

Department of Operations Management

Topics in Supply Chain Management

Session 1

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INTRODUCTION TO SUPPLY CHAIN MANAGEMENT



Mutual Ignorance

In many big corporations, you can observe that each of the different functions do not know what the others are doing.

For instance, you may find yourself in a situation where the sales and marketing people are giving special deals on a particular product when, in fact, you're running up to the capacity limit. There are a lot of great examples of this disconnect.

The most celebrated is Volvo, which made a lot of green cars in 1995 and wasn't able to sell them. So the sales and marketing people started to secretly offer heavy discounts, rebates, and special deals on green cars to their dealerships. The *supply chain* people didn't know that, and when they saw the green cars selling, they doubled their production plan for them for the next year. Volvo had a lot of green cars at the end of that year.



The Thrill of Victory

* **Siemens CT of Forchheim, Germany, makes computed tomography Xray machines for hospitals and diagnostic labs all over the world.**

- The machines cost about half a million dollars per unit and they are custom-build for each customer.
- A few years ago, Siemens CT found itself faced with rising costs and price erosion that threatened its position in this lucrative market.
- The group's response was to completely reinvent the way they provision, assemble, and deliver their products:
 - They cut out two layers of middle management,
 - switched the entire company to team structures,
 - aligned incentives with supply chain success (the teams tightened the links with suppliers, eliminated all interim warehousing, adopted JIT production techniques, and switched to airfreight deliveries for customers outside of Europe).

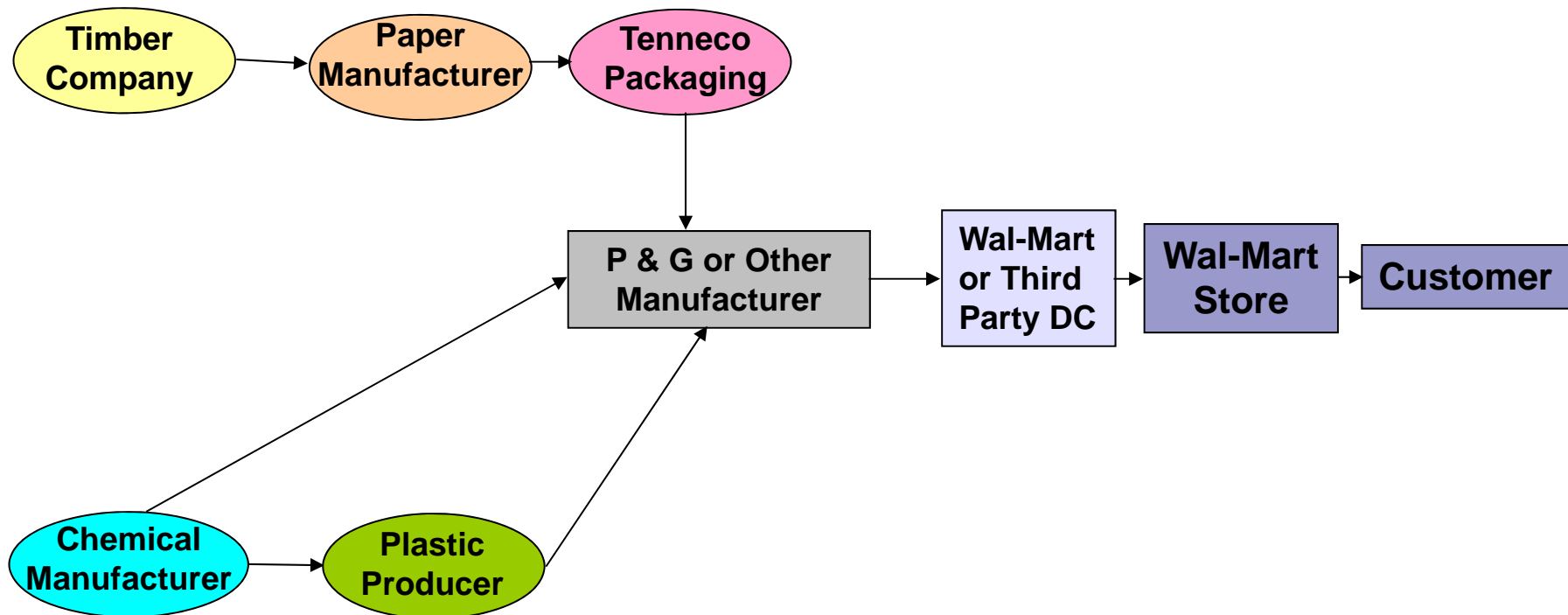
* **Today, Siemens CT has an award-winning supply chain that sets a new standard for best practice in its industry.**

- Lead time for their custom-built machines is down from 22 weeks to just 2 weeks.
- The rate of on-time deliveries has gone from 60% to 99.3% (and on-time now means that deliveries occur within a two-hour window).

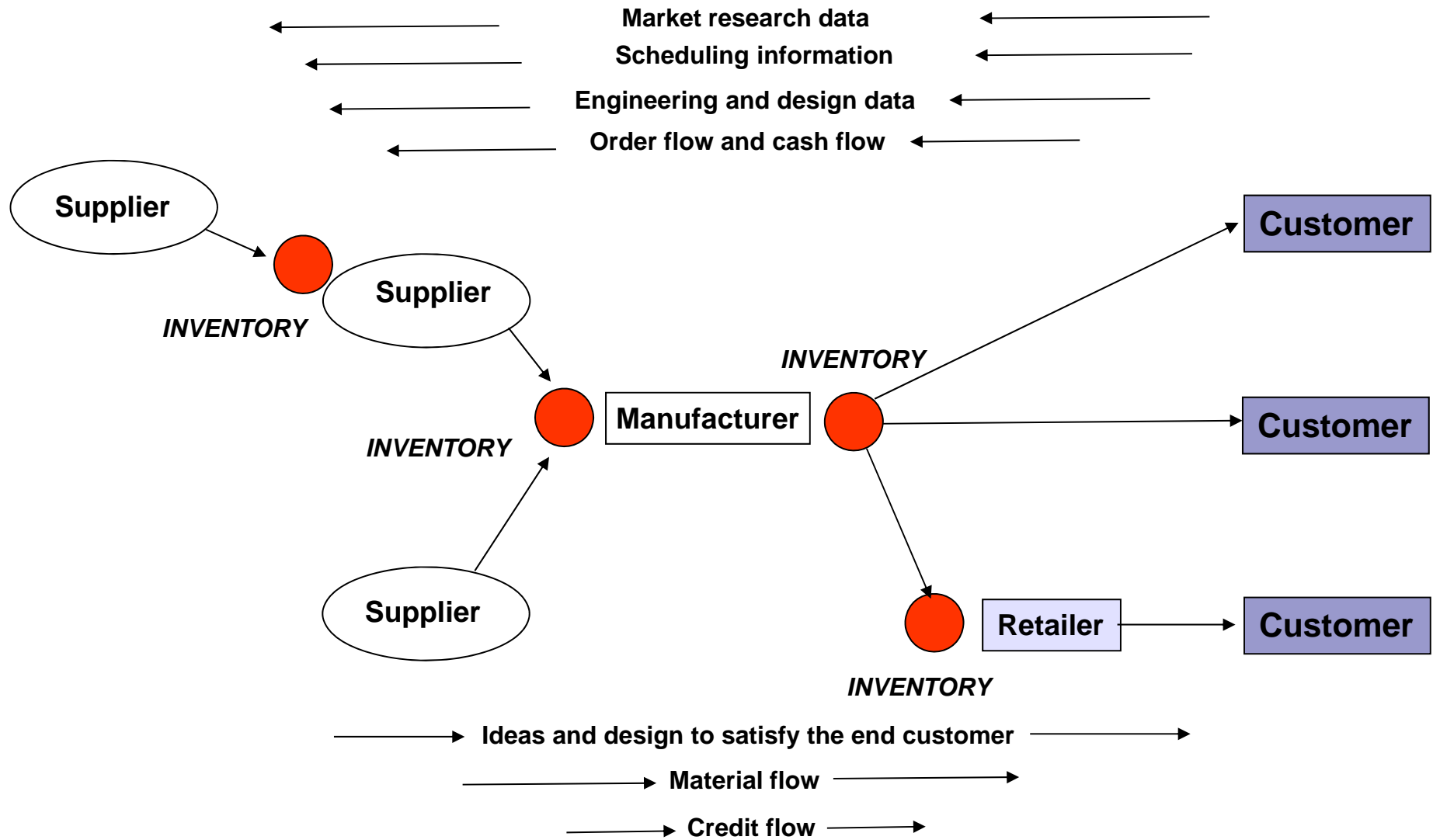
* **The cost of achieving these results ? Zero ! But:**

- 40 % reduction in inventory,
- 50% reduction in factory workspace,
- 76% reduction in assembly time,
- 30% reduction in total costs.

Stages of a Detergent Supply Chain



Supply Chain Stages





Supply Chain Management

Coordinated management of activities, that is:

- Procurement of materials and services,
- Transformation of materials into intermediate goods and final products,
- Delivery of final products to customers through a distribution a network

Main priority: no breakthrough in the supply chain

→ Transversal managerial process

Possible reasons for a breakthrough in the supply chain:

- Wrong demand forecasting,
- Delivery delay,
- Raw materials of insufficient quality,
- Unreliable production equipments,
- Fallacious information,
- Unreliable transportation modes, etc

→ Inventory as an instrument of flexibility



Strategic Management of the Supply Chain

1 – Vertical integration: Control (through internal and/or external growth) of backward and/or forward activities involved into the supply chain.

Examples:

- Ford Motor Company, which manufactures its own car radios (backward),
- TI, which also makes calculators and computers containing integrated circuits (forward).

Prerequisites:

- Large part of purchasing costs on sales,
- Large and stable market share (e.g., Saturday Evening Post).



Purchasing costs as a percent of sales (USA)

INDUSTRIES	Purchasing costs (%)
All industries	52
Car-assembly	67
Agri-Food	60
Paper	55
Oil	79
Transportation	62



Purchasing costs as a percent of production

COMPANIES	Purchasing costs (%)
Chrysler	80
Ford	65
General Motors	55
Kodak (reloadable cameras)	80
Hewlett Packard (printers)	100
Cisco System (switches/routers)	100



Strategic Management of the Supply Chain (continued)

2 – Partnership: Long term mutual cooperative relationship between producers, suppliers, retailers, etc

Modalities:

- Evaluation and selection of suppliers¹,
- Mutual adjustment process,
- Price negotiations.

→ This strategy favors a reduction of the number of suppliers².

Examples:

- For a number of car models (Concorde, Dodge Intrepid, Eagle Vision), the number of Chrysler's suppliers passed from 3 000 to 750;
- For the development of a new engine (Quad 4), GM reduced the number of its suppliers from 140 to 69.

Benefits:

- For the manufacturer: compliance with quality expectations (design and production) and delivery time expectations, cost reduction³,
- For the supplier: increased scale economies, smooth production over the product life cycle, amplified learning effect (*exit* La Fontaine).

¹ *Sourcing.*

² *Single-sourcing.*

³ For instance, by developing a number of partnerships (Rockwell, 3M, Trico, Leslie Arts..), Chrysler saved \$161 million in two years.

Questionnaire for suppliers' evaluation

COMPANY	Excellent	Good	Average	Low	PRODUCTS	Excellent	Good	Average	Low
	(4)	(3)	(2)	(1)		(4)	(3)	(2)	(1)
Size and/or capacity	4				Quality	4			
Financial surface		3			Price		3		
Profit		3			Packaging	4			
Research means	4				Uniformity		3		
Processes flexibility			2		Guarantee	4			
Technical service		3			Total: 18	12	6		
Locations	4				0,4 x Total = 7,2				
Management		3							
Social atmosphere		3			SALES FORCE				
Commercial relations		3			1. Knowledge of:				
Total: 32	12	18	2		Own firm		3		
0,10 x Total = 3,2					Own products	4			
					The sector		3		
SERVICE					Our firm		3		
Delivery time	4				3. Catalogue:				
Arrival conditions		3			Clarity of presentations	4			
Respect of instructions		3			Revision	4			
Number of rejections	4				2. Sales management:				
Claims		3			Availability of information		3		
Technical assistance		3			Orders monitoring	4			
Emergency help	4				Response promptness		3		
Changes of catalogue				1	Order delivery		3		
Price adjustment	4				Claims monitoring		3		
Total: 27	12	12	2		Total: 37	16	21		
0,3 x Total = 8,1					0,2 x Total = 7,4				



Mac Donald's in Moscow

Presentation: One of the largest Mc Donald's restaurant is located in Moscow (Pushkin Square), with 700 indoor and 200 outdoor seats, employing 800 Russian citizens and generating \$80 million.

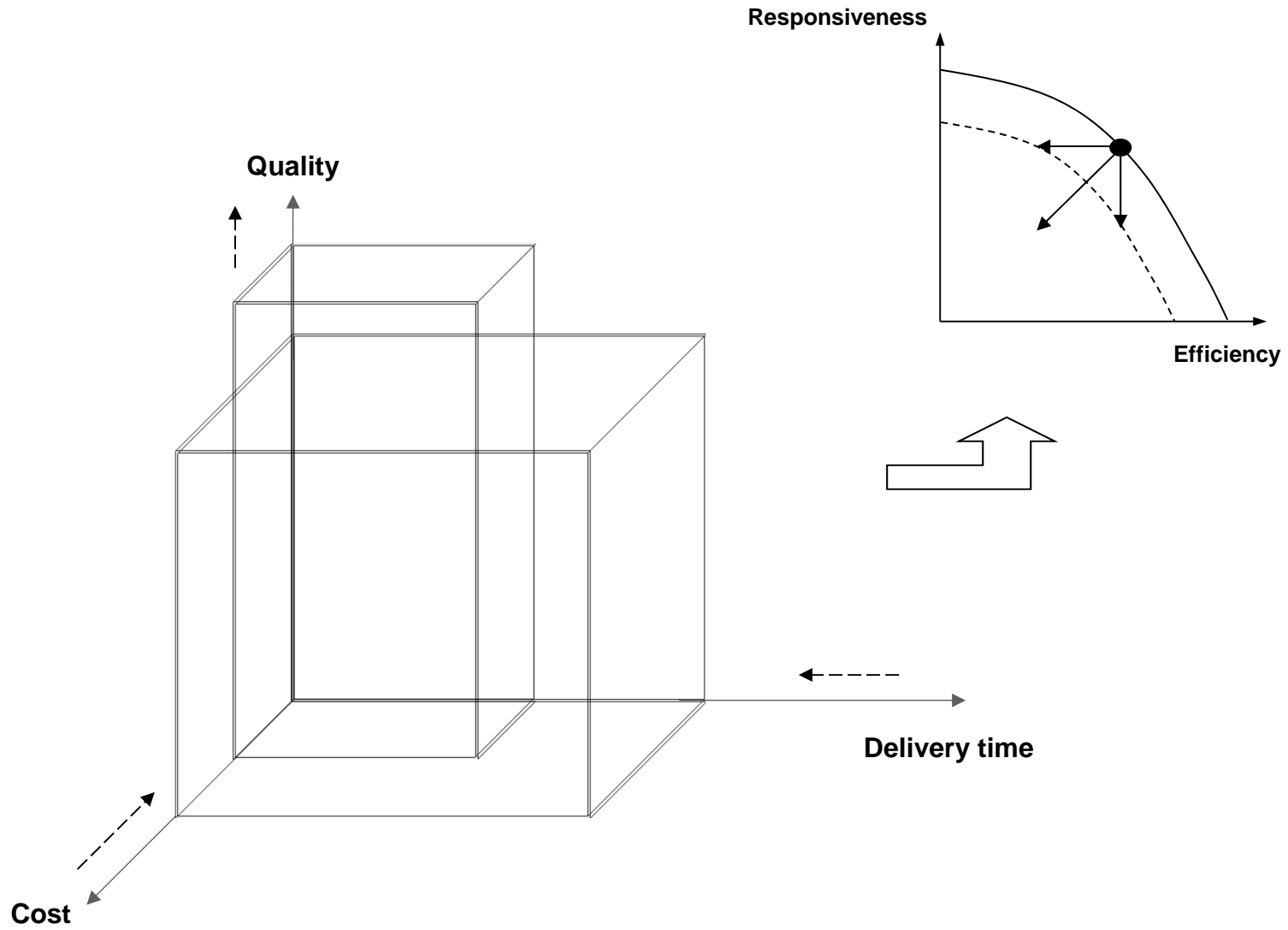
Constraint: Whatever the geographical location (Moscow, New York, Paris, Sydney ...), Mc Donald's products must be perfectly similar (e.g., the Big Mac).

→ When Mc Donald's opened in Pushkin Square in Moscow, it ended six years of advance preparation of a Russian « food town » to supply its desired quality of ingredients (meat, potatoes, flour, milk, etc).

Organization: centralized exclusive suppliers (*food town*), sharing conservation equipments and a distribution center.

→ Production, inventory, handling and transportation costs minimized.

Supply chain performance





Supply chain performance compared

Criteria	Typical Firms	Benchmark Firms
Number of suppliers per purchase manager	34	5
Administrative costs as percentage of purchases	3.3%	0.8%
Lead time (weeks)	15	8
Time spent to placing an order	42 minutes	15 minutes
Percentage of late deliveries	33%	2%
Percentage of rejected material	1.5%	0.0001%
Number of shortages per year	400	4

Benchmarking requires:

- Knowledge of own performances,
- Determination of targeted performances.



Reduction of uncertainty in the supply chain

- 1 – **Postponement:** customization of the generic product as late as possible in the supply chain.
 - Manufacturing and holding centralized inventories of the generic product (standardization and anticipation),
 - Customizing the generic product by adding specific modules⁴ (differentiation and adaptation).→ Reduction of risk and investment in inventory.

- 2 – **Channel assembly:** final assembly, test and delivery of finished goods by the distributor.
 - Modular design of products,
 - Individual components and modules, rather than finished goods, are sent to the distributor.→ Distributors are treated more as manufacturing partners than as distributors,
→ Reduced finished goods inventory since units are built to a shorter, more accurate forecast,
→ Increased flexibility to technological progress⁵.

⁴ For instance, after analyzing the supply chain for its printers, HP determined that if the printer's power supply was moved out of the printer itself and into a power cord, HP could ship the basic printer anywhere in the world. HP modified the printer its power cord, its packaging, and its documentation so that only the power cord and documentation needed to be added at the final distribution point.

⁵ This technique has proven successful in industries where products are undergoing rapid change, such as personal computers (IBM, HP, Compaq...).



Components of the supply chain

1 - Suppliers:

- Many supplier strategy → the supplier responds to the demands and specifications of a « request for quotation », with the order usually going to the low bidder (one supplier against another).
- Few supplier strategy → long-term suppliers are more likely to understand the broad objectives of the procuring firm and the end customer (huge switching cost).

2 – Production sites:

- Location issue (tradeoff between proximity to materials/parts⁶ and regular procurement with low materials/parts inventories, vs. proximity to demand and improvement of customer service level).
- Edification costs (land, construction, layout, equipments, ...), for instance:
 - *Motorola's* factory in Virginia = \$3 billion,
 - *Intel's* factory in Oregon = \$2.2 billion,
 - *Chrysler's* factory in Indiana = \$1billion.
- Modes of transportation (truck, rail, boat, barge, airplane, pipeline).

→ *Location decisions are strategic in nature (i.e., irreversible), since they constrain subsequent choices of suppliers, modes of transportation, distribution centers, etc.*

→ *Location decisions determine the importance of logistical costs (transportation costs, inventory costs).*

⁶ For instance, 75% of Honda's suppliers are located at a distance lower than 150 miles from its Marysville's factory (Ohio).



Components of the supply chain (continued)

3 – Warehouses:

- Intermediary points in the SC which receive, store, split, assemble, test, repackage, and ship the production.
- Determining criteria for the location choice of a warehouse:
 - Transportation costs,
 - Proximity to final demand.

4 – Points of sales:

- Stores, supermarkets, hypermarkets, restaurants, hotels, hospitals, universities....,
- Location factor: proximity to final demand,
- High acquisition costs.

5 – Information system and communication network:

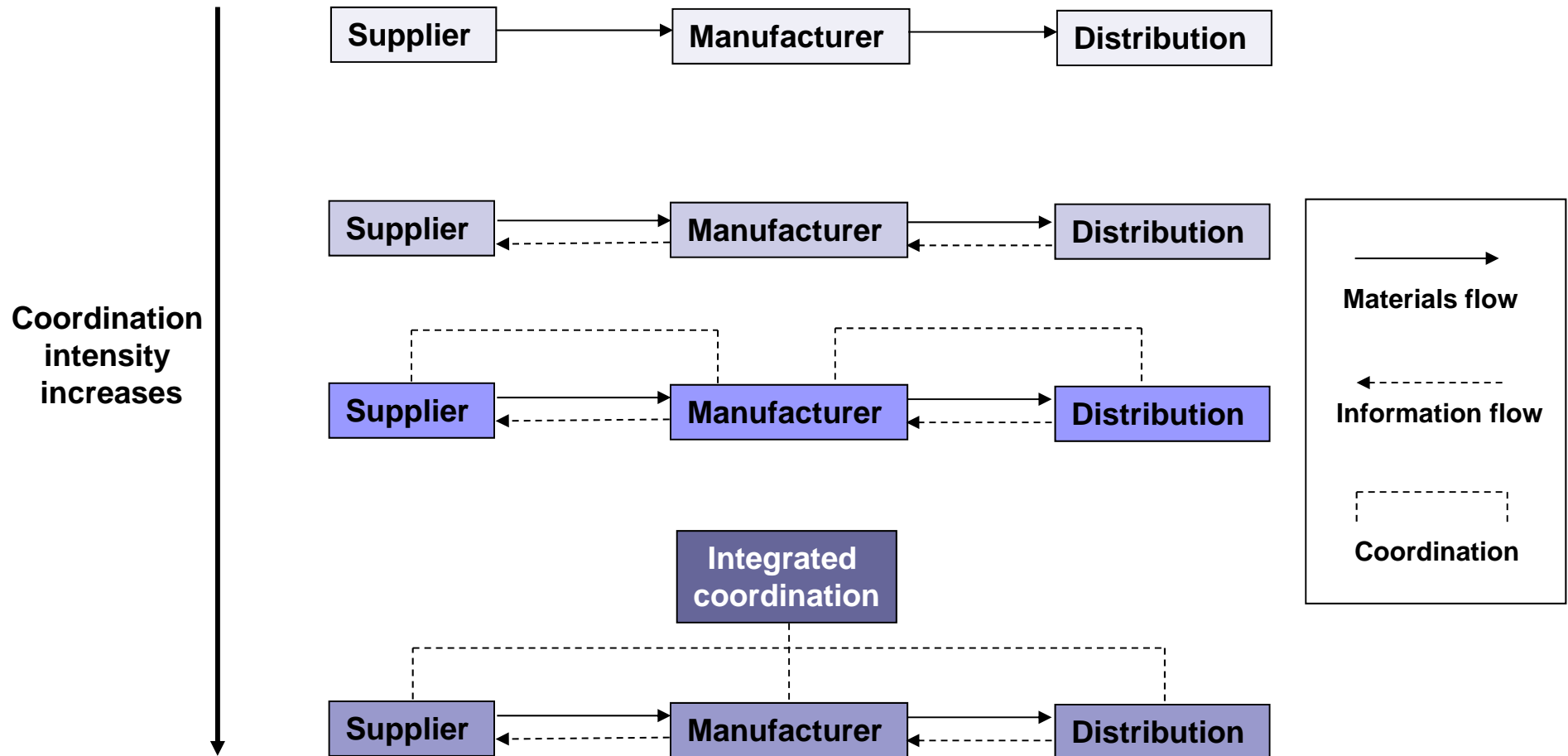
- On line diffusion of information from points of sales,
- Generalized access to available information between the SC's members.

→ Enhanced coordination and reduced inventory,

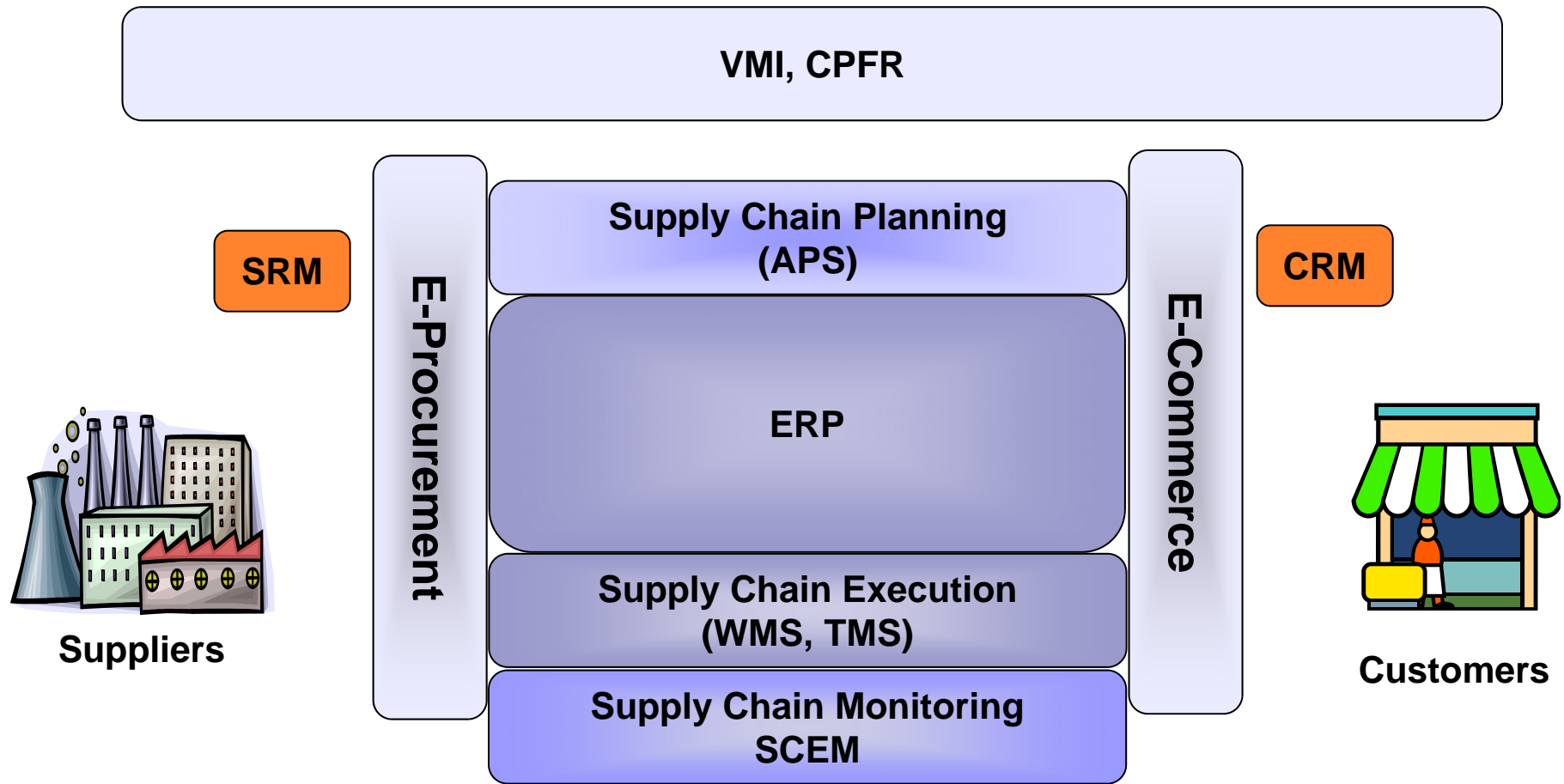
→ Reduced delivery time.



Coordination intensity



Information systems for Supply Chain Management





Vendor Managed Inventory (VMI)

- 📖 In VMI, a producer receives continuous updates on a retailer's inventory level and replenishes it as needed, with the retailer taking ownership of the goods on delivery.
- 📖 This gives producers better visibility of sales of their products, helping them anticipate demand and better plan supply.
- 📖 The retailers benefit because they no longer have to track inventory levels or place orders for products under a VMI program. They also save money because they usually need less inventory, sometimes as little as half of what they would otherwise keep in stock.
- 📖 As the management of the retailer's inventory is outsourced, this system works without the immediate direction of the purchaser.
- 📖 Examples: Procter & Gamble, Kraft-food.



Collaborative Planning, Forecasting and Replenishment (CPFR)

- 📁 Collaborative Planning, Forecasting and Replenishment is the most ambitious replenishment program (e.g., Wal-Mart and P&G).
- 📁 In addition to the direct communication of real-time data *via* internet, trading partners use centralized information servers to view and update shared plans and forecasts.
- 📁 The CPFR program relies on advanced, Internet-based tools to pool information about demand and supply, allowing trading partners to coordinate their inventory decisions and smooth the flow of goods across the chain.
- 📁 The use of such tools offers important advantages, but it also requires companies to make substantial investments in new technologies.
- 📁 Another obstacle is that CPFR requires companies to share highly detailed information about their operations, and many are reluctant to do that.



Enterprise Resource Planning implementation at Abbott Laboratories

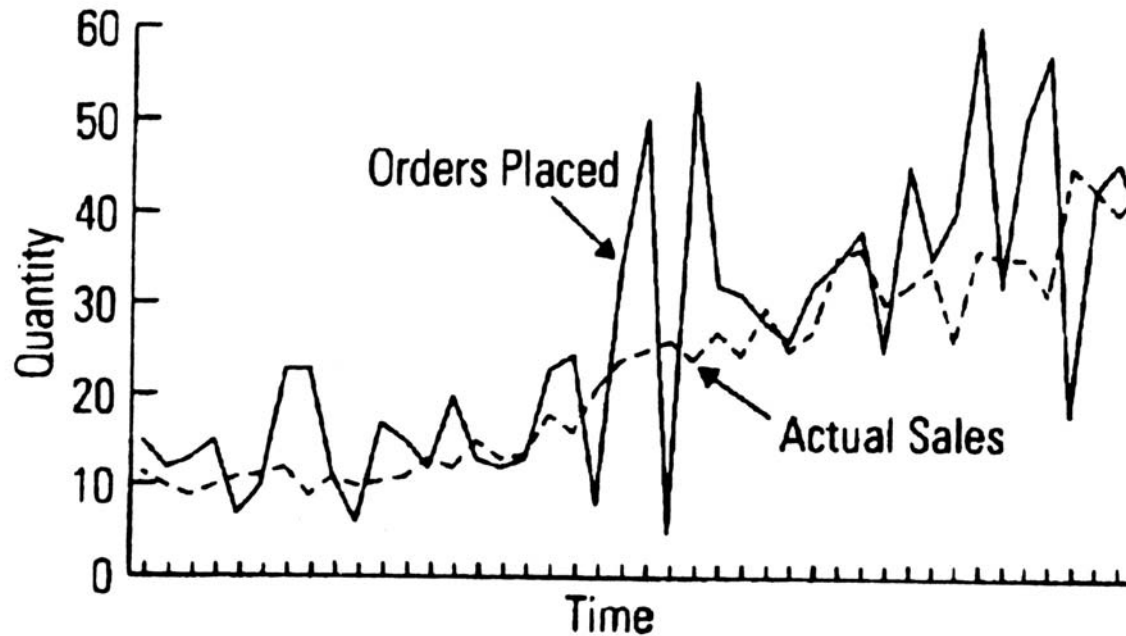
 Abbott Laboratories is a major pharmaceutical company.

 The implementation of an ERP at Abbott Laboratories required an investment of \$55 million.

 This implementation of this tool resulted in:

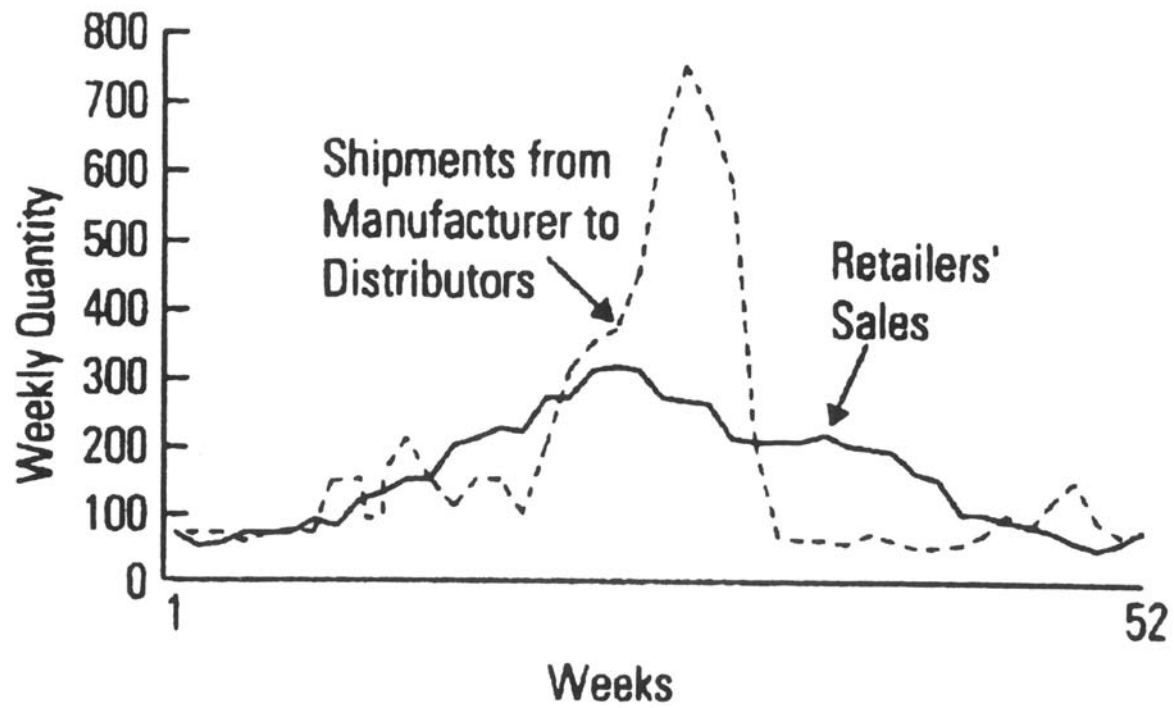
- An increase in the customer service level of 95 to 99 %,
- A reduction of the lead time from 118 days to 85 days,
- An annual cost saving of \$20 million.

Distortion of Information in the Supply Chain: the *Bullwhip effect*

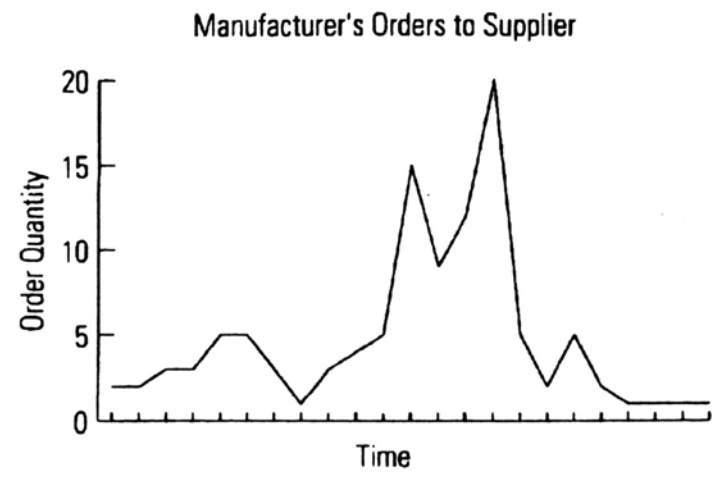
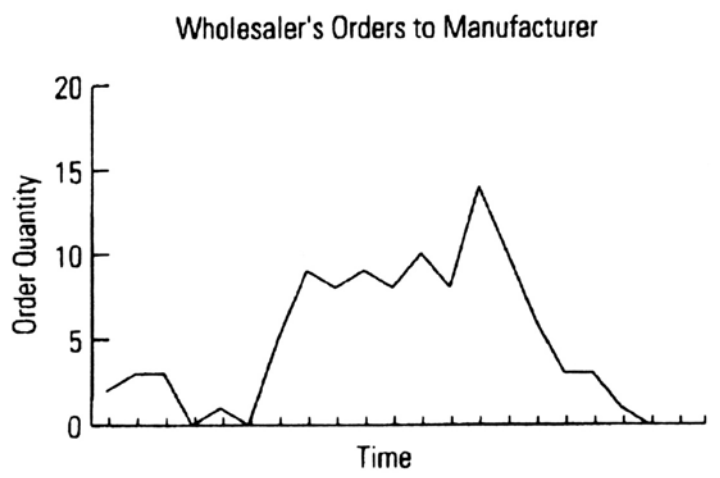
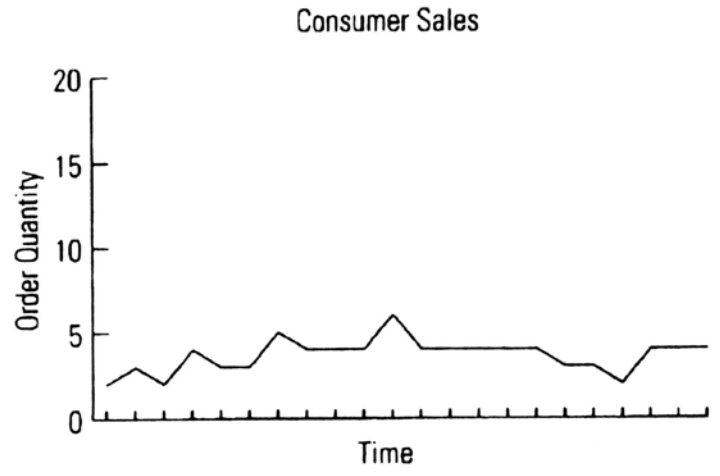


Higher variability in orders from dealer to manufacturer than actual sales

Bullwhip effect due to Seasonal Sales of Soup



Increasing variability of orders up the supply chain





The causes and counter-measures of the *Bullwhip effect*

Causes	Contributing factors	Counter-measures	State of practice
Demand signaling	▪ No visibility on end demand	▪ Access sell-thru or POS data	▪ Sell-thru data in contracts (e.g., HP, Apple, IBM)
	▪ Multiple forecasts	▪ Single control of replenishment	▪ VMI (P&G and Wal-Mart)
	▪ Long lead-time	▪ Lead-time reduction	▪ Quick response mfg strategy
Order batching	▪ High order cost	▪ EDI & CAO	▪ Nabisco
	▪ Full truckload shipment economics	▪ Discount on assorted truckload, consolidation by 3rd party logistics	▪ 3rd party logistics in Europe, emerging in the US
	▪ Random or correlated ordering	▪ Regular delivery appointment	▪ P&G
Fluctuating prices	▪ High-low pricing	▪ EDLP	▪ P&G
	▪ Delivery & purchase not synchronized	▪ Special purchase contract	▪ Under study
Shortage game	▪ Proportional rationing scheme	▪ Allocate based on past sales	▪ Saturn, HP
	▪ Ignorance of supply conditions	▪ Shared capacity & supply information	▪ Scheduling sharing (HP, Motorola)
	▪ Unrestricted orders & free return policy	▪ Flexibility limited over time, capacity reservation	▪ HP



The Wal-Mart supply chain

Objective: delivering quality goods to customers when and where they need at the best price.

Organization: *Cross-Docking*

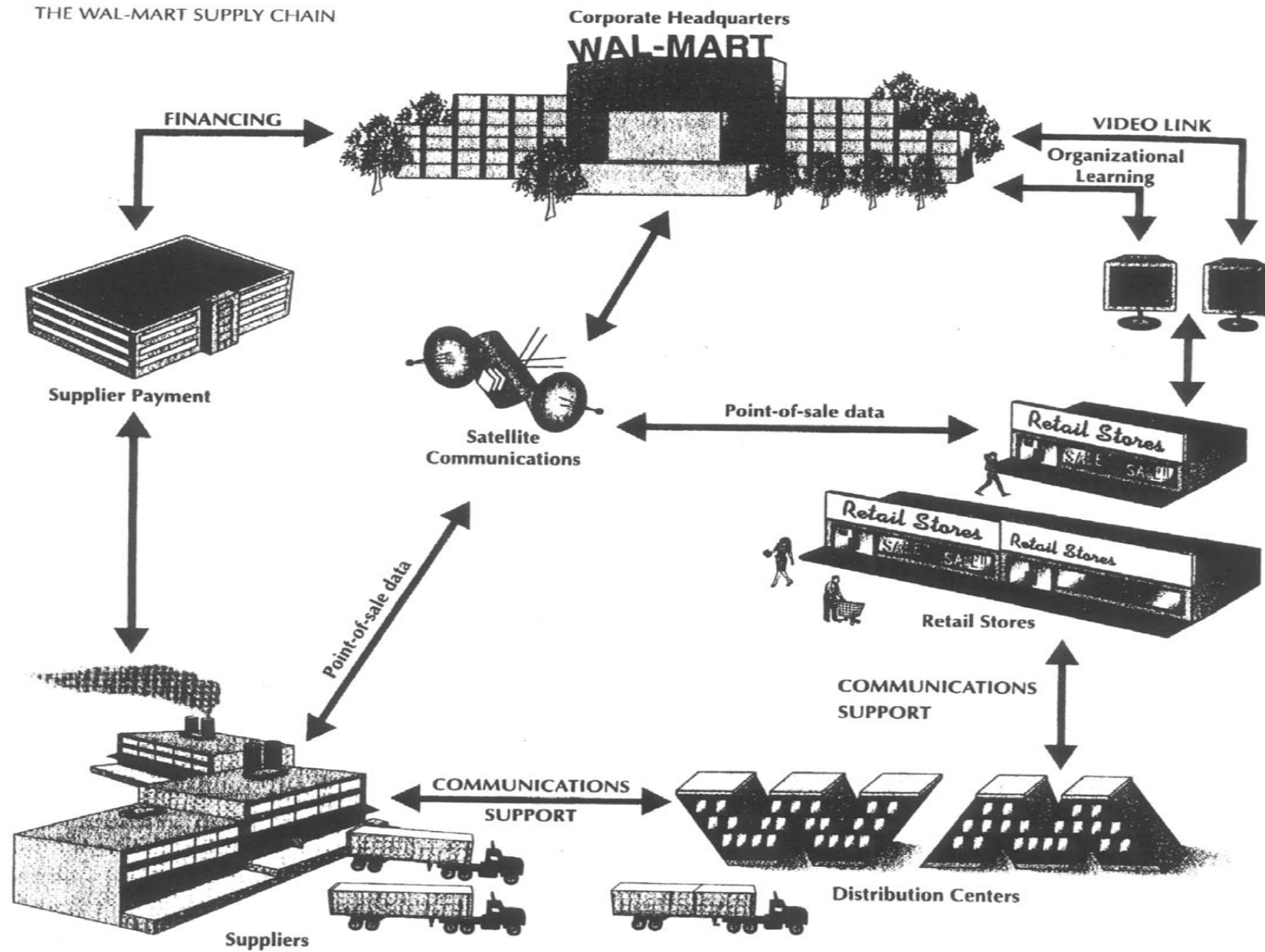
- Continuous replenishment of goods to be repackaged and transported from distribution centers to stores on time.
 - ➔ Near-zero inventory costs,
 - ➔ Distribution costs of Wal-Mart less than 3% of the sector's average,
 - ➔ Price competitive advantage.

- Interconnected suppliers, distribution centers and stores through a satellite communication network.
 - ➔ On-line transmission of sales data from stores to the 4 000 suppliers of Wal-Mart,
 - ➔ Instantaneous knowledge of the stores' needs by the suppliers.

- Delivery of distribution centers and Wal-Mart stores by a fleet of 2 000 trucks.
 - ➔ Delivery time of stores: 48 hours minimum,
 - ➔ Delivery frequency of stores: 2 times a week (vs. Sector: twice a month).

➔ STRATEGIC FOCUS: ZERO STOCK

The Wal-Mart supply chain





Wal-Mart: a major company

Wal-Mart
\$514.405 billion

Exxon Mobil
\$290.212 billion

Apple
\$265.595 billion

Ranking of US companies in terms of sales (2019)

Source: Fortune (2020)



Inventory

- ALLOWS FOR FLEXIBILITY,
- GENERATES COSTS⁷.

➔ ALTERNATIVE: JUST IN TIME STRATEGY⁸.

⁷ " At Dell, a reduction of each daily inventory results in an increase in net benefit of 0.5% ", K. Rollins, PDG, Dell.

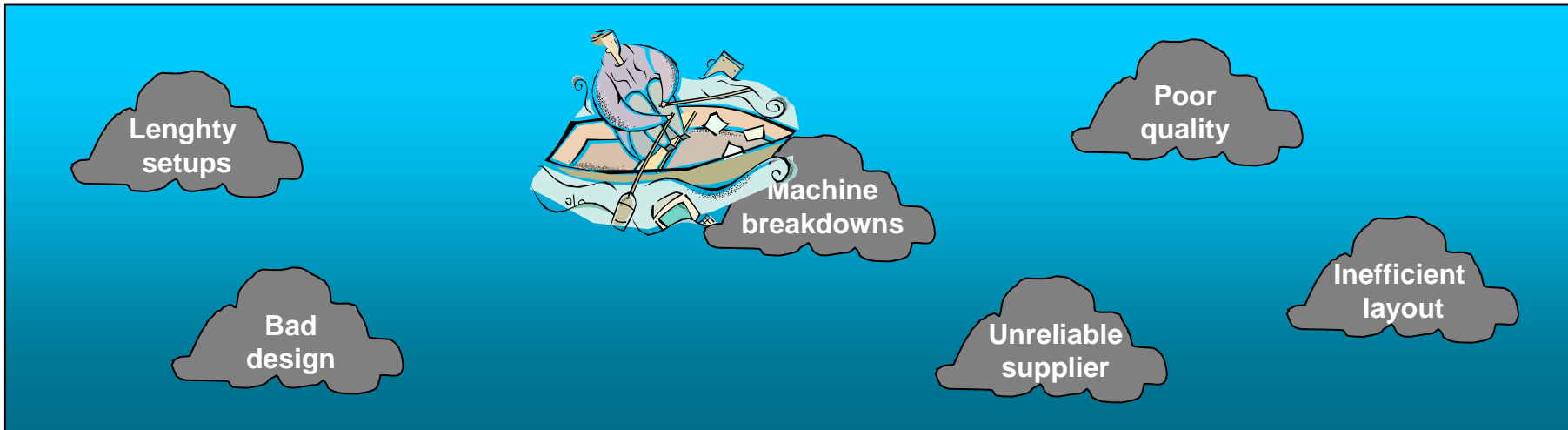
⁸ Cf. Toyota, HP, Harley-Davidson, IBM, Mc Donald's, Federal express, Domino's...

JIT making problems visible

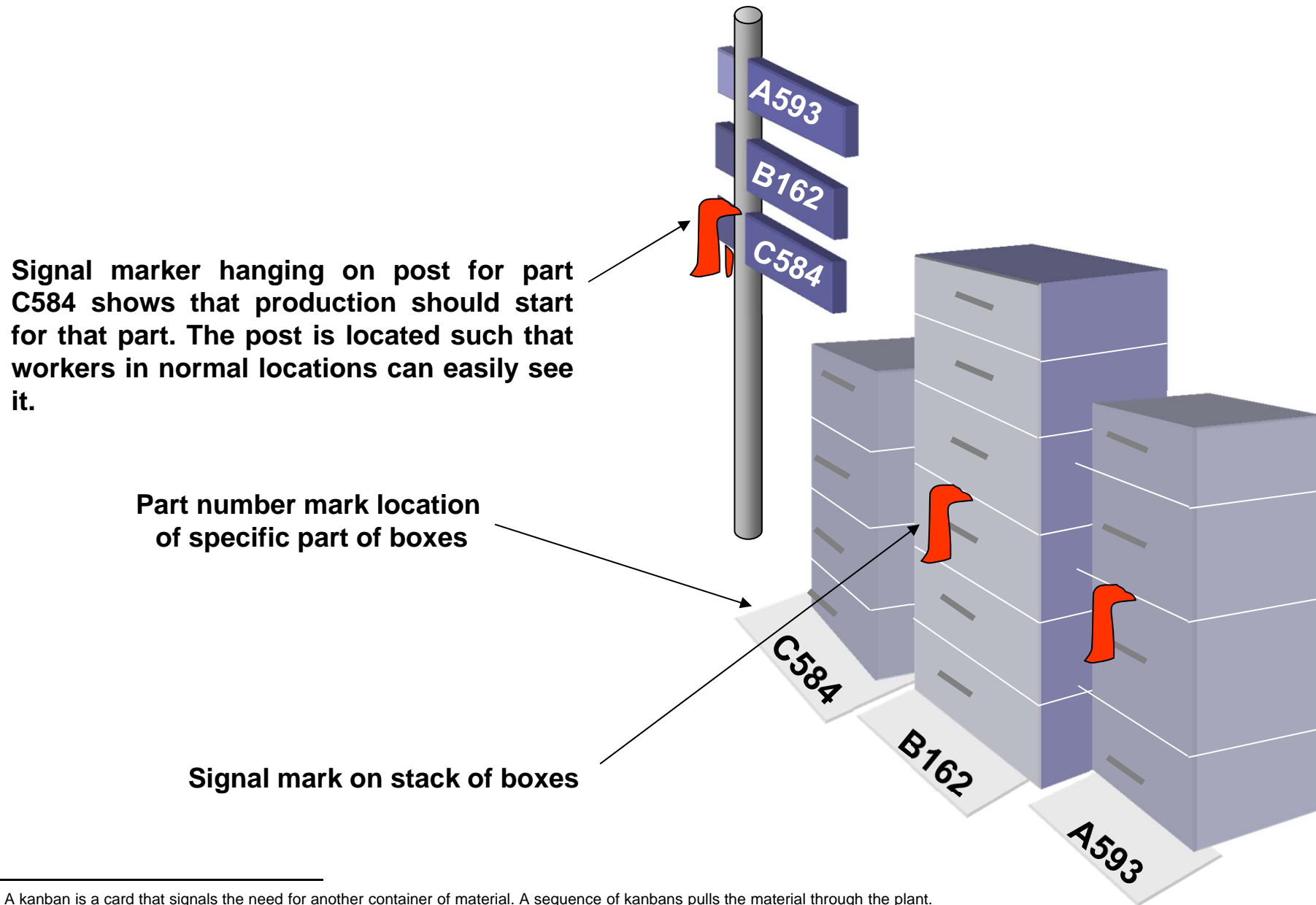
a) Inventory hides problems



b) Lower levels of inventory expose problems



Kanban⁹: an efficient information system, though cheap and archaic



⁹ A kanban is a card that signals the need for another container of material. A sequence of kanbans pulls the material through the plant.

Kanban in fast food restaurants



A kanban need not be as formal as signal lights or empty carts. In this photo, the cook in a fast-food restaurant knows that when six cars are in line, eight meat patties and six orders of French fries should be cooking.



Volkswagen's experiment in supply chain management

Because purchase costs in the auto industry exceed 60% of the sales dollar, even modest reductions in these costs could make Volkswagen's payoff substantial.

Objectives:

- Reduce the rate of defective items,
- Reduce the labor cost,
- Increase the efficiency of the production process.

Specificity: integrated supply chain, where VW is buying not only the materials but also labor and the related services.

Location: 100 miles northwest of Rio de Janeiro (Brasil).

Production: 100 trucks per day.

Workforce: 1 000 workers, with only 200 for VW.



Volkswagen's experiment in supply chain management (continued)

Suppliers involved: Rockwell International, Cummins Engine, Delga Automotiva, Remon, VDO, lochpe-Maxion, Eisenmann.

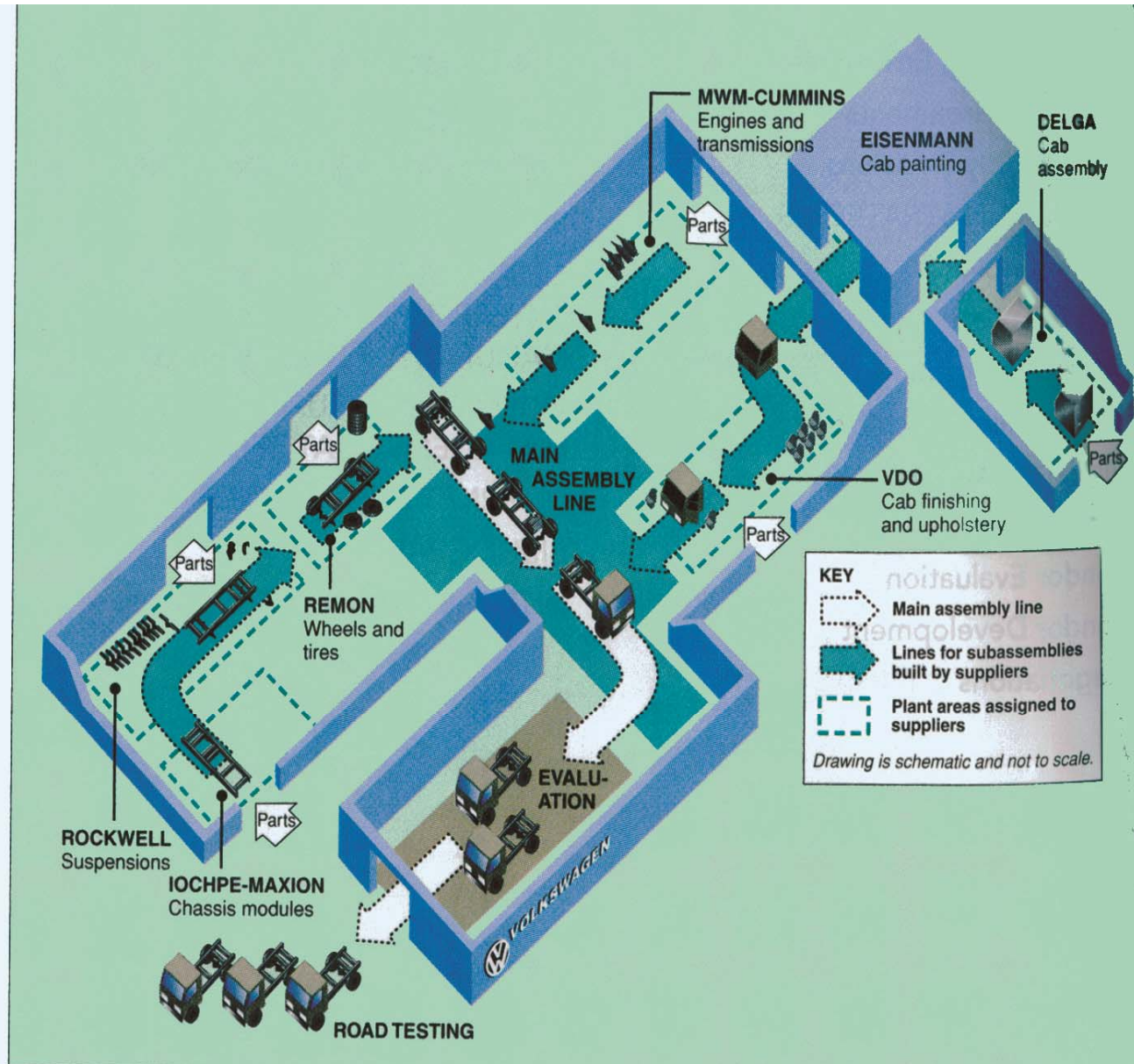
Process:

- Mounting the gas tank, transmission lines and steering blocks (lochpe-Maxion),
- Mounting of axles and brakes (Rockwell),
- Mounting of wheels and adjustment of tire pressure (Remon),
- Installation of the engine and transmissions (MWM/Cummins),
- Assembly of truck cabs (Delga Automotiva),
- Painting of cabs (Eisenmann),
- Finishing of cabs (VDO),
- Evaluation of the final truck (VW).

Extensions: similar approach is developed in Argentina and Czech Republic (Skoda).

Volkswagen's experiment in supply chain management (continued)

Volkswagen's major suppliers are assigned space in the VW plant, but supply their own components, supplies, and workers. Workers from various suppliers build the truck as it moves down the assembly line. Volkswagen personnel inspect.



Volkswagen's experiment in supply chain management (continued)



Remon workers attach the wheels as other parts of the truck are assembled simultaneously.

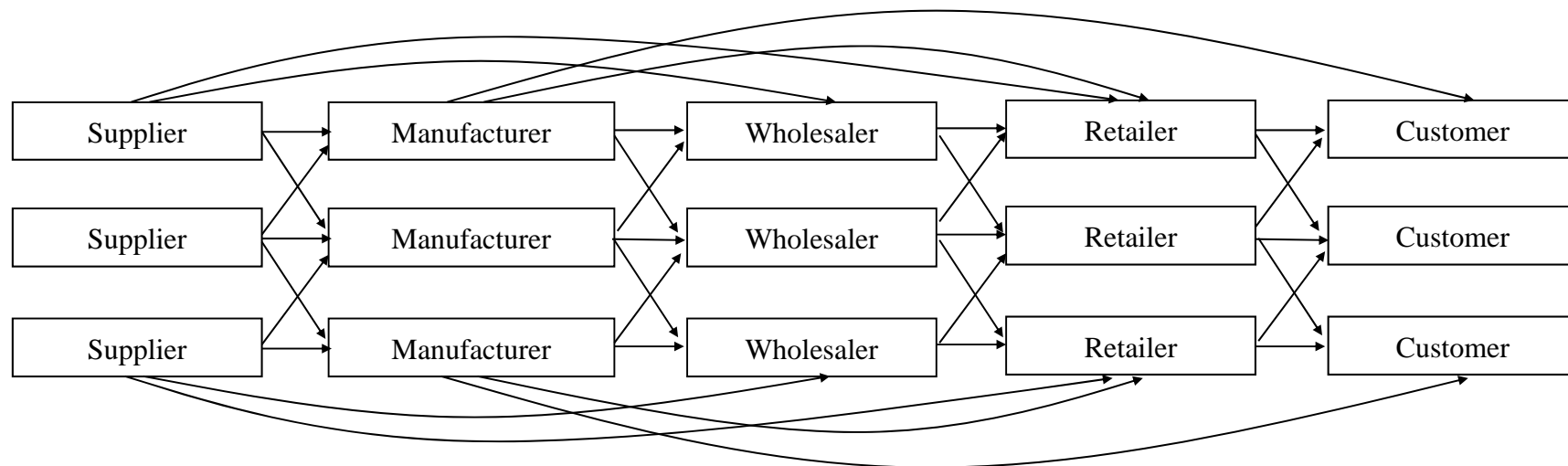
Definition of SCM

SCM is coordination of activities of the supply chain's members (suppliers, producers and retailers) in order to improve its global performance.

⇒ SCM results from tradeoffs elaborated in a multilateral platform.

⇒ SCM depends on the nature of partnerships within the SC.

Network of supply chains





Benefits from the SCM

Coordination in a SC should imply:

⇒ An increase in the customer service level,

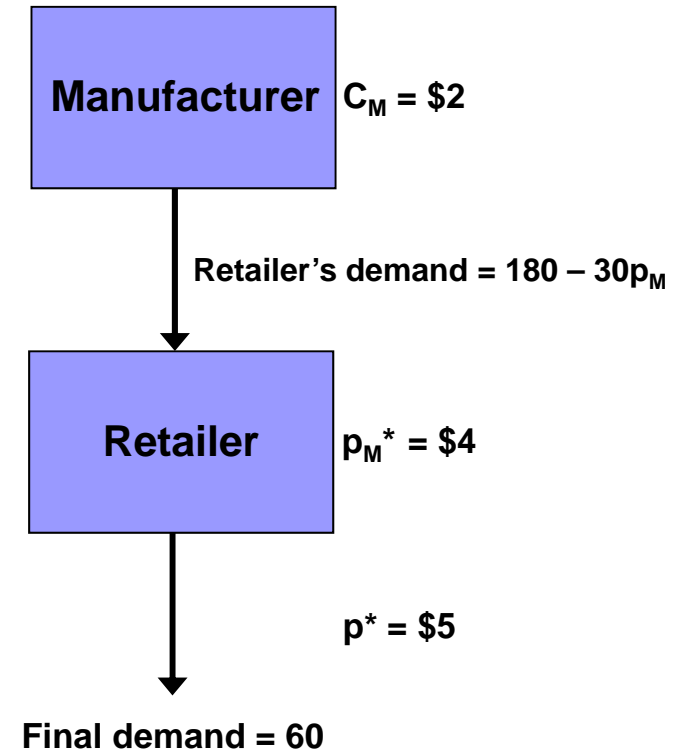
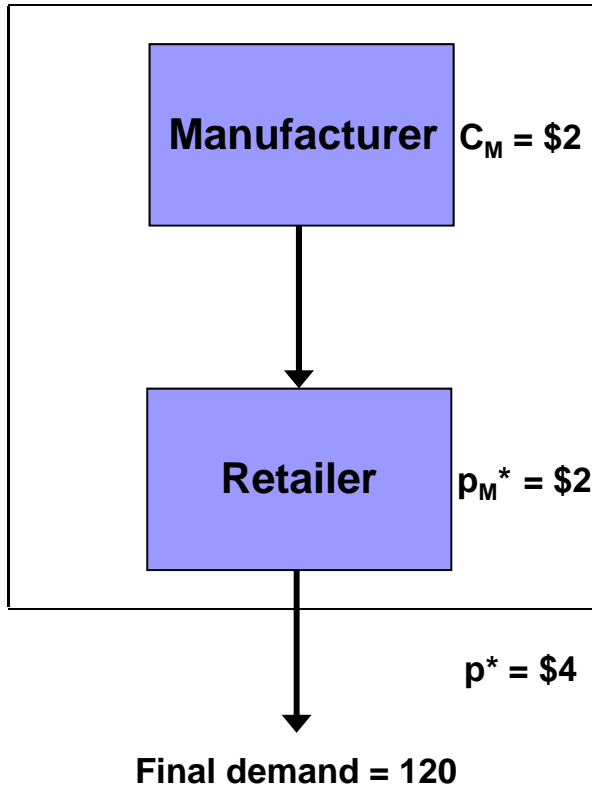
⇒ An improvement of quality,

⇒ A reduction of operating costs,

⇒ The mitigation of the *double marginalization* phenomenon,

⇒ An increase in individual profits of the SC's members.

Double marginalization phenomenon



Decentralized structure:

M's profit: $\text{Max} [\Pi_M = (p_M - C_M)(180 - 30p_M)]$

R's profit: $\text{Max} [\Pi_R = (p - p_M)(360 - 60p)]$

$$\Rightarrow p_M^* = 3 + 0.5C_M = \$4 \Rightarrow \Pi_M^* = \$120$$

$$\Rightarrow p^* = 3 + 0.5p_M = \$5 \Rightarrow \underline{\Pi_R^* = \$60}$$

$$\Pi_M^* + \Pi_R^* = \$180$$

Coordinated structure:

Joint profit: $\text{Max} [\Pi_J = (p - p_M)(360 - 60p)]$

$$\Rightarrow p^* = 3 + 0.5p_M = \$4 \Rightarrow \Pi_J^* = \$240$$



Contractual Arrangements

- **Buyback contracts:** A manufacturer can increase the quantity the retailer purchases by offering to buy back any leftover units at the end of the season at a fraction of the purchase price. This action has the effect of increasing the salvage value per unit for the retailer who, as a result, increases its order size. The manufacturer may benefit by taking on some of the cost of overstocking because the supply chain will, on average, end up selling more products.
- **Revenue-sharing contracts:** The manufacturer charges the retailer a low wholesale price and shares a fraction of the revenue generated by the retailer. Even if no returns are allowed, the lower wholesale price decreases the cost to the retailer in case of an overstock. The retailer thus increases the level of product availability resulting in higher profits for both the manufacturer and the retailer.
- **Quantity flexibility contracts:** The manufacturer allows the retailer to change the quantity ordered after observing demand. These contracts are similar to buyback contracts in that the manufacturer now bears some of the risk of having excess inventory. Because no returns are required, these contracts can be more effective than buyback contracts when the cost of returns is high. Quantity flexibility contracts increase the average amount the retailer purchases and may increase total supply chain profits.

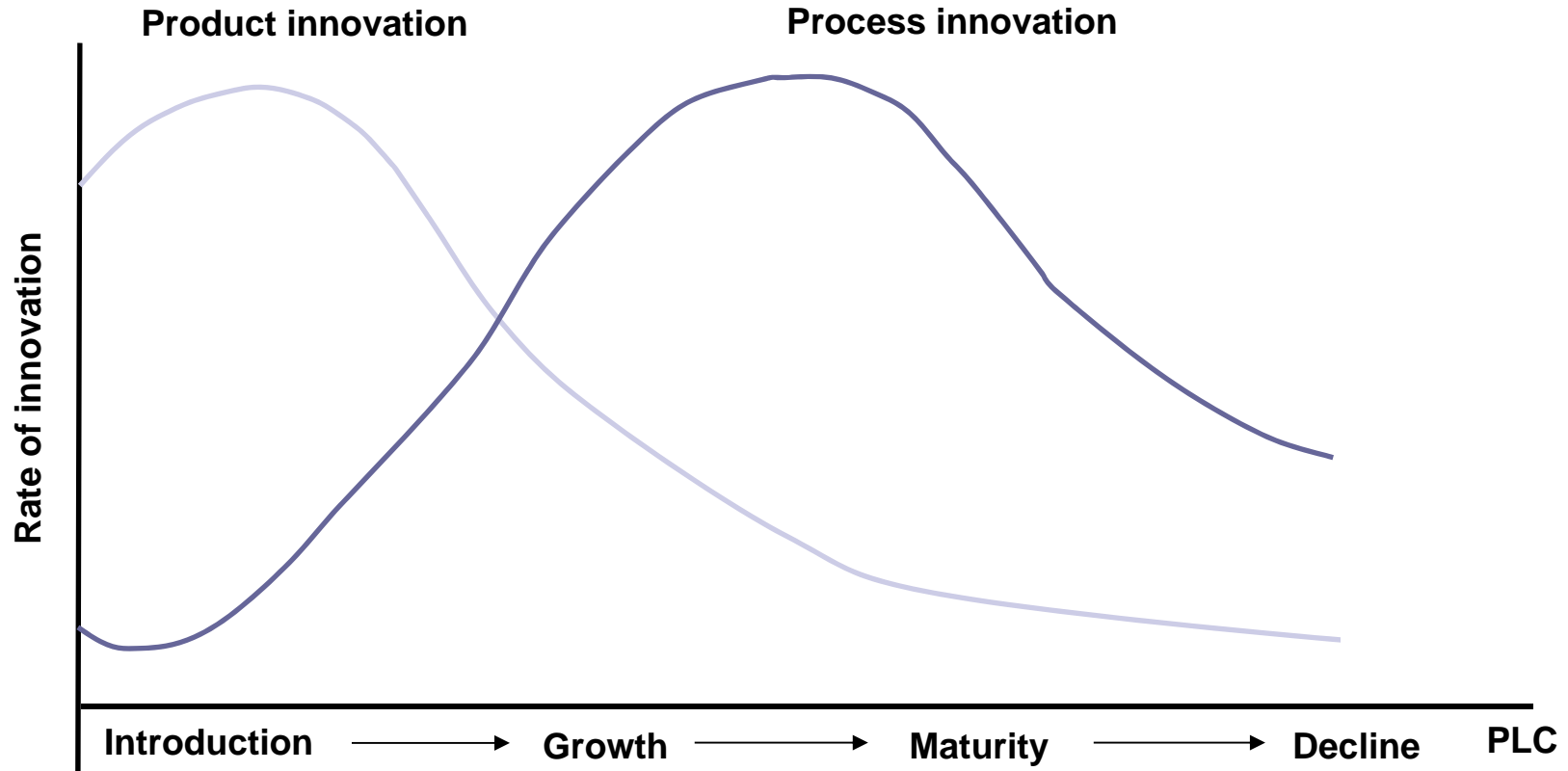


Conflicting objectives

- 📄 Internationalization strategies increase the number of SC (a different SC for a different country),
- 📄 Internationalization strategies extend the SC and reduce their flexibility,
- 📄 The extension of SC increases the risk of failure,
- 📄 Individual firms and SC have divergent priorities. For instance, product innovation is considered as # 1 factor for revenue growth by a sample of 750 companies located in Europe and North America. However, these companies consider quality improvement as # 1 factor for the supply chains in which they are involved, while product innovation and time-to-market are ranked at their lowest supply chains priorities (Source: Deloitte Consulting, 2004).

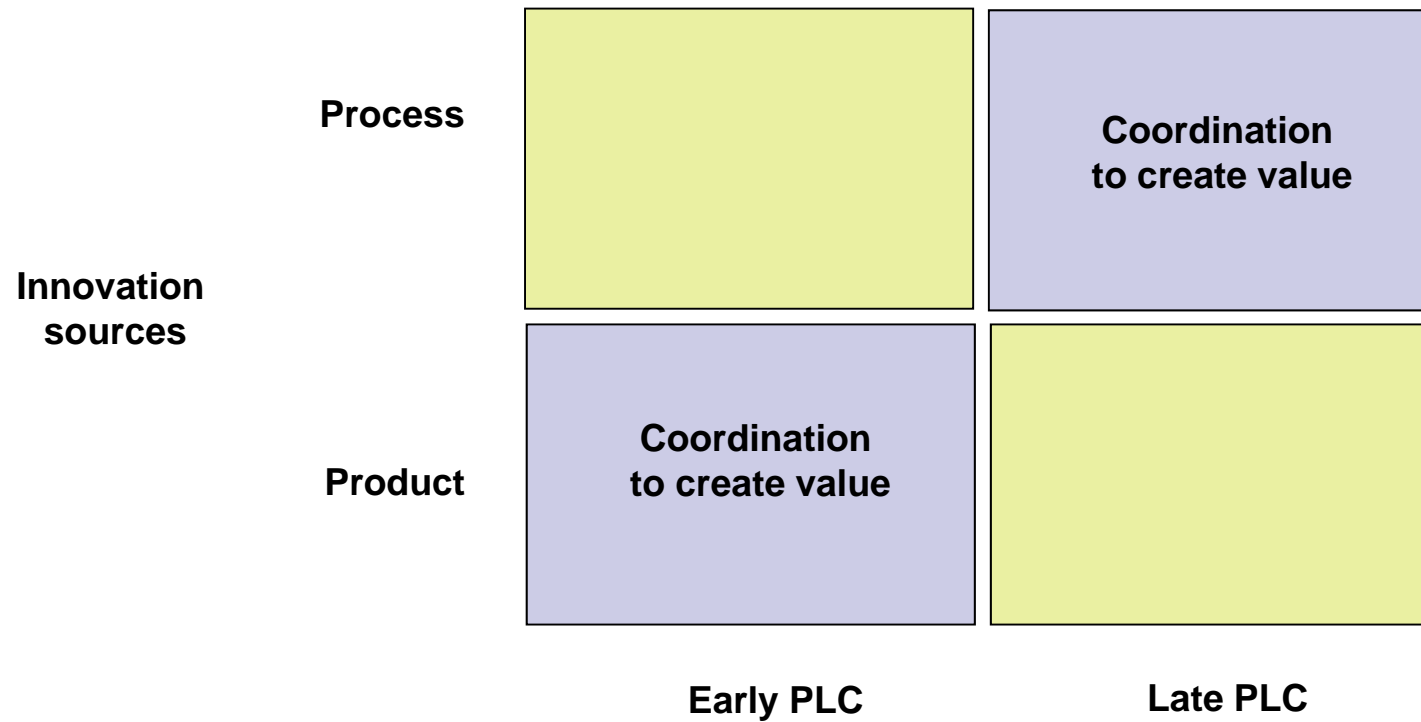


Innovation and product life cycle

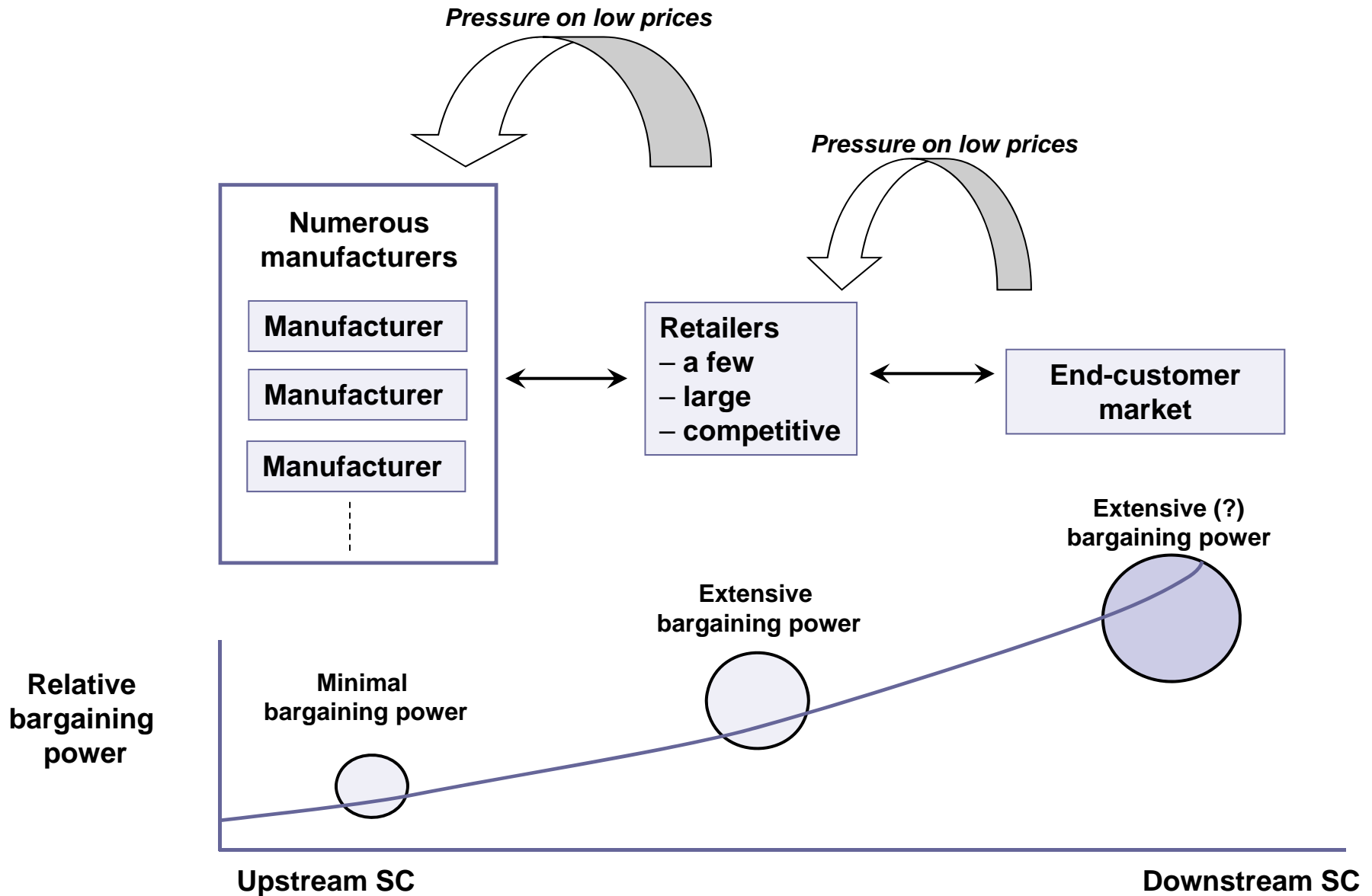




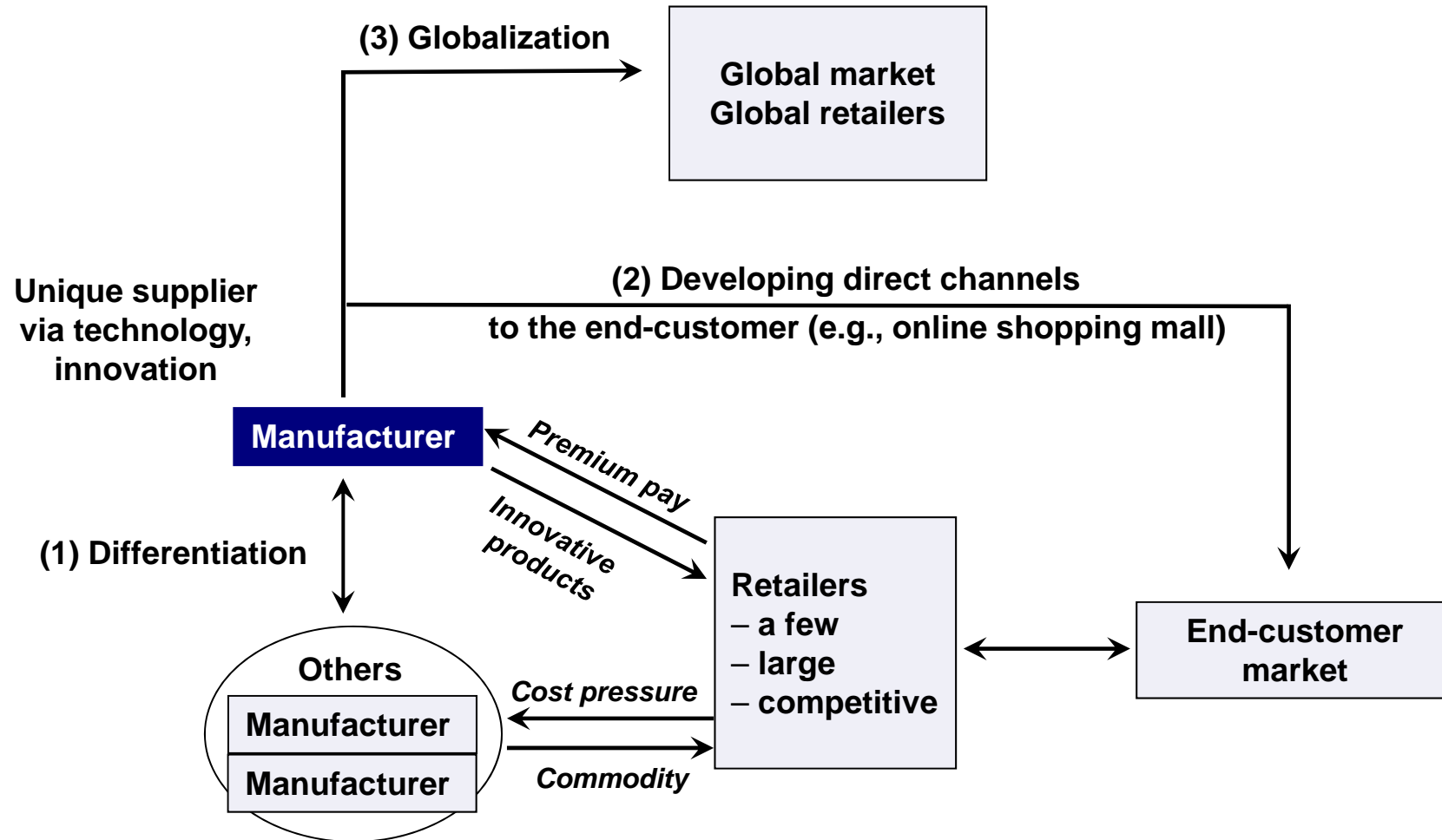
Innovation in a Supply Chain



Retailer-dominated Supply Chain



Strategic responses to the retailer's domination



SCM and financial performance

Market Value

		Leader	Progress	Decline	Late	Total
Supply Chain Performance	Leader	57 50%	5 4%	44 39%	8 7%	114 18%
	Progress	18 32%	18 32%	10 18%	11 19%	57 9%
	Decline	11 17%	7 11%	29 46%	16 25%	63 10%
	Late	58 14%	124 31%	83 21%	137 34%	402 63%
Total		144 23%	154 24%	166 26%	172 27%	636 100%

Kolmogorov-Smirnoff test for 9 degrees of freedom: $\chi^2 = 132,16$.

Source: Accenture-INSEAD-Stanford study performed on 636 of the 3 000 largest world companies (December 2003)



A new business paradigm

 A SC involves multiple internal and external actors around common objectives

 **Alignment of individual interests.**

 SCM requires information exchange and transparency between the SC members

 **Mutual trust development.**

 SCM imposes to each firm a collective perspective

 **Alteration of individual autonomy.**

 SC evolves over time and in space, depending on the supply chain's members involvement

 **Ability to flexibility.**



A new business paradigm (continued)

📖 The SC tends to become a tool for the segmentation of firms' activity

 **Repositioning of functions within the firms.**

📖 Coordination of firms' activities in the SC leads to potential competition between SC

 **Competition between independent or interdependent SC.**