Lecture 02
Warehousing Activities

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Outline

source: General references [BH09, Mul94, Fra02, Kit18]

Review: Warehouse $\in$ Supply Chain

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- **Warehousing management:** maximizing usage of warehouse 'resources' at 'right' service level
- Warehouse $\neq$ Storage room because balance flows, system, policy
- Main components in warehouse are processes/activities & material handling
- Main activities in warehouse are:
  - **Inbound:** before storage i.e., receiving & put-away
  - **Outbound:** after storage i.e., retrieving/picking & shipping

Warehousing concepts so far ...

- **Idea:** swift & uninterrupted flow of materials
- **Principles:** systematic way to manage warehouse (activities & resources)
- **Activities:** focus on main activities, minimize non-value activities
- **Resources:** storage location, equipments, time, money, man-power, utility
- **Warehouse as:** water flow model, queuing model

Two Part Topics

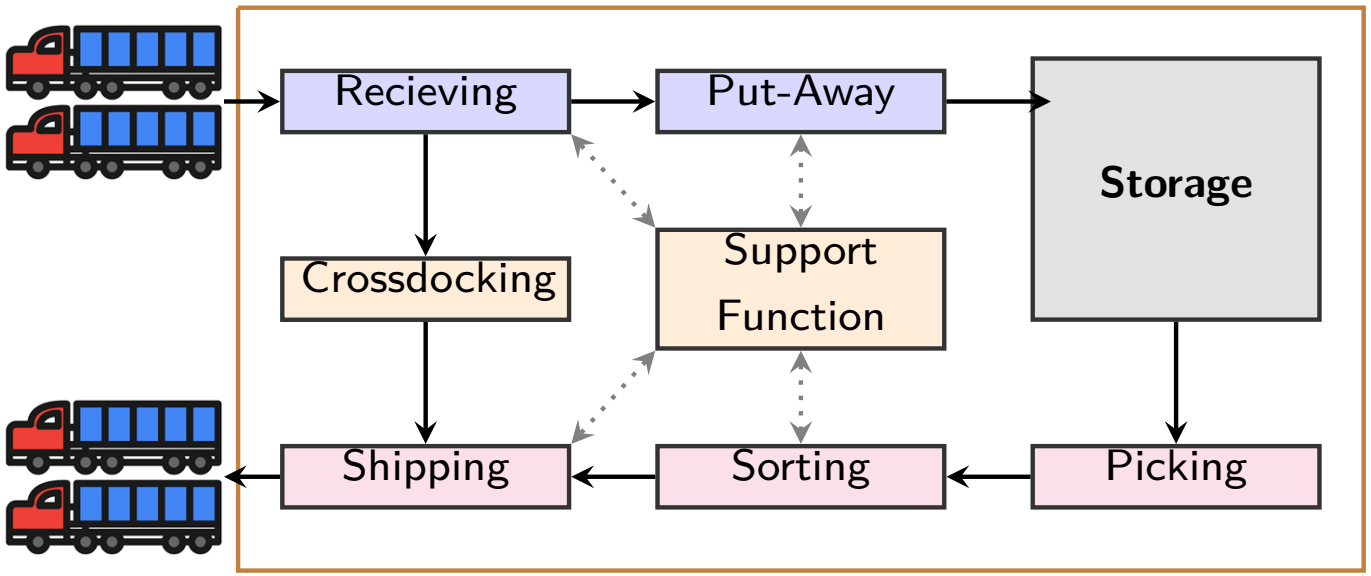
- Comprehensive warehousing activities & storage policies
- Introducing material handling & storage equipments

Trade-offs in warehouse

- **Upstream work VS Downstream work:** batch picking, sorting, unitization, sub-pallet, cross-docking
- **Space utilization VS Efficiency:** aisle width, layout design, equipment selection, storage policy
- **Current productivity VS Future expansion:** warehousing design, picking policy
- **Equipment VS Workforce:** investment, flexibility, IT (WMS)

Warehouse is not about space available, it is space efficiency

Warehousing activities



source: Frazelle, E. 2001. pp 229 [Fra02]

Warehouse activity breakdown

Activities	Percentage
Receiving	10%
Put-away	15%
Retrieving/Picking	55%
Shipping & Sorting	20%

source: Bartholdi, J. & Hackmans, S. 2009. [BH09]

Receiving activity

- **Idea:** unloading & preparation
- **Importance:** initiating all activities
- **Basic:** doing paper work & checking for quantity & quality
- **Functions:**
  - Notification: make appointment → low waiting time
  - Acceptance: compare invoice with PO → data → backlog
  - Receiving: inform pending shipment → reserve locations
  - Inspection: visual and qty check
  - Unitization: build unit load
  - First package seen: measure & register SKU

Receiving management

- **Principle:**
  - Sort according outbound shipments:
  - Combining receiving & shipping: → crossdock
- **Receiving practice:**
  - Direct shipment: direct shipping to consumer, food
  - Pre-receiving: employ information before products arrive
  - Scheduling: balancing workforce (hiring temp), equipments
  - Crossdock: JIT warehouse
- **Issue:** yard management, fast information, near opt realtime scheduling

Put-away activity

- **Idea:** moving SKU to 'designated' locations
- **Importance:** defining all works downstream.
- **Basic:** recording where SKUs are consistently
- **Put-way practice:**
  - Direct put-away: combine receiving & put-away (no inspection w/ RFID)
  - Suggested put-away: use IT to suggest locations
  - Batched: source products for efficient put-away
  - Inter-leaving: combine put-away with picking in single trip
- **Issue:** grouping philosophy, convenance location, multiple storage locations

Grouping philosophy

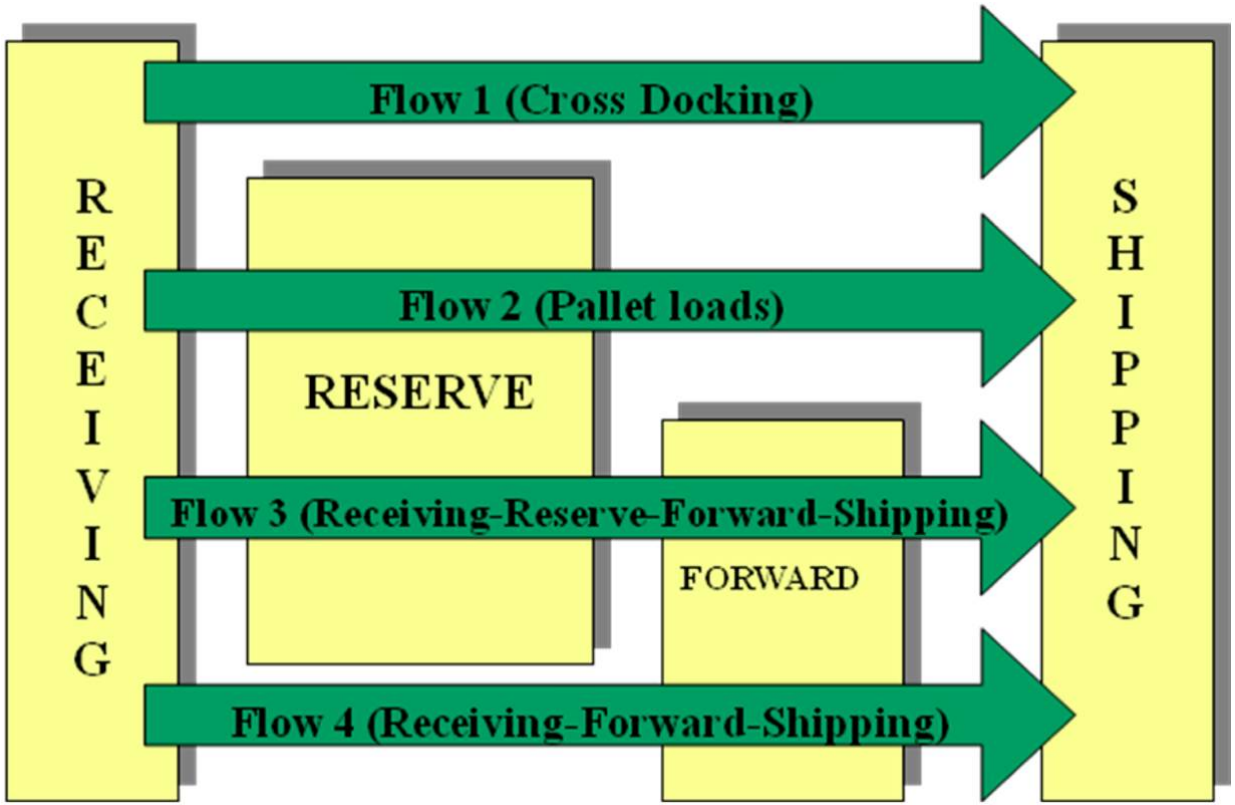
- **SKU popularity:** ABC based on frequency
- **Unload/Load:** #load $\geq$ #unload $\rightarrow$ put near shipping
- **Family group:** value, temperature, hazardous, physical, lot number, tax
- **SKU rotation:** FIFO (LILO), FILO, FEFO
- **Aisle width:** accessibility $\rightarrow$ equipments
- **Space utilization:** maximizing storage space; minimize congestion
- **Quality:** full pallet **VS** break bulk; equipments
- **Others:** default path, efficient tour, quick detection

Put fast-moving items at convenient & suitable locations

Non-productive activity: Storage

- **Idea:** preventing SKUs for damage and/or degrading
- **Importance:** what other thinking of warehouse
- **Basic:** utilizing space, while maintain easy access
- **storage area:**
  - Forward area: storing products for carton/case/piece picking and customer delivery
  - Reserve area: storing pallets for pallet picking or refill other area
- **Issue:** fast-picking area, design of storage area, physical counting, housekeeping

Between receiving & shipping

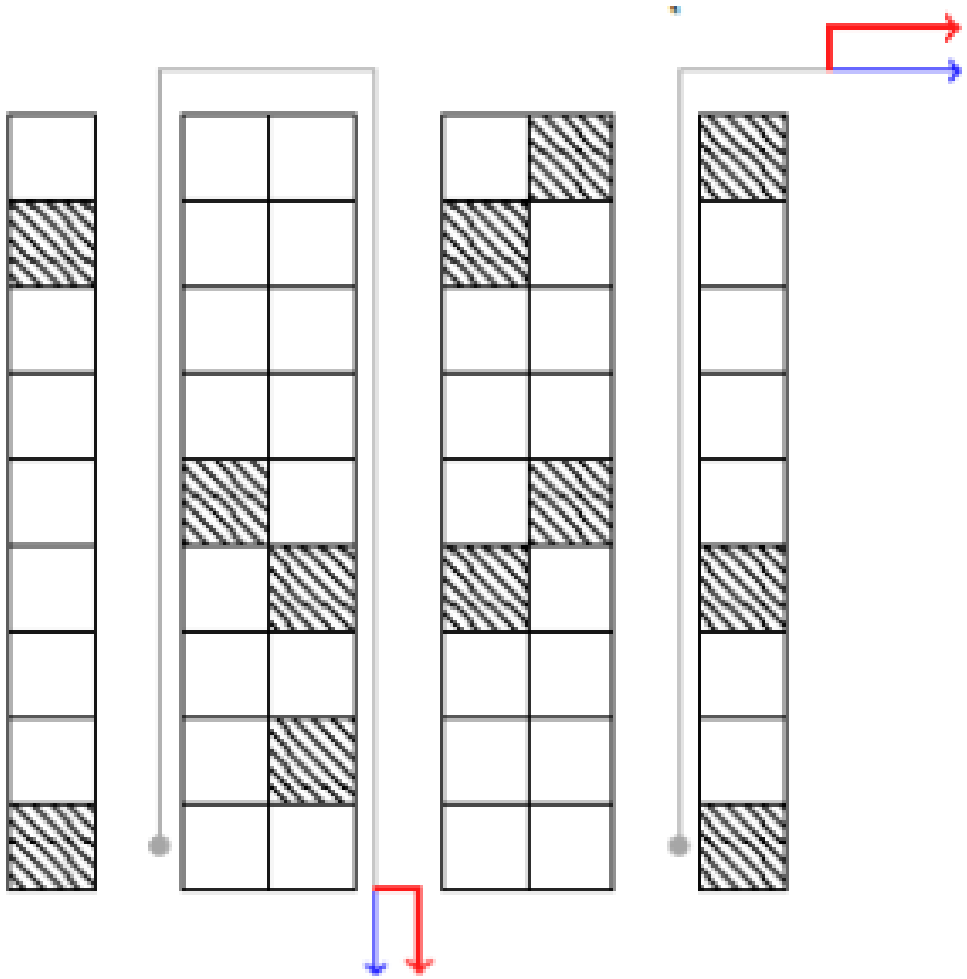


source: Mulcahy, D. 1994. [Mul94]

Picking activity

- **Idea:** getting SKU from 'designated' locations
- **Importance:** majority of costs & times incurred
- **Basic:** distributing 'order' & checking 'right' quantity
- **Principle:**
  - Minimize loose items & staging for shipping
  - Minimize paperwork & time
- **Variation:**
  - Single order: one tour for one order
  - Batch [order]: one tour for many orders
  - Zone: set area for each picker
  - Wave: coordinated between zones
- **Issue:** pick sequence, picking equipments (information/error)

Picking Variation



Trivial about picking

WMS (warehouse management system) a large software system that coordinates the activities of the warehouse

Order line number of items ordered by a customer

Actual pick number of SKU handled by a picker

Pick line number of SKU appeared in pick list

Pick face area of SKU directly face picker (# sku/m^2)

Pick density number of picks achieved per unit of area on the pick face (# pick/hr)

Shipment integrity one order should be shipped in one shipment

Order splitting: customer orders are split base on location of warehouse

Merge-in-transit: combined split order at the last warehouse before delivery

Example: Units of picking

Suppose product A is stored in a warehouse as box (in reserved area) & piece (inforward area). Each box of product A contains 12 pieces & handling of product A always requires cart that has maximum capacity of 2 boxes. Currently, the warehouse has 10 boxes & 5 pieces of product A available. If a customer X requests 40 pieces of product A, what are units of picking

	line	#	unit
• Order line	1	40	piece
• Pick line	2	3	box
		4	piece
• Actual pick	3	2	box
		1	box
		4	piece

How should we track picking activity?

Picking break down activities

Activities	Elimination Method	Equipment
Traveling (55%)	bring SKU to picker	carousel, AS/RS
Searching (15%)	illuminate SKU	pick-2-light/ RFID / pick-2-voice
Extracting (10%)	automated dispensing	scale on vehecle
Other (20%)		
• documenting	re-engineering	ID system
• reaching	wrist-level picking	carousels
• counting	weight, unit-load count	

source: Bartholdi, J. & Hackman, S. 2009. [BH09]

Sorting & shipping activities

- **Idea:** preparing & checking SKU before leaving warehouse
- **Importance:** defining productivity of warehouse, quality control
- **Basic:** checking SKU, documenting transactions & loading in reverse order
- **Sorting & Shipping practice:**
  - Container optimization: select cost & space effective handling units
  - Automated loading: eliminate shipping stacking area by loading to truck
- **Issue:** equipments, yard management, stacking area, shipping integrity

Type of Value added logistics (VAL)

- **Light manufacturing:** re-boxing & re-instruction (DKSH), re-containerizing (Merck), sample assembly (Hefale), measuring & cutting (UF)
- **Labeling:** MUJI price labeling (CRC), can labeling (TUF)
- **Kitting:** component packing (HP),
- **Reverse logistics:** dispose product (Tesco), cleaning tote (7-Eleven), re-location (HomePro)

Non-valued activities

- **Documentations:** data entry, data update, e.g. stock card
- **Stock checking:** visual inspection, counting
- **Re-location:** label process (TUF), 5 S., dead stock (Siam Kubota)
- **Training:** safety & driving (HomePro),

Problems

1. What are **value-added/ main** activities in a warehouse? & which one is the most labor intensive?
2. What is **Inter-leaving**? & How this practice improve the productivity of a warehouse?
3. Many warehouses implemented location identification technology such as, bar code, QR code, or RF tag at their storage locations. How these technology integrate with **receiving** & **picking**

Summary:

- Operating warehouse faces many trade-offs
- Main activities and their main purpose in warehouse are:
  - **Receiving:** defined downstream activities
  - **Put-Away:** location to pick
  - **Picking:** labor intensive
  - **Sorting & Shipping** last chance to check

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