Designing the distribution network in a supply chain

- 1.   Dell => directly to end consumers,
- 2.   Hewlett Packard => through resellers
- 3.   Apple => planning to open retail stores where computers will be sold.
- Grainger, an MRO distributor, stocks about 100,000 SKUs that can be sent to customers within a day of the order being placed. The remaining slower moving products are not stocked but shipped directly from the manufacturer when a customer places an order.

Factors influencing distribution network design

- **Performance:**
- 1. Customer needs that are met.
- 2. Cost of meeting customer needs.

Measures that are influenced by the structure of the distribution network:

- ✖ • **response time** => when a customer places an order and receives delivery
- ✖ • **product variety** => # of different products that a customer desires
- ✖ • **product availability** => probability of having a product in stock when a customer order arrives
- ✖ • **customer experience** => the ease with which the customer can place and receive their order
- ✖ • **order visibility** => the ability of the customer to track their order from placement to delivery
- ✖ • **returnability** => the ease with which a customer can return unsatisfactory merchandise and the ability of the network to handle such returns

✖ 理論上客戶會想要根據上述之dimensions有最高規格的performance。但實際上沒有這樣的case。客戶由amazon.com訂書會願意等久一點，如果開車去附近的Borders可以較快得到書（response time），但是在Amazon可以有較多的選擇（product variety）。

✖ 鎖定可容忍large response time之客戶的公司可以少開分店但增加每個點的capacity。（看如何trade-off）。Borders => 當天取書，有約4oo分店。Amazon.com => 一星期後取書，有約5處倉庫。
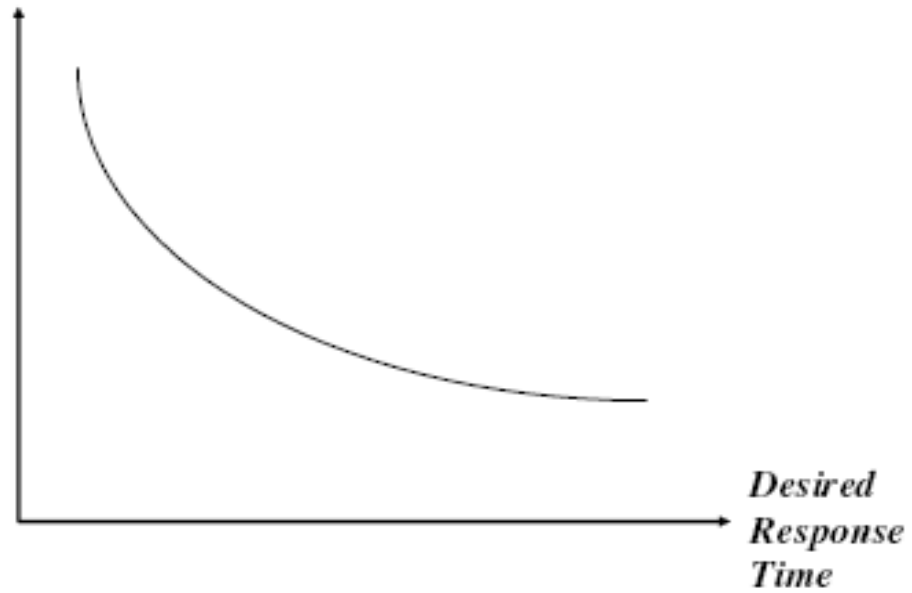
Fig. 1. Relationship between desired response time and number of facilities.

- Changing the distribution network design affects the following supply chain costs:
- • inventories,
- • transportation,
- • facilities and handling,
- • information.

- Number of facilities↑=> inventory and resulting inventory costs↑。Amazon的 facilities較少，一年可有12個turn，而Borders 僅有約2個turn。因為inbound transportation economies of scale, facilities越多，運費越便宜。但當facilities多到一個點，失去規模經濟，那麼運費便開始升高。Amazon.com：多於一個 warehouse比之單一個warehouse的運費便宜。
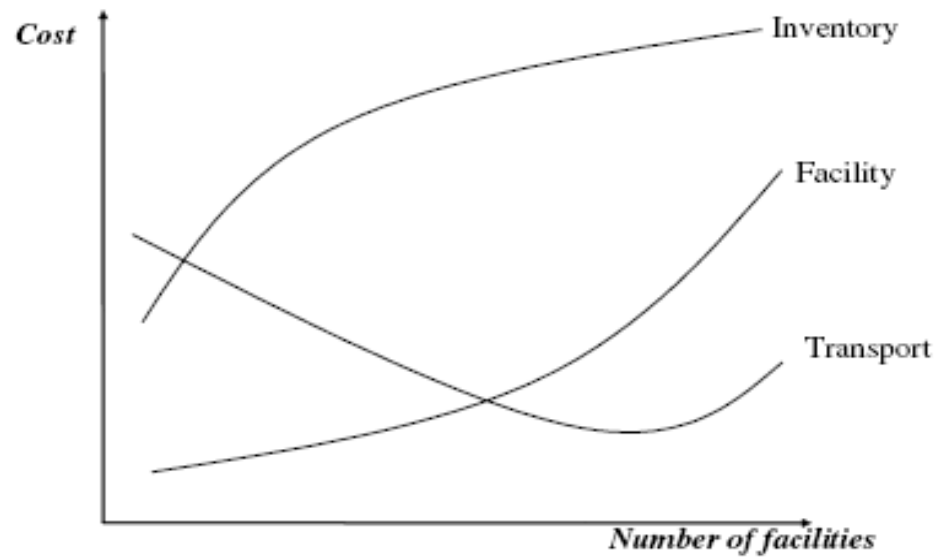
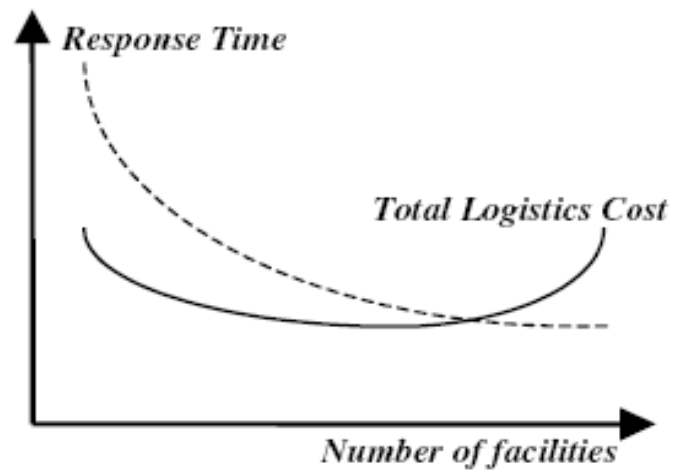Fig. 2. Relationship between number of facilities and logistics cost.

Fig. 3. Variation in logistics cost and response time with number of facilities.

- Total Logistics Cost (TLC) => inventory + transportation + facility costs
- # of facilities ↑ => TLC先減後升
- 想要減少response time => 增加facility，要考慮在最小化的TLC，且確認較好的response time可以增加revenue。

Design options for a distribution network

- There are two key decisions when designing a distribution network:
- 1. Will product be delivered to the customer location or picked up from a preordained site?
- 2. Will product flow through an intermediary (or intermediate location)?
- 根據上述兩個decisions，可以設計出六個不同的配送網路：

- 1. Manufacturer storage with direct shipping.
- 2. Manufacturer storage with direct shipping and in-transit merge.
- 3. Distributor storage with package carrier delivery.
- 4. Distributor storage with last mile delivery.
- 5. Manufacturer/distributor storage with costumer pickup.
- 6. Retail storage with customer pickup.

1. Manufacturer storage with direct shipping.

- Bypass the retailer。又稱drop shipping。資訊流經過retailer到Manufacturer, 貨物流直接往客戶。Retailer可能完全沒有庫存, 或是沒有slow moving的商品庫存, 讓製造商直接送到客戶手中。
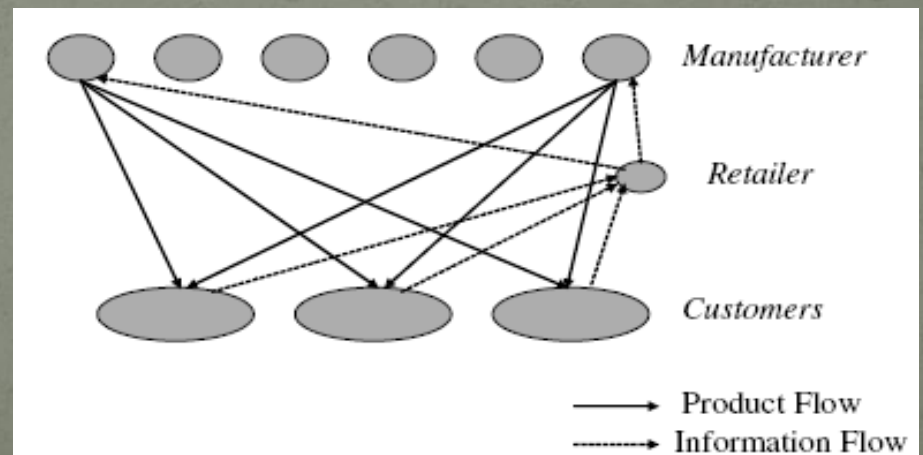
Fig. 4. Manufacturer storage with direct shipping.

- 優勢是**Centralize inventories** at the manufacturer（**good for high value, low demand items with unpredictable demand**）。製造商可以整合需求, 提供高等級的product availability及比個別retailer較低等級的庫存。但對online grocer selling如detergent不合適。

- Build-to-order合適, 可方便customization, 如 Dell。

- Transportation costs are high。Using Package carriers, high shipping costs than TL or LTL。客戶可能由不同的製造商訂購不同的商品, 減少aggregation, 增加Transportation cost.

- 可減少handling cost因為不經過retailer。
- 需要好的資訊系統設備。增加supply chain成員的visibility。
- Response times tend to be large => order has to be transmitted from²   the retailer to the manufacturer and shipping distances are on average longer。
- Allows a high level of product variety because of manufacturer storage.
- Order tracking becomes harder because it requires complete integration of information systems at both retailer as well as the manufacturer. For **direct sellers** such as Dell, order visibility is simpler to provide.

- ² 　　　Is likely to have difficulty handling returns, hurting customer satisfaction.尤其在跟多個製造商訂購多樣商品時。兩個方法：一為直接退回製造商(high transportation and coordination cost)，二為零售商設立另一facility來處理(requires investment in a facility to handle returns)。

Table 1
Performance characteristics of manufacturer storage with direct shipping network

	Performance
Cost factor	
Inventory	Lower costs because of aggregation. Benefits of aggregation are highest for low demand, high value items. Benefits are very large if product customization can be postponed at the manufacturer
Transportation	Higher transportation costs because of increased distance and disaggregate shipping
Facilities and handling	Lower facility costs because of aggregation. Some saving on handling costs if manufacturer can manage small shipments or ship from production line
Information	Significant investment in information infrastructure to integrate manufacturer and retailer
Service factor	
Response time	High response time of between 1 and 2 weeks because of increased distance and two stages for order processing. Response time may vary by product, thus complicating receiving
Product variety	Easy to provide a very high level of variety
Product availability	Easy to provide a high level of product availability because of aggregation at manufacturer
Customer experience	Good in terms of home delivery but can suffer if order from several manufacturers is sent as partial shipments
Order visibility	More difficult but also more important from a customer service perspective
Returnability	Expensive and difficult to implement

2. Manufacturer storage with direct shipping and in-transit merge.

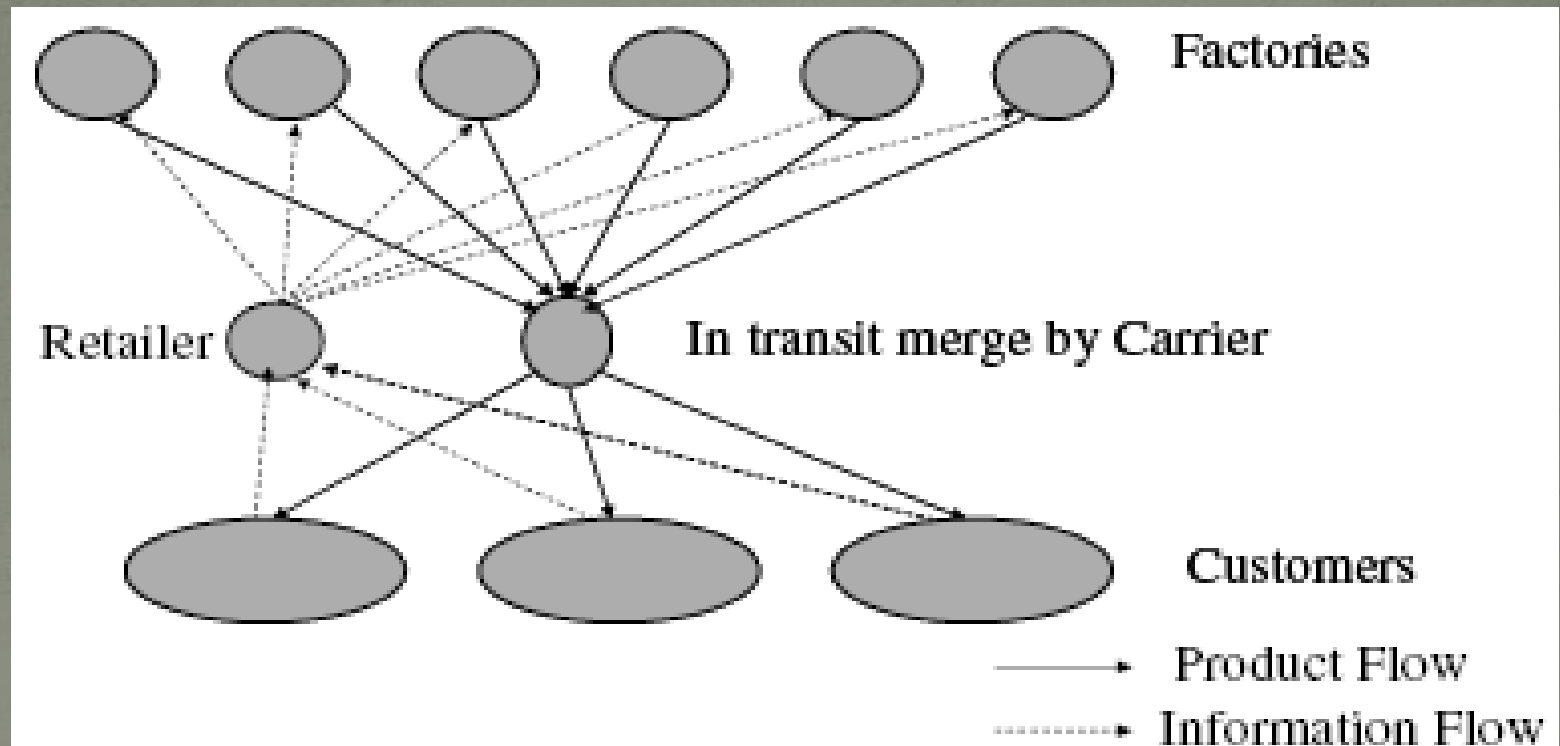

Fig. 5. In-transit merge network.

- 訂一個PC from Dell, 一個Monitor from Sony，先各自pick up然後在hub合在一起再一次送到客戶手中。

- ²　　Fewer deliveries save transportation cost and simplify receiving.

- ²　　Information & operations at the retailer, manufacturers and the carrier must be coordinated.

- ² The main advantage of in-transit merge over drop shipping is the somewhat lower transportation cost and improved customer experience. The major disadvantage is the additional effort during the merge itself.
- ² The greatest benefits for products with high value whose demand is hard to forecast **(best suited for low to medium demand)** . If there are too many sources (manufacturers) , in-transit merge can be very difficult to coordinate and implement.

Table 2
Performance characteristics of in-transit merge

	Performance
Cost factor	
Inventory	Similar to drop shipping
Transportation	Somewhat lower transportation costs than drop shipping
Facilities and handling	Handling costs higher than drop shipping at carrier, receiving costs lower at customer
Information	Investment is somewhat higher than for drop shipping
Service factor	
Response time	Similar to drop shipping, may be marginally higher
Product variety	Similar to drop shipping
Product availability	Similar to drop shipping
Customer experience	Better than drop shipping because a single delivery has to be received
Order visibility	Similar to drop shipping
Returnability	Similar to drop shipping

3. Distributor storage with package carrier delivery

Fig. 6. Distributor storage with carrier delivery.
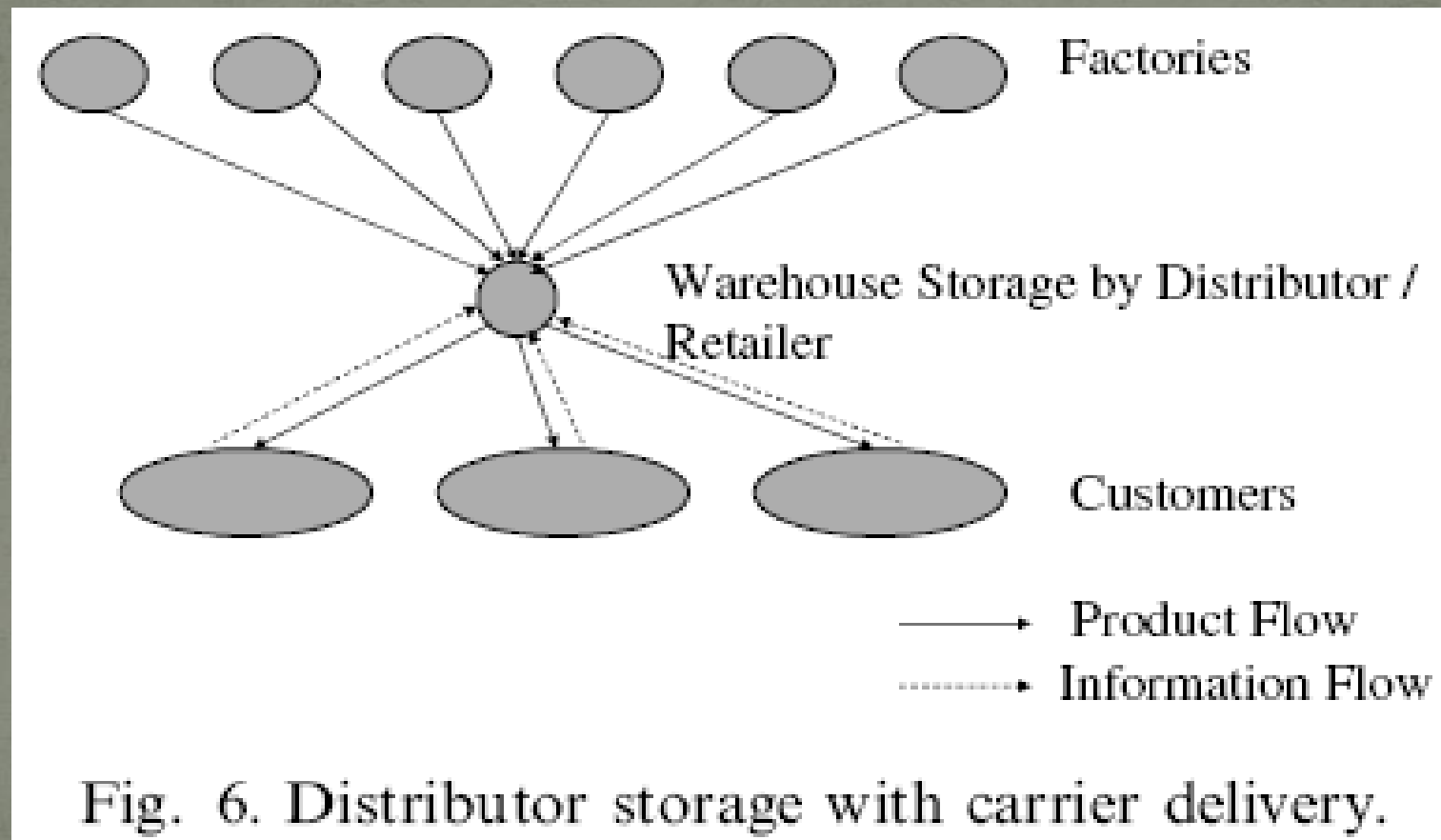
- ² 	Inventory is held by distributors/retailers and package carriers are used to transport products.
- ² 	**Require a higher level of inventory** because the distributor/retailer warehouse aggregates demand uncertainty to a lower level than the manufacturer.
- ² 	配送業會儘可能存放higher demand stock. 將slower moving items stocked further upstream.

- **2**   Transportation costs are somewhat lower because an economic mode of transportation (e.g. TL) can be employed for inbound shipments to the warehouse. In addition, allows outbound orders to the customer to be bundled into a single shipment further reducing transportation cost.

- Distributor storage is not appropriate for extremely slow moving items.

- **2**   Returns can be processed at the warehouse itself, the customer also has to return only one package even if the items are from several manufacturers.

- **2**   Can handle somewhat lower variety than **manufacturer storage** but can handle a much higher level of variety than **a chain of retail stores**.

Table 3
Performance characteristics of distributor storage with carrier delivery

	Performance
Cost factor	
Inventory	Higher than manufacturer storage. Difference is not large for faster moving items
Transportation	Lower than manufacturer storage. Reduction is highest for faster moving items
Facilities and handling	Somewhat higher than manufacturer storage. The difference can be large for slow moving items
Information	Simpler infrastructure compared to manufacturer storage
Service factor	
Response time	Faster than manufacturer storage
Product variety	Lower than manufacturer storage
Product availability	Higher cost to provide the same level of availability as manufacturer storage
Customer experience	Better than manufacturer storage with drop shipping
Order visibility	Easier than manufacturer storage
Returnability	Easier than manufacturer storage

4. Distributor storage with last mile delivery.

Fig. 7. Distributor storage with last mile delivery.
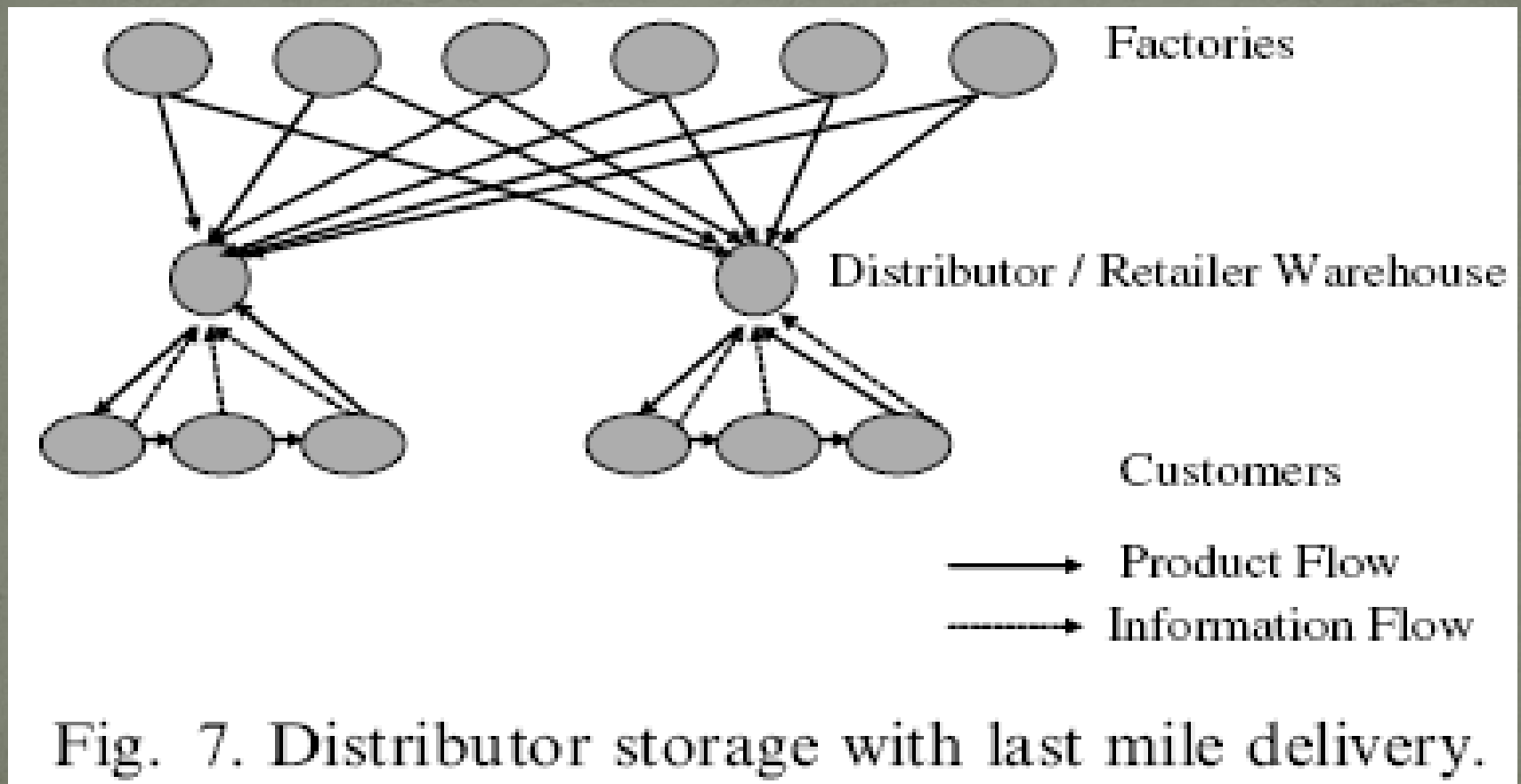
✖ ² 　　配送業/retailer delivering the product to the customer's home instead of using a package carrier. Requires the distributor warehouse **to be much closer to the customer**, **increasing the number of warehouses required**.

✖ ² 　　Requires higher levels of inventory because it has a lower level of aggregation. Suitable for relatively **fast moving items** where disaggregation does not lead to a significant increase of inventory. Staple items in the grocery industry fit this description.

- ²	Delivery costs (including picking and transportation) can be as high as $30-40 per home delivery in the grocery industry. High population density has helped decrease delivery cost.

- ²	Processing costs are much higher than a network of retail stores because all customer participation is eliminated.

- ² 　　Information: requires additional capability of scheduling deliveries.
- ² 　　因為labor cost不同，很難認定此法較有效率或增加利潤。僅能從是否該地有足夠的客戶願意為此便利付費來判斷。一次送得多才划得來。

Table 4
Performance characteristics of distributor storage with last mile delivery

	Performance
Cost factor	
Inventory	Higher than distributor storage with package carrier delivery
Transportation	Very high cost given minimal scale economies. Higher than any other distribution option
Facilities and handling	Facility costs higher than manufacturer storage or distributor storage with package carrier delivery, but lower than a chain of retail stores
Information	Similar to distributor storage with package carrier delivery
Service factor	
Response time	Very quick. Same day to next day delivery
Product variety	Somewhat less than distributor storage with package carrier delivery but larger than retail stores
Product availability	More expensive to provide availability than any other option except retail stores
Customer experience	Very good, particularly for bulky items
Order traceability	Less of an issue and easier to implement than manufacturer storage or distributor storage with package carrier delivery
Returnability	Easier to implement than other options. Harder and more expensive than a retail network

5. Manufacturer/distributor storage with costumer pickup.
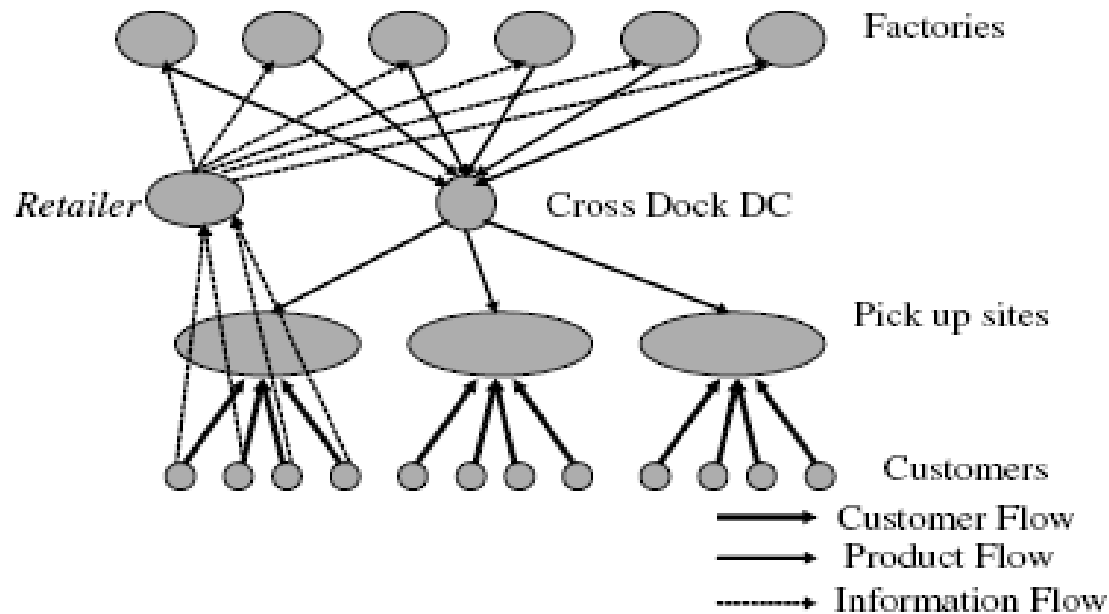
Fig. 8. Manufacturer or distributor warehouse storage with consumer pickup.

- ² 　　　Inventory is stored at the **manufacturer or distributor warehouse** but customers place their orders online or on the phone and then come to designate pickup points to collect their orders.
- ² 　　　Example: 7dream.com operated by 7 Eleven Japan.
- ² 　　　Inventory costs can be kept low with either manufacturer or distributor storage to exploit aggregation.（可將fast moving items放在pick up sites）

- ² Allows the use of TL or LTL carriers to transport orders to the pickup site.原來便有卡車運送至分店，增加網路訂購可增加此使用。
- ² Information: very good coordination is needed between the retailer, the storage location, and the pickup location.
- ² Customer who do not want to pay online can pay by cash using this option.

- ²　　　大家都靠近pickup site（7-Eleven），可隨時去取貨，無time window問題。
- ²　　　**Order visibility**: extremely important but difficult to implement.
- ²　　　**Main advantage**: lower delivery cost. **Major hurdle**: increased handling cost at the pickup site.

Table 5
Performance characteristics of network with consumer pickup sites

	Performance
Cost factor	
Inventory	Can match any other option depending on the location of inventory
Transportation	Lower than the use of package carriers, especially if using an existing delivery network
Facilities and handling	Facility costs can be very high if new facilities have to be built. Costs are lower if existing facilities are used. The increase in handling cost at the pickup site can be significant
Information	Significant investment in infrastructure required
Service factor	
Response time	Similar to package carrier delivery with manufacturer or distributor storage. Same day delivery possible for items stored locally at pickup site
Product variety	Similar to other manufacturer or distributor storage options
Product availability	Similar to other manufacturer or distributor storage options
Customer experience	Lower than other options because of the lack of home delivery. In areas with high density of population loss of convenience may be small
Order visibility	Difficult but essential
Returnability	Somewhat easier given that pickup location can handle returns

6. Retail storage with customer pickup.

- ² 　　Inventory is stored locally at retail stores. Customers either walk into the retail store or place an order online or on the phone, and pick it up at the retail store.

- ² 　　Local storage increases inventory costs because of lack of aggregation.最好大多商品都是 fast moving, 這樣可以減少inventory cost。

- 2 Inexpensive modes of transport can be used to replenish product at the retail store.
- 2 Facility costs are high because many local facilities are required.提供order visibility的資訊infrastructure是必須的。
- 2 Main advantage: lower the delivery cost and provide a faster response. Major disadvantage: increased inventory and facility costs. Best suited for fast moving items or items where customers value the rapid response.

Table 6
Performance characteristics of local storage at consumer pickup sites

	Performance
Cost factor	
Inventory	Higher than all other options
Transportation	Lower than all other options
Facilities and handling	Higher than other options. The increase in handling cost at the pickup site can be significant for online and phone orders
Information	Some investment in infrastructure required for online and phone orders
Service factor	
Response time	Same day (immediate) pickup possible for items stored locally at pickup site
Product variety	Lower than all other options
Product availability	More expensive to provide than all other options
Customer experience	Related to whether shopping is viewed as a positive or negative experience by customer
Order visibility	Trivial for in store orders. Difficult, but essential, for online and phone orders
Returnability	Easier than other options given that pickup location can handle returns

Selecting a distribution network design

Table 7
Comparative performance of delivery network designs

	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery	Manufacturer storage with pickup
Response time	1	4	4	3	2	4
Product variety	4	1	1	2	3	1
Product availability	4	1	1	2	3	1
Customer experience	5	4	3	2	1	5
Order visibility	1	5	4	3	2	6
Returnability	1	5	5	4	3	2
Inventory	4	1	1	2	3	1
Transportation	1	4	3	2	5	1
Facility and handling	6	1	2	3	4	5
Information	1	4	4	3	2	5

1表示最好。
大多公司可以根據product characteristics and strategic position that the firm is targeting來使用數種不同的配送方式。

Table 8
Performance of delivery networks for different product/customer characteristics

	Retail storage with customer pickup	Manufacturer storage with direct shipping	Manufacturer storage with in-transit merge	Distributor storage with package carrier delivery	Distributor storage with last mile delivery	Manufacturer storage with pickup
High demand product	++	−−	−	+−	+	−
Medium demand product	+	−	+−	+	+−	+−
Low demand product	−	+	+−	+	−	+
Very low demand product	−−	++	+	+−	−−	+
Many product sources	+	−	−	++	+	+−
High product value	−	++	+	+	+−	++
Quick desired response	++	−−	−−	−	+	−−
High product variety	−	++	+−	+	+−	++
Low customer effort	−−	+	++	++	++	−

++: Very suitable; +: somewhat suitable; +−: neutral; −: somewhat unsuitable; −−: very unsuitable.

- **Example: Grainger**
- Fast moving and emergency items are stocked locally and customers can either pick them up directly or have them shipped depending upon the urgency（迫切性）.Slower moving items are stocked at a national DC from where they are shipped to the customer within a day or two. Very slow moving items are typically drop shipped from the manufacturer and involve a longer lead time.
- **Example: Another hybrid network => Amazon**
- Some items are stocked at their warehouse while other slow moving items may be drop shipped from distributors or publishers.

Conclusion

* Computer industry: customization and high product variety seem to be valued by the customer.也是客戶願意等幾天才收到的基礎。從 table 8此似乎適合drop shipping or factory storage with pickup from a local site.若是標準配備商品則可在retail stores販售。Apple has decided to open some retail stores and actually carry product for sale at these stores. If Apple uses these retail stores to sell the fast moving items and display the configurable（customized）items（which can be drop shipped）, it will be a good use of their retail network.

Improvement in supply chain performance occurs for the following reasons:

- Reduction in inbound transportation cost because of TL shipments from manufacturers to distributor.

- · Reduction in outbound transportation cost because the distributor combines products from many manufacturers into a single outbound shipment.

✖ Reduction in inventory costs because distributor aggregates safety inventory rather than disaggregating at each retailer.

✖ • A more stable order stream from distributor to manufacturer (compared to erratic orders from each retailer) allows manufacturers to lower cost by planning production more effectively.

✖ • By carrying inventory closer to the point of sale, distributors are able to provide a better response time than manufacturers can.

✖ • Distributors are able to offer one stop shopping with products from several manufacturers.