Lecture 01
Course Introduction & Fundamentals

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Outline

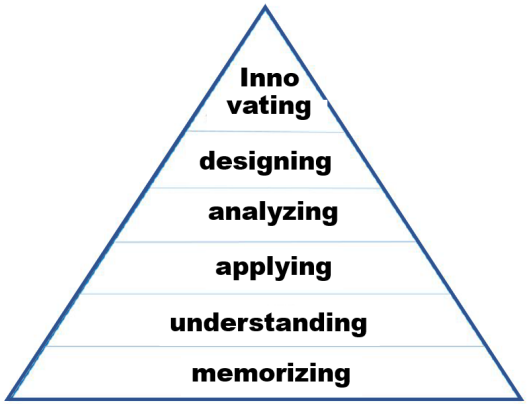
source: General references [**?**, **?**, **?**, **?**]

Syllabus: Before we start

Course Description

The role of the warehouse; warehousing decisions; warehousing operations; materials handling and packaging

Objective



- Understanding roles of a WH, principle of WH Mgt, and WHS decision *[a]*
- Analyzing data related to WHS Mgt *[e]*
- Designing a layout of a WH with suitable storage and MHE *[c]*

Why This Course Matters – Graduate Perspective

Why do need this course?

- **M.Eng:** basic for WHS MGT thesis, logistics cert., profession opportunities
- **B.Eng:** senior project, logistic profession & industry readiness.

What are benefits of this course?

- **Field Trip:** chances to visit state-of-art DC & fulfilment center
- **Hand-On:** layout design, analysis, WH technique,
- **Professional Insight:** shared experience, consulting experience

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BG & Exp:	Profession: analysis, & consultant) Academic: PhD dissertation, courses, training)
LMS:	CourseVille (**passwd:** `warehousing<<`*year*`>>`)
WWW:	http://ie.eng.chula.ac.th/õran/classes/WH.htm https://sites.google.com/site/oranclasses

Grading Policy

Work & Score

- Homework & Quizzes (10%)
- Mid Term Exam (30%)
- Field Trip Report and/or Term Report (20%)
- Term Project and/or Final Exam (40%)
- Participation (Bonus 5%)

Grading agreement

85 & above: final grade id definitely 'A'

between 50 & 85: A, B^+, B, C^+, ... , D

50 & below: final grade is possibly 'F'

Expectations and Class Participation

- No class attendance, except during field trip
- Don't miss field trips
- Don't interrupt others
- Be responsible, especially meeting time & assignment
- Participate during class; this is Master level course

Exams assess foundational basic knowledge of WH & WHS MGT

Academic Integrity and Use of AI

ChatGPT Policy: AI = tools + emerging skill

warning: do not trust AI (inherently bias); user must be **responsible**; any use must be clarified

- Education with ethic standards & social responsibilities
- Trust as integral & essential part of learning process
- Self-discipline necessity
- Dishonesty hurts the entire community

adapted from: Georgia Institute of Technology –The Honor Code

Plagiarism or dishonest conduct will lead to disciplinary action per Chulalongkorn University policy

Textbook & references

Textbook

[?] Oran Kittithreerapronchai, 2559. *Warehouse and Warehousing Management*. G.P. Cyber Print, Bangkok

References

[?] Bartholdi, J. & Hackman, S. 2009. *Warehouse Distribution Science* from http://www.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf .

[?] Mulcahy, D. 1994 *Warehouse Distribution & Operations Handbook*. McGraw-Hill. Singapore.

[?] Frazelle, E. 2002. *World-Class Warehousing & Material Handling*. McGraw-Hill, New York.

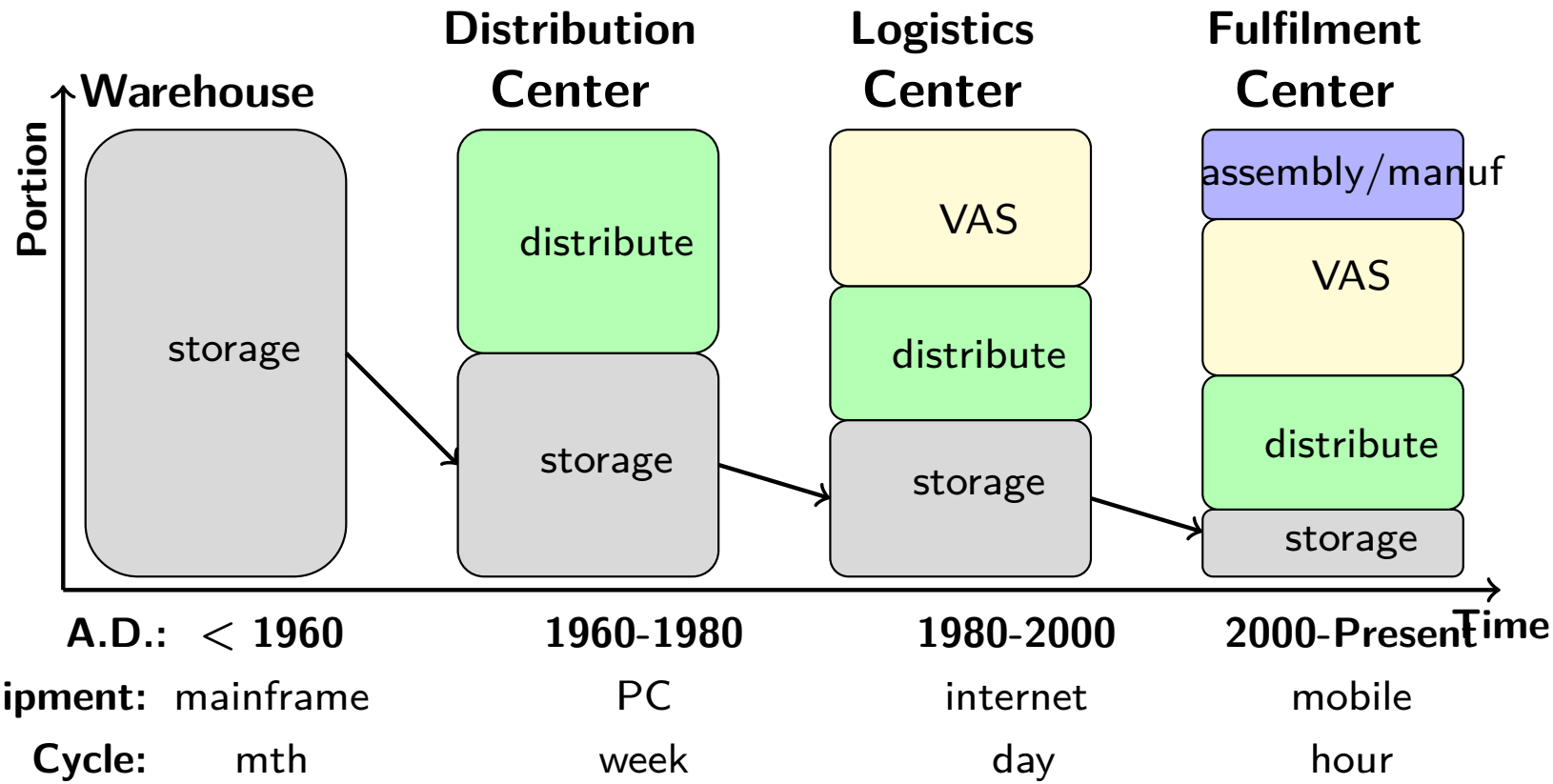
Warehouse & Logistics/Supply Chain

- Warehouse $\in$ Supply Chain
- Warehouse $\stackrel{?}{=}$ a bid dark, gloomy, & messy building
- Warehousing management $\stackrel{?}{=}$ Inventory management
- Warehouse $\stackrel{?}{=}$ DC $\stackrel{?}{=}$ Transit facility $\stackrel{?}{=}$ Silo $\stackrel{?}{=}$ Crossdock $\stackrel{?}{=}$ Fulfillment Center
- If goals of Supply Chain is to ensure that customers got

  the right item
  in the right quantity
  at the right place
  at the right time
  in the right condition
  at the right price
  at the optimum cost to the organization(s)

  then, how these related to warehouse?

Development of Warehousing Management



source: Frazelle, E. 2002. "World-Class Warehousing & Material Handling" [?]

Warehouse VS Warehousing management

Warehouse a physical location store inventory. Types of warehouse are:

- **Products:** finish goods, work-in-process, raw materials
- **Material handling:** unit load, break-bulk, chilled, chemical
- **Interactions:** picker-move (goods-to-men), picker-fixed (men-to-goods)
- **Business:** retail, service parts, 3PL, perishables

Warehousing Management is accountable/responsible for:

- effective use of the available resources & operations
- maintaining and monitoring inventory, systems & equipments

Objectives warehousing management

Objectives

- To ensure availability of resources for planned level of business.
- To meet throughput requirements.
- To provide an cost effective service while meet business objectives.

Specifically: Time, Space, & Cost

- minimizing frequency/distance of movement
- maximizing the use of cubic space
- enabling the use of standard storage & handling equipment
- speeding up loading & unloading
- minimizing damages & thieving

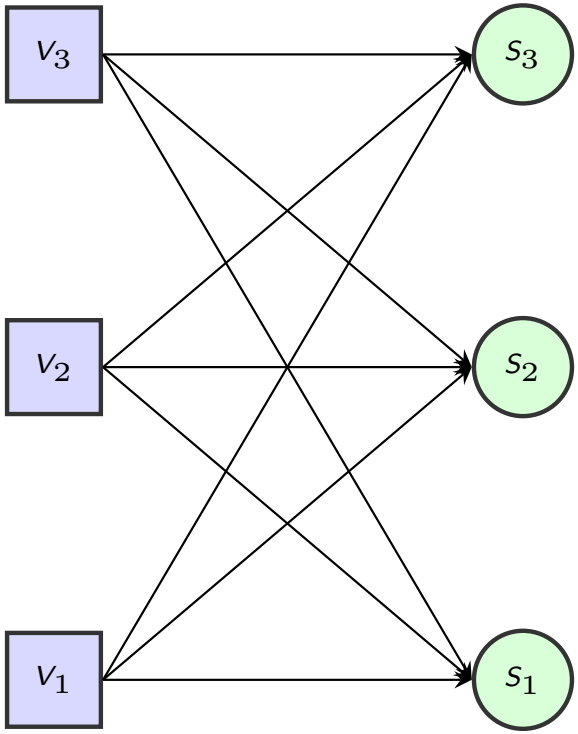
Challenges in warehouse

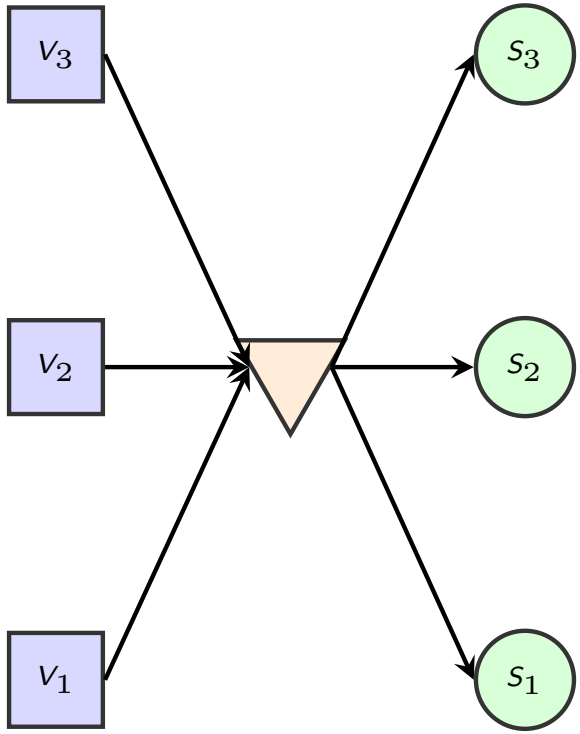
- Warehouse can be viewed as opportunity cost or sunk cost
- Traditional view as cost center $\rightarrow$ lacks of investment, workforce
- Ownership of warehouse: public warehouse (outsourcing) **VS** private warehouse (insourcing)
- Economic pressure from upstream & downstream
- Multi-dimension objectives in warehouse
- Maintaining efficiency & housekeeping of warehouse

Warehousing is not a cost center activities, but strategic activity

Why do we need warehouse?

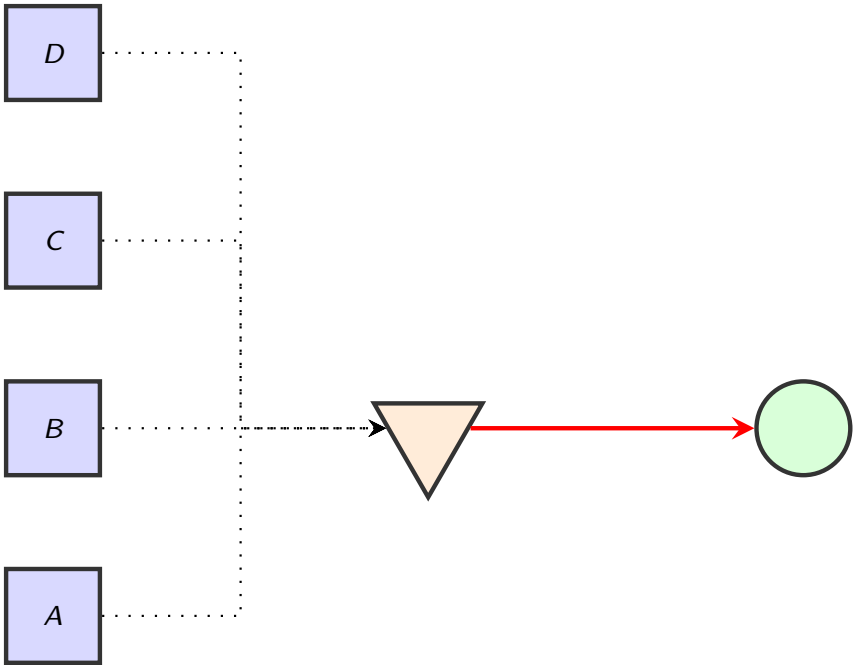
- To prevent against fluctuations from suppliers and/or customers (Wal-Mart, SCG)
- To exploit economy of scale & freight consolidation (THD)
- To perform value-added activities (e.g. HP DeskJet, NY)





Exercise

[?] Wal-Mart usually receives mixed-production shipments form the four manufacturers A, B, C, and D with LTL shipment rate. If transportation cost $= 0.01 \cdot rate \times weight$.

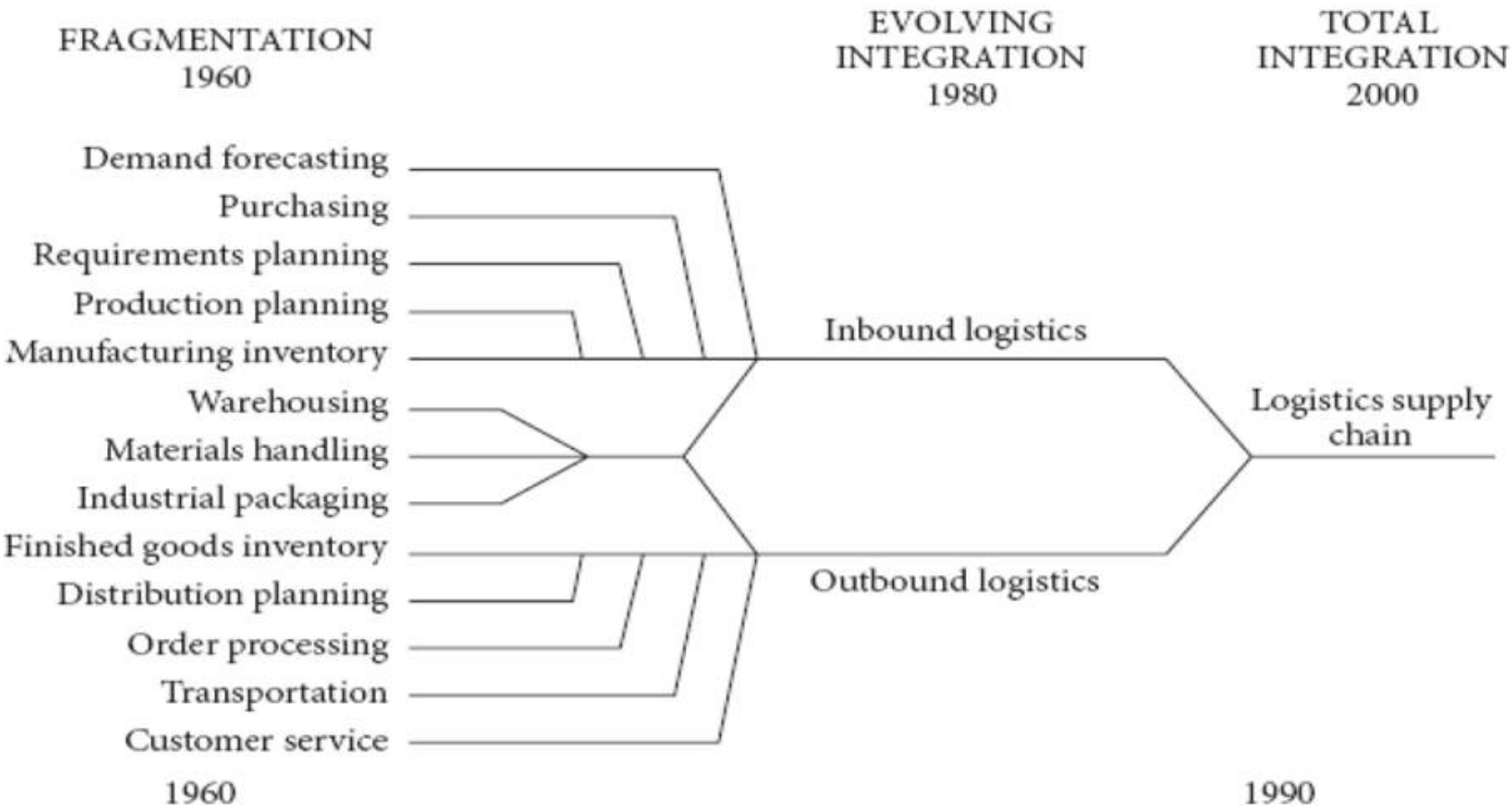


	lbs	rate_{LTL}	$tran_{LTL}$
A	10.0k	2.00	200
B	8.0k	1.80	144
C	15.0k	3.40	510
D	7.0k	1.60	112

By consolidating shipment, total distribution is reduced to 778 USD per shipment

	lbs	rate_{LTL}	$tran_{LTL}$	*hand*	rate_{TL}	tran_{TL}	total
A	10.0k	0.75	75	10	1.00	100	185
B	8.0k	0.60	48	8	1.00	80	136
C	15.0k	1.20	180	15	1.00	150	345
D	7.0k	0.50	35	7	1.00	70	112

Related issues with warehousing management

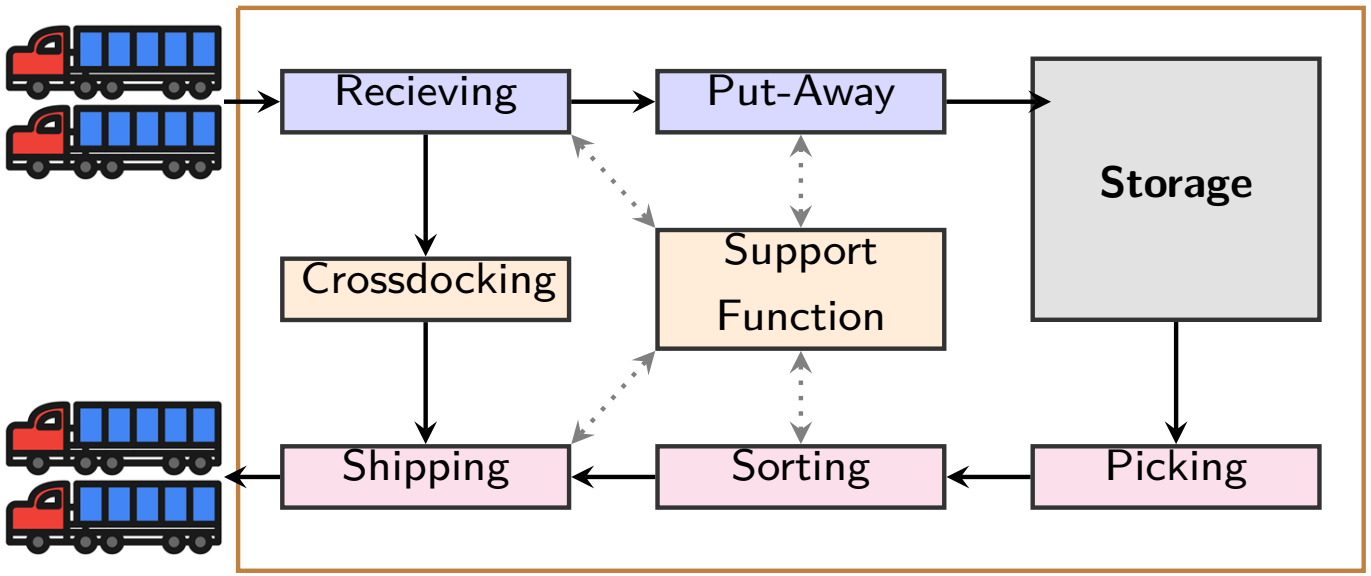


source: Center for Supply Chain Research, Penn State University

Components in warehouse

- **Facility:** building, yard, surroundings
- **Human:** manager, picker, checker, IT, consult
- **Material Handling:** products, storage location, equipments
- **Processes:** main activities, value-added logistics (VAL), counting, reconcile, document

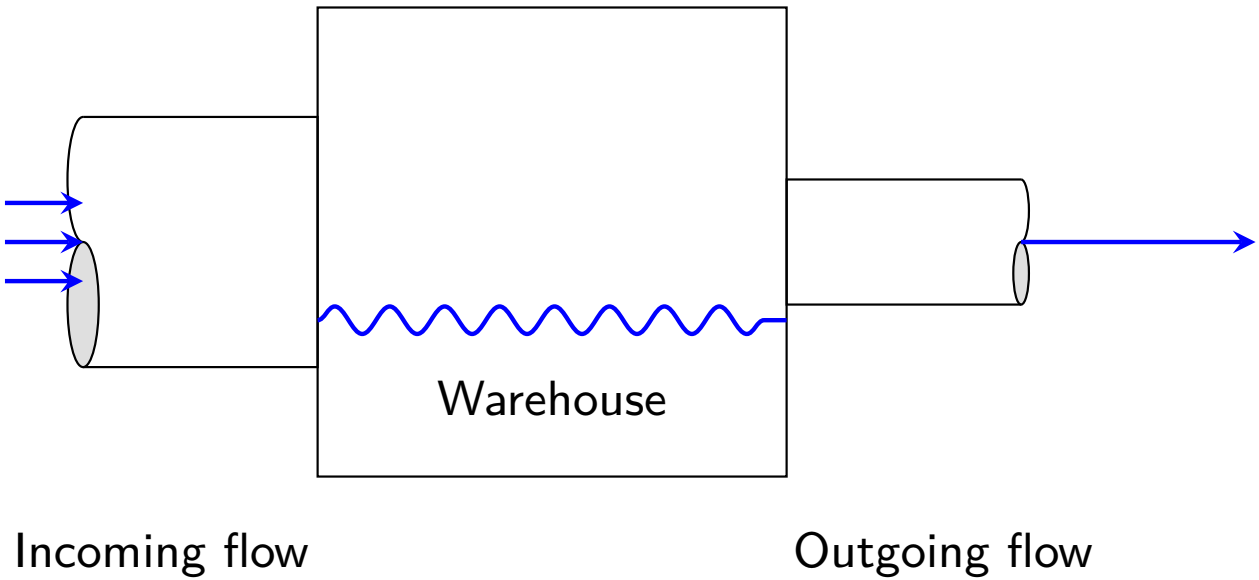
Warehousing activities



source: Frazelle, E. 2001. [?]

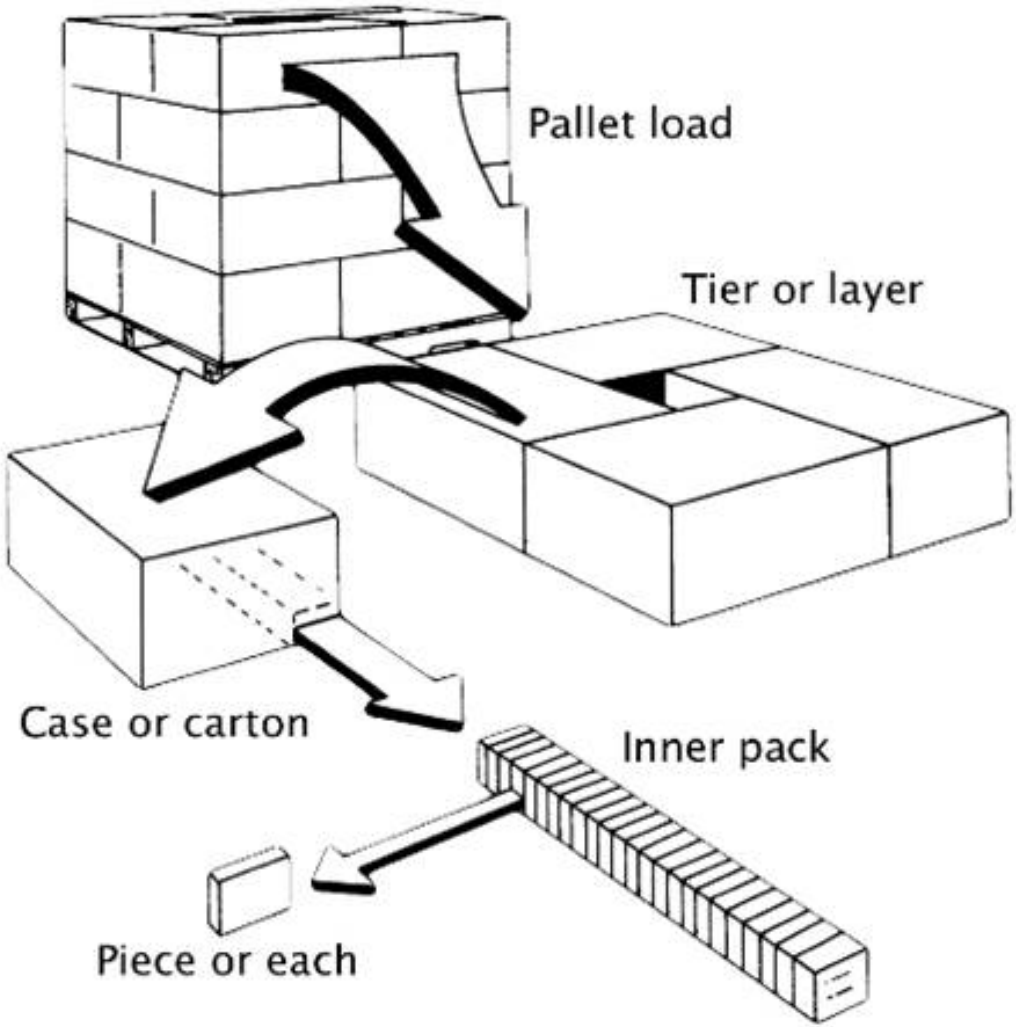
- **Receiving:** yard management (Tesco), unloading, inspection (UF), palletization/ unitization (DKSH), tagging & labeling (HomePro)
- **Put-Away:** positioning, slotting, stock keeping (Jack Daniel)
- **Pick-Up/Retrive:** dispatching (Office Depot), routing
- **Shipping:** sorting, loading (3PL), checker speed (Hafele)

Warehouse as flow process system



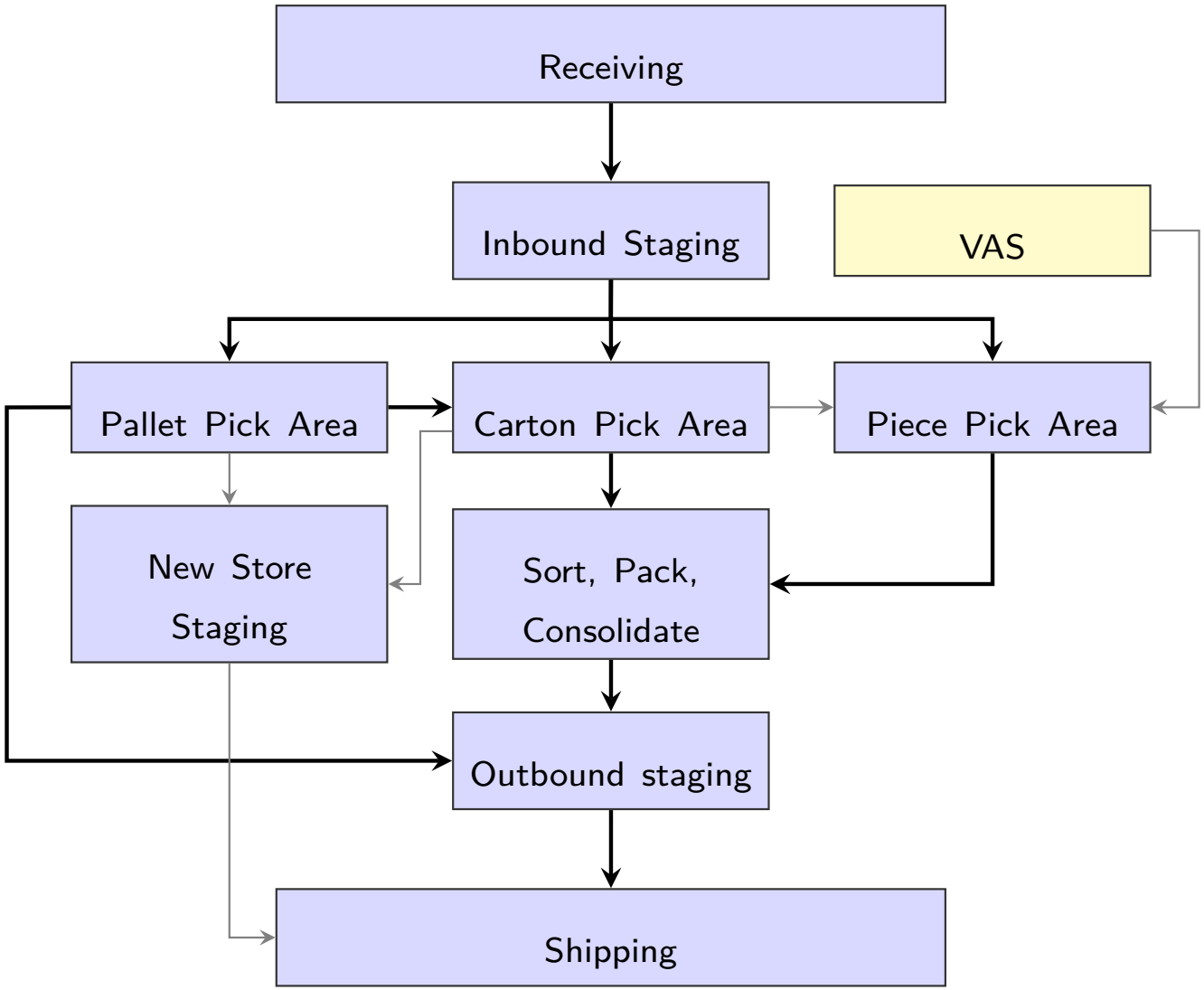
- **Water:** single SKU, and compressible flow
- **Flow balancing:** incoming flow & outgoing flow
- **Keep flow moving:** avoid double handling; space blocking
- **Smooth Flow:** resolve bottlenecks, avoid layouts that impede smooth

Units in warehouse



source: Bartholdi, J. & Hackmans, S. 2009. [?]

Activities in Warehouse



source: Roodbergen, K. *et al.*, 2008. [?]

Nature of warehouse

- Warehouse is labor intensive
- Warehouse is, in general, the last frontier in SCM
- Investment in warehouse depends on values of SKUs in warehouse
- Broken pallets/cases tend to be damaged & lost
- Flows of material in a warehouse is rarely balance at particular time
- Works & effort warehousing activities are unbalance
  - Put-Away $\leq$ Pick-Up
  - Receiving $\leq$ Shipping

Common Classification of Warehouse

Each warehouse is unique, but classification provides useful insight

- **Unit of handling:** material handling equipment (pallet, carton, piece)
- **Nature of Storage:** environment and product (security, storage requirement)
- **Temperature:** Frozen ← Chilled – Air Condition → Ambiance
- **Storage Policy:** dedicated ← class-based → shared/random
- **Management:** Public warehouse ↔ Private warehouse
- **Movement of Good:** Men-to-Goods ← Goods-to-Men → Automation

Extreme Storage Idea

Dedicated each SKU gets pre-determined locations (i.e., adjacent to one others)

Shared each SKU shares all storage locations. (i.e., suggested by IT system)

Example: 7Eleven store as a warehouse

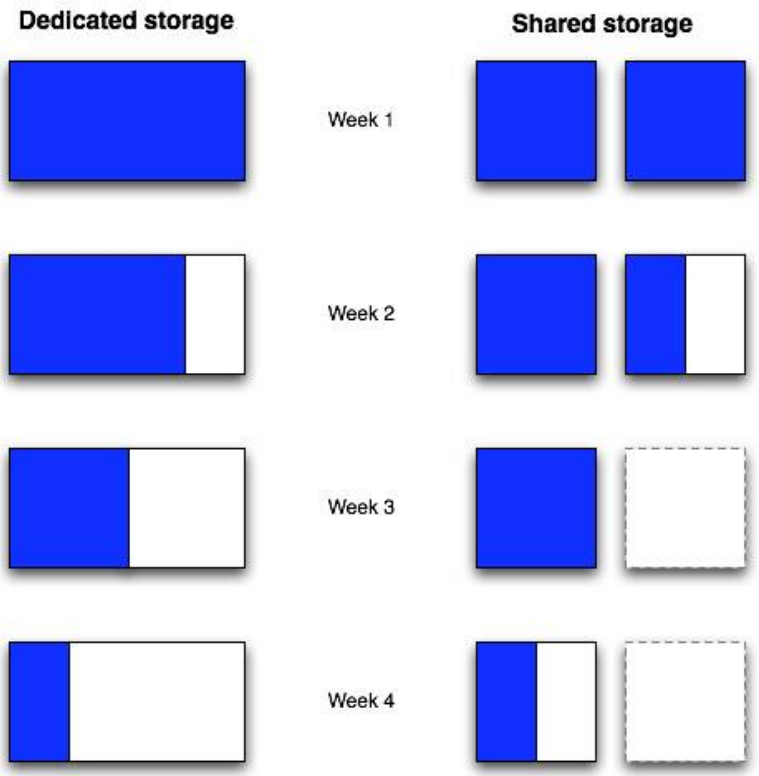
Identify classification of a typical 7Eleven store using a common warehouse classification and identify area

- **Unit of handling:** FG piece picking (basket)
- **Nature of Storage:** security and authorize (back counter)
- **Temperature:** frozen (ice cream, AirCon (Milk, Drink), ambiance (Grocery)
- **Storage Policy:** dedicate-class
- **Management:** private warehouse
- **Movement of Good:** Men-to-Goods
- **Others (TBR):** 24/7, U-shaped layout, vertical bin-shelf racking

Inside CP All DC (7Eleven warehouse)

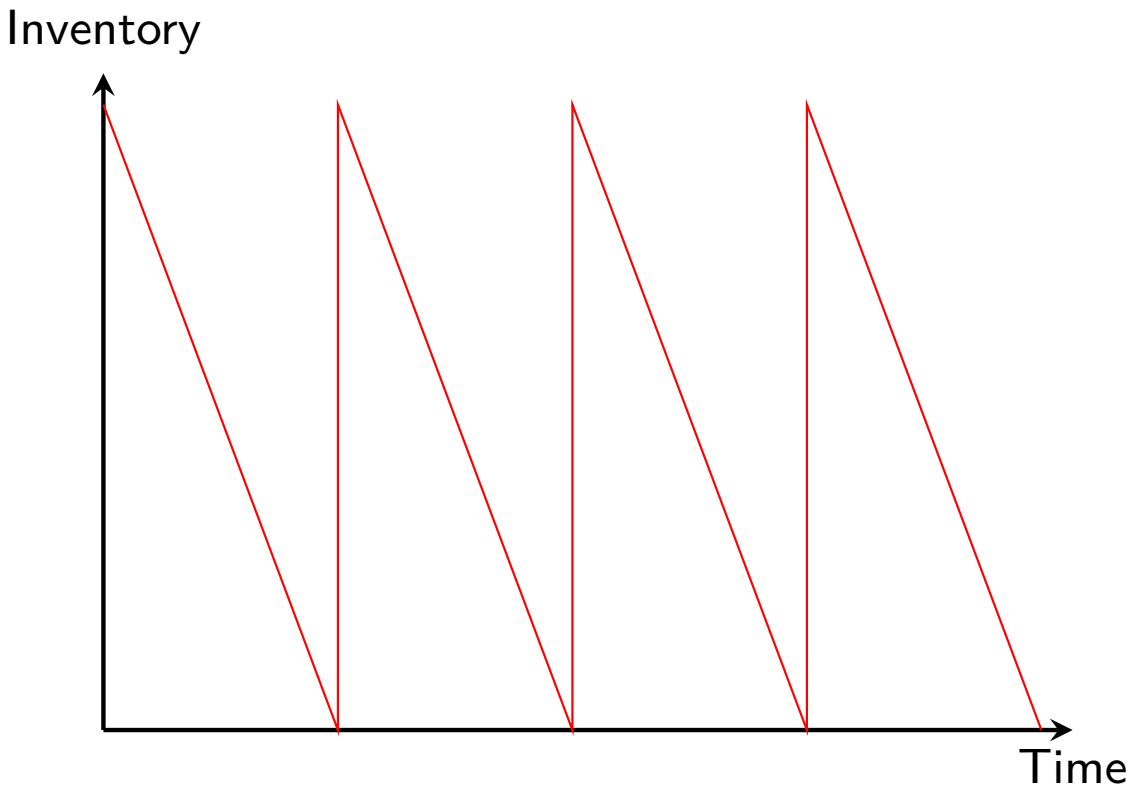
- **Nature:** distributing products in 7Eleven for DC Fee and QC
- **Receiving:** 10w or 18w supplier delivery as carton or pallet
- **Equipment:** trolley, tote, RT, pick-to-light
- **Picking:** wave picking (heavy, pieces $\rightarrow$ tote), chilled
- **Shipping:** 4w outsource as tote + beverage

Dedicated VS Shared



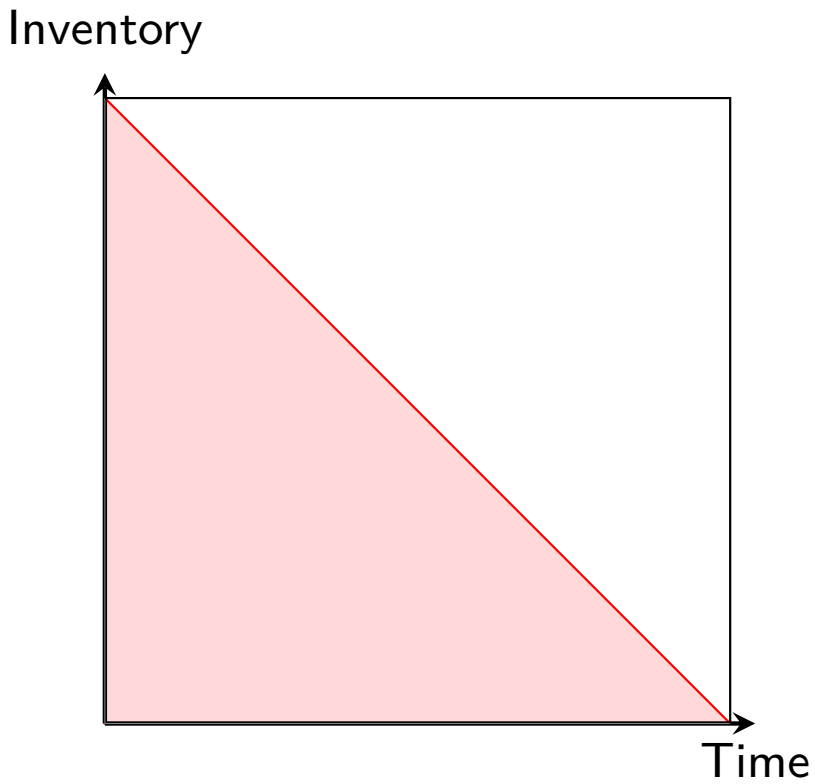
source: Bartholdi, J. & Hackman, S. 2009. [?]

Typical inventory curve



source: Bartholdi, J. & Hackman, S. 2009. [?]

Space utilization of shared



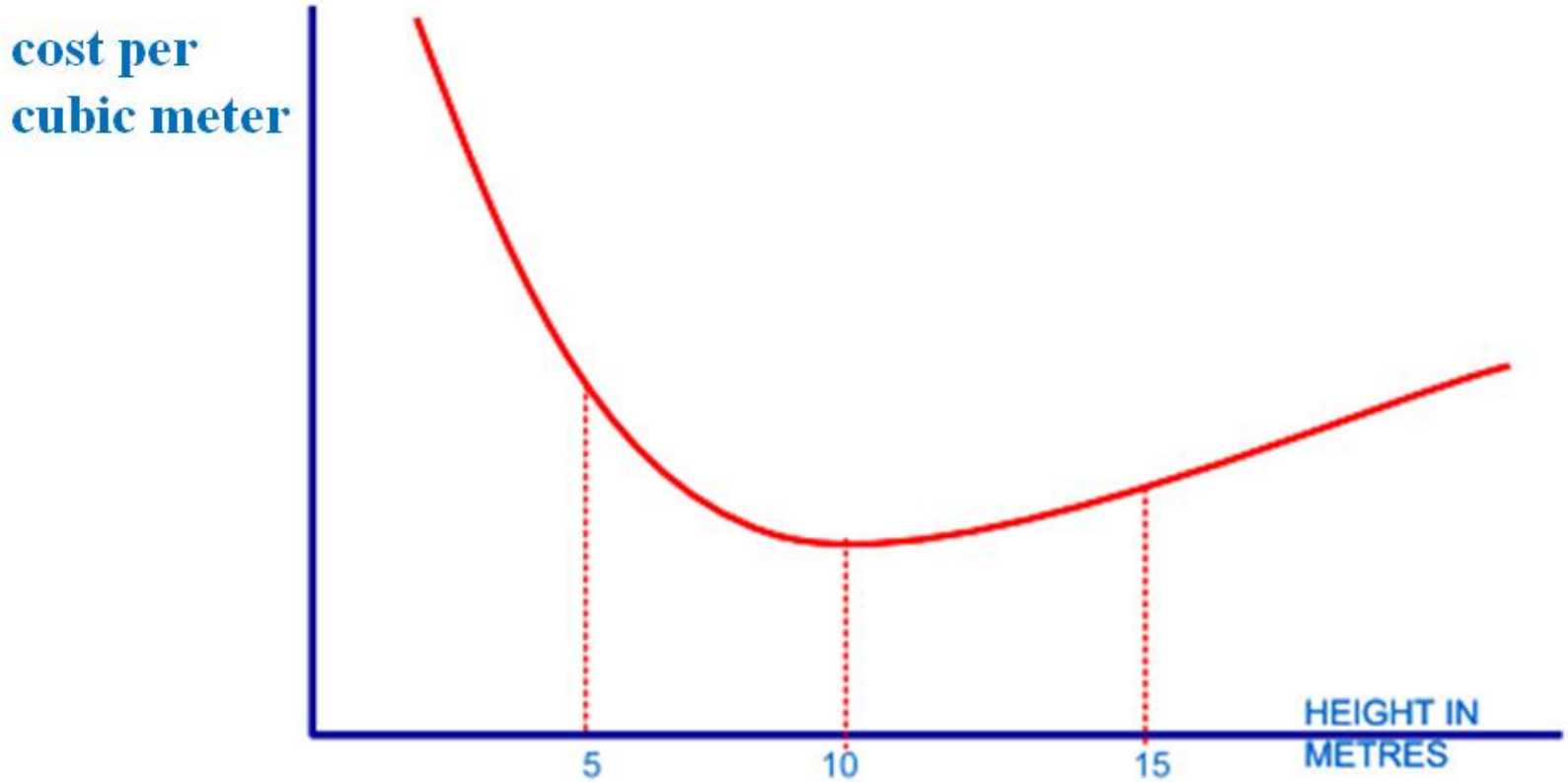
source: Bartholdi, J. & Hackman, S. 2009. [?]

Shared location $\frac{1}{1}$, Space utilization $\frac{1}{2}$

Principle in warehousing management

- **F.A.S.T:**
  - **Flow**: minimizing total movements/cost
  - **Accessibility**: inside & outside buildings
  - **Space**: $\approx$ 40% of cost related to warehouse; use height
  - **Throughput**: equipments, simplification
- **Planning:** long-term goal & short-term req^m, control & feedback,
- **Standardization:** standardized equipments, material handling, flow, workload
- **House keeping:** clean & neat
- **Flexibility:** free space, stacking area, multi-purpose equipment
- **Safety, Security & Eco-friendly:** hazard material control

Costs of using height



source: Airdrie from Logistics bureau asia

Basic Warehouse terminology

 # SKU & coding measuring complexity of warehouse

Inventory turnover ratio of $\frac{\text{sale}}{\text{inventory}}$ measuring efficiency of movement

Cubic utilization: ratio of $\frac{\text{avg vol.}}{\text{total vol.}}$ measuring efficiency of space

Inventory accuracy: ratio of $\frac{\text{stock correct}}{\text{total stock}}$ measuring efficiency of operation

Fill Rate: ratio of $\frac{\text{shipped items}}{\text{ordered items}}$ measuring availability of inventory

On Time In Full: ratio of $\frac{\text{ontime deliveried items}}{\text{ordered items}}$ measure performance of Warehousing & Transportation

Problems

1. Why does a company need a warehouse?
2. What are situations in which a single product ID has multiple SKU IDs?
3. A warehouse is facing economic pressures from both upstream & downstream. What are such economic pressures?
   - **Upstream:** From factories/suppliers to warehouse
   - **Downstream:** From a warehouse to stores/customers

Summary:

- Warehouse brings value to modern SCM
- It is typically ignored $\rightarrow \exists$ value
- Basic to operate warehouse are:
  - **Understanding Flow:** both physical, information, and money
  - **Selecting Equipment:** flexible, suitable, common, ROI
  - **Following safety rule:** no disrupt and worker trust
  - **Knowing Nature of Business** $\rightarrow$ productivity

Reference

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IIE Transactions, 40(11):1032–1045, 2008.