PURDUE UNIVERSITY

MANUFACTURING EXTENSION PARTNERSHIP

WIRE HARNESS MANUFACTURING ASSOCIATION

An Overview of Total Cost Ownership (TCO)

Purdue Manufacturing Extension Partnership
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MANUFACTURING EXTENSION PARTNERSHIP
National Network

About the Instructor

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- Background:
  - Roles included plant superintendent, manufacturing supervisor, quality manager, quality auditor
  - Knowledge of safety, manufacturing, assembly, process improvement, project management, maintenance, supply chain management, inspection and metrology

About Purdue MEP

- **Who we are:** Purdue Manufacturing Extension Partnership (MEP)
  - Division of Purdue Technical Assistance Program.
  - Our staff consists of experts from a wide variety of business and manufacturing sectors.
- **What we do:**
  - We work exclusively with Indiana businesses, **primarily manufacturers**, to maximize performance through **streamlined processes, increased profitability, and increased competitiveness.**
  - We offer public workshops, on-site training, and consulting services.
  - Through these services Purdue MEP clients report **new sales, product and market growth, cost reductions, and job growth.**

TOTAL COST OF OWNERSHIP (TCO)

Using TCO to make strategic sourcing decisions

MEP Supply Chain OPTIMIZATION

The MEP Network

MEP • MANUFACTURING EXTENSION PARTNERSHIP

The National Institute of Standards and Technology's Manufacturing Extension Partnership (MEP) Centers

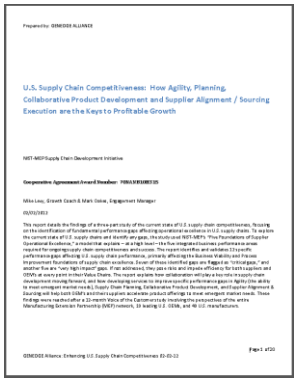
MEP Supply Chain OPTIMIZATION

MEP Supply Chain Optimization

Voice of the Customer Survey Results

Critical

1. **Better Total Cost of Ownership decisions**
2. Increase effectiveness of ERP/MRP
3. Mitigate global risks
4. Reduce/manage volatility
5. Expand supplier matching capabilities to source for emergent needs
6. Improve OEM/Supplier product development collaboration



U.S. Supply Chain Competitiveness Study

Highly Important

7. Document supply chain strategy
8. Align supply chain metrics with long-term business focus
9. Identify and address choke points in a sustainable manner
10. Optimization of supply chain
11. Recognize the emergent needs for future capabilities and technology
12. Enhance value chain collaboration among suppliers, OEMs and customers

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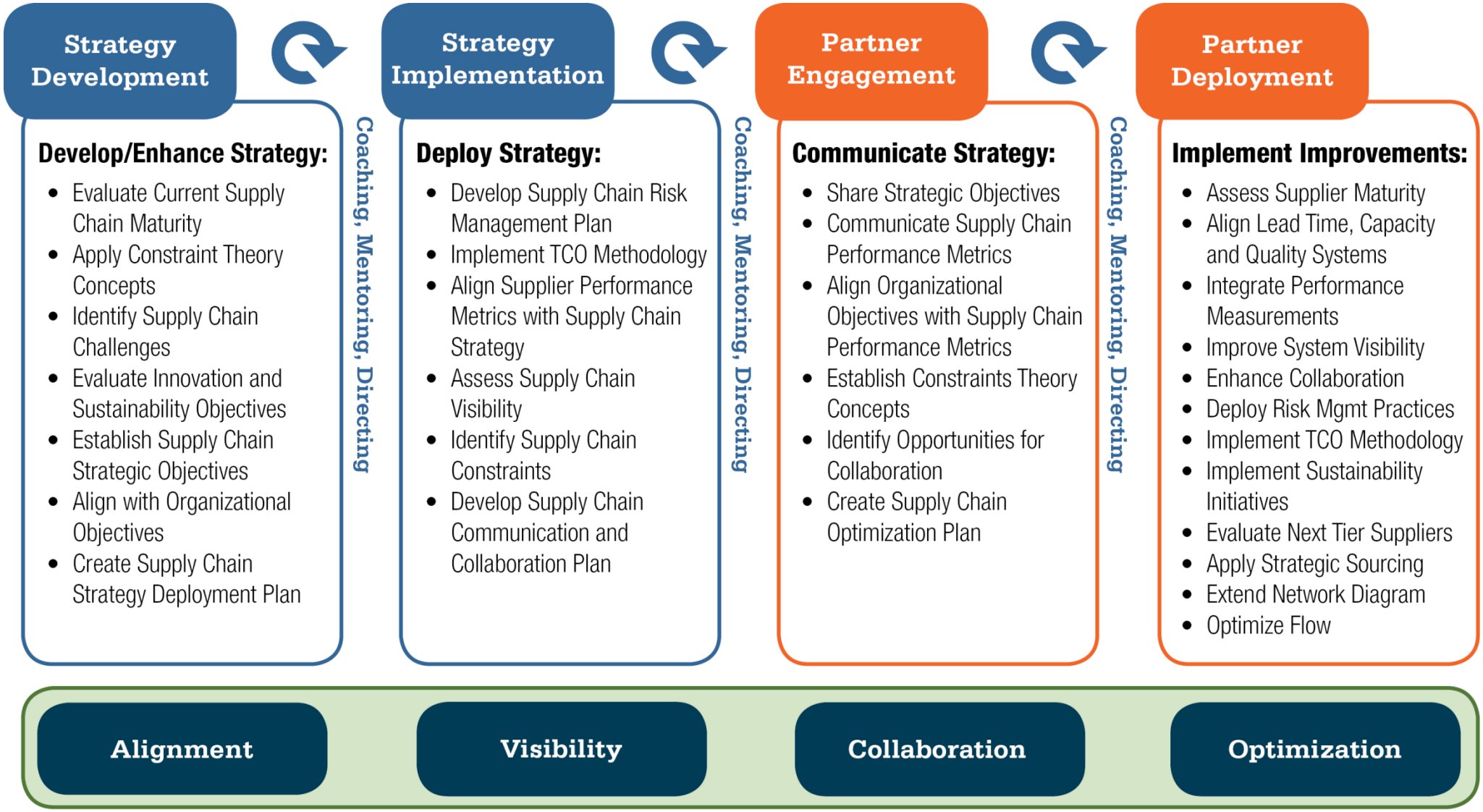
Supply Chain Optimization Roadmap



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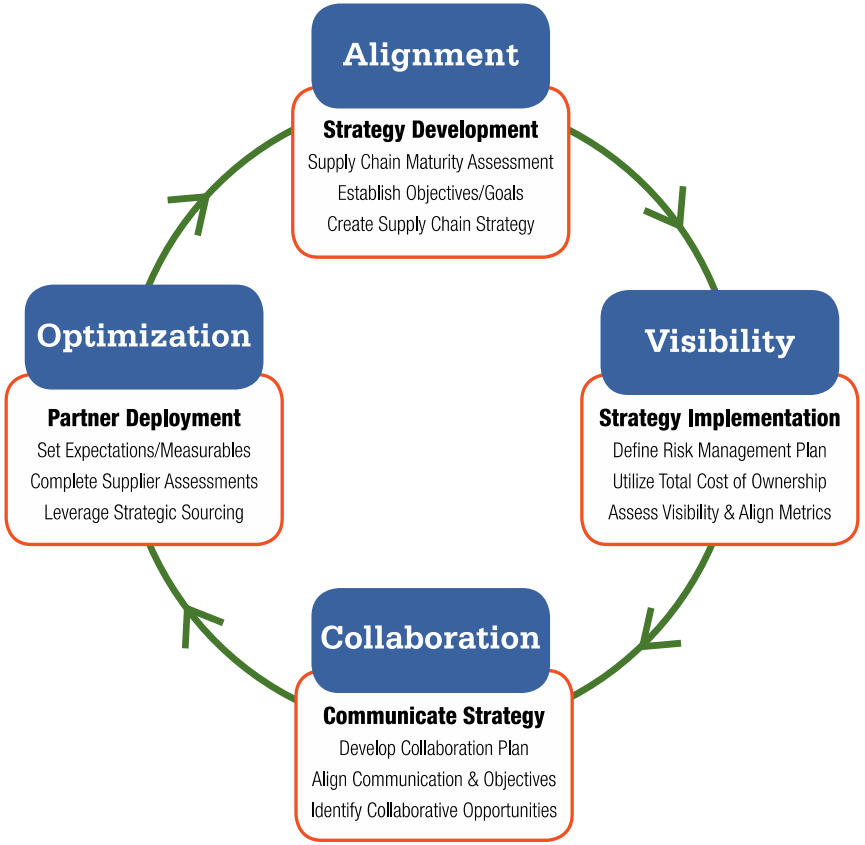
Competitive Edge

Competition is no longer between companies, it's between supply chains. The volatile economy means that manufacturers have to be much more agile, flexible, and responsive to external pressures.

Those with optimized supply chains experience benefits like:

- Lower Costs
- Better Delivery
- Increased Quality
- A Competitive Edge



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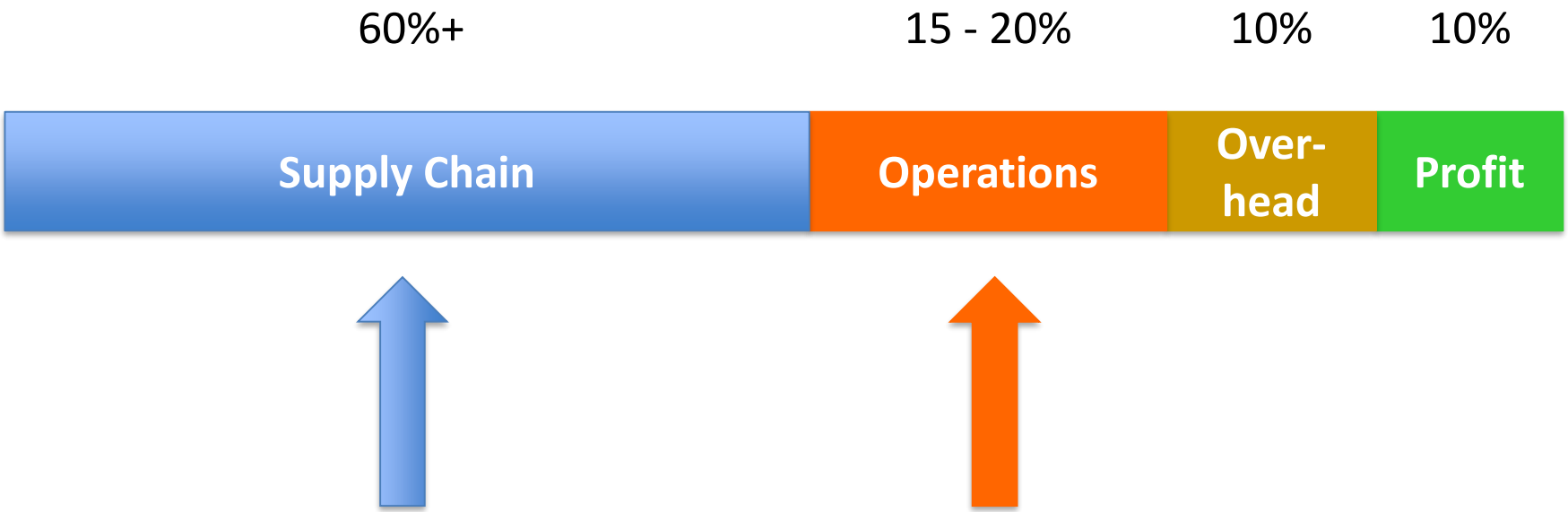
Why Supply Chain Optimization?



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Workshop Objectives

- What is Total Cost of Ownership and how does an accurate calculation assist my procurement department to function more effectively?
- How do I identify the elements of TCO that affect each product I sell and each supplier that I have or am considering?
- How do I use the cost elements to assist in ongoing performance evaluations of my supply chain?
- Looking at Make vs Buy decisions from a Manufactures point of view?

TCO Introduction

What is “Total Cost of Ownership” (TCO)?

- Definition
  - The sum of all visible and hidden costs associated with the acquisition, transportation, storage, finance, transactions, and environmental impacts of every activity of the supply chain

Supply Chain Costs

Supply Chain Costs as a Percent of Sales *

Industry	% Purchased
All industry	52
Automobile	67
Food	60
Lumber	61
Paper	55
Petroleum	79
Transportation	62

*(APICS study 2009)

In efforts to continuously improve the TCO, the bottom line improves significantly

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What is the Total Cost of Ownership?

Chances are your actual Supply Chain costs are greater than you think…

Surveys indicate that Supply Chain total cost of ownership can be *20% higher than piece part price*.

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Our Goal - Strategic Sourcing

A systematic and fact-based approach for optimizing an organization's supply base and improving the overall value proposition.

What it is	What it is NOT
Focused on the Total Cost of Ownership (TCO) incorporating customer needs, organizational goals, and market conditions	Focused ONLY on cost
Getting the best product/service at the best value	Getting the cheapest product/service
Driven by a rigorous and collaborative approach	Ad-hoc activities involving only purchasing
Addresses all levers for savings	Focused on “beating up suppliers”
Decisions based on fact based analysis and market intelligence	Decisions on opinion, unjustified preference, or complacency
A continuous process	A one-time project or decision

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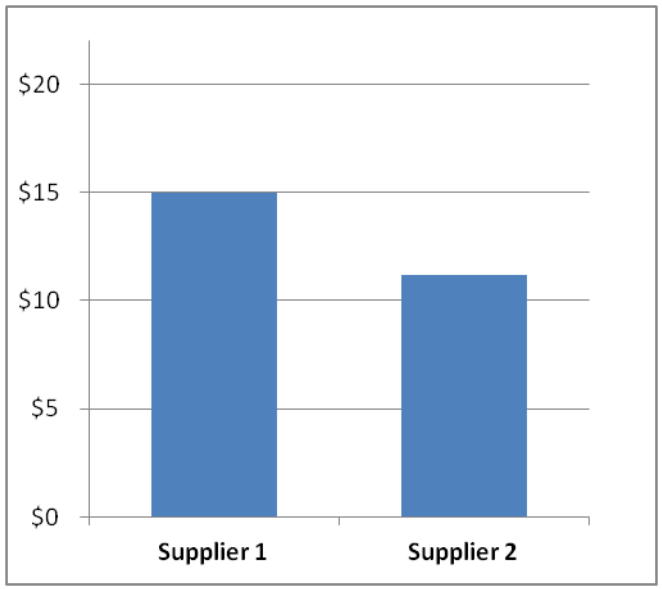
Benefits of Using TCO in Strategic Sourcing

Provides knowledge of both visible and hidden costs, to:

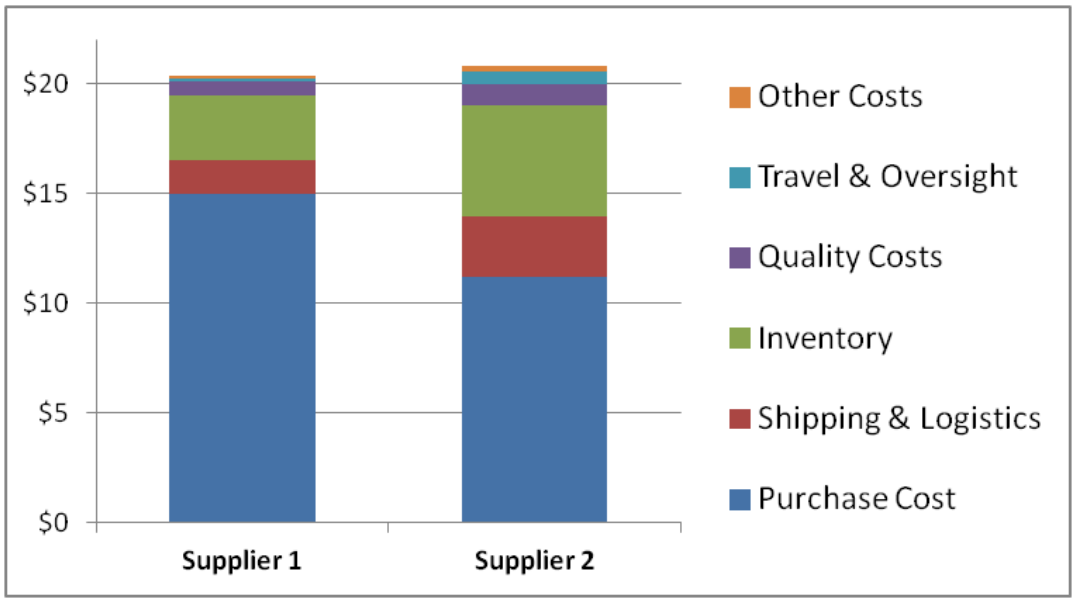
- Allow comparison of acquisition with other supporting and investment costs
- Allow better operating and financial trade-off decisions
- Provide an assessment of ecological and social costs
- Understand the true cost of sourcing decisions

“Traditional” vs. TCO Cost Comparison

Purchase Cost Only



Total Cost of Ownership



TCO Provides a More Complete & Competitive Measurement of Both Direct *and* Indirect Acquisition Costs

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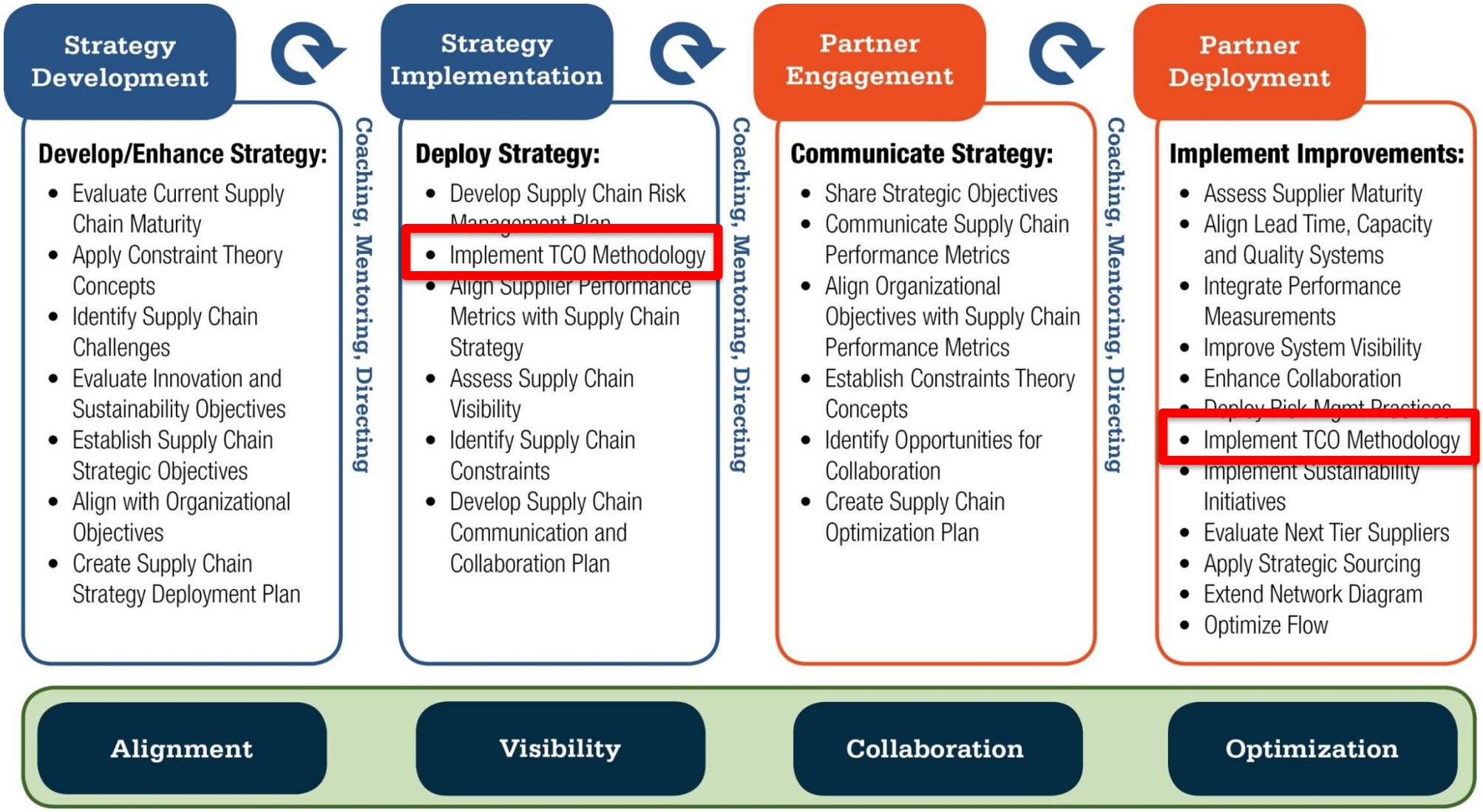
TCO is just a part of SC Optimization



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Questions about Strategic Sourcing Direction

- Multiple sourcing?
- Proximity sourcing?
- Make vs. Buy decisions?
- Make to Order vs. Make to Stock (MTO vs. MTS)?
- Purchase quantities? Buffer sizing?
- Direct buy from supplier or distribution center, VMI?

Informed decisions require an understanding of the supply chain

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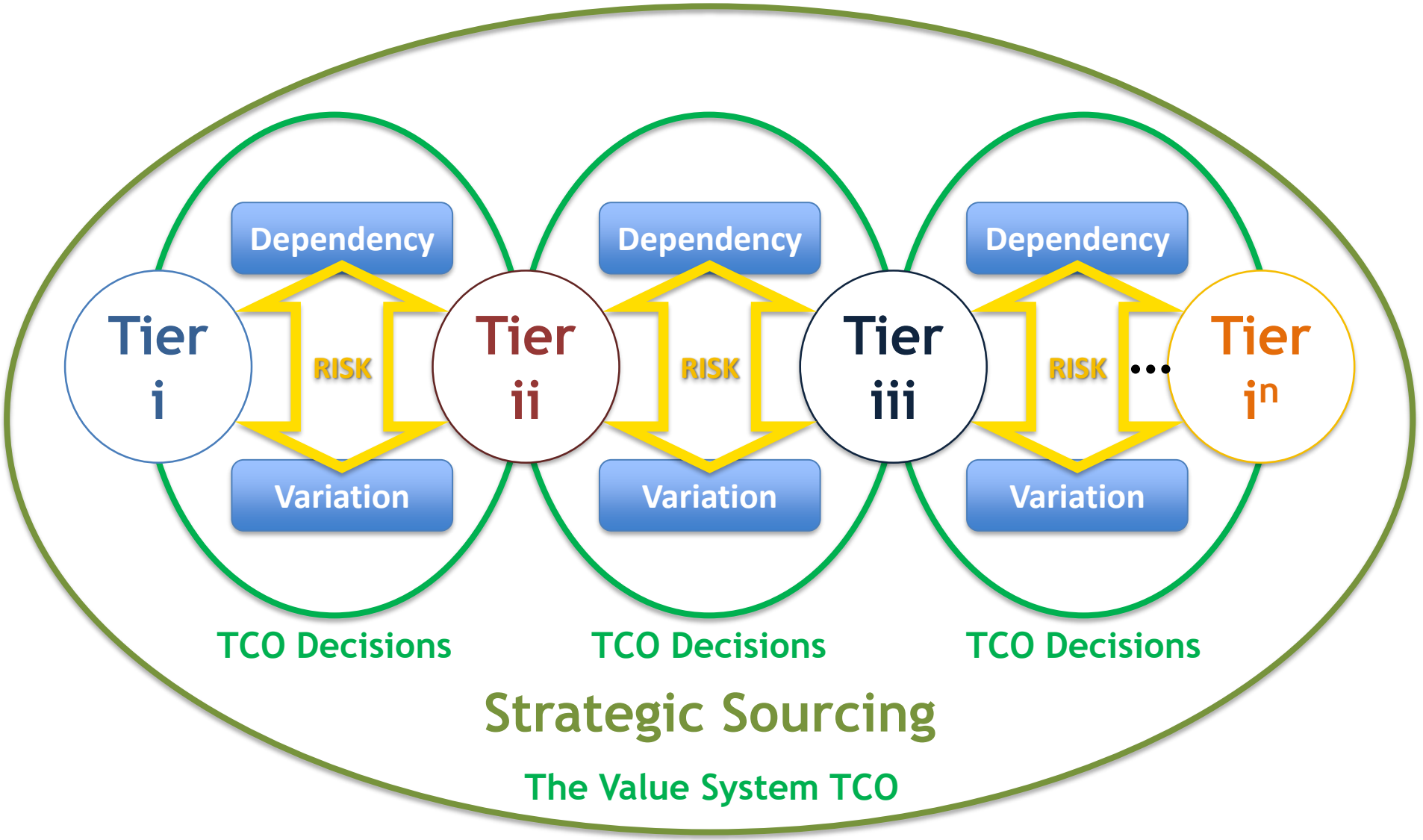
Supply Chain Dynamics

Dependency, Variation, Risk and TCO



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Experiencing the Effects of System Dynamics

Realities of "The Chain"

- The existence of ***dependent events*** and the resulting interactions between resources (our capacity to supply) and products (our demand)

- The occurrence of ***statistical fluctuations*** and random events within every manufacturing environment

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Supply Chain Dependencies

Dependencies link together the processes and functions in the supply chain

Characterized by event-outcome relationships

- May be sequential or separated by several steps
- Outcomes may be predicted or unforeseen
- Unforeseen outcomes create vulnerabilities in the supply chain

Common Dependencies

- Material use/availability
- Quality/design
- Infrastructure support

Dependencies: Bottlenecks and Constraints

Bottleneck

Anything that has less capacity than is demanded of it

Limits the flow **locally**

Constraint

Anything that has less capacity than the system requirements

Limits performance of **entire system** relative to goal

A system may have multiple bottlenecks, but only one constraint

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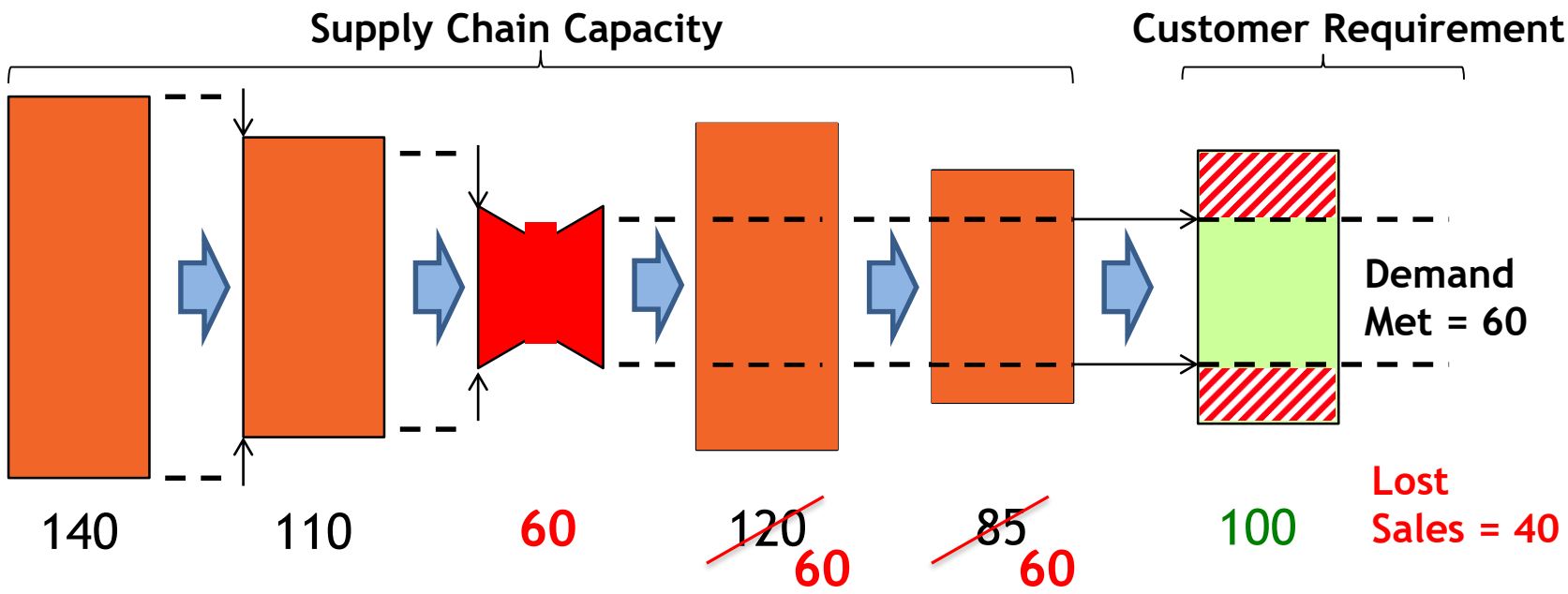
Dependencies: A Supply Chain Constraint



- The Constraint limits the performance *of a system* relative to its goal
- Only one constraint – it controls system output
- Common Constraint Categories
  - Process/ Physical Resources
  - Policy/Paradigms
  - People
  - The Market

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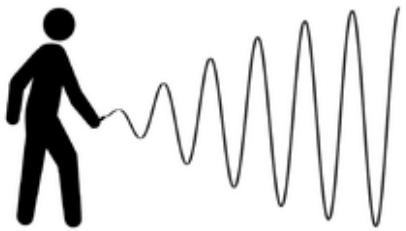
Supply Chain Variation

- Impacts quality and level of supply chain output and performance
- Sources of Variation
  - Statistical variation
  - Random events
  - The bullwhip effect
- Stable output requires minimizing and/or mitigating variation
  - Improved SC visibility
  - Improved process capability
  - Resource buffers

Variation: The Bullwhip Effect

The bullwhip effect is the tendency of order rates to increase as they pass through tiers of a supply chain towards producers and raw materials suppliers.

Bullwhip creates unstable production schedules, causing a range of unnecessary costs in supply chains.



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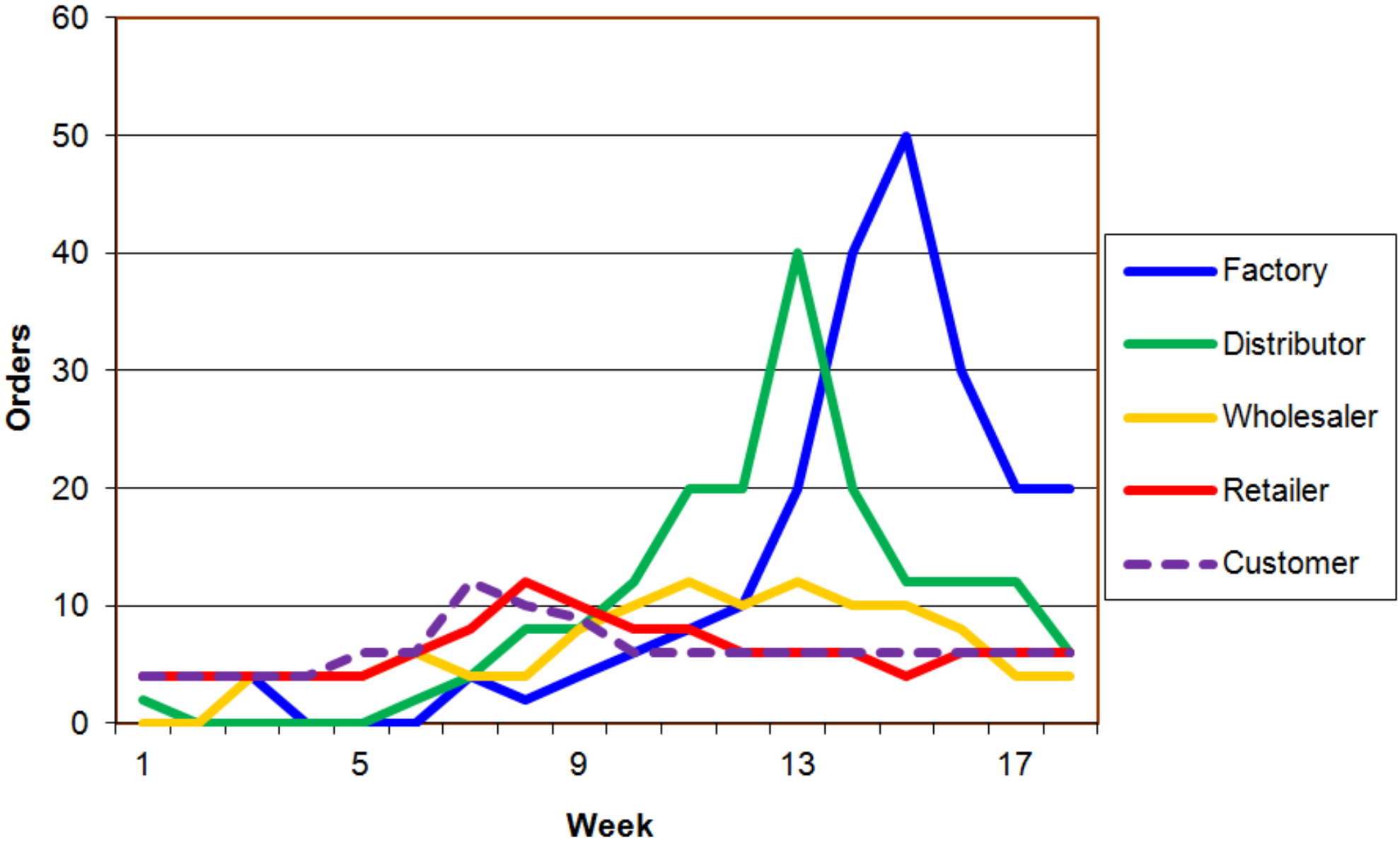
“Bullwhip Effect” on Order Placement



The Bullwhip Effect is also called Demand Amplification

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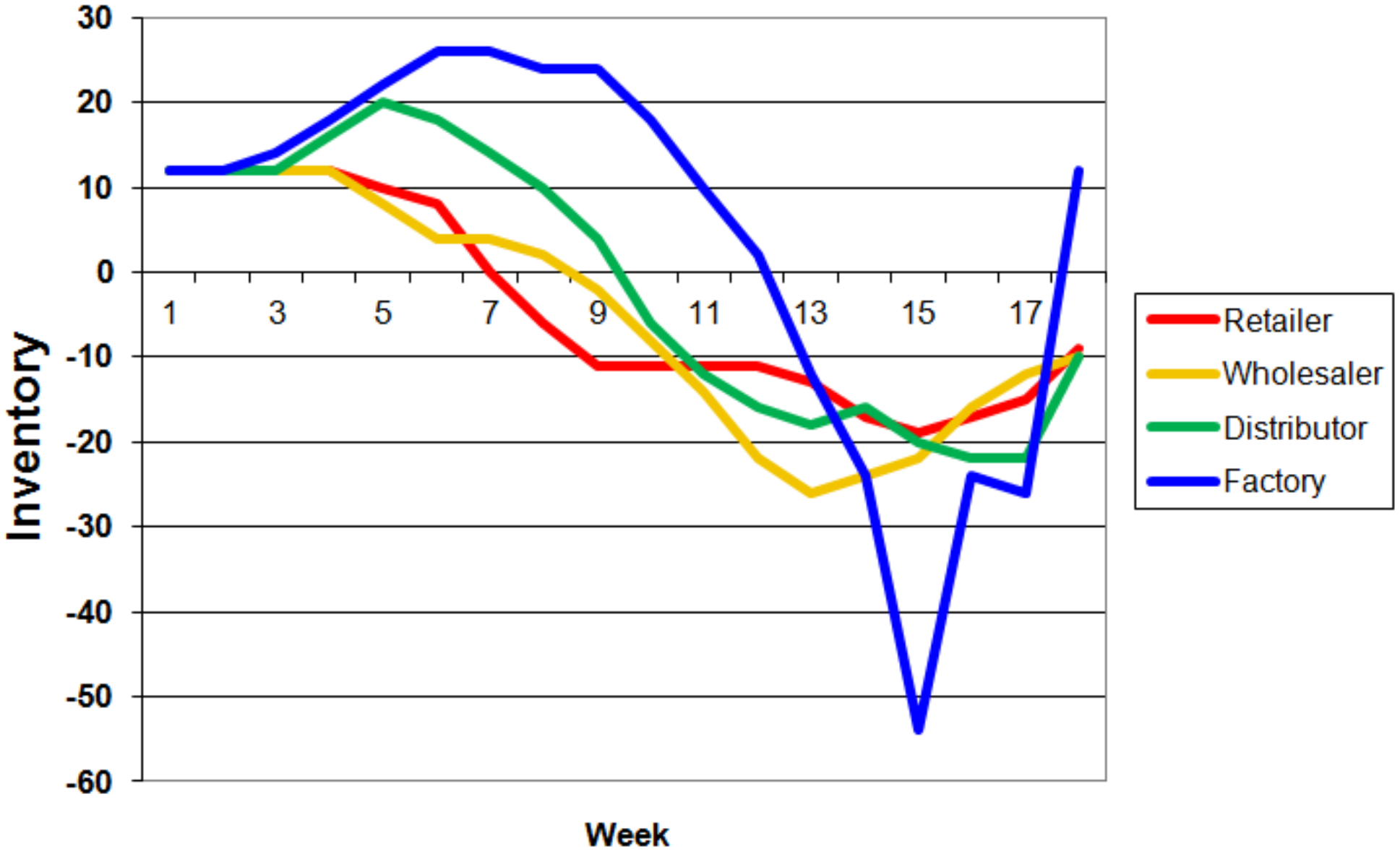
“Bullwhip Effect” on Inventory Levels



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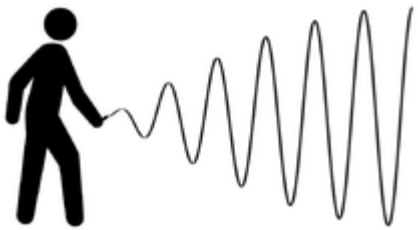
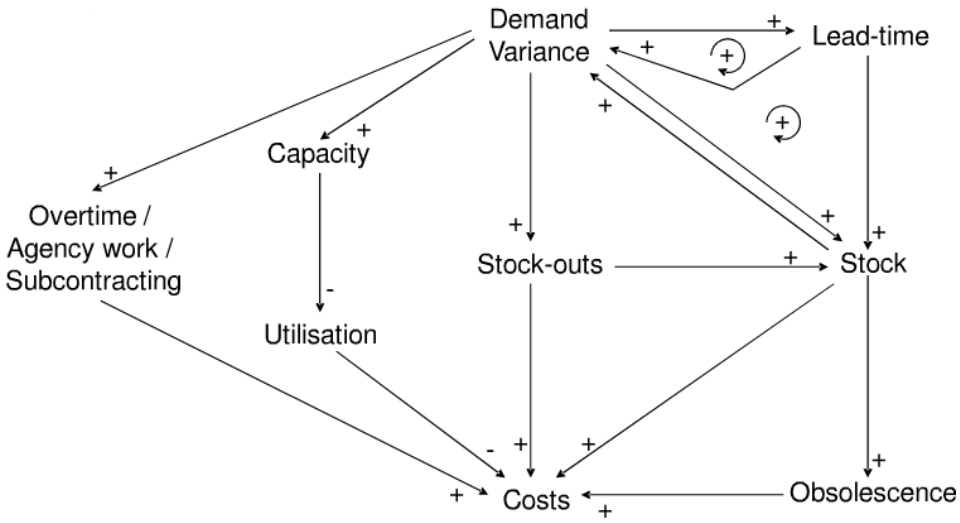
Bullwhip Effect Problems

- Can drive high inventory levels and low service levels (back orders)
- Creates higher costs and greater risks!
  - Inventory carrying costs/Stockout costs
  - Obsolesce/spoilage risk
  - Labor costs (overtime; supplemental workforce)
  - Excess capacity/capital investment
  - Reduced agility





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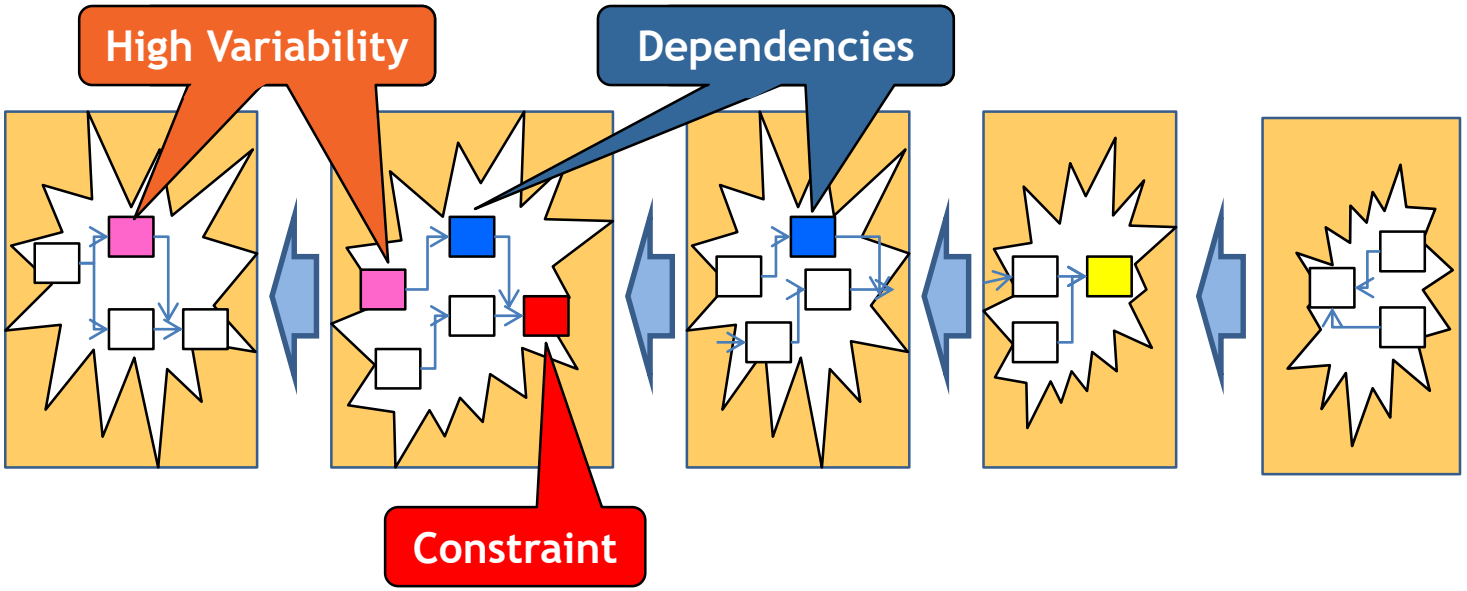
Factors Contributing to Bullwhip Effect

1. **Demand forecasting**
   - Usage of aggregate and thus inaccurate data does not allow for good predictions
   - High variability leads to continuous adaptations of order policies and thus increases variability upstream
2. **Lead time**
   - High lead time creates uncertainty
   - Requires high safety stock levels
   - Reduces flexibility and adaptability to unforeseen changes in demand

Factors Contributing to Bullwhip Effect

3. **Batch ordering**
   - Batch ordering at one stage in SC leads to observing high variability at next stage upstream:
4. **Price fluctuation**
   - Stock up when prices are lower → large orders
   - Promotions and discounts
5. **Rationing and shortage gaming**
   - If product demand exceeds supply, a manufacturer may ration its products. Customers, in turn, may exaggerate their orders to counteract the rationing.

Identifying Dependency and Variation



- Mapping provides an analytical framework for examining supplier-customer relationships and interactions
- Aids in the identification of bottlenecks, constraints, dependencies, and improvement opportunities

TCO Concepts & Categories

Traditional Cost Control Metrics vs. TCO Cost Elements

Traditional: **Purchase Part Price/Piece Part Variance**

Piece Part Variance is the difference in price between the amount paid to the supplier and the planned or standard cost of that item.

TCO: Evaluates **Visible and Hidden Elements**

Considering additional cost elements will reveal the true cost of purchased items and is a more accurate measure of procurement performance.

Components of TCO

Ref: URL: http://acetool.commerce.gov/overview

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Shipping/Freight Costs

- Carriers Involved – direct freight charges
- Loading/Unloading – cost and responsibility
- Transfer/cartage between carriers – existing infrastructure, i.e., security & reliability
- Storage/warehousing between carriers
- Shipping Time
- Regulatory/Inspection costs and delays

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Trade Financing Costs

This is different from inventory/purchasing costs

- Reflects costs associated with financial instruments such as Letters of Credit (LOC)
- Additional customs brokerage and other fees
- Involves financial currency exchange rates
- Costs of hedging against currency fluctuations (buying positions in foreign currency)

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Inventory Carrying/Holding Costs

Increased Holding Costs caused by:

- Stored inventory – Cost of capital, insurance, taxes, obsolescence, administrative demands.
- Alternate or second-source suppliers to ensure reliability of supply.
- Inventory which may be in transit for weeks, plus regulatory delays.

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Quality Costs

Unforeseen or uncontrolled problems within the supply chain due to lack of management of a supplier may lead to:

- Lower product quality – unhappy customers
- Potentially costly product returns/shortages
- Possible legal liability
- Lack of flexibility to respond to customer needs
- Inability of supplier to meet certification, safety or other regulatory issues
- Increase in oversight costs to resolve

Oversight

Travel to supplier sites:

- Supplier selection and management
- Develop or strengthen supplier relationships
- Oversee design, production, or shipping
- Resolve unforeseen issues like supply chain disruptions or production errors

Travel Frequency and costs increase greatly as the distance to the supplier becomes greater – particularly overseas

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Regulatory Compliance

There can be additional costs to ensure compliance with:

- U.S. regulations on the importation of goods
- Foreign regulations on all aspects of business when operating abroad

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Intellectual Property

Do your products involve patents or trademarks?

Infringement may have significant cost impacts, such as:

- Loss of market share
- High legal costs
- Design control
- Compromising of strategic national interests

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Political/Security Risk Assessment

The other categories have certain inherent risks. This will cover those not found and discussed elsewhere. These include:

- Transfer risk (Capital Controls = Transfer of Money)
- Security Risks (War and Crime)
- Natural Disasters
- Labor and Infrastructure Stability
- Restrictions on Natural Resources
- Accidental loss in transit

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Other Inputs

- Energy Cost variations at different supplier locations
- Availability of skilled workforce
- Support services – design, engineering, prototyping
- Strategic Nature of products being sources
- “Business Friendly” political climate

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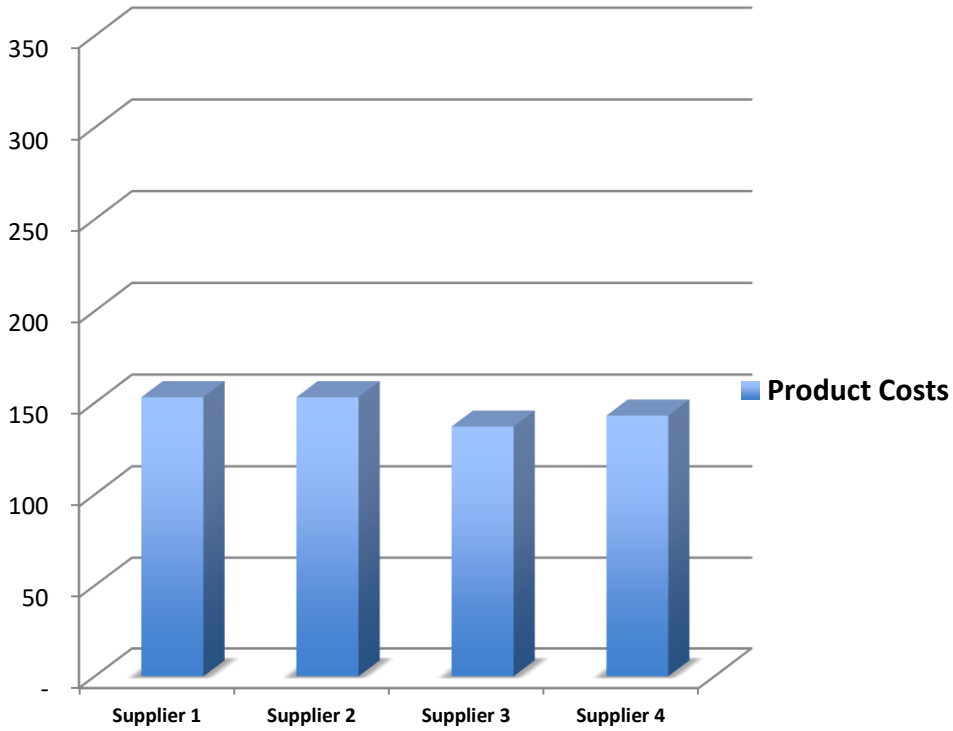
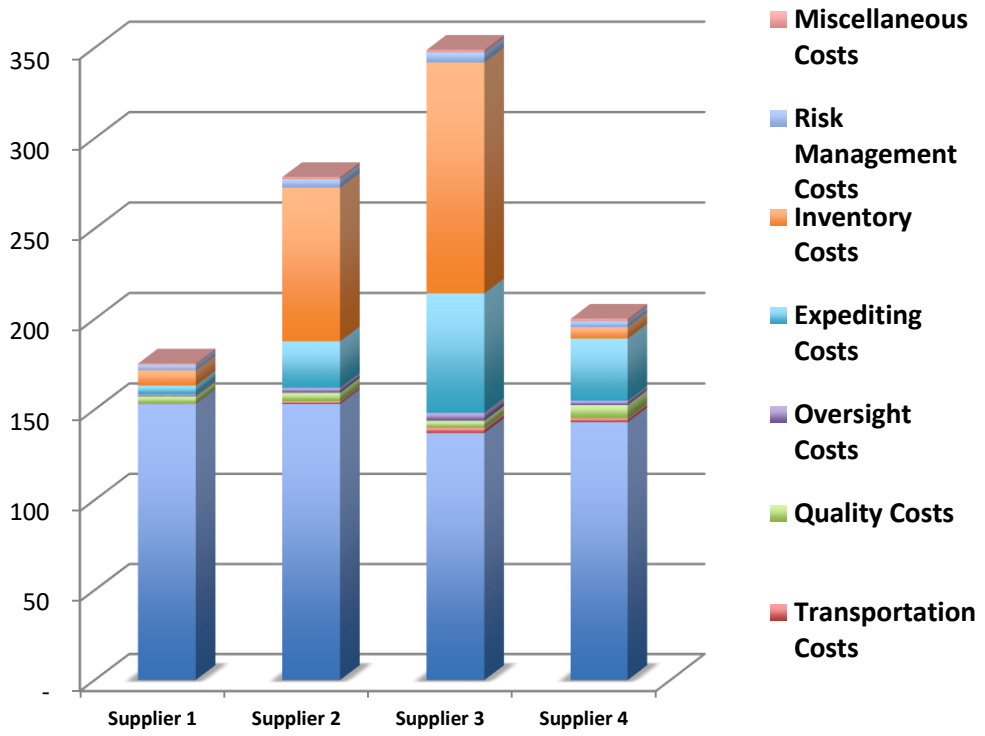
“Traditional” vs. TCO Cost Comparison

Purchase Cost Only



Total Cost of Ownership



TCO Provides a More Complete & Competitive Measurement of Acquisition Costs

The TCO Calculator allows for comparisons of up to 4 scenarios at a time

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TCO Calculator Basics

About the TCO Calculator

- The TCO Calculator runs in Microsoft Excel, utilizing macros. Excel was chosen over an online tool to safeguard sensitive customer information.
- It is a tool which can be used to assist in making side-by-side comparisons of the true cost of acquiring a product from different sources.
- The TCO Calculator provides an estimate of cost by considering up to 56 data inputs in 8 sourcing categories for up to 4 suppliers at a time.
- To keep complexity manageable, the calculator does *not* cover all possible scenarios.

Do I need to have ALL of that data?

- The more data you have the better your output will be - the output will be based on the information that is entered.
- It seems like there is a lot of data required for the TCO Calculator because we are used to dealing only with piece part price and variance.

TCO Calculator, Excel, and Macros

- The TCO Calculator is a Microsoft Excel program that runs using macros
  - Microsoft Office Macros are Visual Basic for Applications (VBA) code saved inside a document
  - Macros need to be “enabled” to run the Calculator
  - Other Excel worksheets should be saved and closed prior to running the TCO Calculator
  - You may not be able to access other workbooks while using the TCO Calculator

The Data Collection Form

TCO Calculator Data Collection Form

	Company Information	
	Date	
	Company/Division/Location/Cost Center	
	List/Record the person(s) name and contact information who have knowledge of or have completed the following sections. This is for your reference.	
	Product Information POC	
	Demand Information POC	
	Vendor Information POC	
	Shipping Information POC	
	Vendor Leadtime Information POC	
	Transportation Information POC	
	Inventory Information POC	
	Expediting Information POC	
	Oversight Information POC	
	Risk Management Information POC	
	Additional/Miscellaneous Information POC	

	Product Information	
1	Product Identification Number	
	Enter your product ID# - This is for your reference only and it is not used in TCO calculations	
2	Product Description	
	Enter a short description or product name - this is for your reference only and it is not used in TCO calculations	

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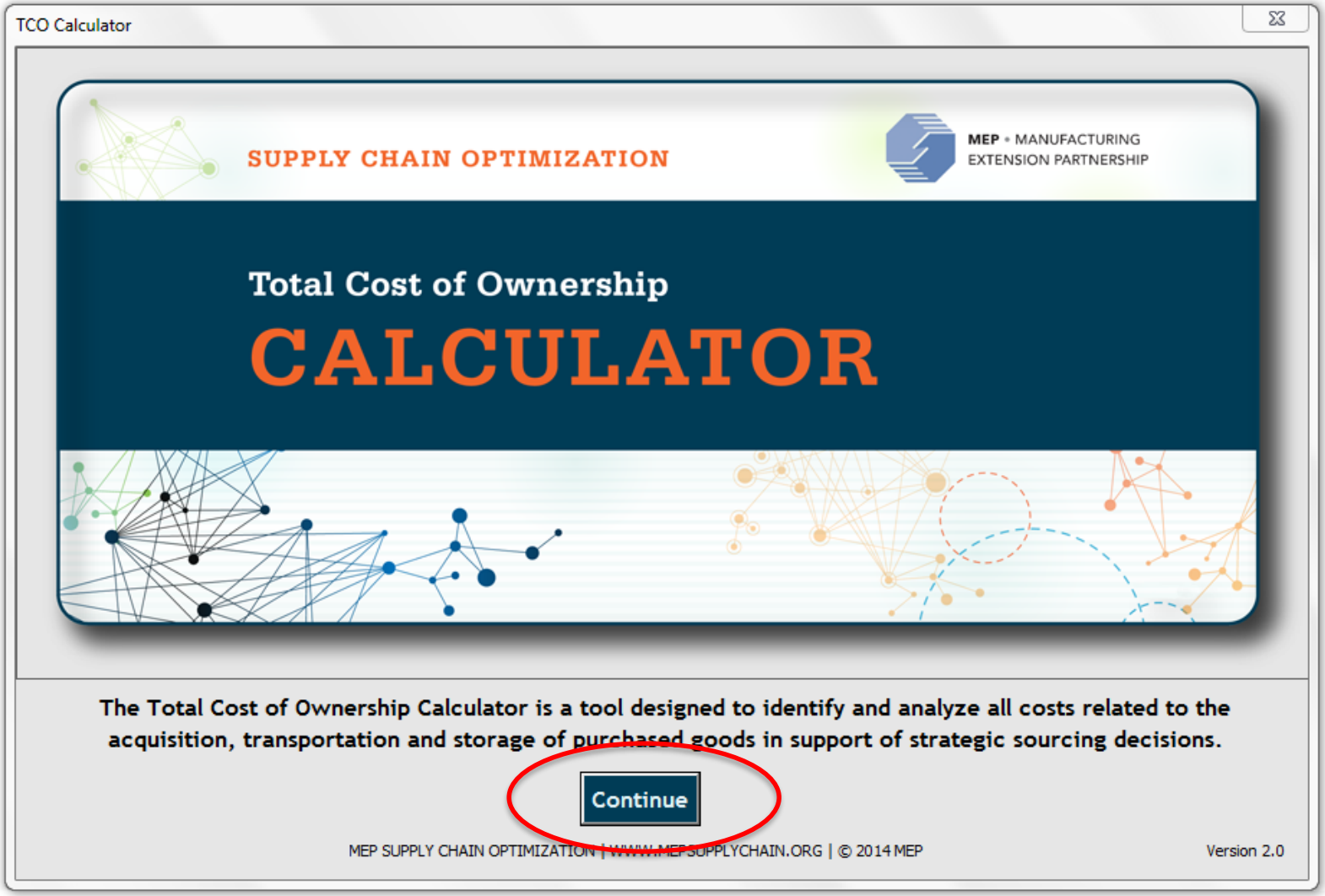
TCO Calculator Tool - Data Entry Structure

- Up to 81 separate data elements (56 user supplied) facilitate the TCO calculations and generate the output for review.
- The TCO Menu Screen allows selecting categories individually for ease of entering and modifying input values.
- An Input Form can be used to gather and record data.

Start-Up Screen



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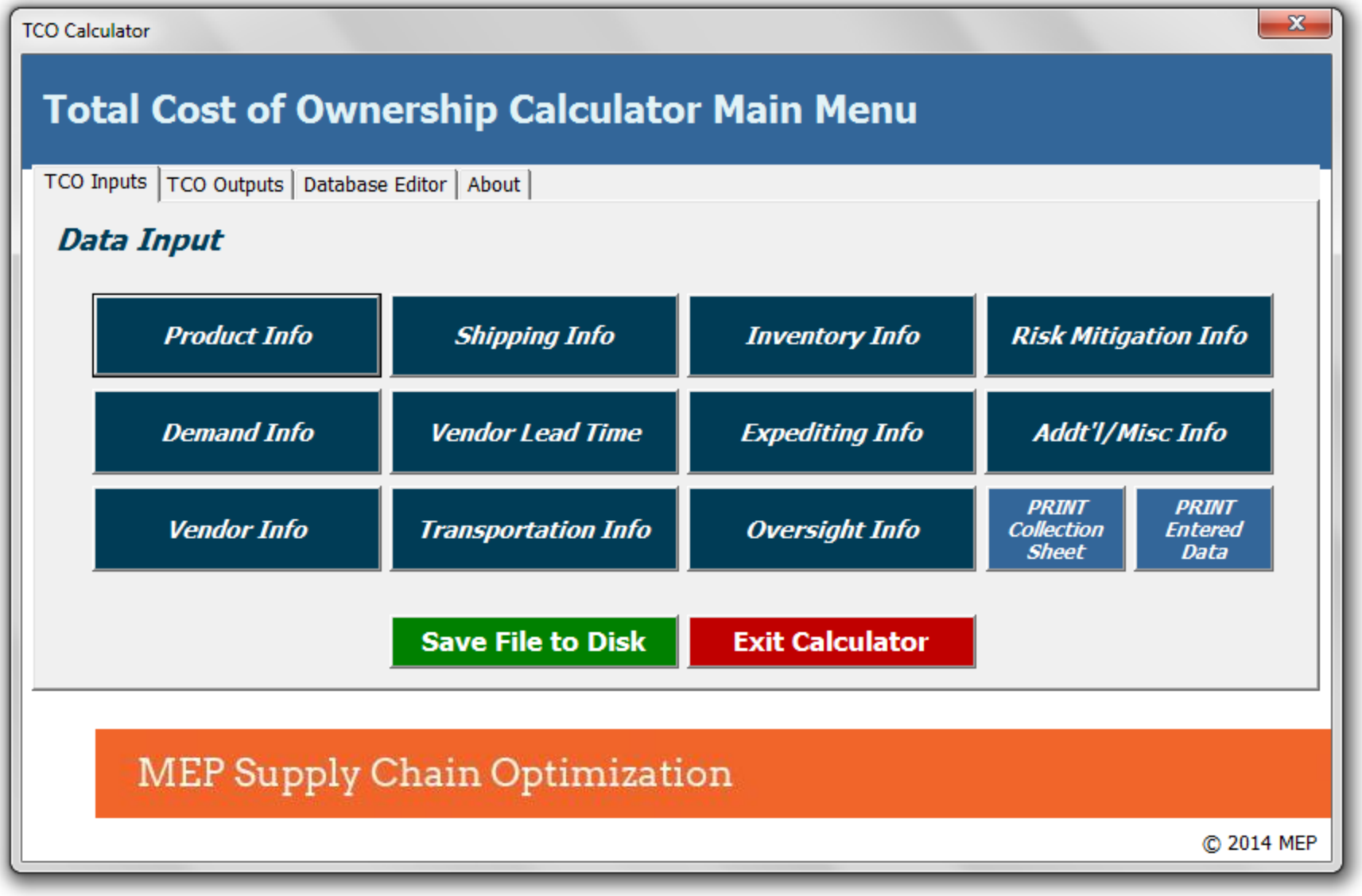
The Main Menu



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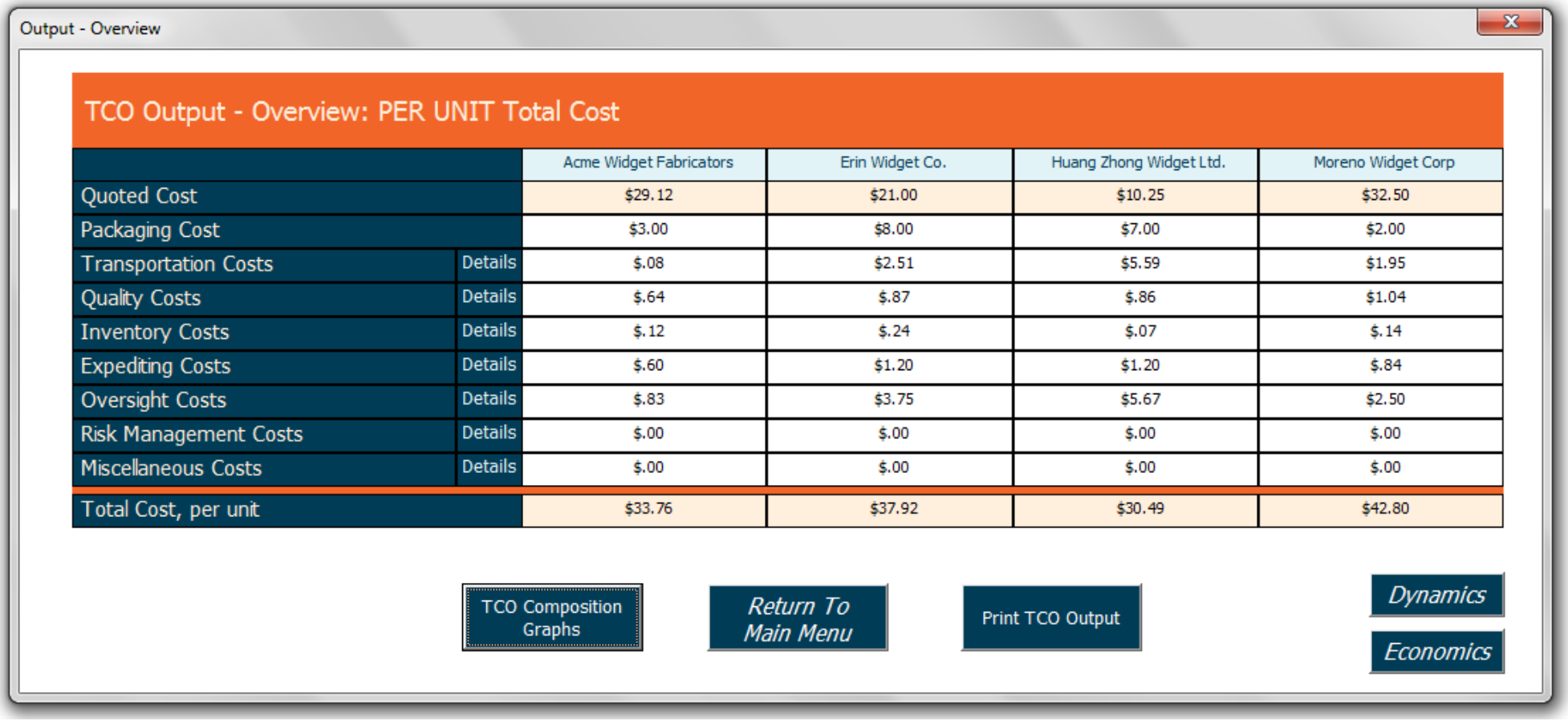
The TCO Calculator Output

Total Cost of Ownership – Overview Page



		Acme Widget Fabricators	Erin Widget Co.	Huang Zhong Widget Ltd.	Moreno Widget Corp
Quoted Cost		$29.12	$21.00	$10.25	$32.50
Packaging Cost		$3.00	$8.00	$7.00	$2.00
Transportation Costs	Details	$.08	$2.51	$5.59	$1.95
Quality Costs	Details	$.64	$.87	$.86	$1.04
Inventory Costs	Details	$.12	$.24	$.07	$.14
Expediting Costs	Details	$.60	$1.20	$1.20	$.84
Oversight Costs	Details	$.83	$3.75	$5.67	$2.50
Risk Management Costs	Details	$.00	$.00	$.00	$.00
Miscellaneous Costs	Details	$.00	$.00	$.00	$.00
Total Cost, per unit		$33.76	$37.92	$30.49	$42.80

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Total Cost of Ownership – Overview Page

TCO Output - Overview: PER UNIT Total Cost		Acme Widget Fabricators
Quoted Cost		$29.12
Packaging Cost		$3.00
Transportation Costs	Details	$.08
Quality Costs	Details	$.64
Inventory Costs	Details	$.12
Expediting Costs	Details	$.60
Oversight Costs	Details	$.83
Risk Management Costs	Details	$.00
Miscellaneous Costs	Details	$.00
Total Cost, per unit		$33.76

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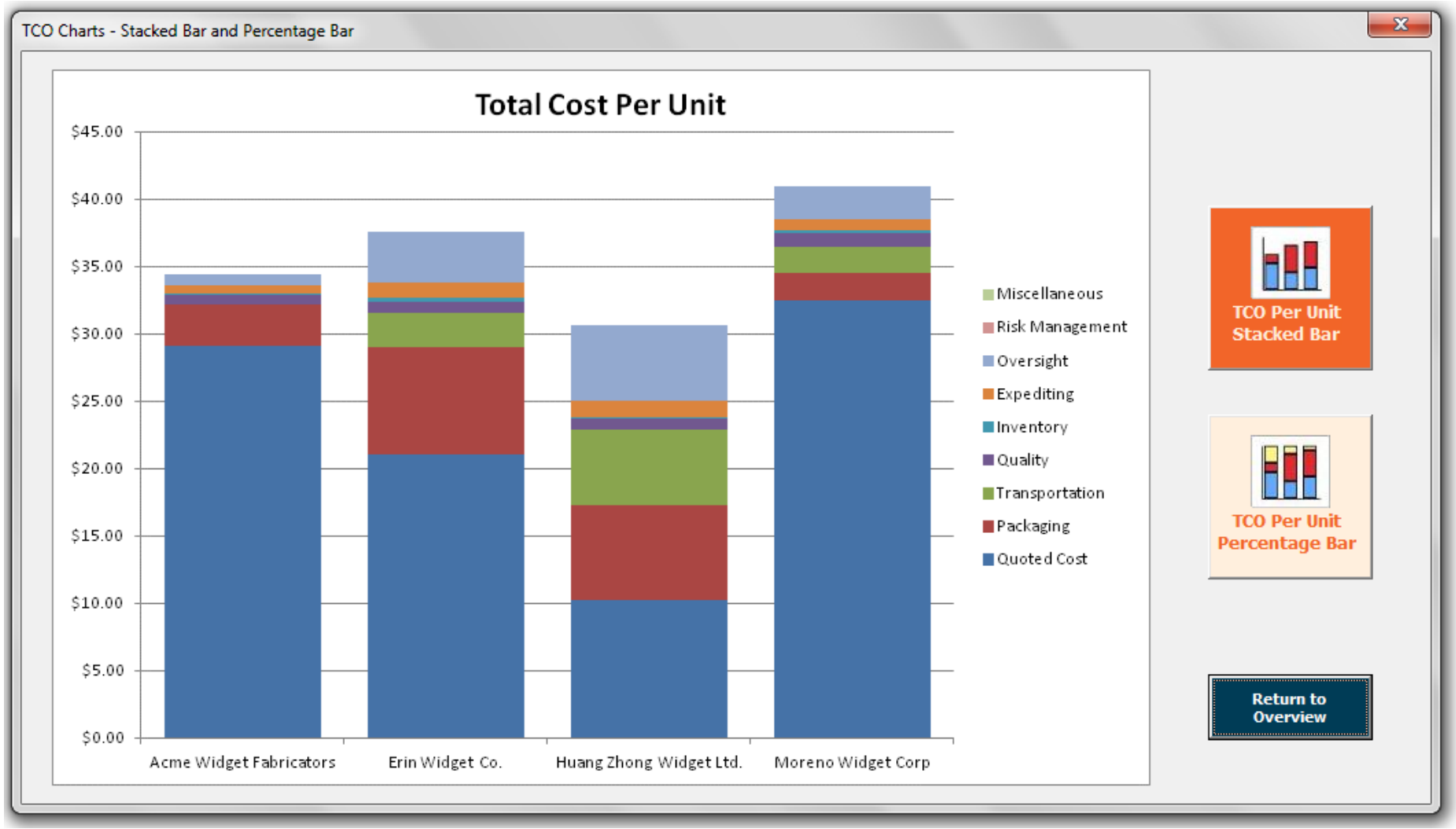
TCO Composition Graphs - Stacked



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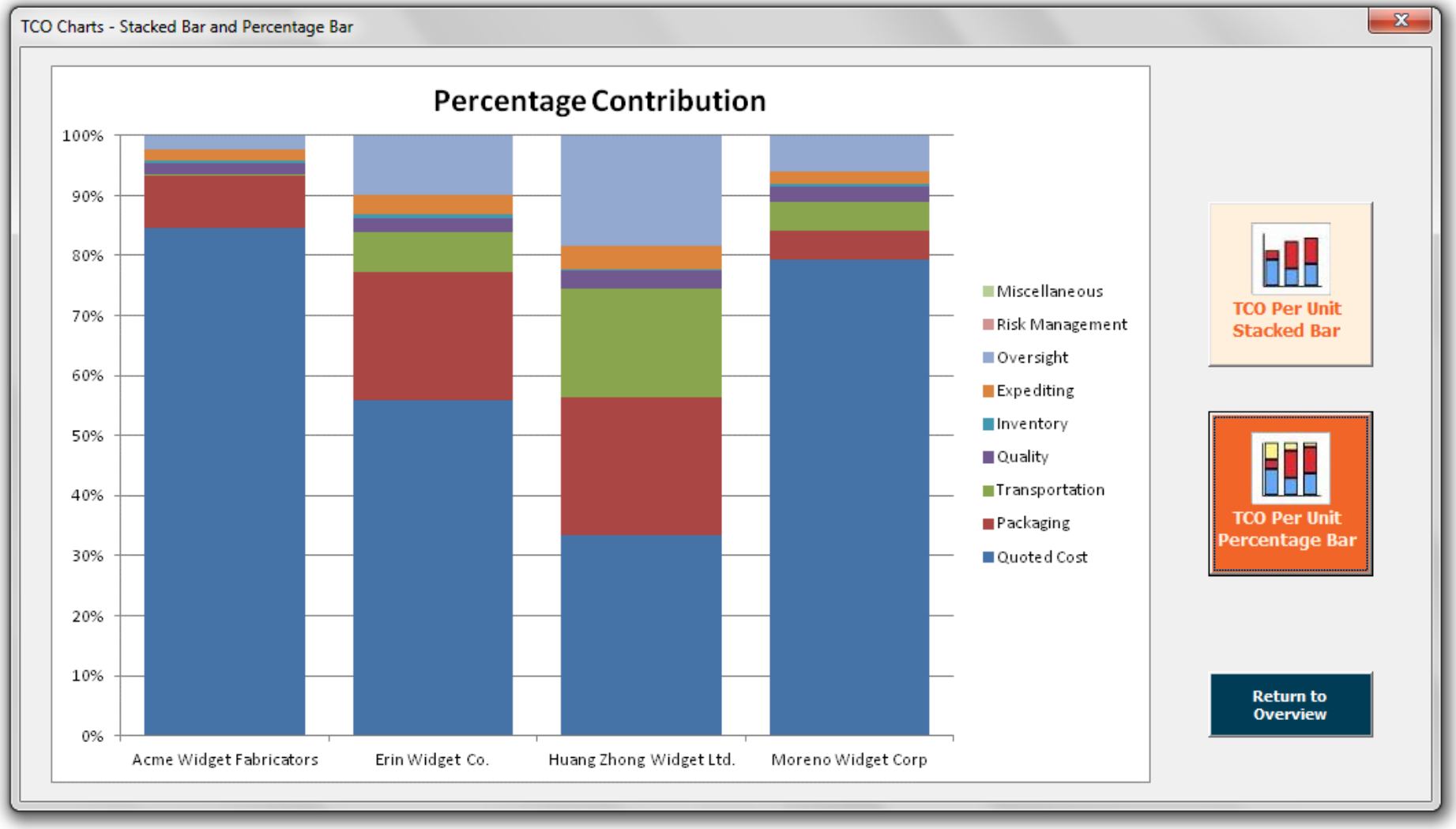
TCO Composition Graphs - Percentage



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Economic and Political Environment

Output - Overview

TCO Output - Economic and Political Environment Heat Map

Supplier	Supplier SAE	Supplier SLE	SupplierCanada	SupplierMexico
Country	China	United States	Canada	Mexico
Political Risk (1)	52	81	92	49
Control of Corruption (1)	22	72	87	24
Infrastructure (1)	43	75	85	45
Logistics Performance Index (2)	70	79	77	61
Local Supplier Quality (1)	47	78	81	63
Contract Enforcement (2)	90	95	70	63
Labor Freedom (3)	62	97	83	58
Business Freedom (3)	50	89	89	77
Property Rights (3)	20	80	90	50
Trade Freedom (3)	72	87	88	86

Color Key

- 90 -100
- 75-90
- 50-75
- 0-50

1: FMGlobal Resilience Index 2014
2: The World Bank "Doing Business" Project
3: Heritage/Wall Street Journal 2014 Index of Economic Freedom

Main Menu

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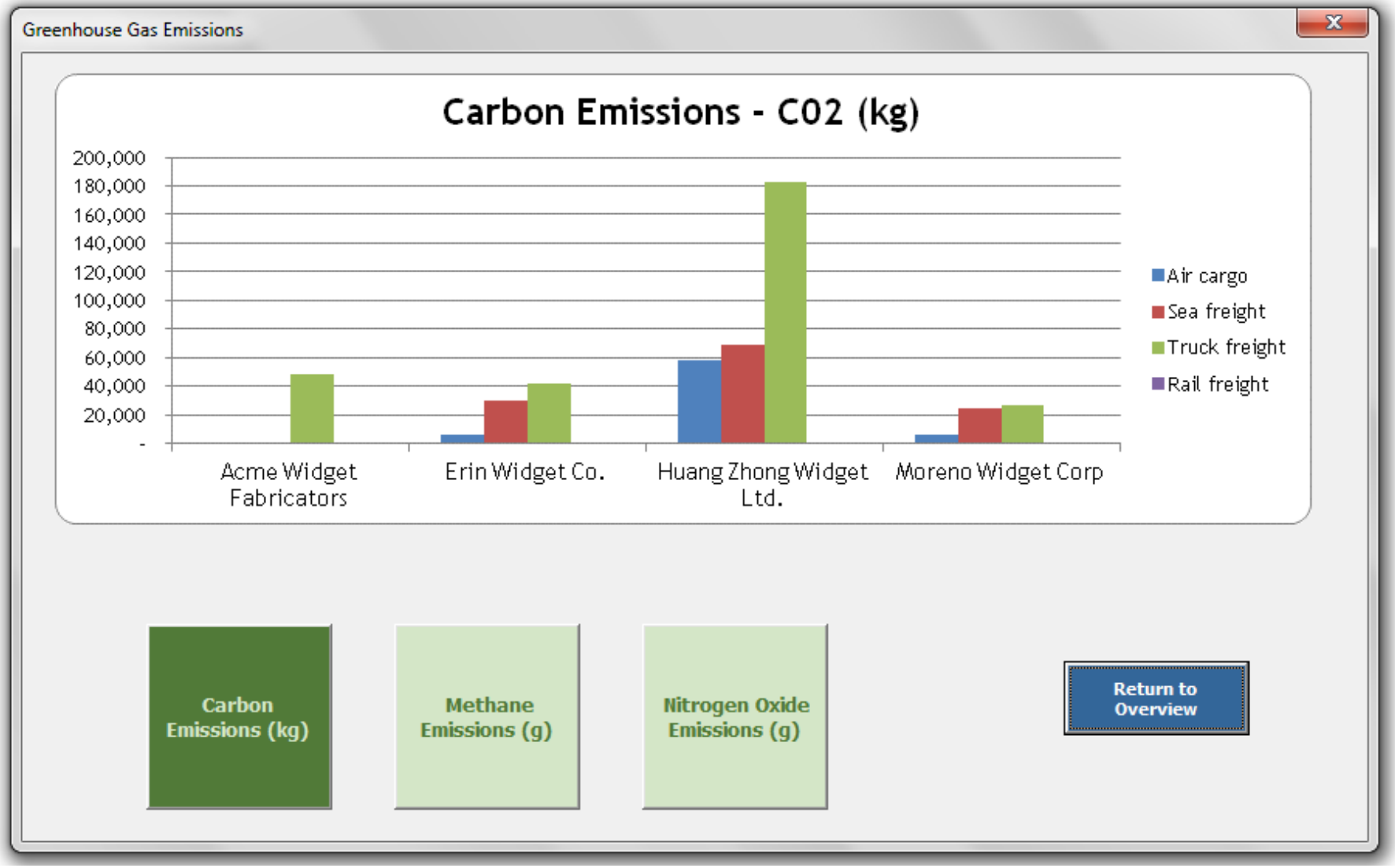
5 Year TCO Graph

	Current Year	Year 2	Year 3	Year 4	Year 5
Acme Widget Fabricators	$40.82	$42.10	$43.46	$44.81	$46.15
Erin Widget Co.	$56.43	$57.69	$59.10	$60.69	$62.31
Huang Zhong Widget Ltd.	$41.15	$43.20	$46.23	$51.31	$59.01
Moreno Widget Corp	$60.55	$61.83	$63.19	$64.70	$66.32

Transportation Greenhouse Gas Graphs



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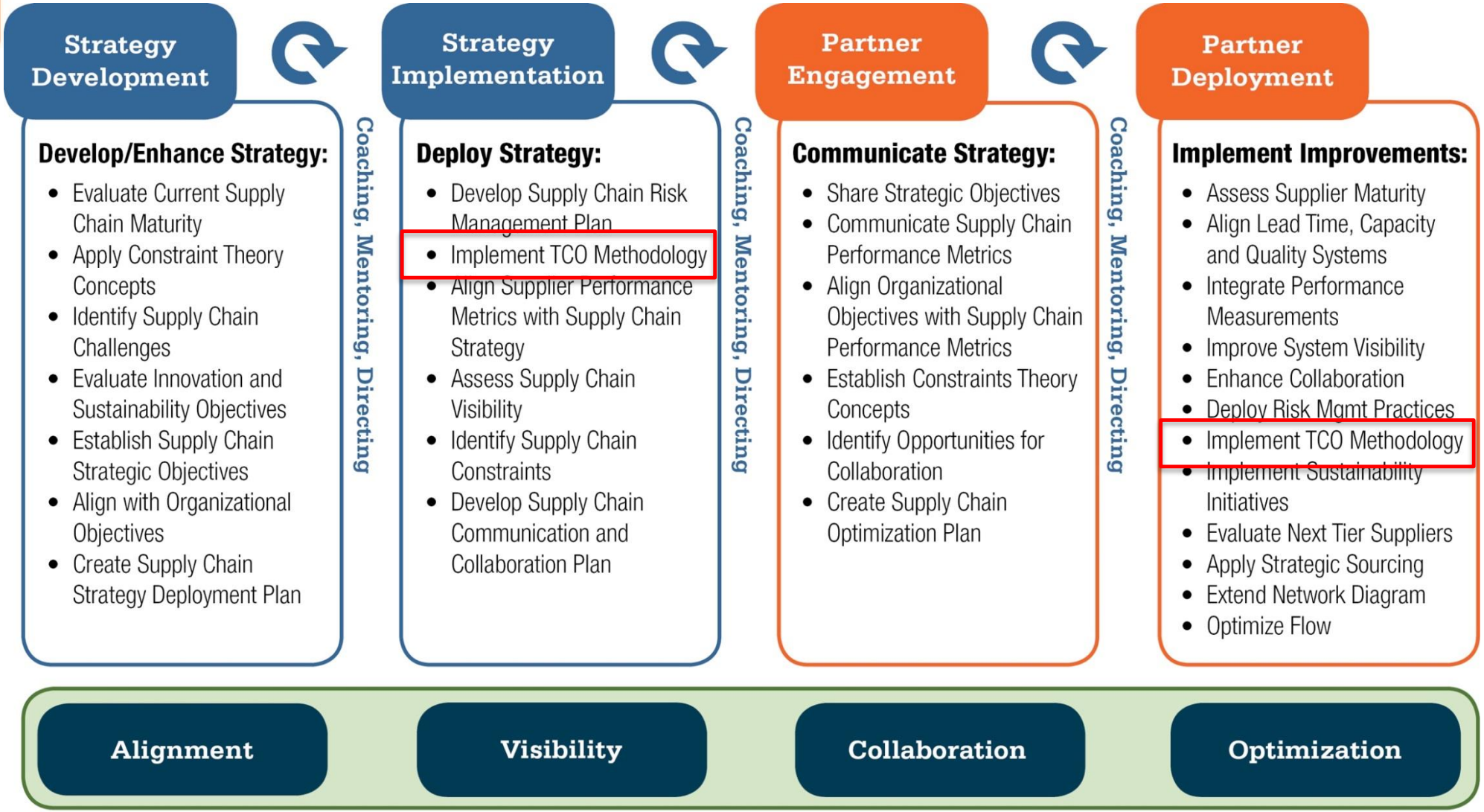
Implementing a TCO Strategy

TCO is just a part of SC Optimization



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Implementing TCO Methodology

1. Select product line or part group to evaluate
2. Map current supplier network
3. Evaluate potential demand pattern
4. Build Current State Total Cost model
5. Identify potential scenarios
6. Build Total Cost models for each scenario
7. Compare to Current State
8. Deploy to strategic sourcing

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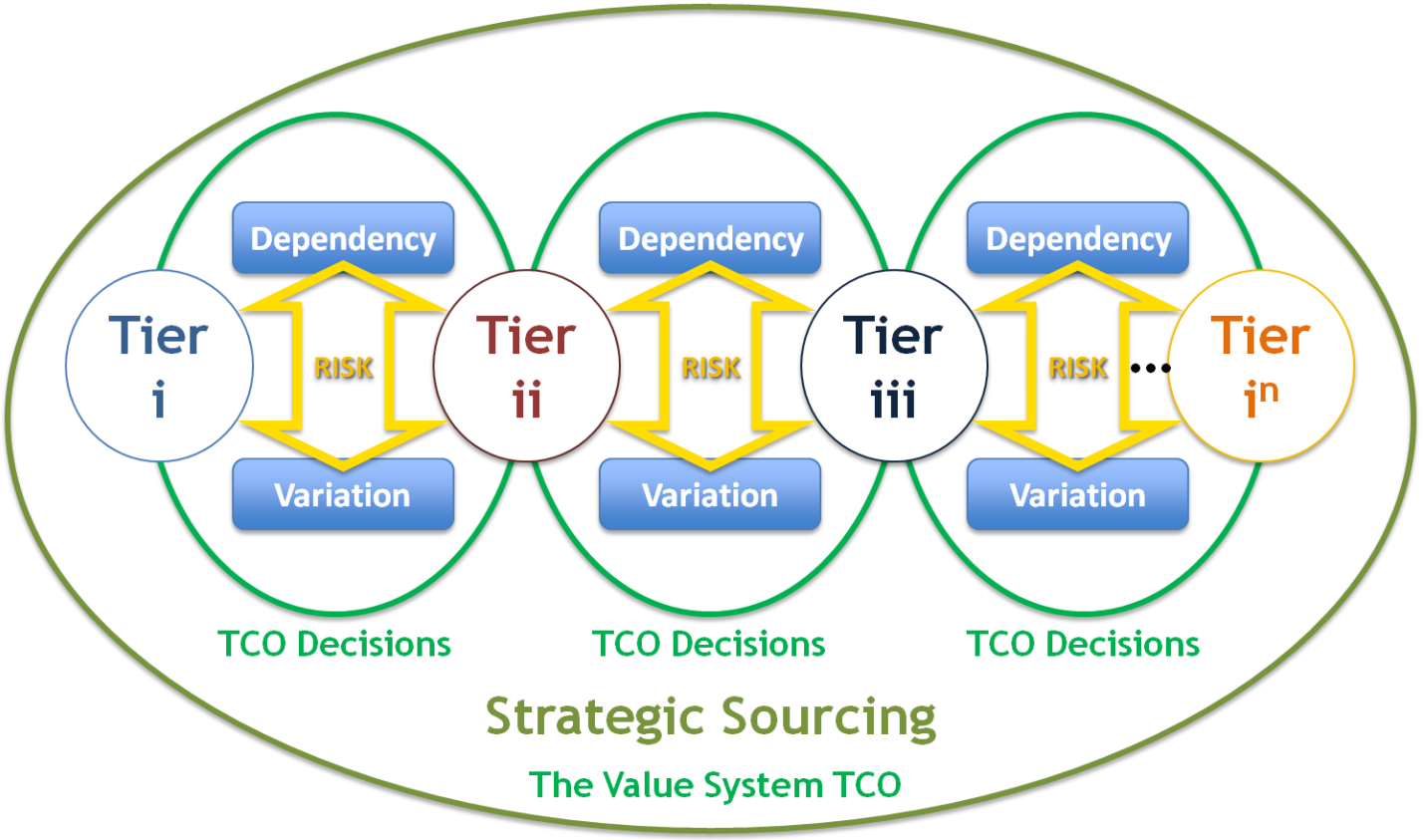
Strategic Sourcing and TCO



Competition is no longer between companies, it is between supply chains.

Strategic sourcing should be approached to minimized the Value System TCO.

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Thoughts on Make vs. Buy Decisions

Inputs for Make vs Buy Decisions

- Be careful when you include some overhead in you internal costs when compared to vendor costs!
  - This can become a downward spiral for manufacturing.
- Is manufacturing at capacity?
  - Personal example
- Are you outsourcing to relieve the constraint?
- Outsourcing generally increases variation in the process.
  - This is almost always true if the outsourcing happens in the middle of the overall process.
  - Outsourcing almost always demands that the safety stock is increased.

Inputs for Make vs Buy Decisions

- How stable is you demand?
  - The more variation in demand the generally higher the safety stock factor will be for outsourcing.
- Do you know your suppliers disaster recovery plan?
  - Are you the back-up?

Takeaways

- What is Total Cost of Ownership and how does an accurate calculation assist my procurement department to function more effectively?
- How do I identify the elements of TCO that affect each product I sell and each supplier that I have or am considering?
- How do I use the cost elements to assist in ongoing performance evaluations of my supply chain?
- Looking at Make vs Buy decisions from a Manufactures point of view?

Questions?

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