Lecture 05
Managerial Decisions in Warehouse

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Outline

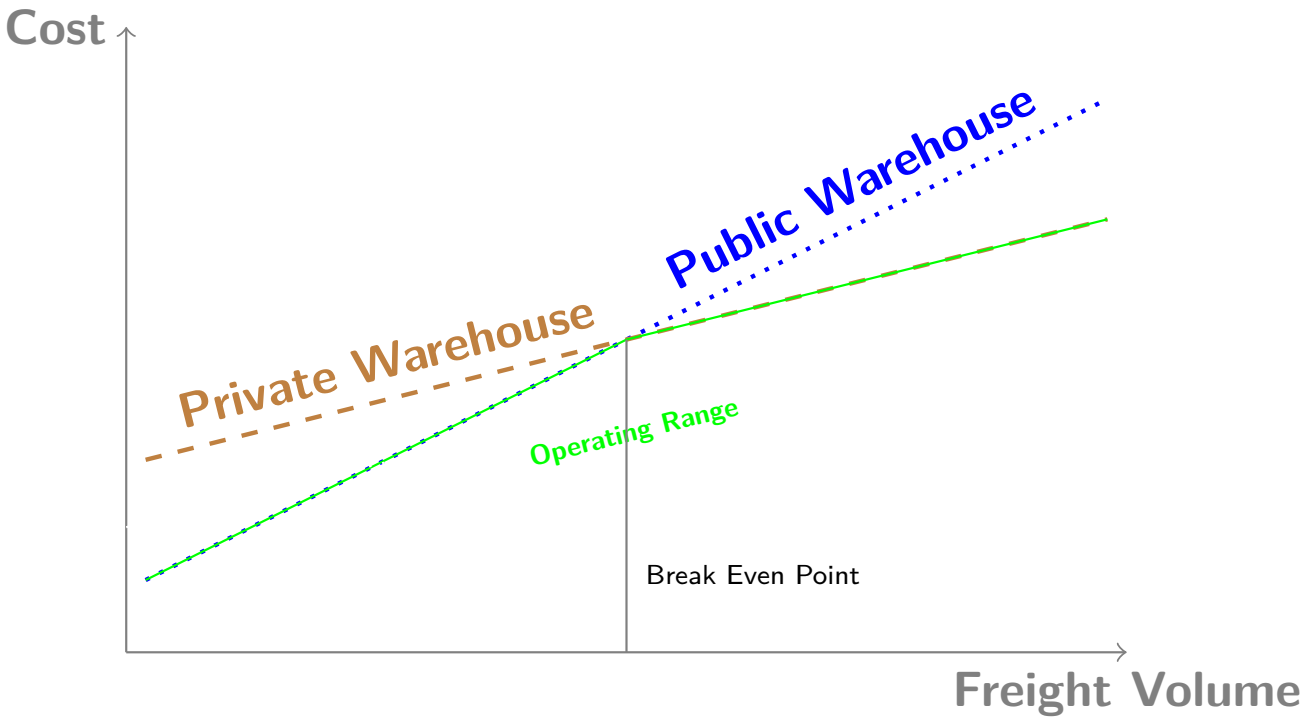
source: General references [**?**, **?**, **?**, **?**]

Basic warehousing decisions

- **Ownership:** inhouse $\leftarrow$ dedicated (modern trade) $\rightarrow$ outsource (3PL: equipments, mgt, location)
- **Site & Number:** numbers, centralize VS de-centralize
- **Space:** storage inventory turnover, aisle, admin,
- **SKU & Equipment:**

Private VS Public warehousing

- **Private warehousing:** a company owned warehouse can be on-site or off-site
- **Public warehousing:** an outsourcing warehouse
- **Leased warehousing:** long-term pubic warehousing based on contract for space and/or service (e.g., T-PARK , WHA)



source: Ballou, B.H. 2004. Business Logistics/ Supply Chain Management [?]

Considerations of private warehousing

- **Business:** business (BTV) & product (HazChem) → inventory cycle
- **Responsiveness:** service level (high/low?– UPS) → to whom
- **Availability & Capital:** investment, available location
- **Management:** W/H Mgt → professional,
- **Control & Visibility:** flexible, expense, special service
- **Other:** real estate, possible sites (mfg, sale)

Benefits of public warehousing

- **Expansion:** no fixed investment → many sites
- **Professional:** equipments, data collection
- **Predictable rate:** no risk & on surprise expense
- **Special public warehouse:** ambient, chilled, bonded, household, bulk (unit load)

Public warehousing rates

- **Products:** value, fragility, weight, density, qty & volume
- **Time:** storage charge
- **Transaction:** handling, documents, report, #counts
- **Others:** reserved, fluctuation, data connection

Centralized & De-Centralized

Centralized warehouse

- **Idea:** pooling all inventories/resources in one location
- **What:** big & single warehouse
- **Example:** Boon Tha Worn, Pine Pacific, SCG dealer, HomePro

Decentralized warehouse

- **Idea:** improving response & customer service
- **What:** 'small' & many warehouses
- **Examples:** Barn & Nobles, Wal-Marts, Home Depot, 7Eleven, Zara

Advantages of centralizing inventory

- **Simplify ordering:** one-location → all items
- **Eliminate additional sites/operations:** explore cheap labor & economy of scale
- **Reduce capital & inventory:** specialized equipments, reducing safety stock
- **Consolidate freight:** reduce transport cost, create freight integrity
- **Multiple means of transportation:** justify intermodal (rail+truck, water+truck)

Limitation of centralizing inventory

- **Customer pick-up:** e.g., Best Buy policy, Home Depot, Whole Food
- **Long transportation time:** poor response & service lv
- **Slow decision:** # of traffic & transactions
- **Risk from consolidation:** no back up plan
- **Selecting locations:** many customer $\nrightarrow$ single location

Questions for decentralized warehouse

- How many warehouses should there be?
- Where should they be located?
- How does customers get their orders? $\rightarrow$ assigning item-warehouse; shipping item-to-customer

Good news

- **Cluster of customers or facility:** city, population, airport, utility, workforce
- **Site of competitors:** e.g., Boots **VS** Watson, 7Eleven **VS** 'other'
- **Wait-And-See approach:** one warehouse/one building at a time
- **Issues:** expanding urban area, restricted zone

Brown Field Space Requirement

- **What:** $\exists$ data (trend) & design
- **Idea:** weight/throughput $\rightarrow$ volume $\rightarrow$ storage space $\rightarrow$ req.space

Space requirements: building & equipments

- **Storage:** equipments, stackable, inventory turnover $(> 50\%)$
- **Aisle:** equipments, flow $(20 - 40\%)$
- **Docks:** staging area, buffer area
- **Admin:** expansion, investment (5%)

Example: ChemTech Part I

ChemTech, a small chemical company, plans to build a warehouse. The projected monthly demands are as follow:

Month	Demand (ton)
Jan	66.5
Feb	328.0
Mar	1048.5
Apr	2141.0

Month	Demand (ton)
May	2820.0
Jun	2395.0
Jul	1303.0
Aug	460.9

Month	Demand (ton)
Sep	99.9
Oct	15.3
Nov	302.2
Dec	556.7

If inventory turnover ratio of 36 turn per year & average density of chemical of 500 kg/m^3 are expected. Historically, products can be stacked 3.0 m high, required 50% of area for aisle, & utilized 80% space.

- What are space requirement of each month?
- What is your recommend space of warehouse (justify)?

source: Ballou, B.H. 2004. Business Logistics/ Supply Chain Management [?]

Part 1: Solution

	Demand (1000kg)	Avg Inv (1000kg)	Avg Vol (m^3)	Area Storage (m^2)	Area Required (m^2)
Jan	66.5	22.17	44.33	14.8	36.9
Feb	328.0	109.33	218.67	72.9	182.2
Mar	1048.5	349.50	699.00	233.0	582.5
Apr	2141.0	713.67	1427.33	475.8	1189.4
May	2820.0	940.00	1880.00	626.7	1566.7
Jun	2395.0	798.33	1596.67	532.2	1330.6
Jul	1303.0	434.33	868.67	289.6	723.9
Aug	460.9	153.63	307.27	102.4	256.1
Sep	99.9	33.30	66.60	22.2	55.5
Oct	15.3	5.10	10.20	3.4	8.5
Nov	302.2	100.73	201.47	67.2	167.9
Dec	556.7	185.57	371.13	123.7	309.3
Total	11537.0	3845.7	7691.3	2563.8	6409.4

What is the suitable warehouse site?

- **option:** $\frac{1}{2}(256.1 + 309.3)$=282.2 m^2, 534.11 m^2 ,1566 m^2, 6409 m^2
- **answer:** depend of cost

Example: ChemTech Part II

A warehouse with equipment can be constructed for \$600 /m^2 deprecated over 20 years, & operated at 0.01 /kg of throughput. The annual maintaining fixed cost are \$30 /m^2 . In addition to the warehouse, the company may rent additional space with the same configuration at an adjacent location. The rental charge & in-out handling fee are \$0.01 /m^2-month of space & \$0.015 /kg of throughput, respectively. What warehouse size should be constructed?

source: Ballou, B.H. 2004. Business Logistics/ Supply Chain Management [?]

- **Summary:** how much should construct? (s_p) $\rightarrow$ rental space (s_r)
- **Private:** must pay maintenance; single huge construction; lower operation
- **Issues:** construct invests 20 years VS rent pays monthly as need

Analysis: ChemTech Part II

A warehouse with equipment can be constructed for \$600 /m^2 deprecated over 20 years, & operated at 0.01 /kg of throughput. The annual maintaining fixed cost are \$30 /m^2 . In addition to the warehouse, the company may rent additional space with the same configuration at an adjacent location. The rental charge & in-out handling fee are \$0.01 /m^2-month of space & \$0.015 /kg of throughput, respectively. What warehouse size should be constructed?

$s_p =$ m^2 required for a private warehouse

$s_r =$ m^2 required for a public warehouse $s_r = S_t - s_p$

$d_{pt} =$ monthly throughput $\equiv$ forecasting demand at a private warehouse space s_p

$d_{rt} =$ monthly remaining throughput at a public warehouse, $d_{rt} = D_t - d_{pt}$

	Private		Rent	
	name	value	name	value
	capital		**rent**	
Space (m^2)	Construction	$\frac{1}{20\times 12}\,600 s_p$	Storage	$10\,s_r$
$(s_p + s_r)$	Maintenance	$\frac{1}{12}\,30\,s_p$		
	oper		**fee**	
Throughput (ton)	Oper.	$10\,d_p$	In-Out Fee.	$15\,d_r$
$(d_p + d_r)$				

Part 2: If build 1000 m^2

	Demand	Req.A		Private		Rent		Total
				capital	oper.	rent	fee	
Jan	66.5	22.17	100%	5000.0	665.0	0.0	0.0	5665.0
Feb	328.0	109.33	100%	5000.0	3280.0	0.0	0.0	8280.0
Mar	1048.5	349.50	100%	5000.0	10485.0	0.0	0.0	15485.0
Apr	2141.0	713.67	84%	5000.0	18000.0	1894.4	5115.0	30009.4
May	2820.0	940.00	64%	5000.0	18000.0	5666.7	15300.0	43966.7
Jun	2395.0	798.33	75%	5000.0	18000.0	3305.6	8925.0	35230.6
Jul	1303.0	434.33	100%	5000.0	13030.0	0.0	0.0	18030.0
Aug	460.9	153.63	100%	5000.0	4609.0	0.0	0.0	9609.0
Sep	99.9	33.30	100%	5000.0	999.0	0.0	0.0	5999.0
Oct	15.3	5.10	100%	5000.0	153.0	0.0	0.0	5153.0
Nov	302.2	100.73	100%	5000.0	3022.0	0.0	0.0	8022.0
Dec	556.7	185.57	100%	5000.0	5567.0	0.0	0.0	10567.0
Total	11537.0	3845.7		60000.0	95810.0	10866.7	29340.0	196016.7

note: demand 1800 ton $\equiv$ avg. inventory 600 ton $\equiv$ volume 1200 m^3 $\equiv$ space 1000 m^2

Part 2: Trial & Error

	Private		Rent		
Area	capital	oper.	rent	fee	Total
500	30000	63295	28931	78113	200338
600	36000	71980	24106	65085	197171
700	42000	79180	20106	54285	195571
800	48000	85010	16867	45540	195417
900	54000	90410	13867	37440	195717
1000	60000	95810	10867	29340	196017
1100	66000	101210	7867	21240	196317
1200	72000	106420	4972	13425	196817
1300	78000	110020	2972	8025	199017
1400	84000	112370	1667	4500	202537
1500	90000	114170	667	1800	206637

Example: MHE replacement

A company is considering two type of forklift trucks: forklift A and forklift B. Based on speed and productivity, the company requires three forklift B for productivity of two forklift B.

	Two forklift A	Three forklift B
Total investment (USD)	20.0k	15.0k
Useful lift (planned)	7	7
Est. savage value (USD)	5.0k	2.0k
Annual operation (USD)	4.0k	6.0k

Given MARR 20%, what is the best alternative

source: Ballou, B.H. 2004. Business Logistics/ Supply Chain Management [?]

Solution

- **Idea:** NPV in Eng Econ/ time value money
- **Forklift A:**

$$20.0 + 4.0(1.2)^1 + \cdots + 4.0(1.2)^6 + (4.0 - 5.0)(1.2)^7 = 33.023k$$

- **Forklift B:**

$$15.0 + 6.0(1.2)^1 + \cdots + 6.0(1.2)^6 + (6.0 - 2.0)(1.2)^7 = 36.040k$$

Problems

1. Explain why warehouses have a tendency to cluster around each others?
2. What are an leased warehouse? Why this practice become popular after 2010 Thailand Flood.
3. The initial value (I) of an electric RT truck with useful life (N) 8 years is 1,200.0k THB. Despite changing battery every two year at cost 150.0k THB, the the savage value (S_t) and annual operation cost (C_t^o) depend on duration (t),particularly

$$S_t = I\frac{t}{N}, \quad \text{and} \quad C_t^o = 0.5 \times I(\frac{t}{N})^3$$

Calculate the replacement plan if MARR is 20%

Summary:

- Understanding trade-offs warehouse management
- Examples of layout are:
  - **'U'-shaped layout:** collaboration, many convenance locations found in DC
  - **'I'-shaped layout:** reducing congestion, found in Factory
  - **'L'-shaped layout:** P>> {P,C,EA}, collaboration
- Key managerial issues in Warehouse are:
  - **ownership:** private/contracted VS public
  - **location:** where?
  - **produce:** centralize VS de-centralize
  - **accounting**$_{contract}$**:** open VS close

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