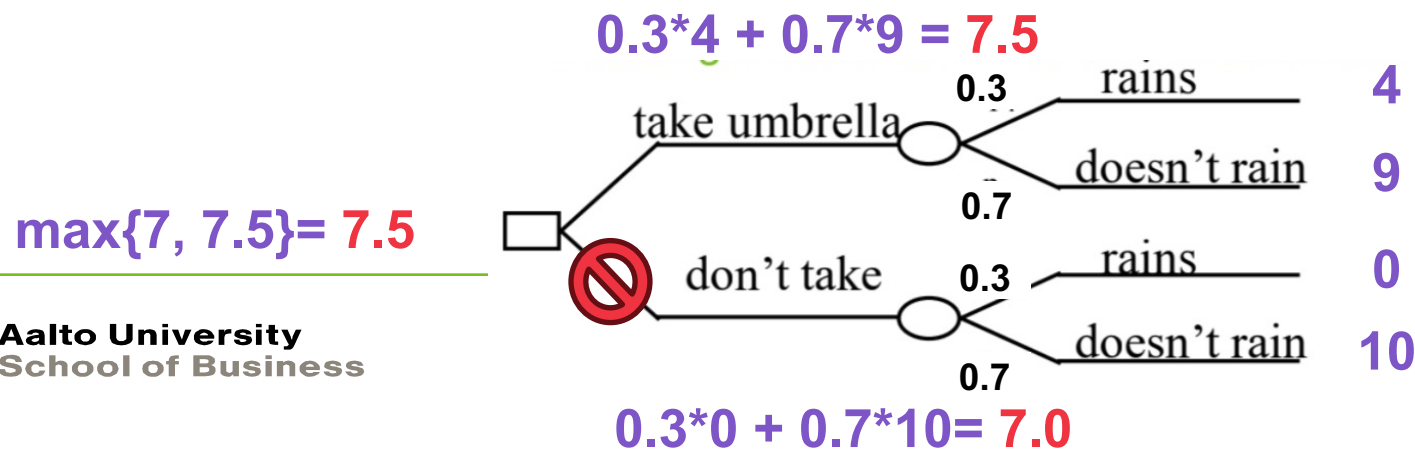Deciding whether or not to take an umbrella
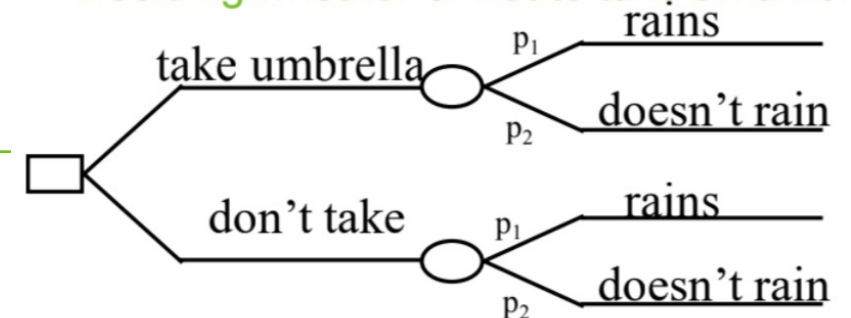
Decision tree as a Decision Support Model

A conceptual model for relationships among uncertainties and decisions

- In which order are decisions made?
- What information is available when making a specific decision?

A normative model for identifying the (sequence of) optimal decisions

- Solution procedure: Go through the nodes from right to left
  - Chance node: compute expected value over outcomes
  - Decision node: select the alternative with maximum value

$0.3*4 + 0.7*9 = 7.5$

take umbrella

0.3 — rains — 4

doesn't rain — 9

0.7

$\max\{7, 7.5\} = 7.5$

don't take — 0.3 — rains — 0

doesn't rain — 10

0.7

$0.3*0 + 0.7*10 = 7.0$

I recommend the course Business Analytics 2 if you're interested in this topic

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Recap

Course contents

Part 1. Background

1. Understanding supply chains
2. Achieving supply chain fit
3. Mathematical programming for Logistics & SCM
4. Guest lecture: Janne Kilpua

Part 2. Transportation

5. Urban logistics
6. Vehicle routing problems

Part 3. Facilities

7. Warehousing operations
8. Guest lecture: Konecranes
9. Facility location problems

Part 4. Digitalization

10. Digital logistics / Analytics / Monte Carlo
11. Logistical drivers and metrics / decision-making under uncertainty

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TFC report

Recommended structure (1/2)

- **What are your strategies (competitive strategy, supply chain strategy, etc.)?**
    - Remember to provide justifications for those strategies (i.e., why?)

- **How did you plan to operationalize your supply chain strategy?**
    - What did VP Sales/Purchasing/Operations/SCM do to execute the strategy?
    - How was the coordination guaranteed?
    - NOTE: Please do not provide a decision log

- **How did your plans/strategy turn out?**
    - Was it the right strategy? Why? (justifications)
    - Was it the right execution? Why? (justifications)

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Recommended structure (1/2)

- **Other reflections**
  - Coordination?
  - Strategic fit?
  - Information asymmetry
  - Decision-making under uncertainty
    - *Demand uncertainty*
    - *Supply uncertainty*
    - *Operational uncertainty*
  - Network design?
  - Network perspective

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Exam prep

Exam preparation

- **The exam will be a closed-book exam**

- **You need to familiarize yourself with all topics covered in the course**
  - Don't <u>memorize</u> but <u>understand and remember</u>

- **You may need to provide examples**
  - Examples from TFC *may* also work
  - Therefore, you need to think about the <u>implications</u> of what we covered in class

Exam preparation

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Keep in touch!

tri.tran@rug.nl

https://www.linkedin.com/in/tritranaalto/

Groningen, Netherlands

Groningen: A winning alternative to Amsterdam.

Shutterstock

Young and hip, Groningen is a winning alternative to Amsterdam. The canals and classic Dutch buildings are all in evidence, but without the bustling hordes of tourists. The bike is king here, with the majority of journeys taken on two wheels.

The routes are flat and easy, so hire one and head off for an explore. Clamber to the top of the Martini Tower, take a stroll around the Noorderplantsoen park and grab brunch at achingly cool Bakkerij Blanche.

Thank you!

Questions?

Dr. Tri M. Tran
tri.tran@aalto.fi