

**SUPPLY CHAIN
PERFORMANCE
MEASUREMENT AND
FINANCIAL ANALYSIS**



Learning Objectives

- Understand the scope and importance of supply chain performance measurement.
- Explain the characteristics of good performance measures.
- Discuss the various methods used to measure supply chain costs, service, profit, and revenue.
- Understand the basics of an income statement and a balance sheet.

Learning Objectives, continued

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- Demonstrate the impacts of supply chain strategies on the income statement, balance sheet, profitability, and return on investment.
- Understand the use of the strategic profit model.
- Analyze the financial impacts of supply chain service failures.
- Utilize spreadsheet computer software to analyze the financial implications of supply chain decisions

Agenda

1. Definitions
2. Why Measure Performance?
3. Measure Characteristics
4. Focus of Measure and Levels of Performance
5. Good Practice in Performance Measurement
6. Examples of Performance Measurement
7. Conclusions

Dimensions of Supply Chain Performance Metrics

- Measures
 - ▣ Require no calculations and are uni-dimensional
- Metric
 - ▣ Requires calculation and often contains several measures
- Index
 - ▣ Combines two or more metrics into a single value

What is Performance?

- Gleason and Barnum (1986) chose to distinguish between effectiveness and efficiency
 - ▣ Effectiveness – the extent to which an objective is achieved
 - ▣ Efficiency – the degree to which resources have been used economically

Efficiency is “doing things right”

Effectiveness is “doing the right thing”

Definitions

- A Performance Measure can be defined as a..

“Measure of the effectiveness of an operation”

(Bititci, 2002)

- A Performance Management System

*A combination of performance measures to control
performance*

Why Measure Performance?

- To determine and control commercial performance
- To ensure achievement of strategic goals
- To identify problems
- Benchmarking against other companies

Benefits of Measurement

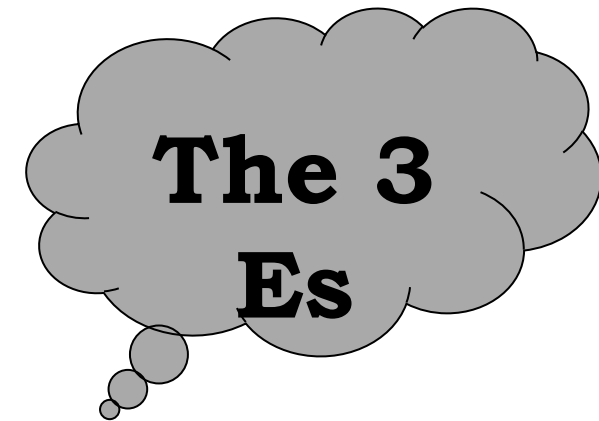
- Decision making aligned with corporate goals
- Improved communication channels
- Improved visibility of operations
- Motivated employees

Measure Characteristics

- There are three dimensions to a performance measure
 - What is being measured?
 - How is it being measured?
 - Do you maximise or minimise?

Measure Characteristics – What?

- Economy
 - ▣ Target setting
 - ▣ Ignores output
 - E.g. Staffing or Vehicle Costs
- Efficiency
 - ▣ Output from given input
 - ▣ Utilisation or productivity
 - E.g. TPH (Turnover per head) or Vehicle Fill Rate
- Effectiveness
 - ▣ Ability to meet predetermined goals
 - ▣ Reflects quality
 - E.g. (DOT) Delivery on Time Performance



Measure Characteristics – How?

- Quantitative (Hard Measures)
 - ▣ Numerical (e.g. costs, income etc.)
 - ▣ Easy to compile

- Qualitative (Soft Measures)
 - ▣ Descriptive (e.g. product quality, customer satisfaction ratings)
 - ▣ May be converted to quantitative for analysis
 - ▣ Often impact upon quantitative factors

Measure Characteristics - Max/Min?

- Maximise

- ▣ The higher the value, the better the performance
 - E.g. Vehicle Fill Percentage

- Minimise

- ▣ The lower the value, the better the performance
 - E.g. Absenteeism

Characteristics of a Good Measure

A GOOD MEASURE	DESCRIPTION
<ul style="list-style-type: none">• Is quantitative• Is easy to understand• Encourages appropriate behavior• Is visible• Is defined and mutually understood• Encompasses both outputs and inputs• Measures only what is important• Is multidimensional• Uses economies of effort• Facilitates trust	<ul style="list-style-type: none">• The measure can be expressed as an objective value.• The measure conveys at a glance what it is measuring and how it is derived.• The measure is balanced to reward productive behavior and discourage “game playing.”• The effects of the measure are readily apparent to all involved in the process being measured.• The measure has been defined by and/or agreed to by all key process participants (internally and externally).• The measure integrates factors from all aspects of the process measured.• The measure focuses on a key performance indicator that is of real value to managing the process.• The measure is properly balanced between utilization, productivity, and performance and shows the tradeoffs.• The benefits of the measure outweigh the costs of collection and analysis.• The measure validates the participation among the various parties.

Multidimensional

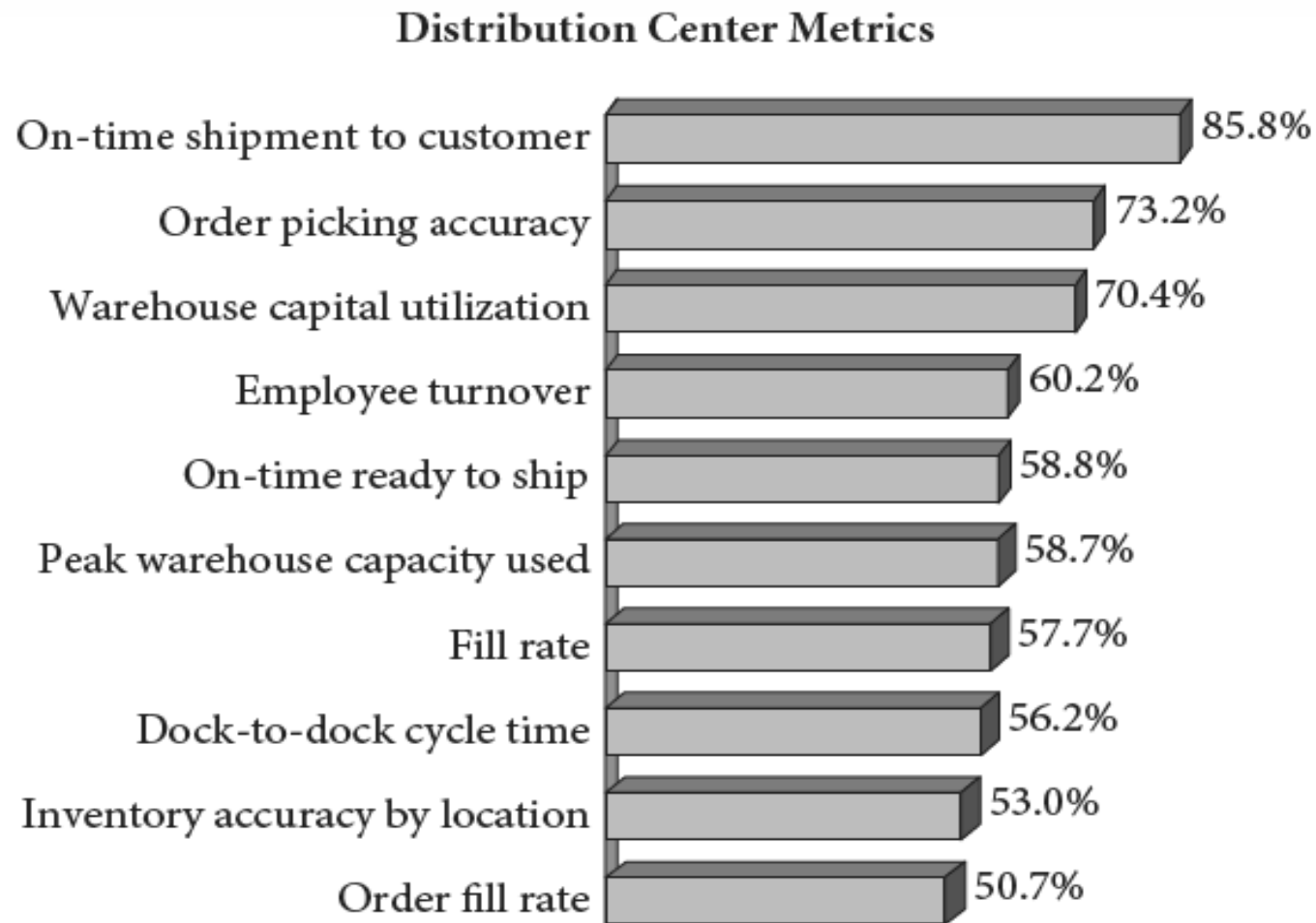
- Performance Measure – also can be known as a KPI (Key Performance Indicator)
- Defining performance is problematic as it has been defined in many ways by the literature
- This stems from the fact that organisations have many, sometimes conflicting, goals..
 - ▣ The goal could be optimising profit or customer satisfaction or sales maximisation!

Performance is Multi-Dimensional



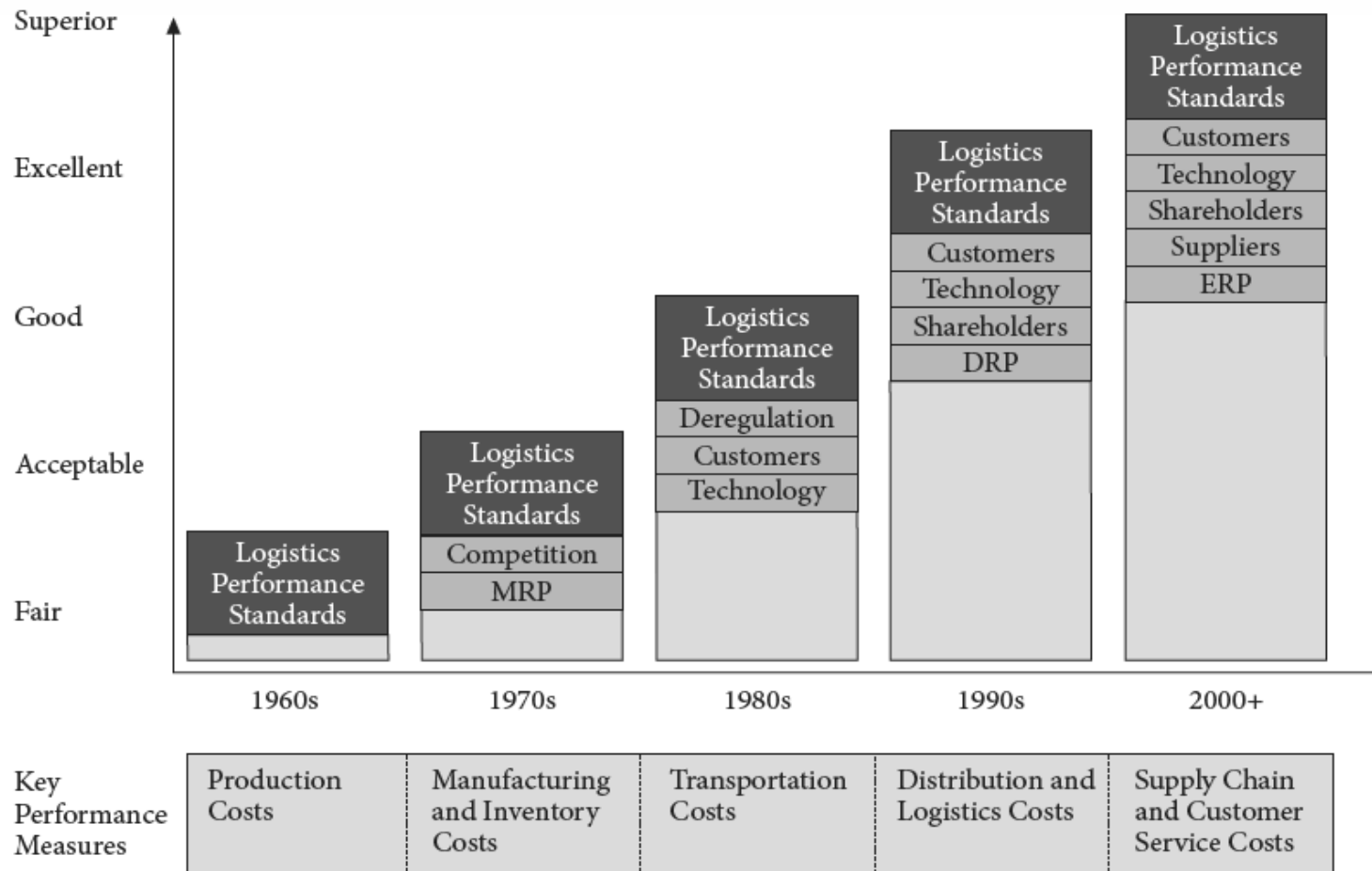
Chow et al, (1994) Logistics Performance: Definition and Measurement – Int. Jnl. of Physical Distribution & Logistics Mgt.

Distribution Center Metrics



Source: 2010 Metrics Report, WERC, (May 26, 2010).

Raising the Performance Bar



Source: Koebler, Durtsche, Manrodt, & Ledyard, Keeping score: *Measuring the business value of logistics in the supply chain* (Univ. Tennessee Council of Logistics Management, 1999) p8

Developing Supply Chain Performance Metrics

- The development of a metrics program should be the result of a team effort.
- Second, involve customers and suppliers, where appropriate, in the metrics development process.
- Develop a tiered structure for the metrics.
- Identify metric “owners” and tie metric goal achievement to an individual’s or division’s performance evaluation.

Developing Supply Chain Performance Metrics, continued

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- Establish a procedure to mitigate conflicts arising from metric development and implementation.
- Establish a procedure to mitigate conflicts arising from metric development and implementation.
- Establish top management support for the development of a supply chain metrics program

Process Measure Categories

Time

On-time delivery/receipt
Order cycle time
Order cycle time variability
Response time
Forecasting/Planning cycle time

Quality

Overall customer satisfaction
Processing accuracy
Perfect order fulfillment

- On-time delivery
- Complete order
- Accurate product selection
- Damage-free
- Accurate invoice

Forecast accuracy
Planning accuracy

- Budgets and operating plans

Schedule adherence

Cost

Finished goods inventory turns
Days sales outstanding
Cost to serve
Cash-to-cash cycle time
Total delivered cost

- Cost of goods
- Transportation costs
- Inventory carrying costs
- Material handling costs

All other costs

- Information systems
- Administrative

Cost of excess capacity
Cost of capacity shortfall

Other/Supporting

Approval exceptions to standard

- Minimum order quantity
- Change order timing

Availability of information

Source: Koebler, Durtsche, Manrodt, & Ledyard, Keeping score: *Measuring the business value of logistics in the supply chain* (Univ. Tennessee Council of Logistics Management, 1999) p8

Performance Categories

- Time
 - Captures the effectiveness dimension
- Cost
 - Captures the efficiency dimension
- Quality
 - Captures the customer service dimension
- Other / Supporting
 - SCOR model
 - Order cycle time (OCT)
 - Once an expected order cycle time is established for customers, service failures can be measured.
 - OCT influences product availability, customer inventories, and seller's cash flow and profit.

SCOR Model: Process D1 Metrics

PROCESS CATEGORY: DELIVER STOCKED PRODUCT		PROCESS NUMBER: D1
Process Category Definition		
<p>The process of delivering product that is sourced or made based on aggregated customer orders/demand and inventory re-ordering parameters. The intention of Deliver Stocked Product is to have the product available when a customer order arrives (to prevent the customer from looking elsewhere). For services industries, these are services that are pre-defined and off-the-shelf (e.g. standard training). Products or services that are “configurable” cannot be delivered through the Deliver Stocked Product process, as configurable products require customer reference or customer order details.</p>		
Performance Attributes	Metric	
Supply Chain Reliability	Perfect Order Fulfillment	
Supply Chain Responsiveness	Delivery Cycle Time Order Fulfillment Cycle Time	
Supply Chain Agility	Upside Deliver Adaptability Downside Deliver Adaptability Upside Deliver Flexibility	
Supply Chain Costs	Cost to Deliver Finished Goods Inventory Days of Supply Order Management Costs	
Supply Chain Asset Management	Return on Supply Chain Fixed Assets Return on Working Capital Cash-to-Cash Cycle Time	

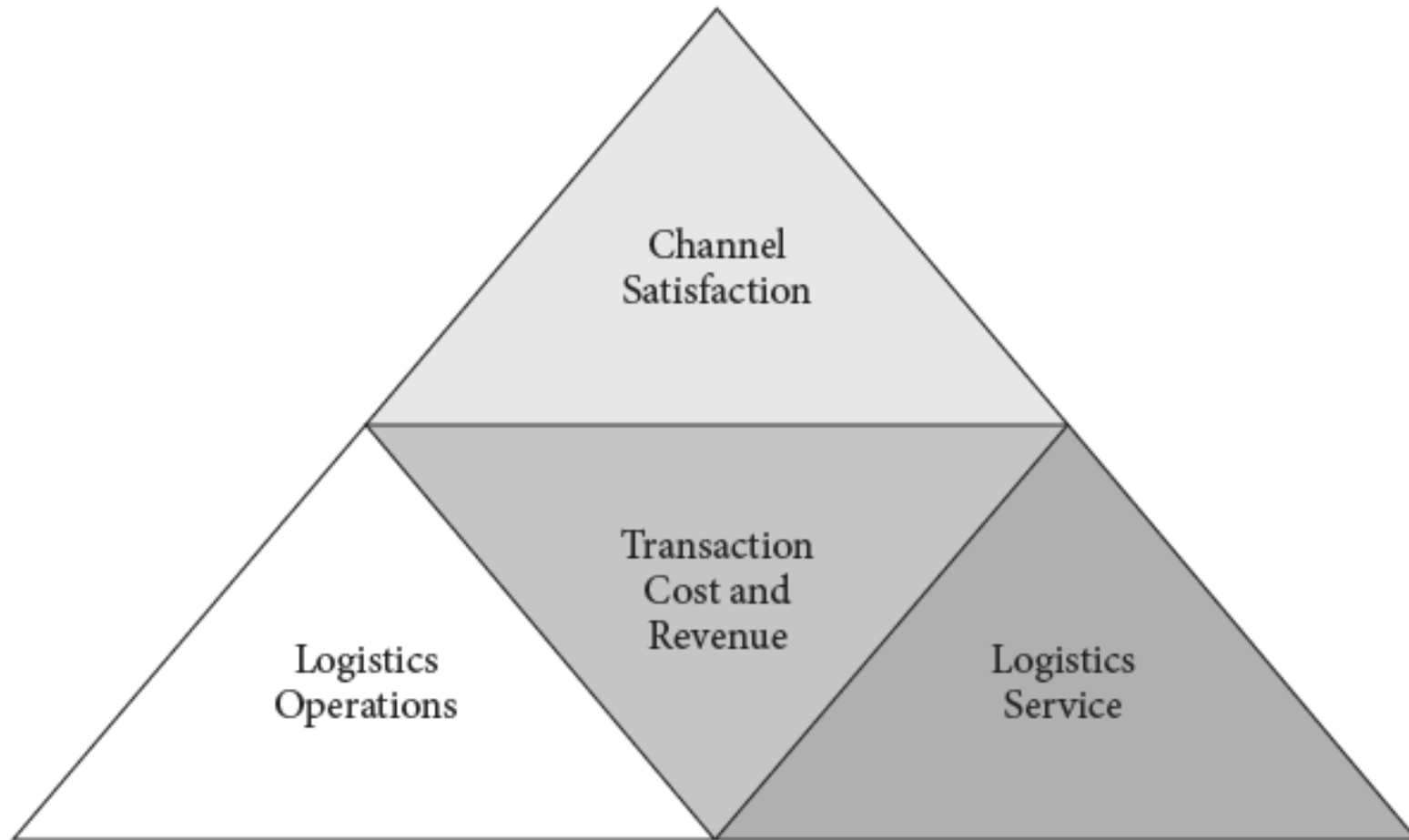
Source: Adapted from Supply Chain Council 2011

SCOR Model: Process D1.3 Metrics

Process Element: Reserve Inventory and Determine Delivery Date		Process Element Number: D1.3
Process Element Definition		
Inventory (both on hand and scheduled) is identified and reserved for specific orders and a delivery date is committed and scheduled.		
Performance Attributes	Metric	
Supply Chain Reliability	Delivery Performance to Customer Commit Date Fill Rate % of Orders Delivered in Full	
Supply Chain Responsiveness	Reserve Inventory and Determine Delivery Date Cycle Time Order Fulfillment Dwell Time	
Supply Chain Agility	None Identified	
Supply Chain Costs	Cost to Reserve Resources Determine Delivery Date	
Supply Chain Asset Management	None Identified	

Source: Adapted from Supply Chain Council 2011

Logistics Quantification Pyramid



Source: R.A. Novak, Center for Supply Chain Research, Penn State University (2010)

The Supply Chain – Finance Connection

- Focusing attention on the supply chain and the resources it utilizes is a means to improving financial performance.
- Inventory levels affect the amount of capital required to finance the inventory.
- Supply chain efficiency impacts time to process an order which bears on the order-cash cycle time.

The Revenue – Cost Savings Connection

$$\text{Profit} = \text{Revenue} - \text{Costs}$$

where

$$\text{Cost} = (X\%)(\text{Revenue})$$

then

$$\text{Profit} = \text{Revenue} - (X\%)(\text{Sales}) = \text{Revenue}(1 - X\%)$$

where

$$(1 - X\%) = \text{Profit Margin}$$

$$\text{Sales} = \text{Profit}/\text{Profit Margin}$$

Sales Equivalent of Cost Savings

Table 5-1

Sales Equivalent of Supply Chain Cost Savings

	CLGN 2007		SALES EQUIVALENT FOR COST SAVINGS OF		
	(000)	%	\$200,000	\$500,000	\$1,000,000
Sales	\$150,000	100.0%	\$2,857,143*	\$7,142,857**	\$14,285,714†
Total cost	139,500	93.0	2,657,143	6,642,857	13,285,714
Net profit	10,500	7.0	200,000	500,000	1,000,000

*\$200,000 cost saving ÷ 0.07 profit margin
 **\$500,000 cost saving ÷ 0.07 profit margin
 †\$1,000,000 cost saving ÷ 0.07 profit margin

Source: Edward J. Bardi, Ph.D.

Equivalent Sales with Varying Margins

	PROFIT MARGINS			
	20%	10%	5%	1%
Sales	\$50,000	\$100,000	\$200,000	\$1,000,000
Total cost	40,000	90,000	190,000	990,000
Cost saving/Profit	10,000	10,000	10,000	10,000

Source: Edward J. Bardi, Ph.D.

The Supply Chain Financial Impact

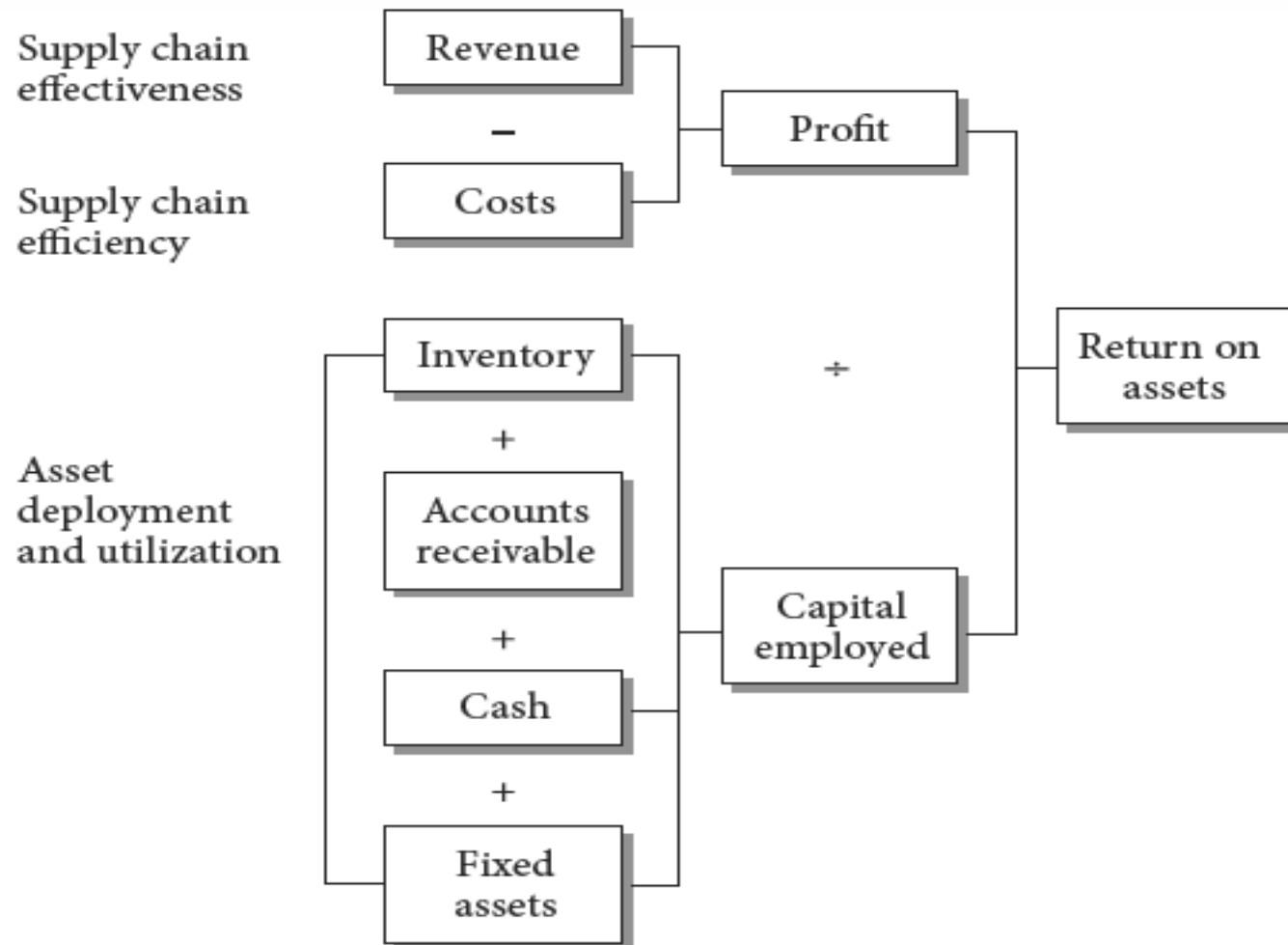
- A major financial objective for any organization is to produce a satisfactory return for stockholders.
- The absolute size of the profit must be considered in relation to the stockholders' net investment, or net worth.
- An organization's financial performance is also judged by the profit it generates in relationship to the assets utilized, or return on assets (ROA).

The Supply Chain Financial Impact, continued

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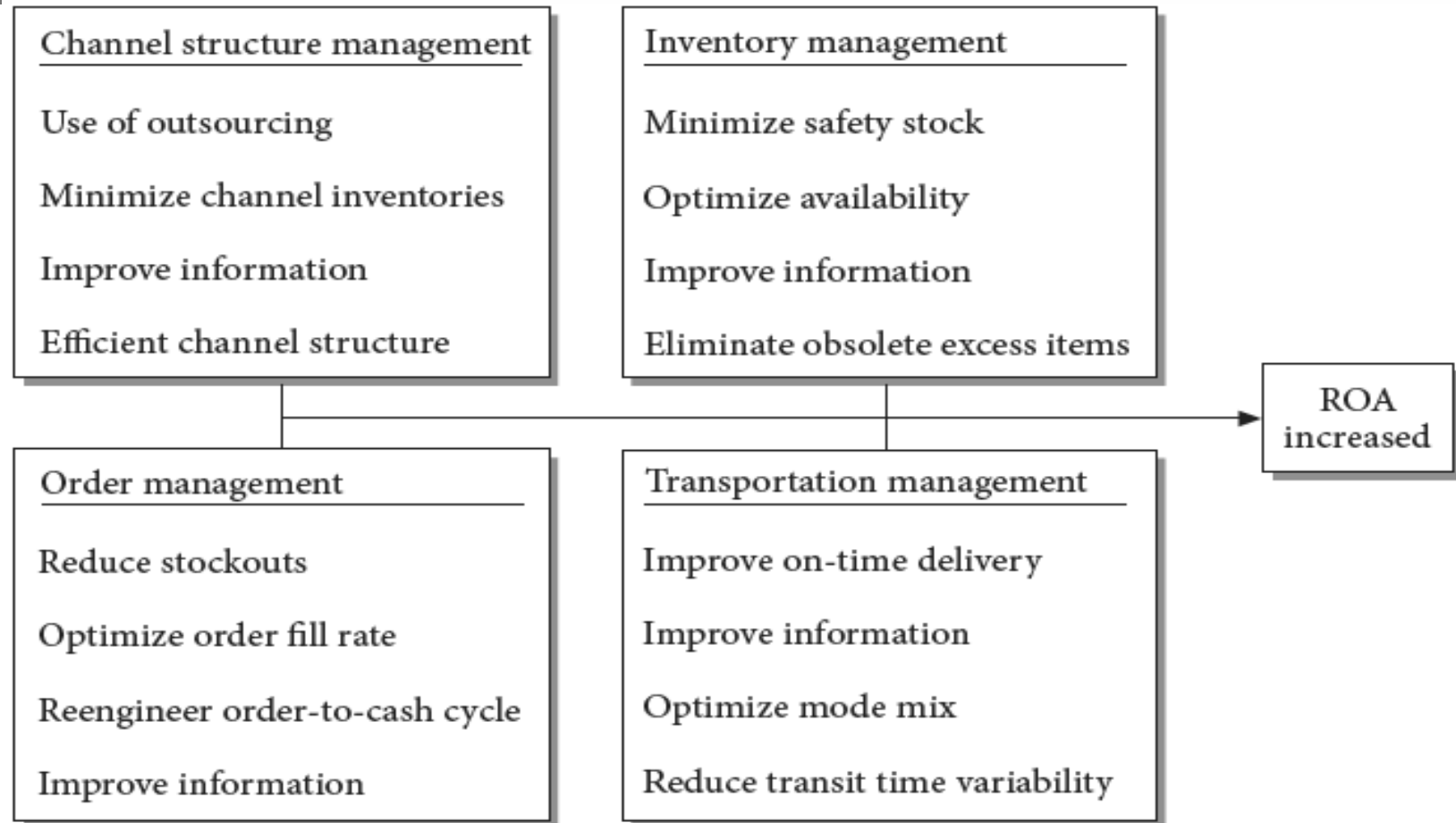
- The supply chain plays a critical role in determining the level of profitability in an organization.
- Return on assets (ROA) is a metric that is used as a benchmark to compare management and organization performance to that of other firms in the same or similar industry.

Supply Chain Impact on ROA



Source: R.A. Novak, Center for Supply Chain Research, Penn State University (2010)

Supply Chain Decision and ROA

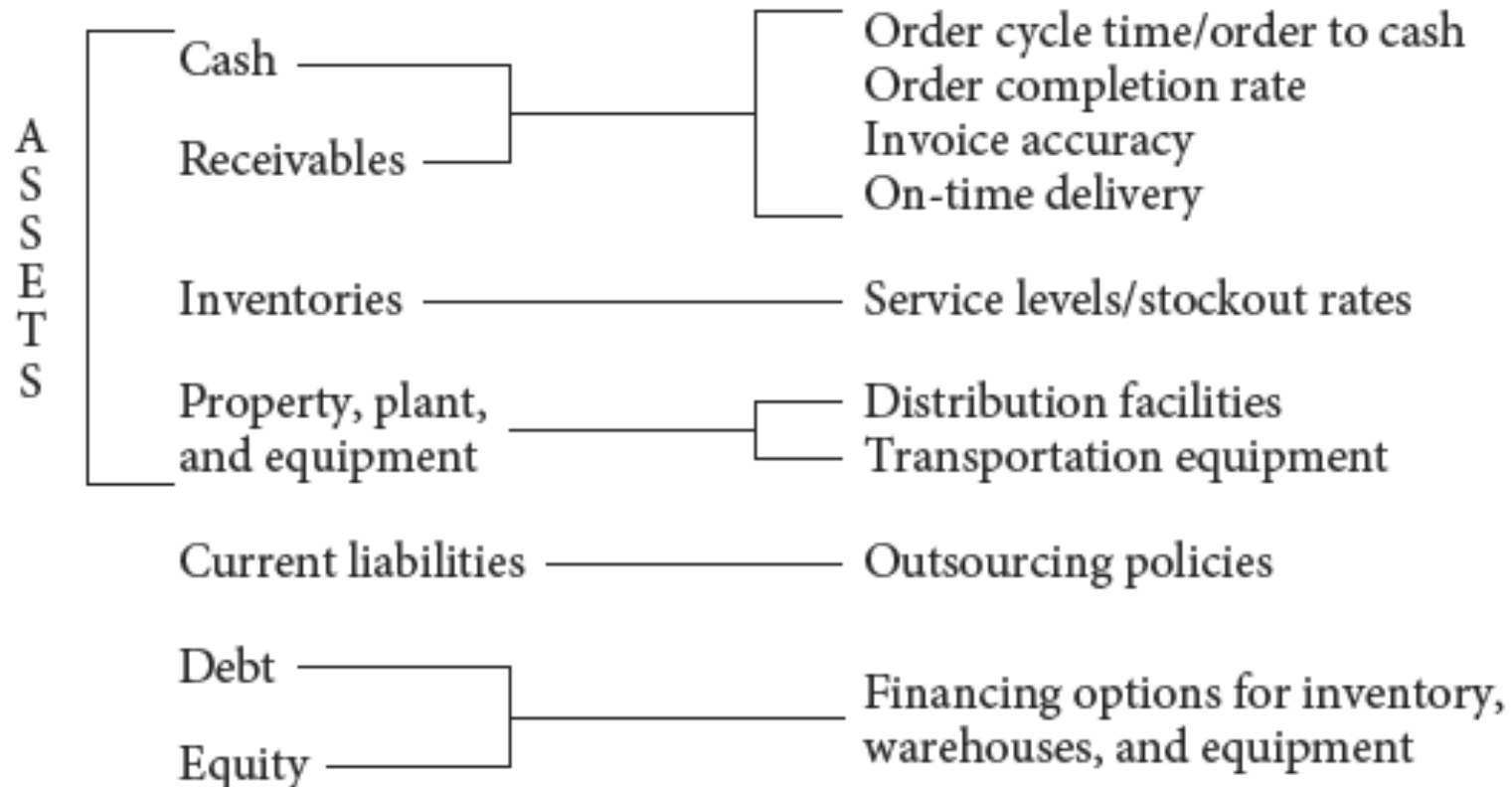


Source: R.A. Novak, Center for Supply Chain Research, Penn State University (2010)

Financial Statements

- Income statement details income and cost.
- Balance sheet details assets and liabilities

Supply Chain Impact on Balance Sheet



Source: R.A. Novak, Center for Supply Chain Research, Penn State University (2010)

Financial Impact of Supply Chain Decisions

- Reducing the cost of transportation, warehousing, or inventory by 10% will lead to significant impacts on the financial statements

Impact of 10% Transportation Reduction

	SYMBOL	CLGN, 2010 \$(000)	TRANSPORTATION COST REDUCED 10 PERCENT
Sales	<i>S</i>	\$150,000	\$150,000
Cost of goods sold	<i>CGS</i>	<u>80,000</u>	<u>80,000</u>
Gross margin	<i>GM = S - CGS</i>	<u>\$ 70,000</u>	<u>\$ 70,000</u>
Transportation	<i>TC</i>	\$ 6,000	\$ 5,400
Warehousing	<i>WC</i>	1,500	1,500
Inventory carrying	<i>IC = IN × W</i>	3,000	3,000
Other operating cost	<i>OOC</i>	<u>30,000</u>	<u>30,000</u>
Total operating cost	<i>TOC</i>	<u>\$ 40,500</u>	<u>\$ 39,900</u>
Earnings before interest and taxes	<i>EBIT</i>	<u>\$ 29,500</u>	<u>\$ 30,100</u>
Interest	<i>INT</i>	\$ 12,000	\$ 12,000
Taxes	<i>TX</i>	<u>7,000</u>	<u>7,240</u>
Net income	<i>NI</i>	<u>\$ 10,500</u>	<u>\$ 10,860</u>
Asset Deployment			
Inventory	<i>IN</i>	\$ 10,000	\$ 10,000
Accounts receivable	<i>AR</i>	30,000	30,000
Cash	<i>CA</i>	15,000	15,000
Fixed assets	<i>FA</i>	<u>90,000</u>	<u>90,000</u>
Total assets	<i>TA</i>	<u>\$145,000</u>	<u>\$145,000</u>
Ratio Analysis			
Profit margin	<i>NI/S</i>	7.00%	7.24%
Return on assets	<i>NI/TA</i>	7.24%	7.49%
Inventory turns/year	<i>CGS/IN</i>	8.00	8.00
Transportation as percentage of sales	<i>TC/S</i>	4.00%	3.60%
Warehousing as percentage of sales	<i>WC/S</i>	1.00%	1.00%
Inventory carrying as percentage of sales	<i>IC/S</i>	2.00%	2.00%

Source: Edward J. Bardi, Ph.D.

Figure 5.15

Impact of 10% Warehousing Reduction

	SYMBOL	CLGN, 2010 \$(000)	WAREHOUSING COST REDUCED 10 PERCENT
Sales	<i>S</i>	\$150,000	\$150,000
Cost of goods sold	<i>CGS</i>	<u>80,000</u>	<u>80,000</u>
Gross margin	$GM = S - CGS$	<u>\$ 70,000</u>	<u>\$ 70,000</u>
Transportation	<i>TC</i>	\$ 6,000	\$ 6,000
Warehousing	<i>WC</i>	1,500	1,350
Inventory carrying	$IC = IN \times W$	3,000	3,000
Other operating cost	<i>OOC</i>	<u>30,000</u>	<u>30,000</u>
Total operating cost	<i>TOC</i>	<u>\$ 40,500</u>	<u>\$ 40,350</u>
Earnings before interest and taxes	<i>EBIT</i>	<u>\$ 29,500</u>	<u>\$ 29,650</u>
Interest	<i>INT</i>	\$ 12,000	\$ 12,000
Taxes	<i>TX</i>	<u>7,000</u>	<u>7,060</u>
Net income	<i>NI</i>	<u>\$ 10,500</u>	<u>\$ 10,590</u>
Asset Deployment			
Inventory	<i>IN</i>	\$ 10,000	\$ 10,000
Accounts receivable	<i>AR</i>	30,000	30,000
Cash	<i>CA</i>	15,000	15,000
Fixed assets	<i>FA</i>	<u>90,000</u>	<u>90,000</u>
Total assets	<i>TA</i>	<u>\$145,000</u>	<u>\$145,000</u>
Ratio Analysis			
Profit margin	<i>NI/S</i>	7.00%	7.06%
Return on assets	<i>NI/TA</i>	7.24%	7.30%
Inventory turns/year	<i>CGS/IN</i>	8.00	8.00
Transportation as percentage of sales	<i>TC/S</i>	4.00%	4.00%
Warehousing as percentage of sales	<i>WC/S</i>	1.00%	0.90%
Inventory carrying as percentage of sales	<i>IC/S</i>	2.00%	2.00%

Source: Edward J. Bardi, Ph.D.

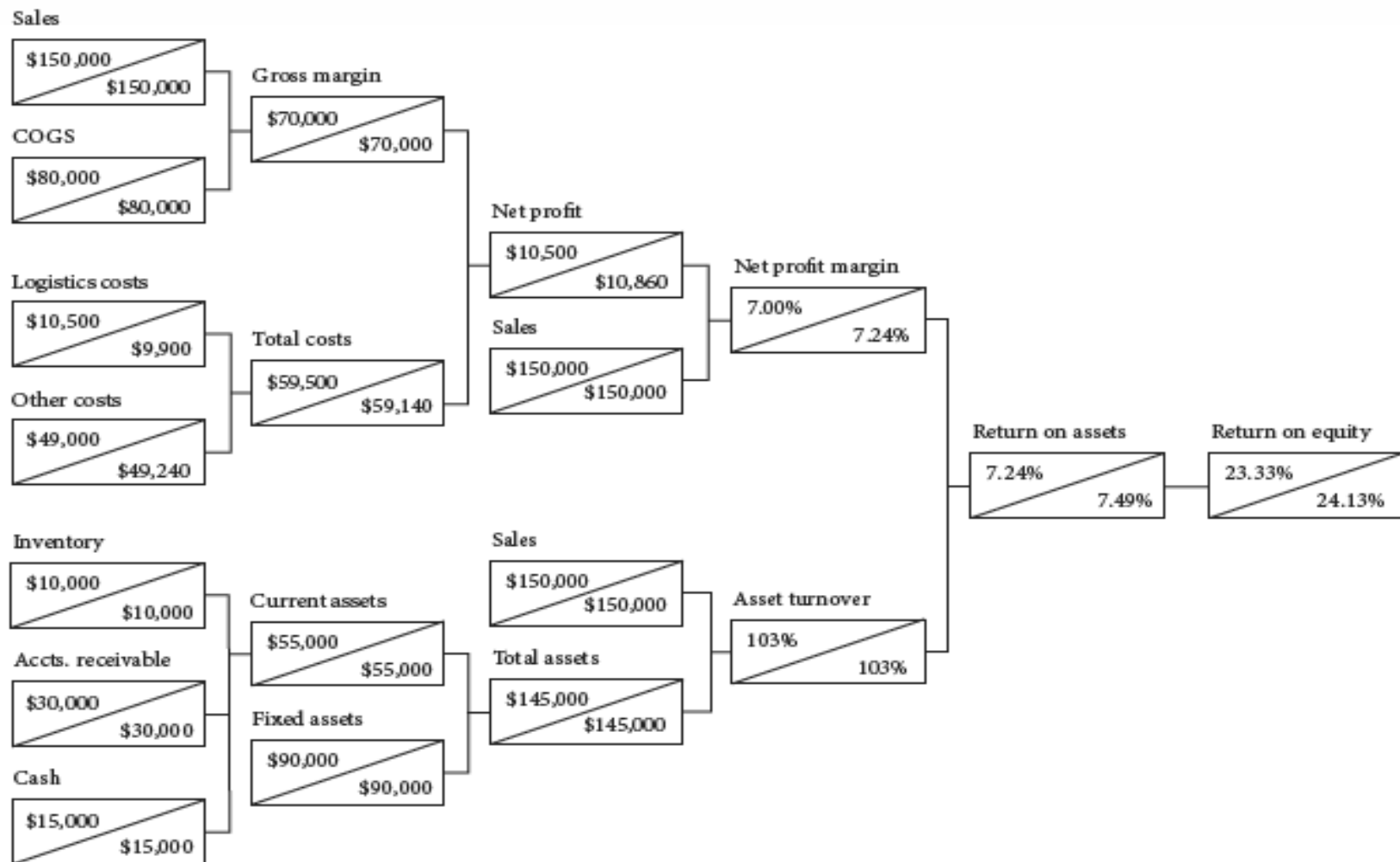
Figure 5.16

Impact of 10% Inventory Reduction

	SYMBOL	CLGN, 2010 \$(000)	AVERAGE INVENTORY REDUCED BY 10 PERCENT
Sales	<i>S</i>	\$150,000	\$150,000
Cost of goods sold	<i>CGS</i>	<u>80,000</u>	<u>80,000</u>
Gross margin	$GM = S - CGS$	\$ 70,000	\$ 70,000
Transportation	<i>TC</i>	\$ 6,000	\$ 6,000
Warehousing	<i>WC</i>	1,500	1,500
Inventory carrying	$IC = IN \times W$	3,000	2,700
Other operating cost	<i>OOC</i>	<u>30,000</u>	<u>30,000</u>
Total operating cost	<i>TOC</i>	\$ 40,500	\$ 40,200
Earnings before interest and taxes	<i>EBIT</i>	\$ 29,500	\$ 29,800
Interest	<i>INT</i>	\$ 12,000	\$ 12,000
Taxes	<i>TX</i>	<u>7,000</u>	<u>7,120</u>
Net income	<i>NI</i>	\$ 10,500	\$ 10,680
Asset Deployment			
Inventory	<i>IN</i>	\$ 10,000	\$ 9,000
Accounts receivable	<i>AR</i>	30,000	30,000
Cash	<i>CA</i>	15,000	15,000
Fixed assets	<i>FA</i>	<u>90,000</u>	<u>90,000</u>
Total assets	<i>TA</i>	\$145,000	\$144,000
Ratio Analysis			
Profit margin	<i>NI/S</i>	7.00%	7.12%
Return on assets	<i>NI/TA</i>	7.24%	7.42%
Inventory turns/year	<i>CGS/IN</i>	8.00	8.89
Transportation as percentage of sales	<i>TC/S</i>	4.00%	4.00%
Warehousing as percentage of sales	<i>WC/S</i>	1.00%	1.00%
Inventory carrying as percentage of sales	<i>IC/S</i>	2.00%	1.80%

Source: Edward J. Bardi, Ph.D.

Strategic Profit Model & Reduced Transportation Costs



Source: Edward J. Bardi, Ph.D.

Supply Chain Service Financial Implications

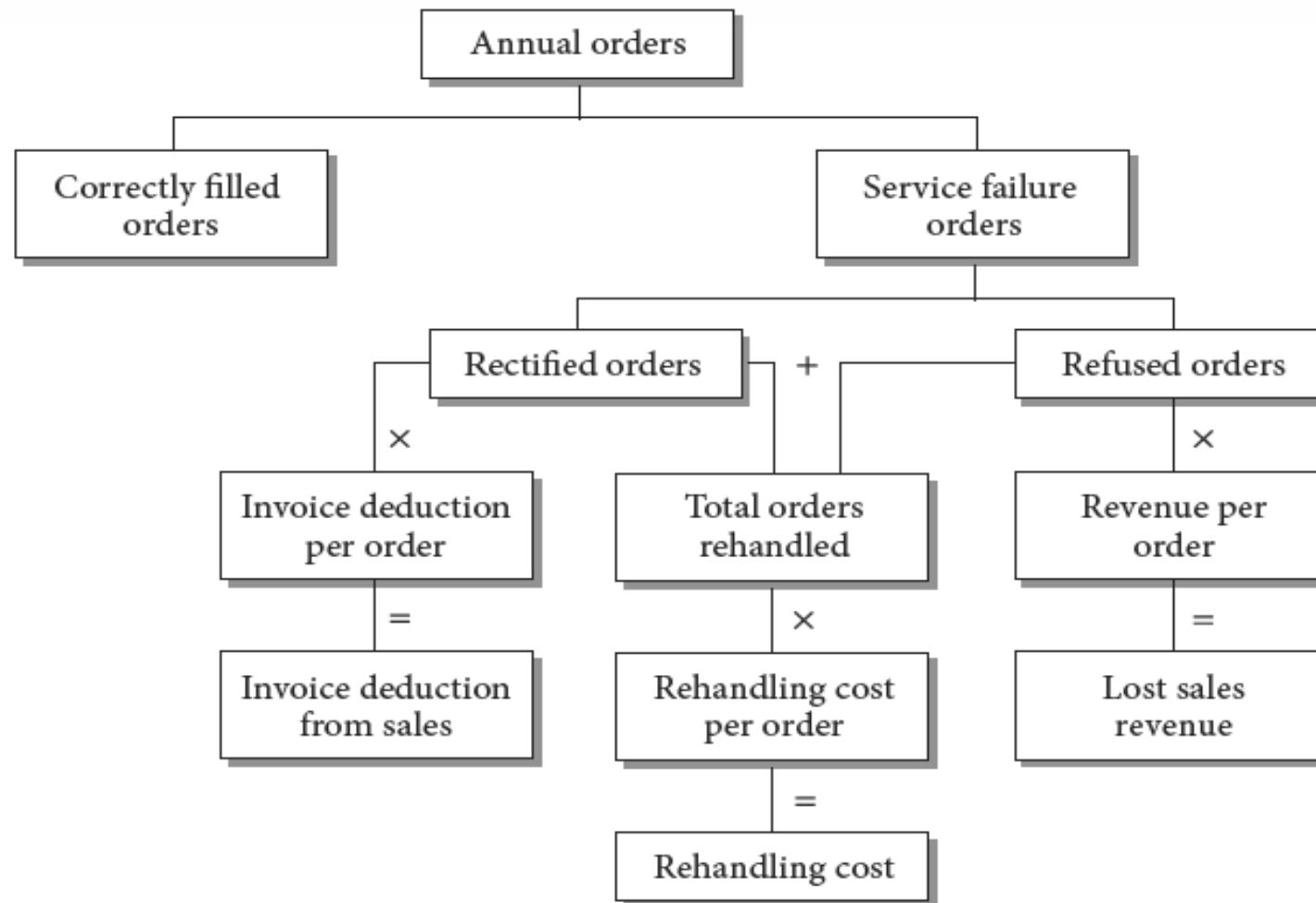
- The results of supply chain service failures are added to the cost to correct the problem and lost sales.
- When service failures occur, some customers experiencing the service failure will request that the orders be corrected and others will refuse the orders.
- The refused orders represent lost sales revenue that must be deducted from total sales..

Supply Chain Service Financial Implications, continued

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- For the rectified orders, the customers might request an invoice deduction to compensate them for any inconvenience or added costs.

Supply Chain Service Failure



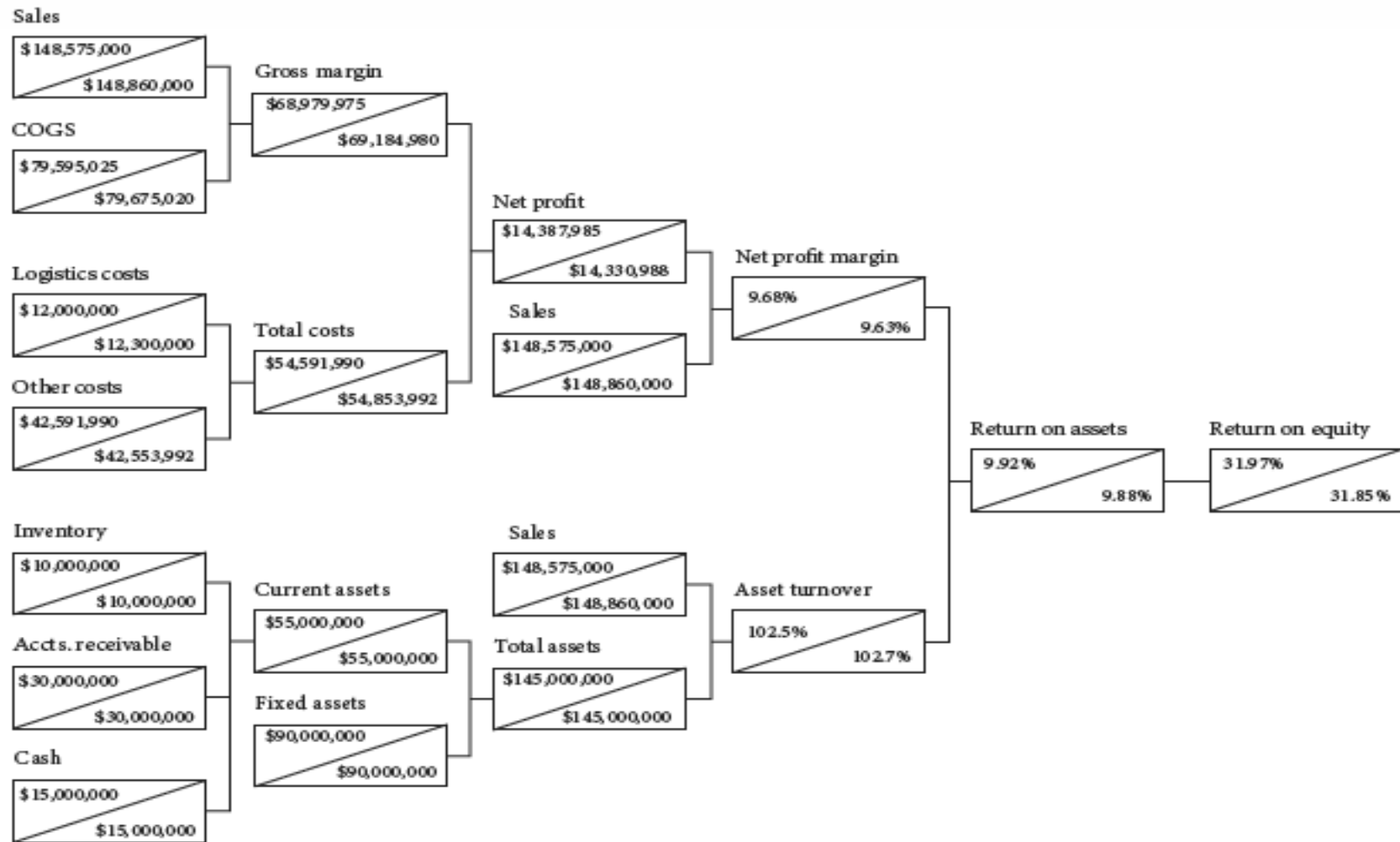
Source: Edward J. Bardi, Ph.D.

Financial Impact of Improving On-Time Delivery

	SYMBOL	ON-TIME RATE 55%	ON-TIME RATE 96%	INPUT DATA	95%	96%
Annual orders	AO	1,500,000	1,500,000	$\%CF$	95%	96%
Orders filled correctly	$OFC = AO \times \%CF$	1,425,000	1,440,000	Annual orders	1,500,000	1,500,000
Service failure orders	$SF = AO - OFC$	75,000	60,000	$SP = \text{Revenue/order}$	\$ 100	\$ 100
Lost sales orders	$LS = SF \times LSR$	7,500	6,000	$CG = \text{Cost of goods/order}$	\$ 53.33	\$ 53.33
Rectified orders	$RO = SF - LS$	67,500	54,000	Lost sales rate	10%	10%
Net orders sold	$NOS = AO - LS$	1,492,500	1,494,000	$RCD = \text{Rehandling cost/order}$	\$ 20	\$ 20
Sales	$S = SP \times AO$	\$150,000,000	\$150,000,000	$IDR = \text{Invoice deduction rate}$	\$ 10	\$ 10
Less: Invoice deduction	$ID = IDR \times RO$	\$ 675,000	\$ 540,000	Transportation cost	\$ 6,000,000	\$ 6,600,000
Lost sales revenue	$LSR = LS \times SP$	\$ 750,000	\$ 600,000	Warehousing cost	\$ 1,500,000	\$ 1,500,000
Net sales	$NS = S - ID - LSR$	\$148,575,000	\$148,860,000	Interest cost	\$ 3,000,000	\$ 3,000,000
Cost of goods sold	$CGS = CG \times (NOS)$	\$ 79,595,025	\$ 79,675,020	Other operating cost	\$30,000,000	\$30,000,000
Gross margin (GM)	$GM = NS - CGS$	\$ 68,979,975	\$ 69,184,980	Inventory	\$10,000,000	\$10,000,000
Rehandling cost	$RC = RCD \times SF$	\$ 1,500,000	\$ 1,200,000	Cash	\$15,000,000	\$15,000,000
Transportation	TC	\$ 6,000,000	\$ 6,600,000	Accounts receivable	\$30,000,000	\$30,000,000
Warehousing	WC	\$ 1,500,000	\$ 1,500,000	Fixed assets	\$90,000,000	\$90,000,000
Inventory carrying	$IC = IN \times W$	\$ 3,000,000	\$ 3,000,000	$W = \text{Inventory carrying rate}$	30%	30%
Other operating cost	OOC	\$ 30,000,000	\$ 30,000,000			
Total operating cost	TOC	\$ 42,000,000	\$ 42,300			
Earnings before interest and taxes	$EBIT = GM - TOC$	\$ 26,979,975	\$ 26,884,980			
Interest	INT	\$ 3,000,000	\$ 3,000,000			
Tax (40% × (EBIT - INT))	TX	\$ 9,591,990	\$ 9,553,992			
Net income	$NI = EBIT - INT - TX$	\$ 14,387,985	\$ 14,330,988			
Profit increase of 1% improvement						(\$56,997)

Source: Edward J. Bardi, Ph.D.

Strategic Profit Model & On-Time Delivery Improvement



Source: Edward J. Bardi, Ph.D.

Summary

- Performance measurement for logistics systems and, especially, for supply chains is necessary but challenging because of their complexity and scope.
- Certain objectives should be incorporated into good metrics – be quantitative, be easy to understand, involve employee input, and have economies of effort.
- Important guidelines for metric development for logistics and supply chains include consistency with corporate strategy, focus on customer needs, careful selection and prioritization of metrics, focus on processes, use of a balance approach, and use of technology to improve measurement effectiveness.

Summary, continued

- There are four principal categories for performance metrics: time, quality, cost, and miscellaneous or support. Another classification for logistics and supply chains suggests the following categories for metrics: operations cost, service, revenue or value, and channel satisfaction.
- The equivalent sales increase for supply chain cost saving is found by dividing the cost saving by the organization's profit margin.
- Supply chain management impacts ROA via decisions regarding channel structure management, inventory management, order management, and transportation management. be analyzed using the SPM.

Summary, continued

- Alternative supply chain decisions should be made in light of the financial implications to net income, ROA, and ROE.
- The SPM shows the relationship of sales, costs, assets, and equity; it can trace the financial impact of a change in any one of these financial elements.
- Supply chain service failures result in lost sales and re-handling costs. The financial impact of modifications to supply chain service can be analyzed using the SPM.

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- Basic reading
 - Christopher, M. (2011), *Logistics and Supply chain management*, 4th Edition, Pearson, Chapters 3.