The Road to Success for CleanTech

--Cost Control for Purchasing Department

Sailing

HZ20222049

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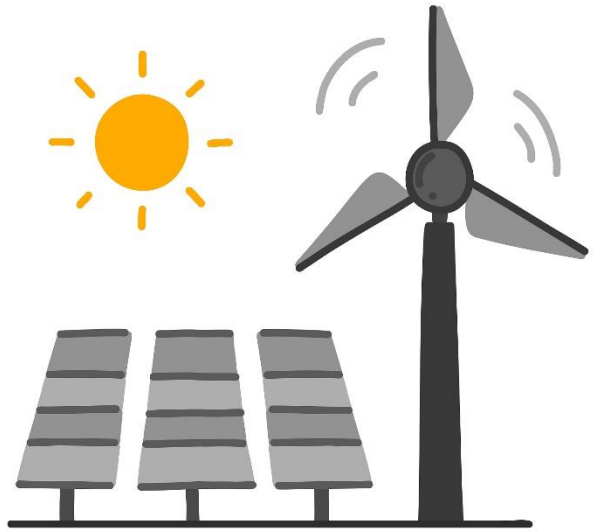
CleanTech 2022 Business Analysis Meeting

Meeting Outline

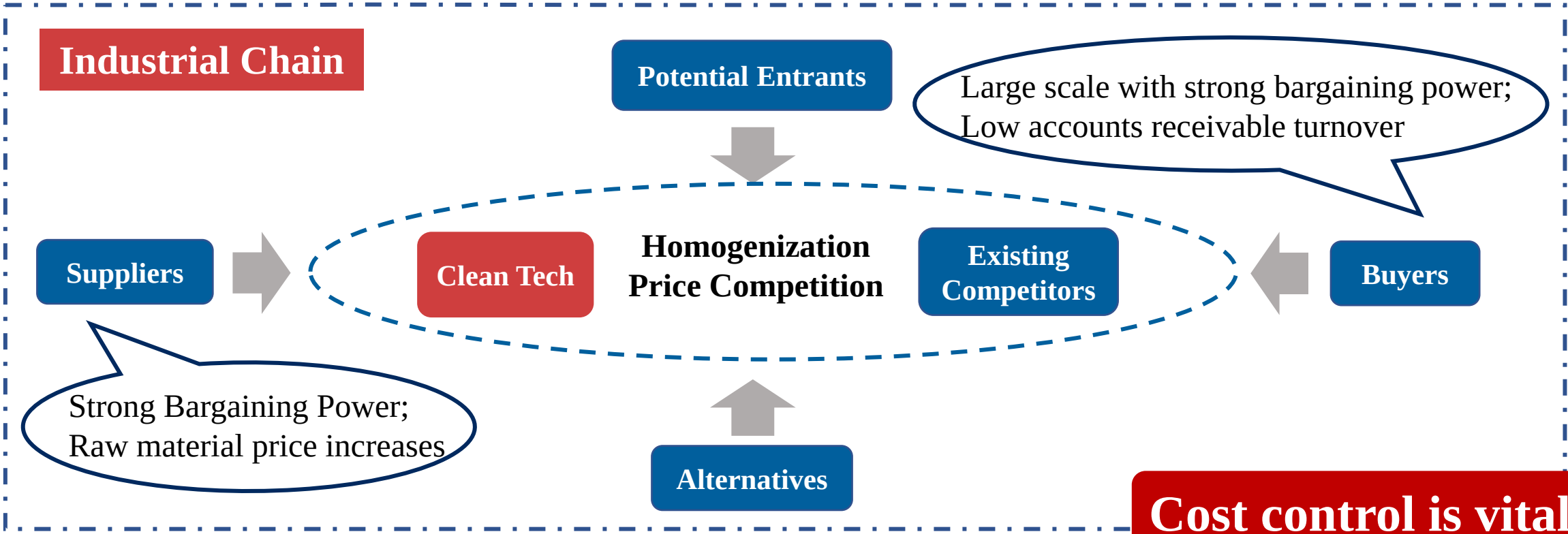
- Overview
- Issue 1
- Issue 2
- Issue 3



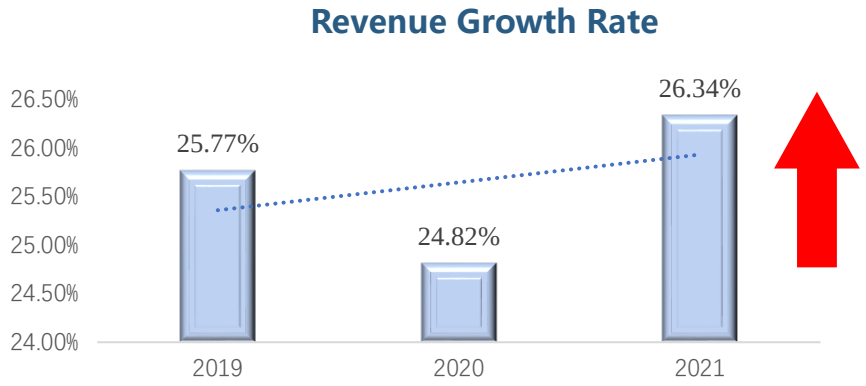
Overview -- *External Environment Analysis*

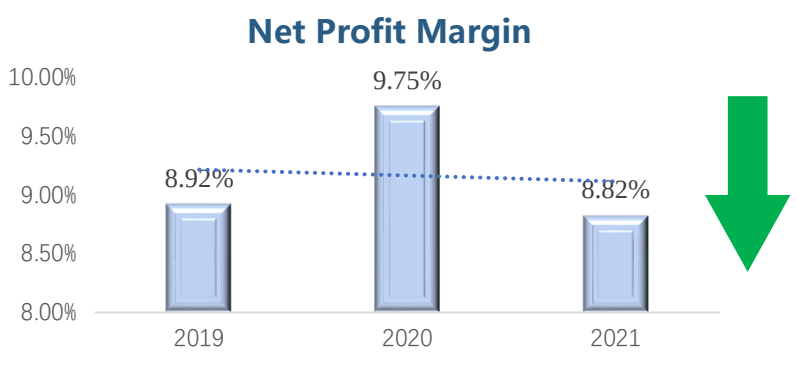
Macro-Environment

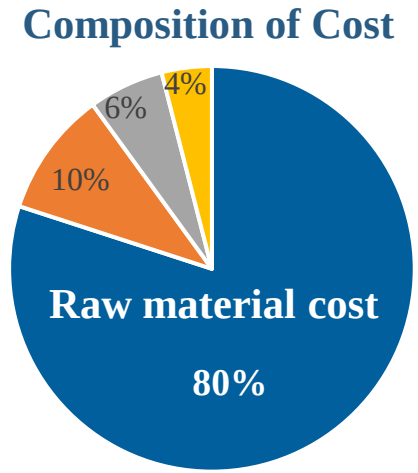
- ☐ Subsidy-free grid parity for PV generation
- ☐ Speed up technological innovation
- ☐ Increasing demand for PV construction



Overview -- *What are Our Problems?*







Cost must be reduced -- procurement cost is the core!

"Carton Case"

Broke out in the process of cost reduction

- ☐ Short-sighted: only cares purchase price
- ☐ Cause negative influence to other departments
- ☐ Passive order purchasing
- ☐ Lack of supplier relationship management

Operational procurement

Must change operational procurement !

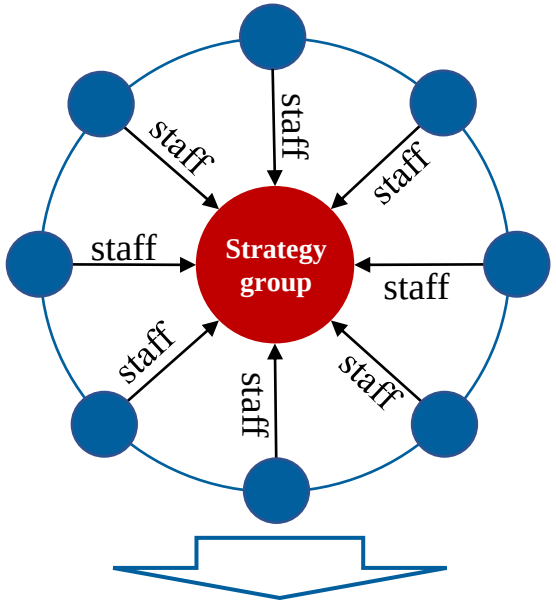
Issue 1
Choose Strategic Procurement

Strategic Procurement is Better

Problems of Operational Procurement		Strategic Procurement
☐ Short-sighted: only cares purchase price	Improve →	☐ Long-term development: care total cost of purchase
☐ Cause negative influence to other departments	Improve →	☐ Focus on multi-department cooperation
☐ Lack of supplier relationship management	Improve →	☐ Committed to suppliers management
☐ Passive order purchasing	Improve →	☐ Actively collect demand information and formulate differentiation strategies

Turn into strategic procurement!

Reconstruct the Procurement Process

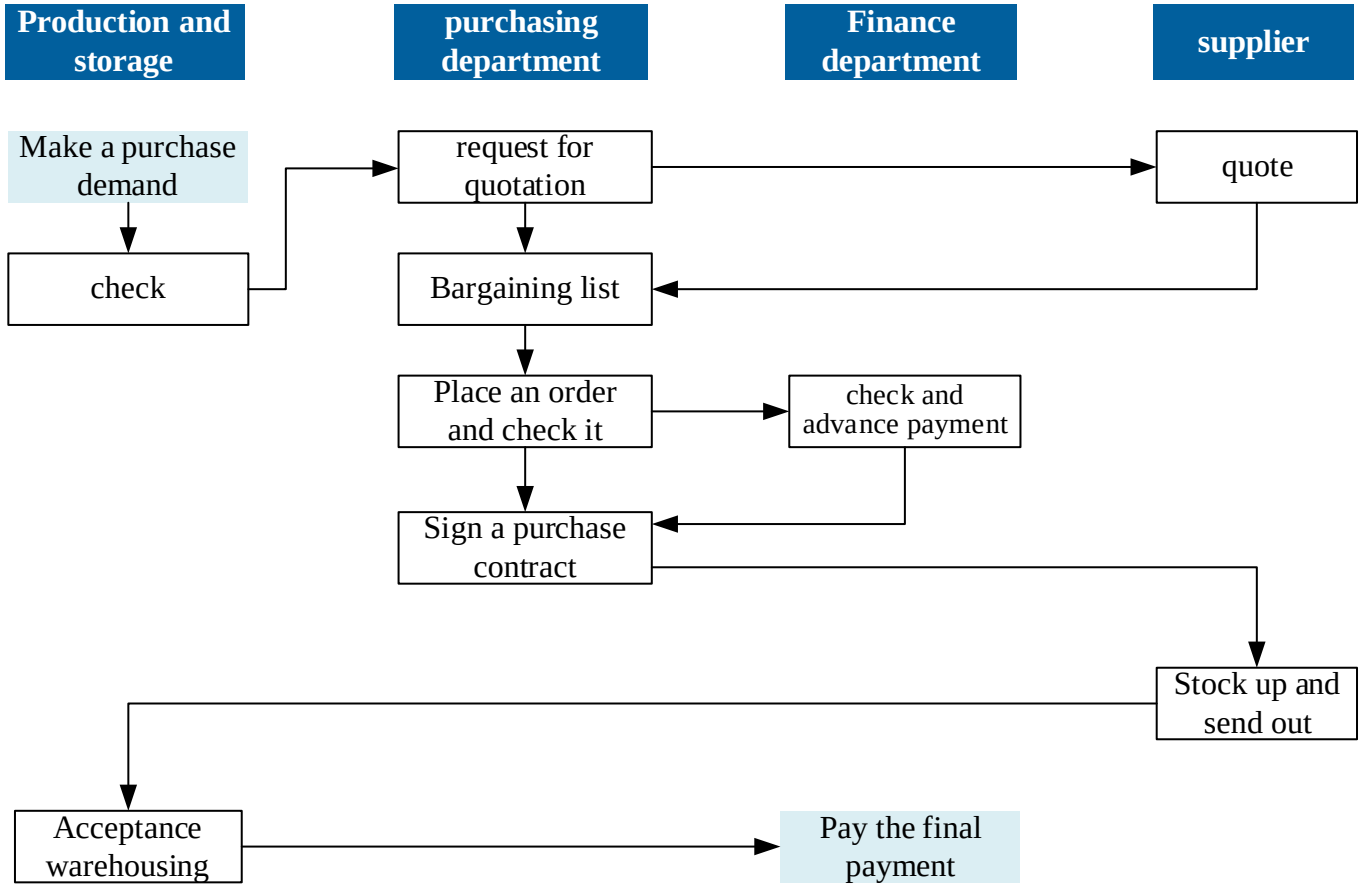


Strengths

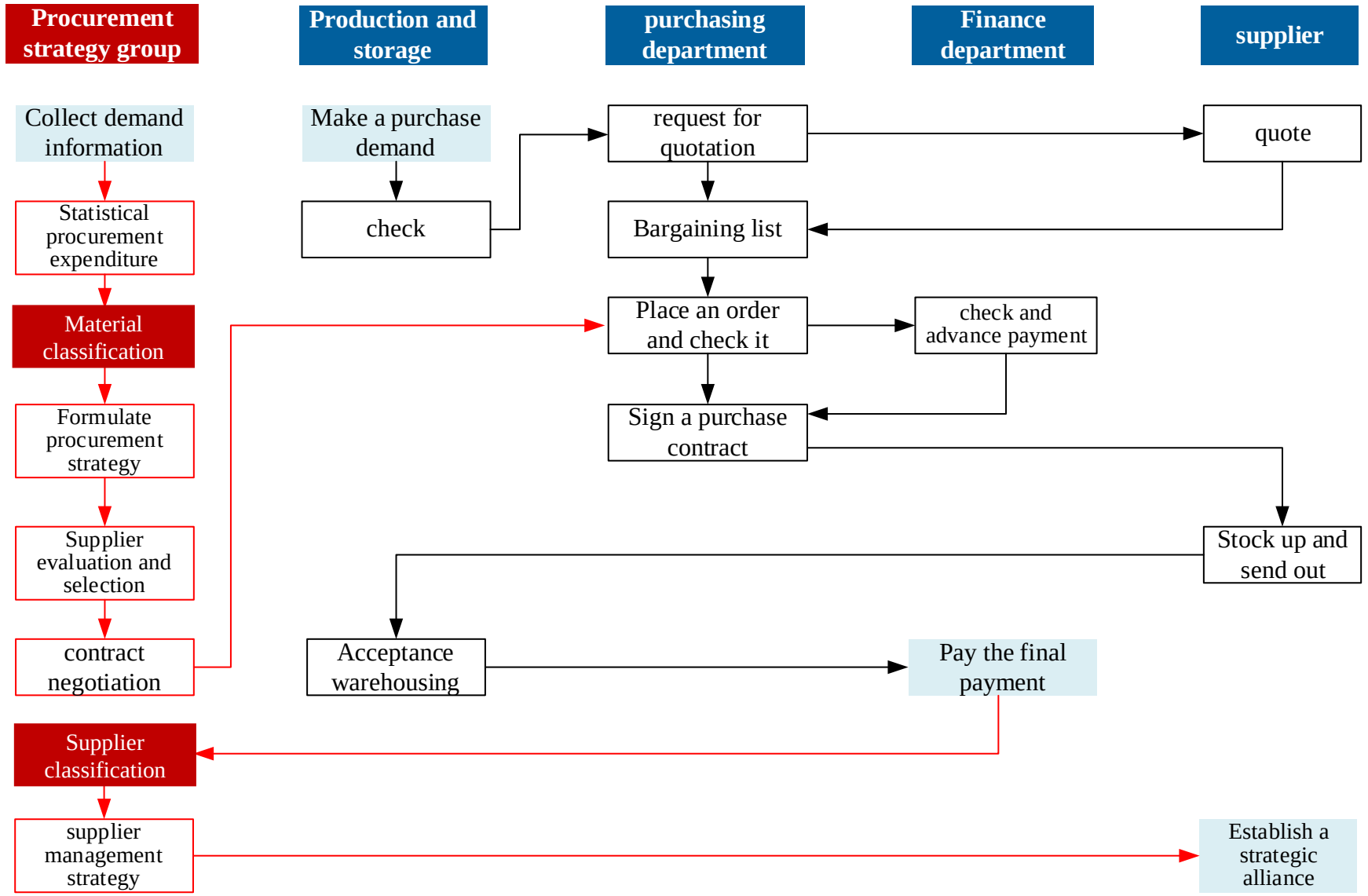
More complete information feedback

Better performance management

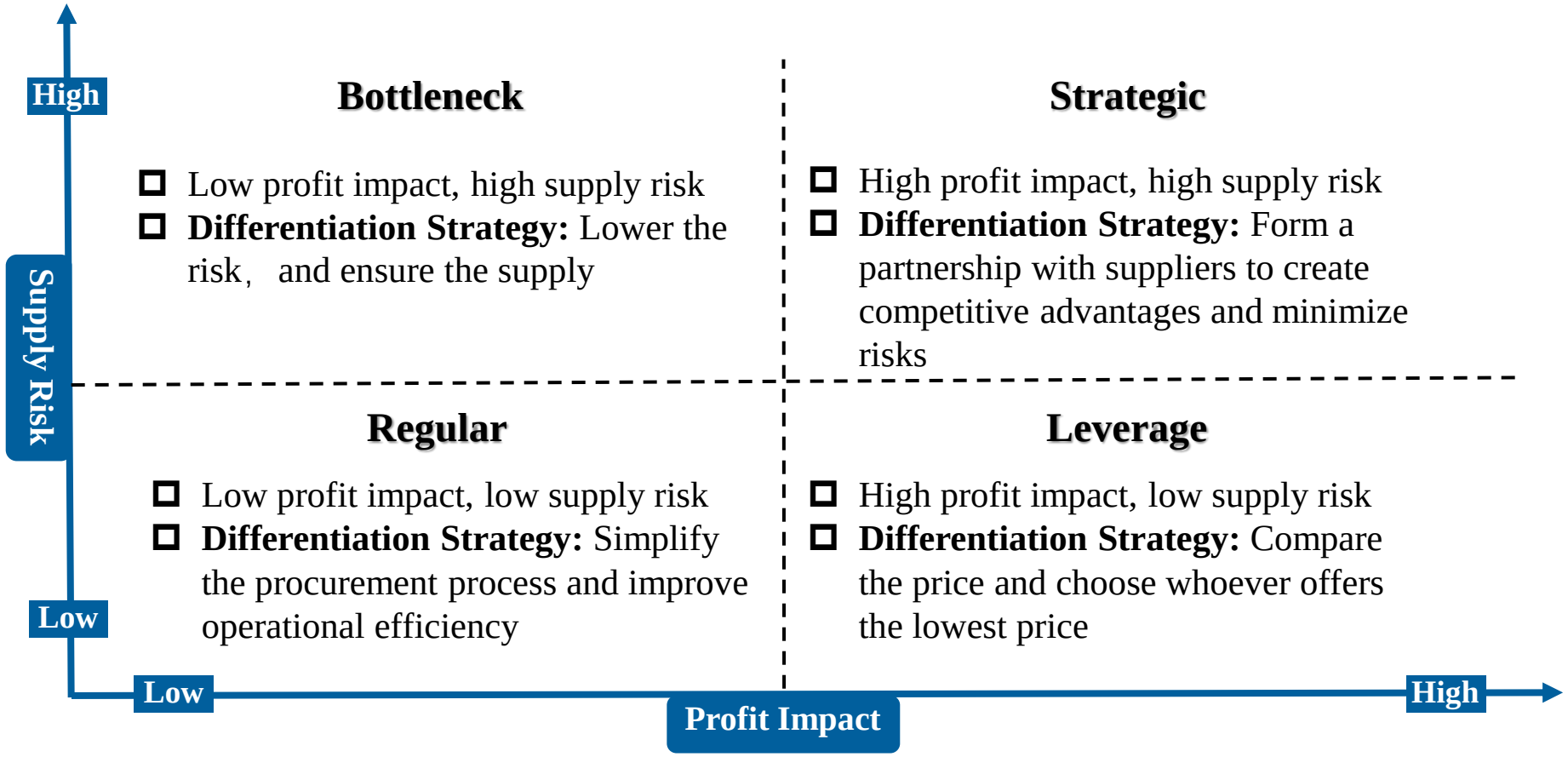
More timely communication



Reconstruct the Procurement Process



Classification Method based on Karajack Matrix

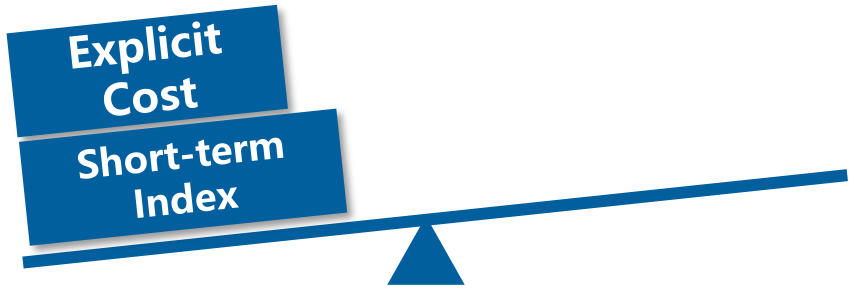


Formulate differentiation strategy and establish a high-quality supplier management system

Issue 2
Strategic Supplier Management

Improve Cost Item

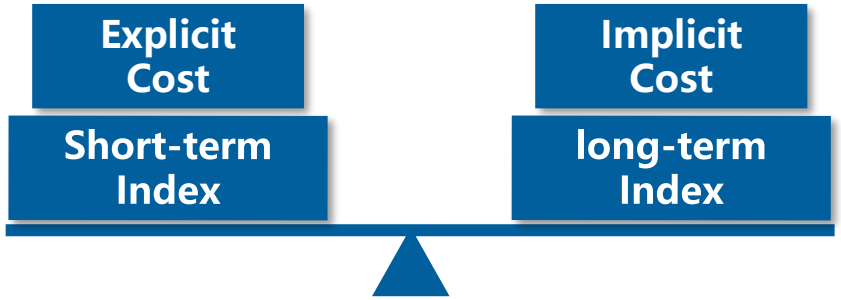
Cost Category	Cost Item
Acquisition Cost	material cost order fee insurance fee
Storage Cost	warehousing fee
Supply Chain Cost	freight loading and unloading fees
Quality Cost	testing cost



Problems:
Existing price comparison methods overlook some cost items

Improve Cost Item

Cost Category	Cost Item
Acquisition Cost	material cost order fee insurance fee
Storage Cost	warehousing fee fund occupancy expense normal loss fee
Shortage Cost	shutdown loss loss of sales opportunity
Supply Chain Cost	freight loading and unloading fees
Quality Cost	testing cost internal failure cost external failure cost



Complete!

Assumptions

Source of cost information	Assumptions
Production Center	scrap rate -- m_n average product production quantity -- o_n average scrap cost -- p_n
Quality Inspection Department	unit testing cost -- l_i shutdown loss -- $\mathbf{X}_n$ loss of sales opportunity -- $\mathbf{Y}_n$
Sales Department	return rate -- r_n average sales quantity -- s_n average return processing cost -- t_n
Purchasing Department	material unit price -- a_{ij} single order cost -- b_{ij} unit insurance cost -- d_{ij} material quantity -- Q_{ij} order times -- u_{ij}
Warehousing Department	unit storage cost -- c_{ij} loss rate -- e_{ij}
Transportation Department	transportation unit price -- f supplier distance -- h_{ij} unit loading and unloading fee -- k
Financial Center	weighted average cost of capital -- $WACC$

** **Tips**: "n" represents the n^{th} product; "i" represents the i^{th} material; "j" represents the j^{th} supplier*

Total Cost of Ownership Model -- *Acquisition Cost*

Cost Item	Cost Item Description	Calculation Results
material cost	material unit price × material quantity	$Q_{ij} \times a_{ij}$
order fee	order times × single order cost	$b_{ij} \times u_{ij}$
insurance fee	material quantity × unit insurance cost	$Q_{ij} \times d_{ij}$

explicit cost
implicit cost

$$Acquisition\ Cost = \sum_{i=1,j=1} \left[Q_{ij} \times (a_{ij} + d_{ij}) + b_{ij} \times u_{ij}\right]$$

Total Cost of Ownership Model -- *Storage Cost*

Cost Item	Cost Item Description	Calculation Results
warehousing fee	unit storage cost × average inventory quantity	$\frac{Q_{ij}}{2} \times c_{ij}$
fund occupancy expense	WACC × unit testing cost	$\frac{Q_{ij}}{2u_{ij}} \times WACC$
normal loss fee	material quantity× loss rate ×material unit price	$Q_{ij} \times e_{ij} \times a_{ij}$

explicit cost
implicit cost

$$Storage\ Cost = \sum_{i=1,j=1} Q_{ij} \times \left(\frac{c_{ij}}{2} + \frac{WACC}{2u_{ij}} + a_{ij} \times e_{ij} \right)$$

Total Cost of Ownership Model -- *Shortage Cost*

Cost Item	Cost Item Description	Calculation Results
shutdown loss	*Production downtime losses caused by delayed material supply*	X_n
loss sales opportunity cost	*loss of delayed delivery caused by inventory shortage of finished products*	Y_n

explicit cost
implicit cost

$$Shortage\ Cost = \sum_{n=1} (X_n + Y_n)$$

Total Cost of Ownership Model -- *Supply Chain Cost*

Cost Item	Cost Item Description	Calculation Results
freight	transportation unit price × material quantity × supplier distance	$Q_{ij} \times f \times h_{ij}$
loading and unloading fees	material quantity × unit loading and unloading fee	$Q_{ij} \times k$

explicit cost
implicit cost

$$Supply\ Chain\ Cost = \sum_{i=1,j=1} Q_{ij} \times (f \times h_{ij} + k)$$

Total Cost of Ownership Model -- *Quality Cost*

Cost Item	Cost Item Description	Calculation Results
testing cost	material quantity × unit testing cost	$Q_{ij} \times l_i$
internal failure cost	scrap rate × average product production quantity × average scrap cost	$m_n \times o_n \times p_n$
external failure cost	return rate × average sales quantity × average return processing cost	$r_n \times s_n \times t_n$

explicit cost
implicit cost

$$Quality\ Cost = \sum_{i=1,j=1} Q_{ij} \times l_i + \sum_{n=1} (m_n \times o_n \times p_n + r_n \times s_n \times t_n)$$

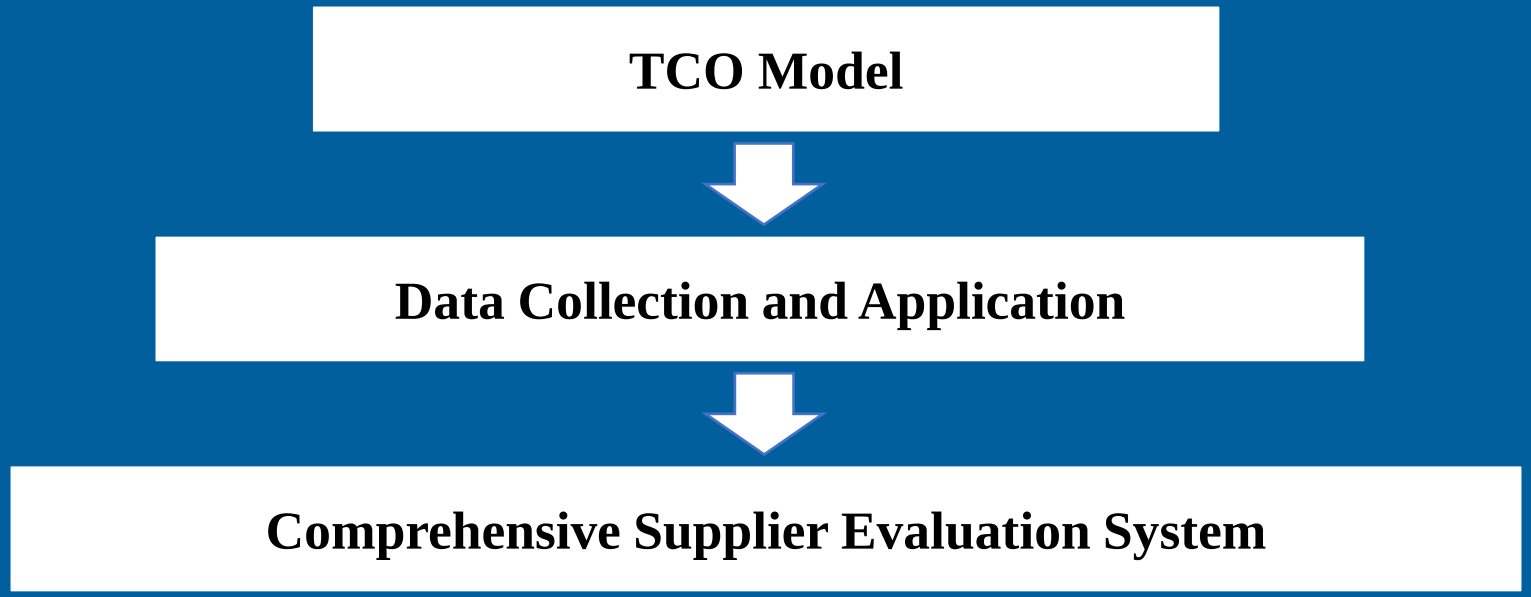
Total Cost of Ownership Model

Cost Category	Calculation Results
Acquisition Cost	$\sum_{i=1,j=1} [Q_{ij} \times (a_{ij} + d_{ij}) + b_{ij} \times u_{ij}]$
✚	
Storage Cost	$\sum_{i=1,j=1} Q_{ij} \times \left(\frac{c_{ij}}{2} + \frac{WACC}{2u_{ij}} + a_{ij} \times e_{ij}\right)$
✚	
Shortage Cost	$\sum_{n=1} (X_n + Y_n)$
✚	
Supply Chain Cost	$\sum_{i=1,j=1} Q_{ij} \times (f \times h_{ij} + k)$
✚	
Quality Cost	$\sum_{i=1,j=1} Q_{ij} \times l_i + \sum_{n=1} (m_n \times o_n \times p_n + r_n \times s_n \times t_n)$

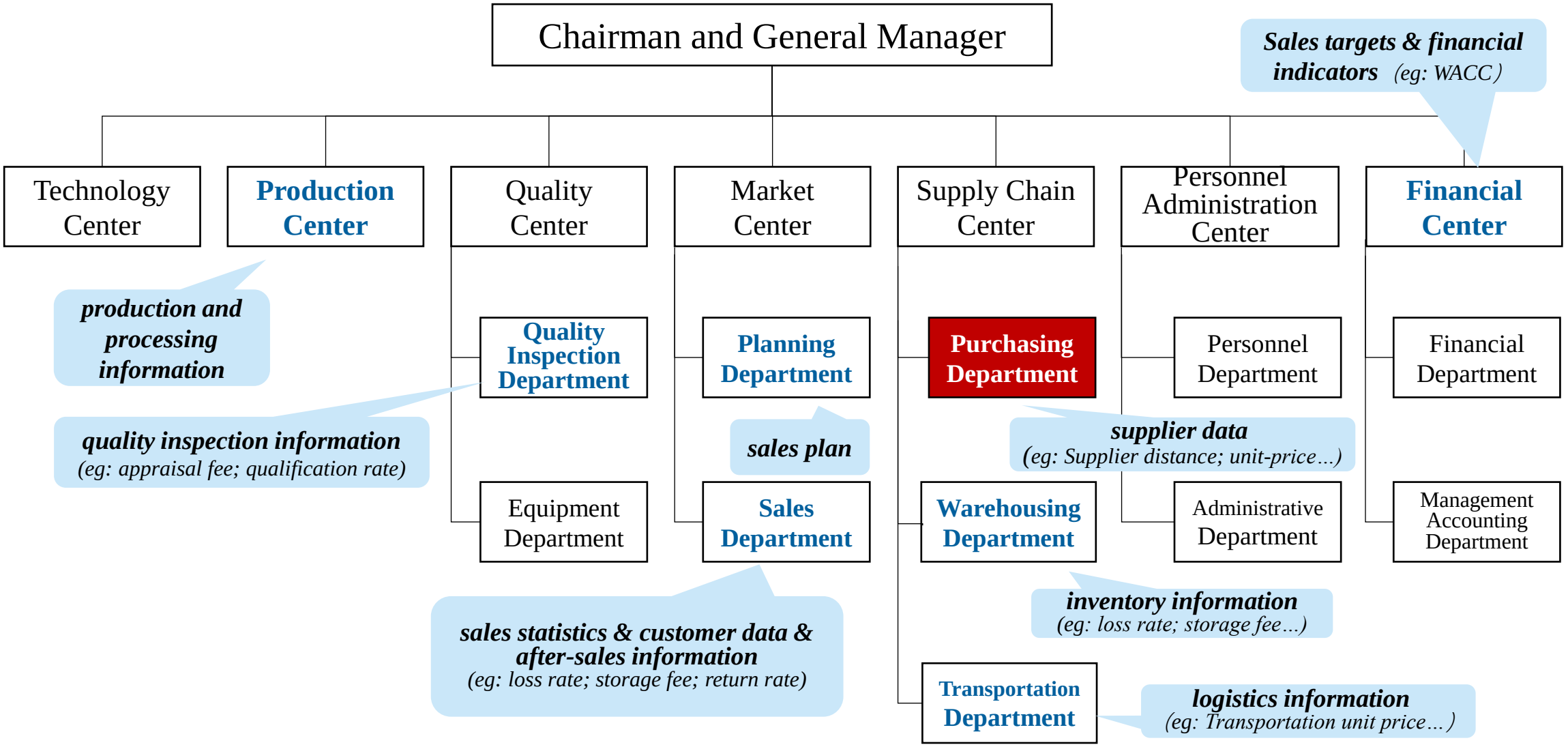
Total Cost of Ownership

$$= \sum_{i=1,j=1} \left\{ Q_{ij} \times \left[a_{ij} + d_{ij} + \frac{c_{ij}}{2} + \frac{WACC}{2u_{ij}} + a_{ij} \times e_{ij} + f \times h_{ij} + k + l_i \right] + b_{ij} \times u_{ij} \right\} + \sum_{n=1} (m_n \times o_n \times p_n + r_n \times s_n \times t_n + X_n + Y_n)$$

How to apply the TCO model for supplier evaluation?



Data Collection



Application Result & Room for Improvement

Multi-department cooperation: Data collection

↓

Substitute into TCO Model: Data application

↓

Total cost of purchase

Tiansheng *vs* **Dali**

Win!

Room for Improvement

★ **TCO Model**

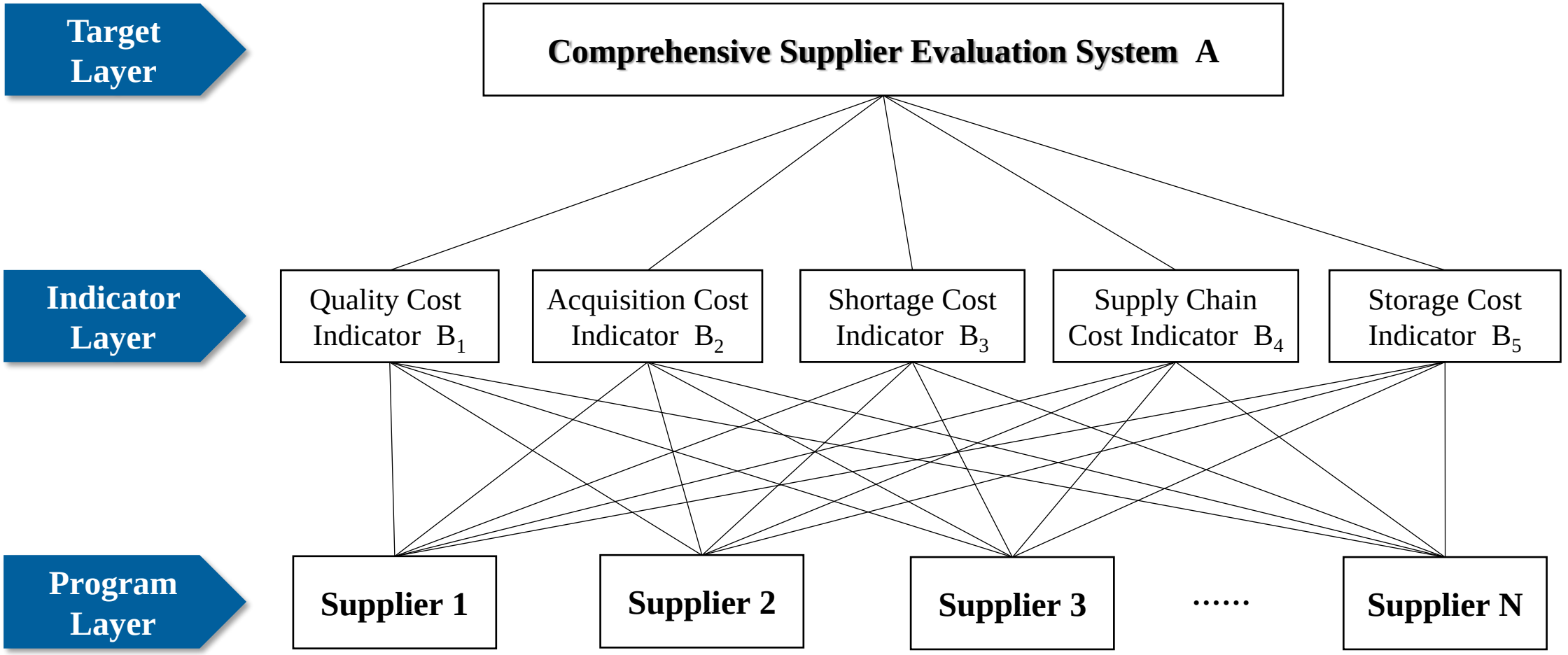
- Each cost item is equally weighted.

★ **Refinement Path**

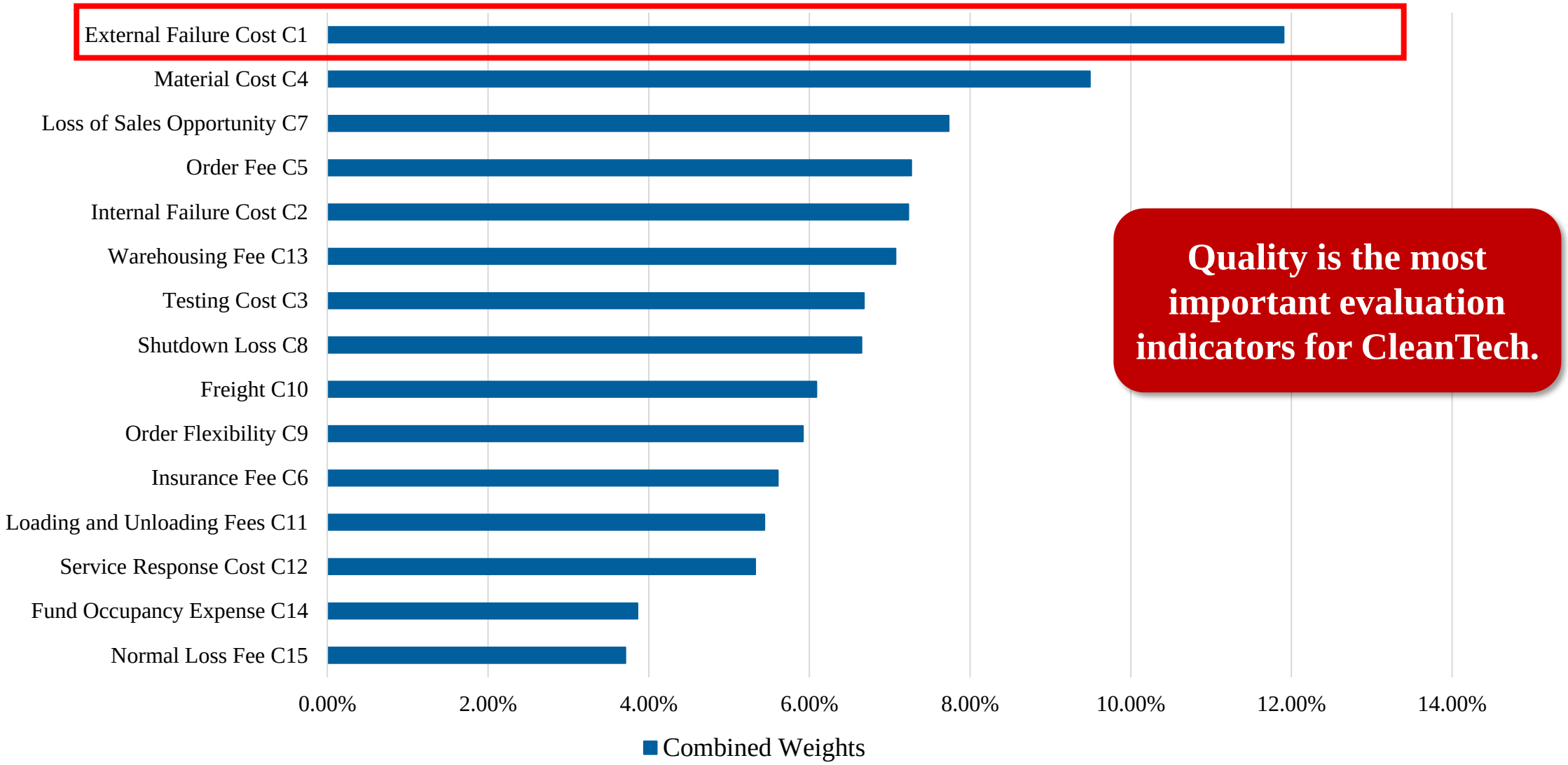
Empower Weight: Distinguish between Core and Non-Core Cost Items

Refinement:AHP-based Assignment of Weights -- *Hierarchical Model*

We use AHP to:
Assign Weights to Cost Items - Establish a Comprehensive Supplier Evaluation System



Refinement:AHP-based Assignment of Weights -- *Rank the Weights*



Quality is the most important evaluation indicators for CleanTech.

Check and Correction: DEA-AHP Model

AHP Model

- Highly influenced by the **subjective** choices and **judgments** of decision makers.

DEA Pairwise Comparisons

①Two-by-two comparison of candidate suppliers

②Calculate the efficiency evaluation index h_{12} and h_{21}

LP1:

$$h_{12} = Max \sum_{r=1}^{s} u_r y_{r1}$$

$$st. \begin{cases} \sum_{r=1}^{s} u_r y_{rj} \le 1 \quad (j = 1,2) \\ u_r \ge 0 \quad (r = 1,2,\dots s) \end{cases} \quad (1)$$

LP2:

$$h_{21} = Max \sum_{r=1}^{s} u_r y_{r2}$$

$$st. \begin{cases} \sum_{r=1}^{s} u_r y_{rj} \le 1 \quad (j = 1,2) \\ u_r \ge 0 \quad (r = 1,2,\dots s) \end{cases} \quad (2)$$

* For any supplier j (j=1,2…n), there are s types of outputs.
* y_{rj} ($r = 1,2,\dots s$) is the output volume of the jth spplier for the rth output.

AHP Sorting

①Construct judgment matrix based on relative efficiency ratio

②Calculate the ranking vector of candidate suppliers

$$a_{12} = h_{12}/h_{21}$$

$$a_{21} = h_{21}/h_{12} \quad (3)$$

$$a_{11} = 1$$

Tips

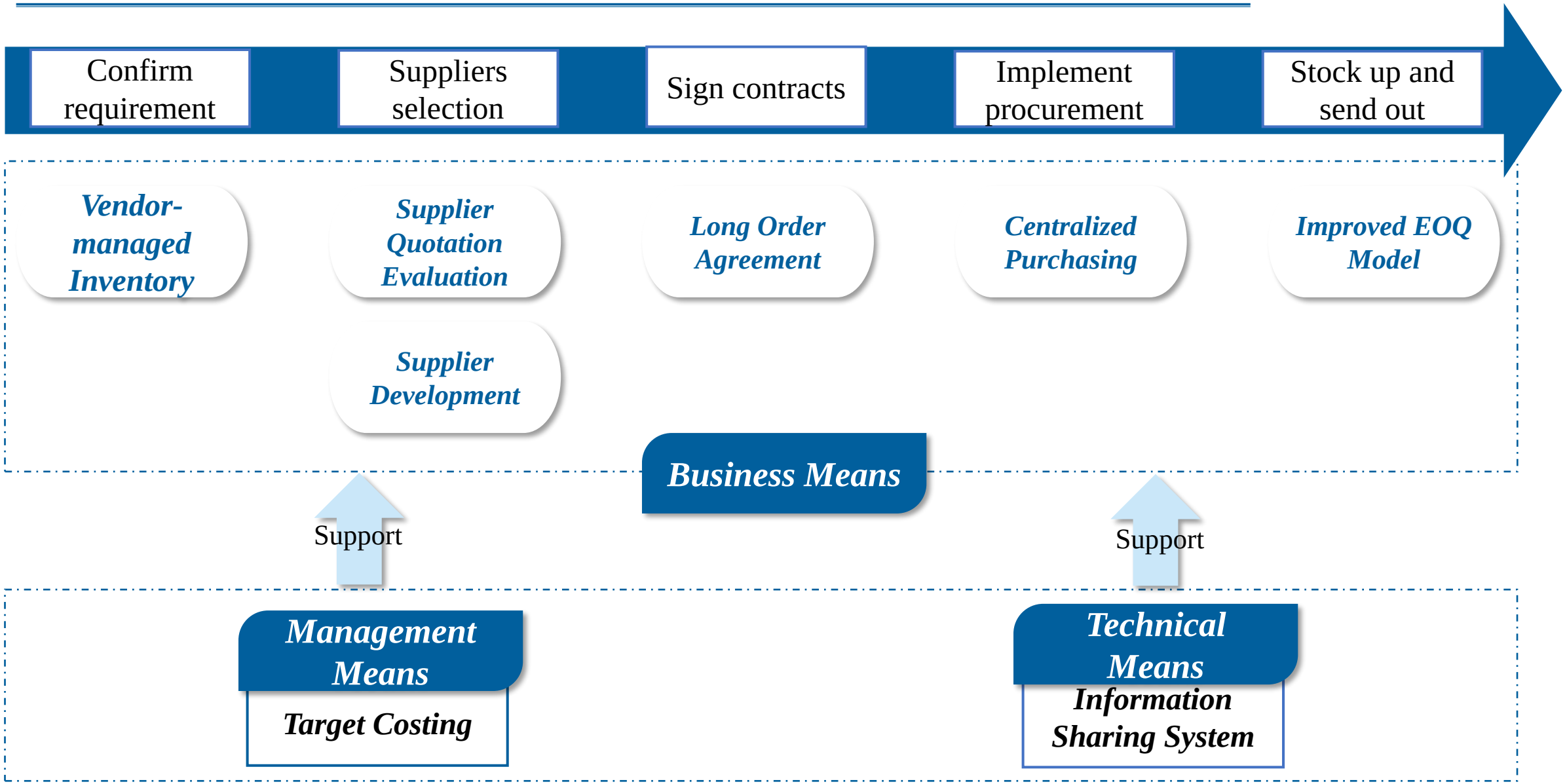
Judgment Matrix

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}$$

Reduce the Influence of Subjective Factors

Issue 3
Cost Reduction Practice
-- from Finance to Business

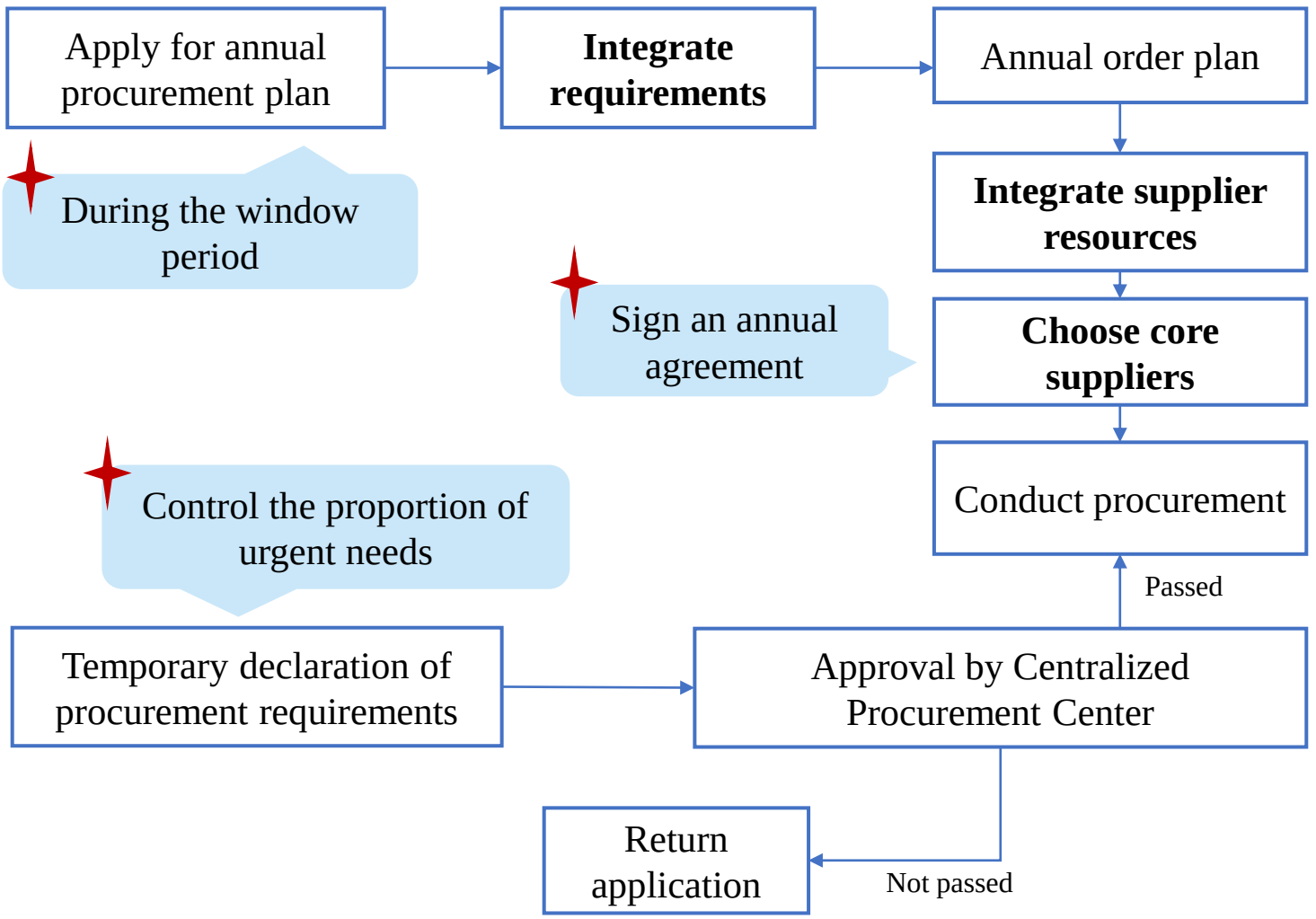
Business Strategy Overview



Problem 3.1-Business Means: *Centralized Purchasing*

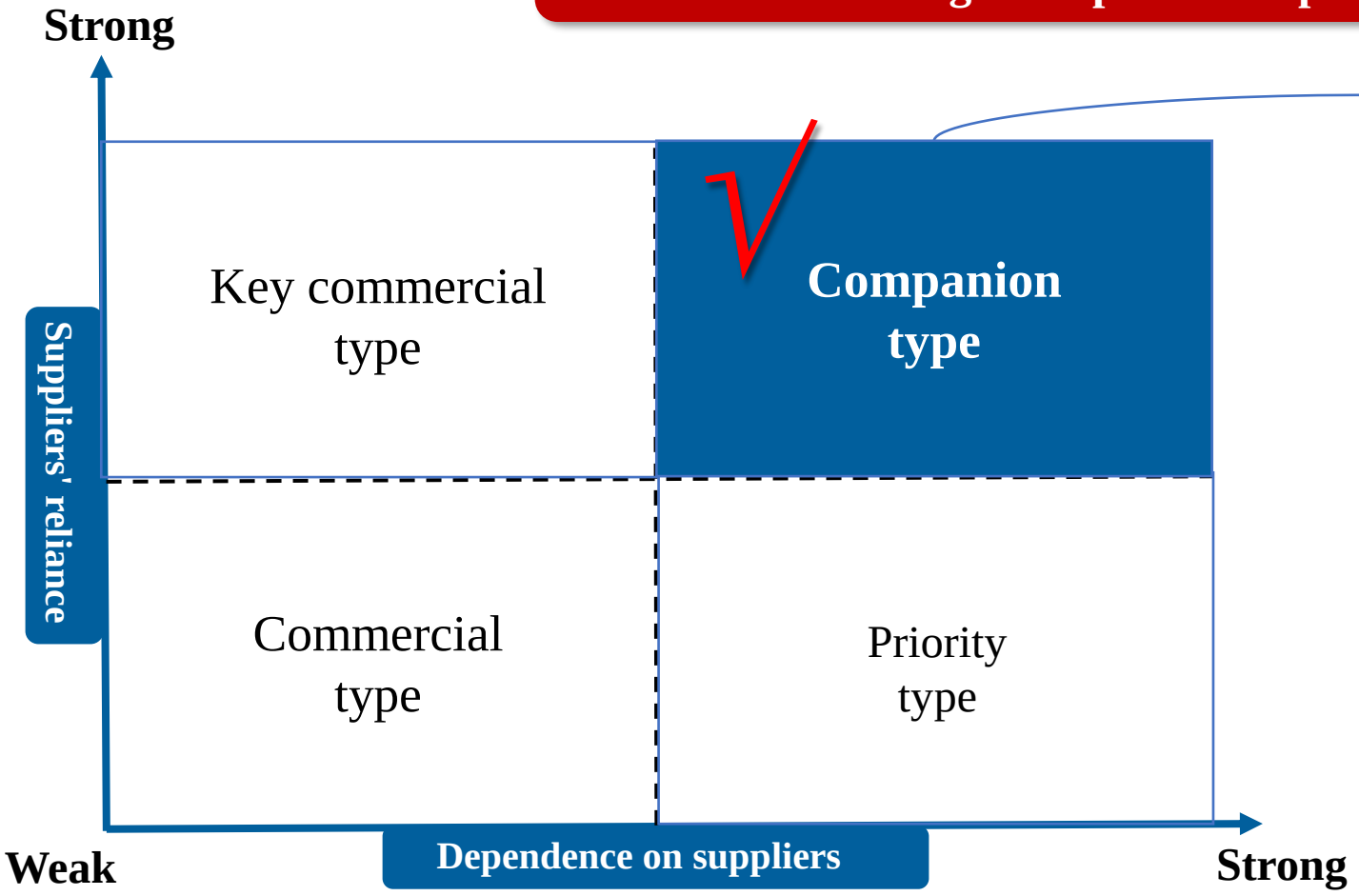
Problems

Standard parts : small batch & multi suppliers



Problem 3.1-Business Means: *Centralized Purchasing*

Select companion type suppliers to establish supply long-term partnership

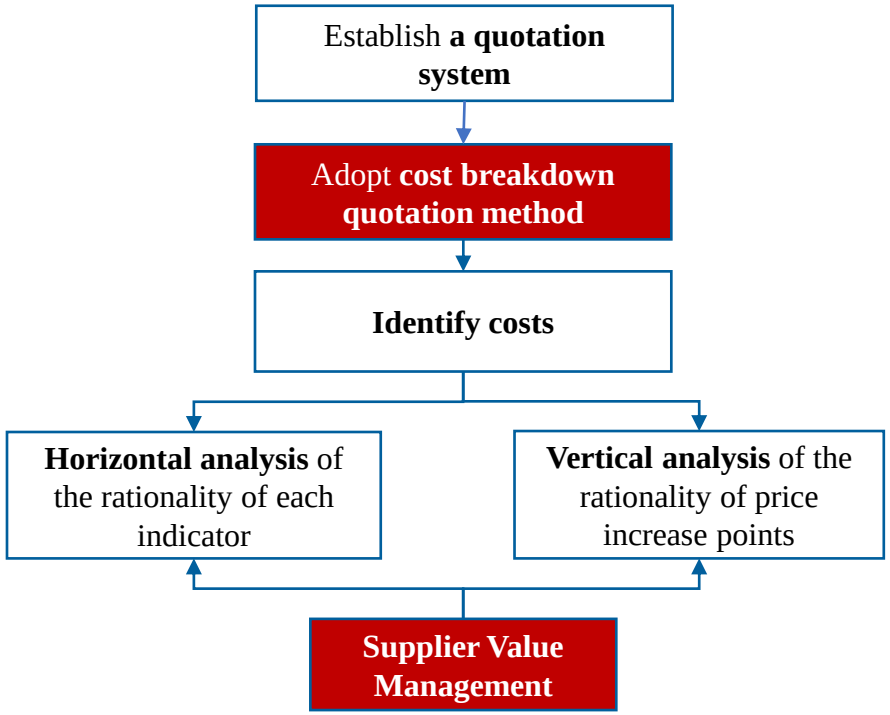


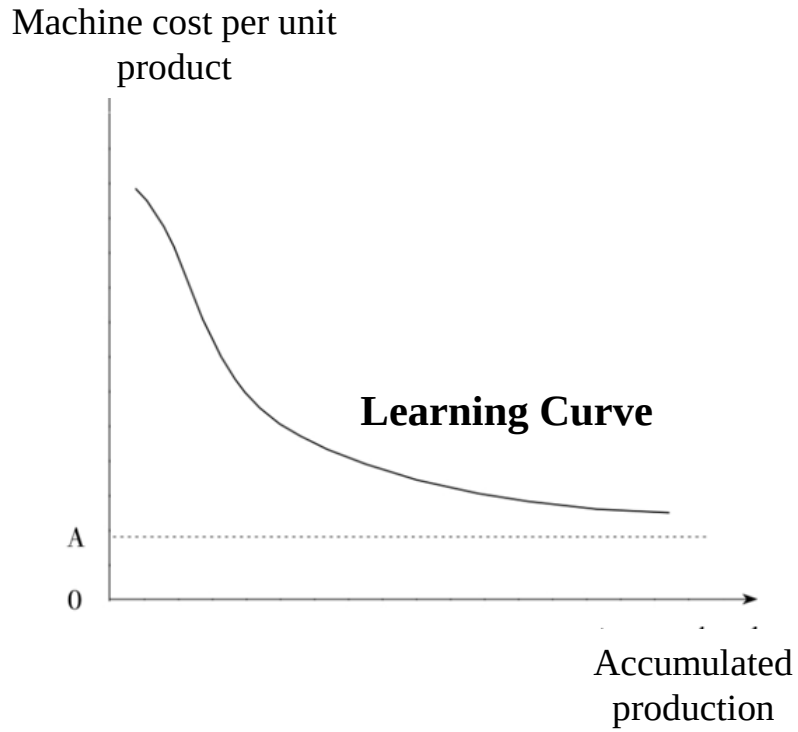
Companion type supplier (Tactical partners)	
Relationship characteristics	Tactical considerations
Supply characteristics	Customers **regularly provide material demand plans** to suppliers
Contract type	**Annual orders Quality orders**
Price target	Price & Price reduction target

Problem 3.2-Business Means: *Supplier Quotation Evaluation*

Problems

Outsourcing suppliers increase prices





Cost Split Quotation

Material Requirement List					Supplier filling out list						
Order number	Material code	Material Name	Order quantity	Minimum order quantity	Material cost	Process cost	Management expense	Profit rate	Tax rate	…	Unit-price (excluding taxes)
1		A									
2		B									
…											

Problem 3.2-Business Means: *Supplier Development*

Problems

Outsourcing suppliers increase prices

Refuse to rely on a single supplier & Select lower-priced suppliers for development to establish strategic partnerships

- Supply
- Service
- Quality
- Price
- Cooperation

→ Supplier Selection → Supplier Development →

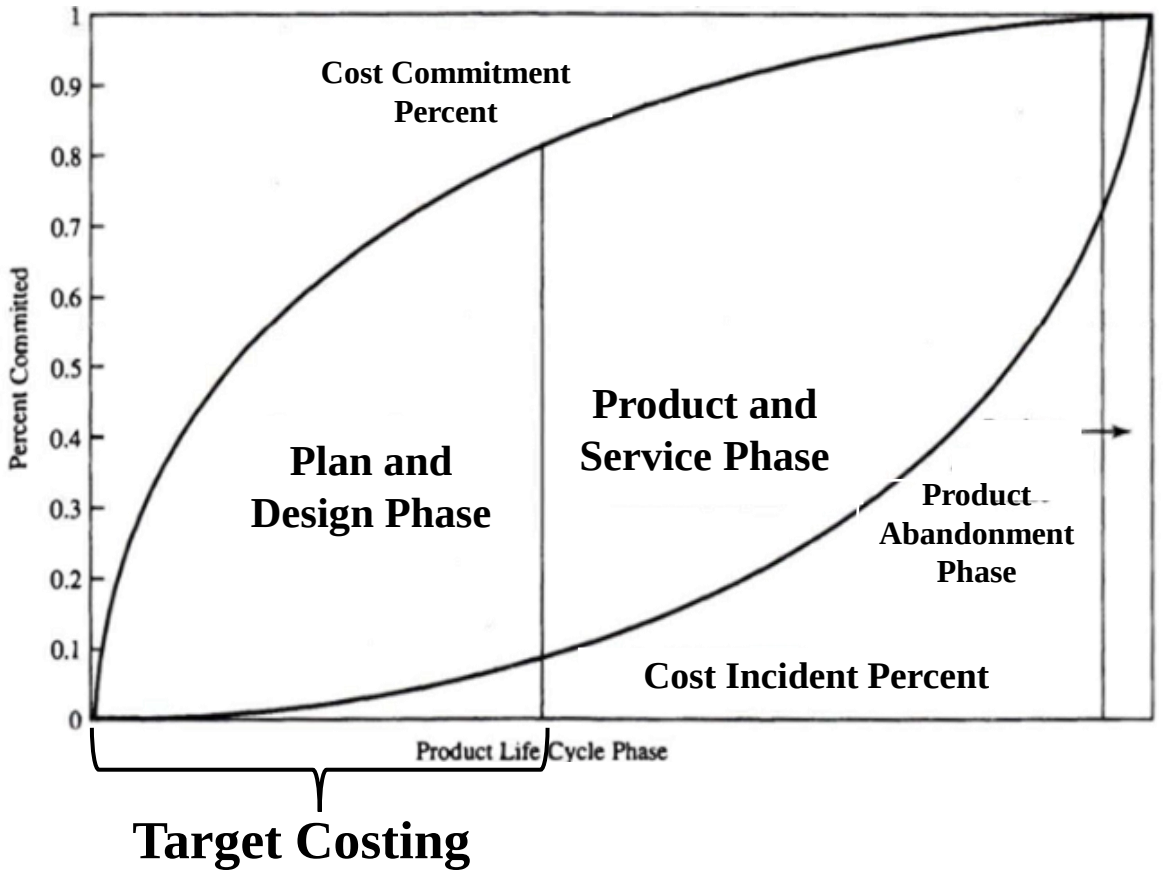
Definition	Define the problem and clarify the requirements
Weigh	Compare and clarify improvement points
Analyse	Analyze supplier weaknesses and develop improvement plans
Improve	Implement improvement plans
Control	Refer to customer feedback and continue to improve

Problem 3.3 – Management Means: *Target Costing*

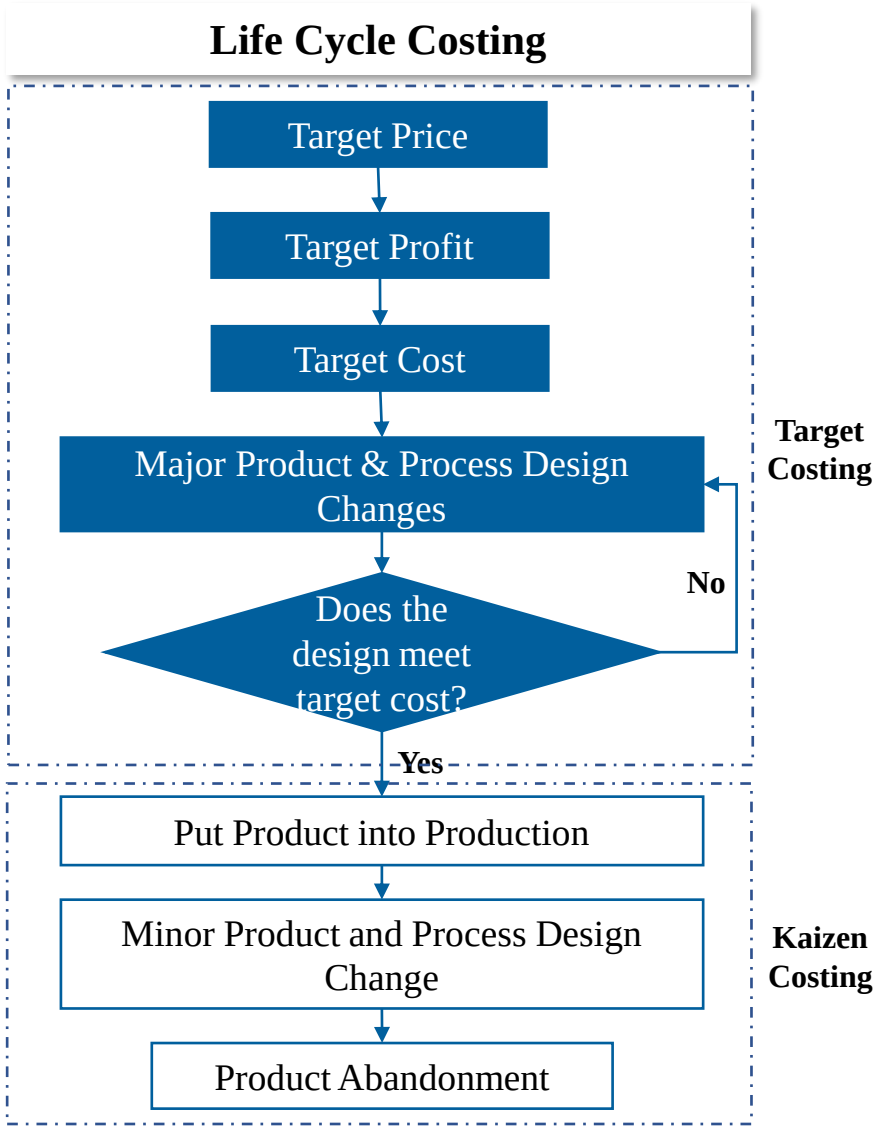
Problems

Quotation of competitor is 10% lower than us, our weight of junction box is unreasonable

Realize Cost Control at Plan and Design Phase



Problem 3.3 – Management Means: *Target Costing*



Cleantech needs to improve product & process design

Tear down analysis - Benchmarking
Competitor's price is 10% lower

⇩

Quality Function Deployment - Understand Customer's Need
Weight is 20% higher than competitors,
not relevant with customer's need

⇩

Value Engineering - Value Optimization
Suppliers involve in design ⇨ Reduce weight ⇨ Reduce Cost Per Piece

⇩

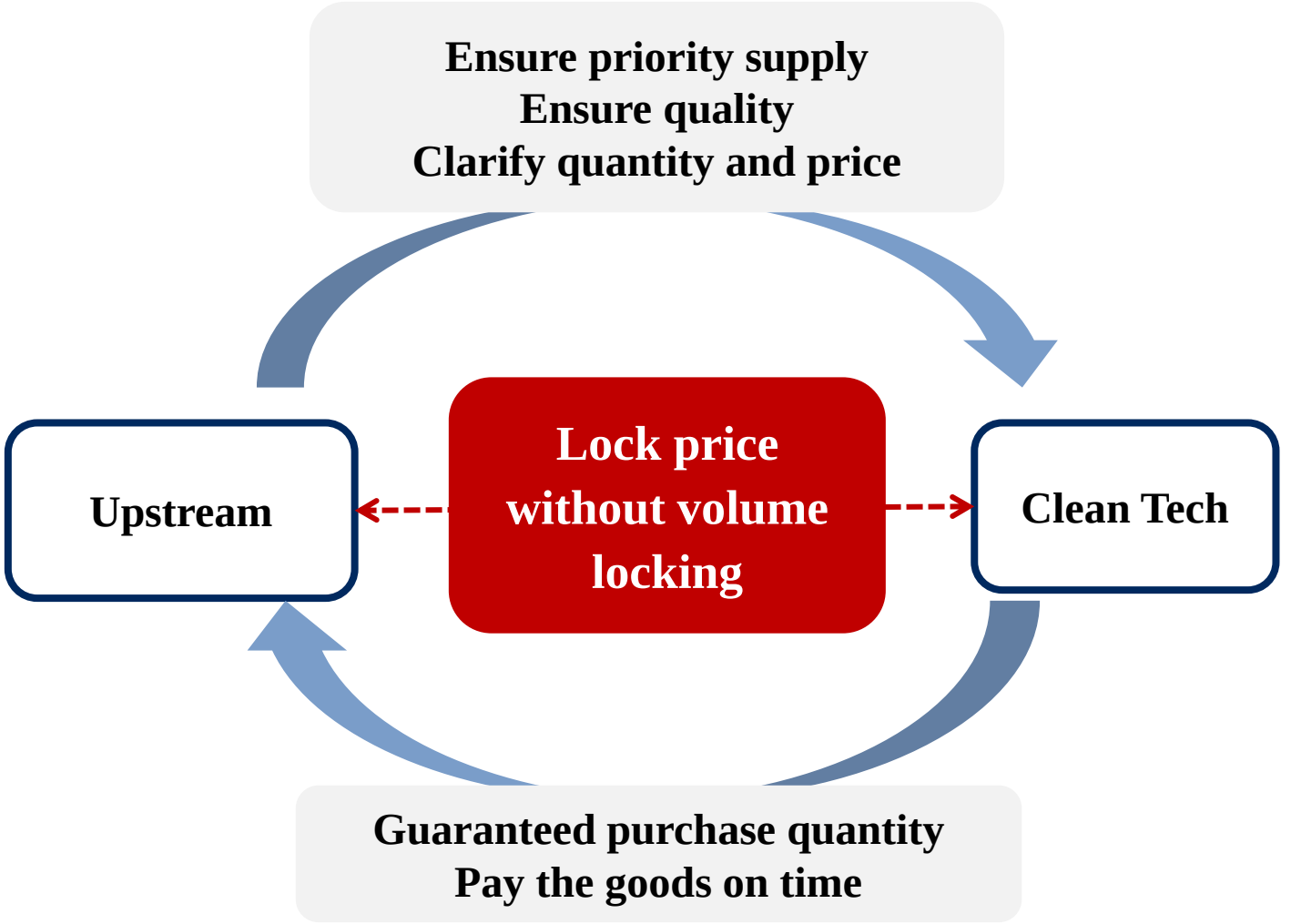
Reengineering - Optimize Process Design

Problem 3.4 – Business Means: *Long Order Agreement*

Problems

9%① price increase of plastic particles, whether stock large amount or not?

① referred from QC Solar



Problem 3.4 –Management Means: *Improved EOQ Model*

Problems

9%① price increase of plastic particles, whether stock large amount or not?

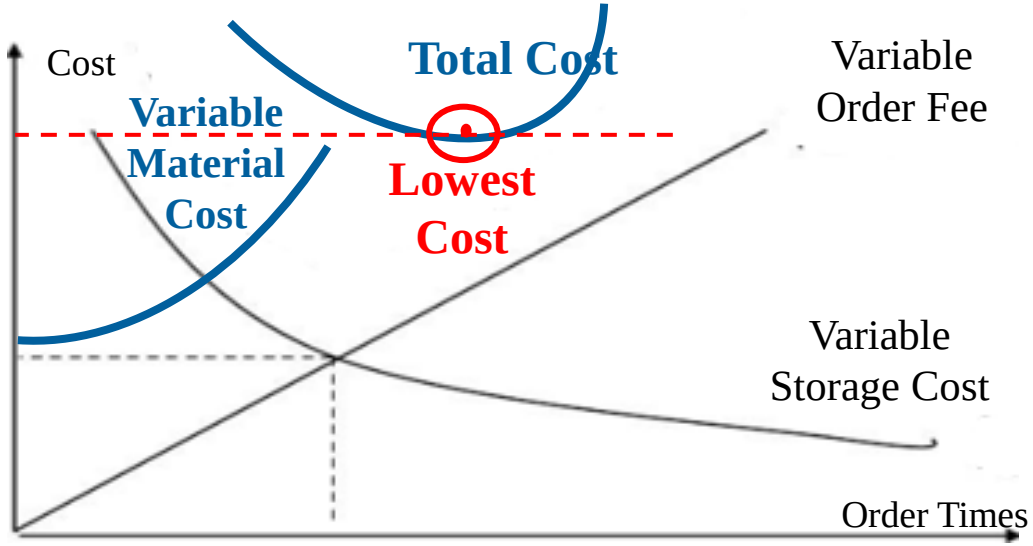
① referred from QC Solar

Use data to forecast price growth

Hypotheses for Cleantech:

- **H1: Price of raw material increases;**
- H2: There is no leading time pf procurement;
- H3: There is no insurance reserves for cleantech;
- H4: Timely supply and consumption.

Improved EOQ Model



Use improved EOQ to determine storage and order cycle

Problem 3.5 – Management Means: *Vendor-managed Inventory (VMI)*

Problems

Unstable of procurement cycle of diodes, how to reduce shortage risk?

VMI is difficult to execute, is it feasible for Cleantech?

To successfully use VMI, Cleantech and supplier should:

- Have advanced information systems;
- Establish a strategic partnership;
- Sign framework agreement.

	QC Solar	TongLin Electric
Information systems	✓	✓
Strategic partnership	×	✓
Framework agreement	×	✓
VMI	×	✓

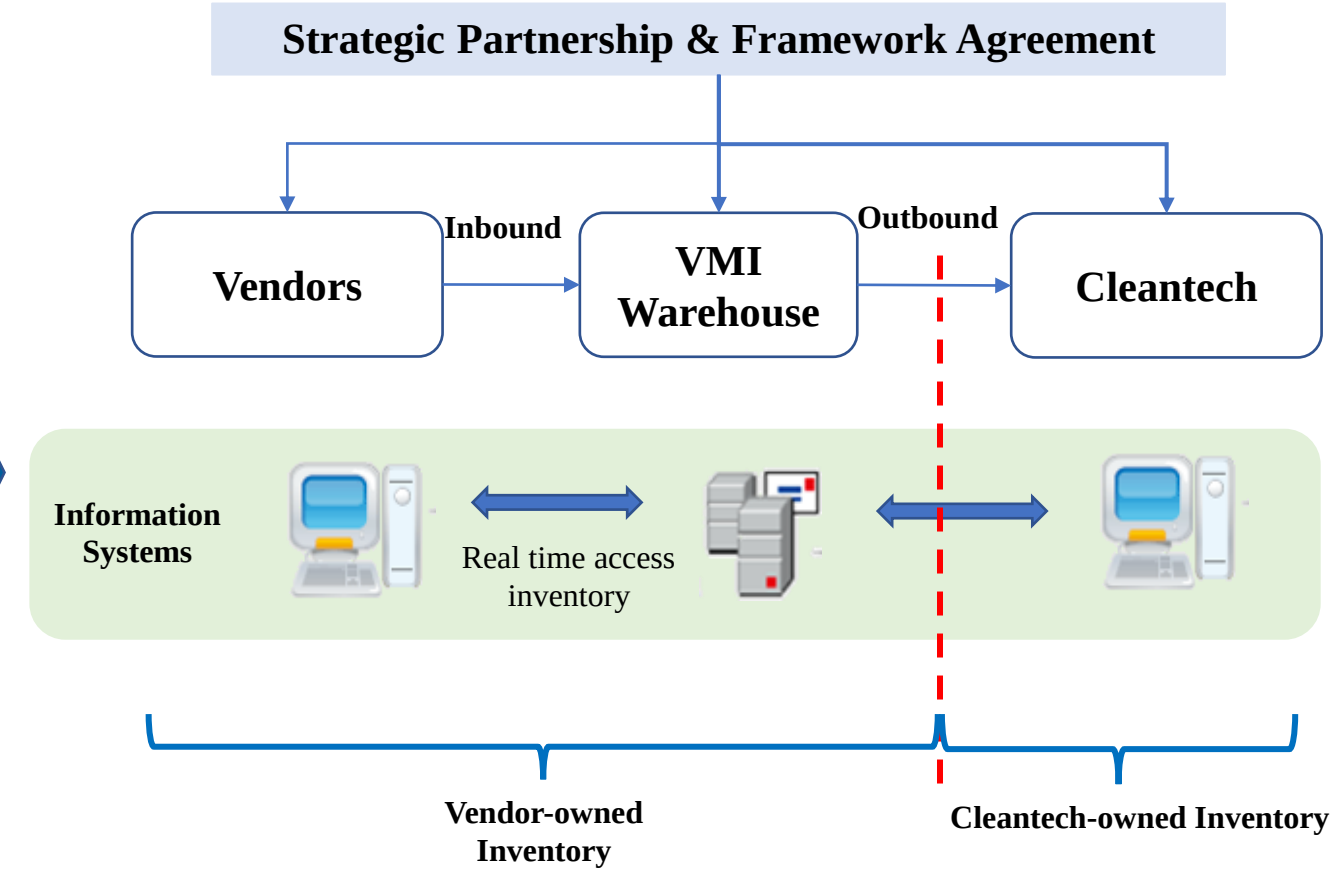
Peer companies partly use VMI, it is feasible.

Cleantech can try VMI!

Problem 3.5 – Management Means: *Vendor-managed Inventory (VMI)*

Bullwhip Effect deteriorate order fluctuation and increase inventory storage cost

Increase fluctuation & storage cost



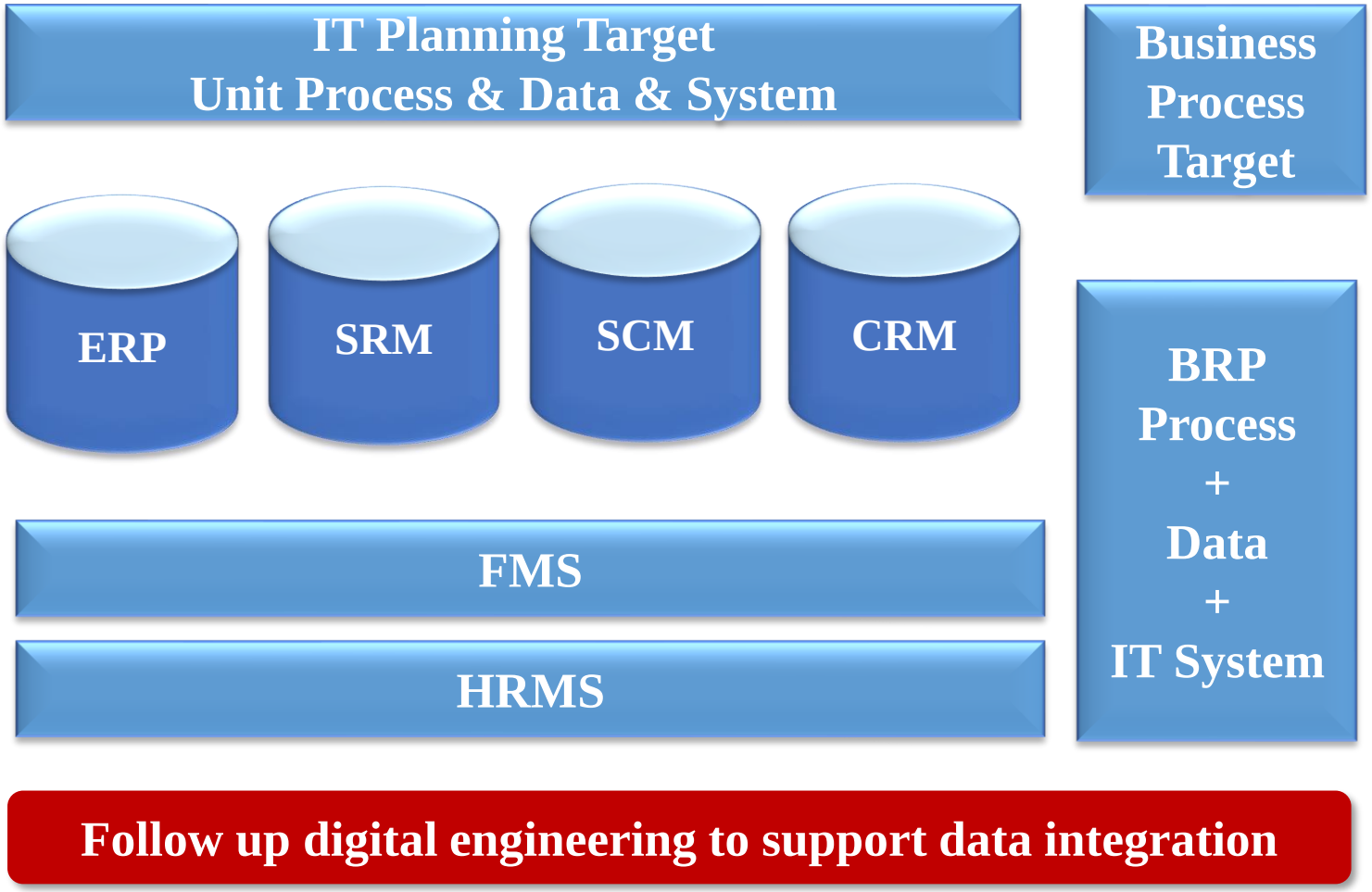
VMI reduces inventory costs by inhibiting Bullwhip Effect

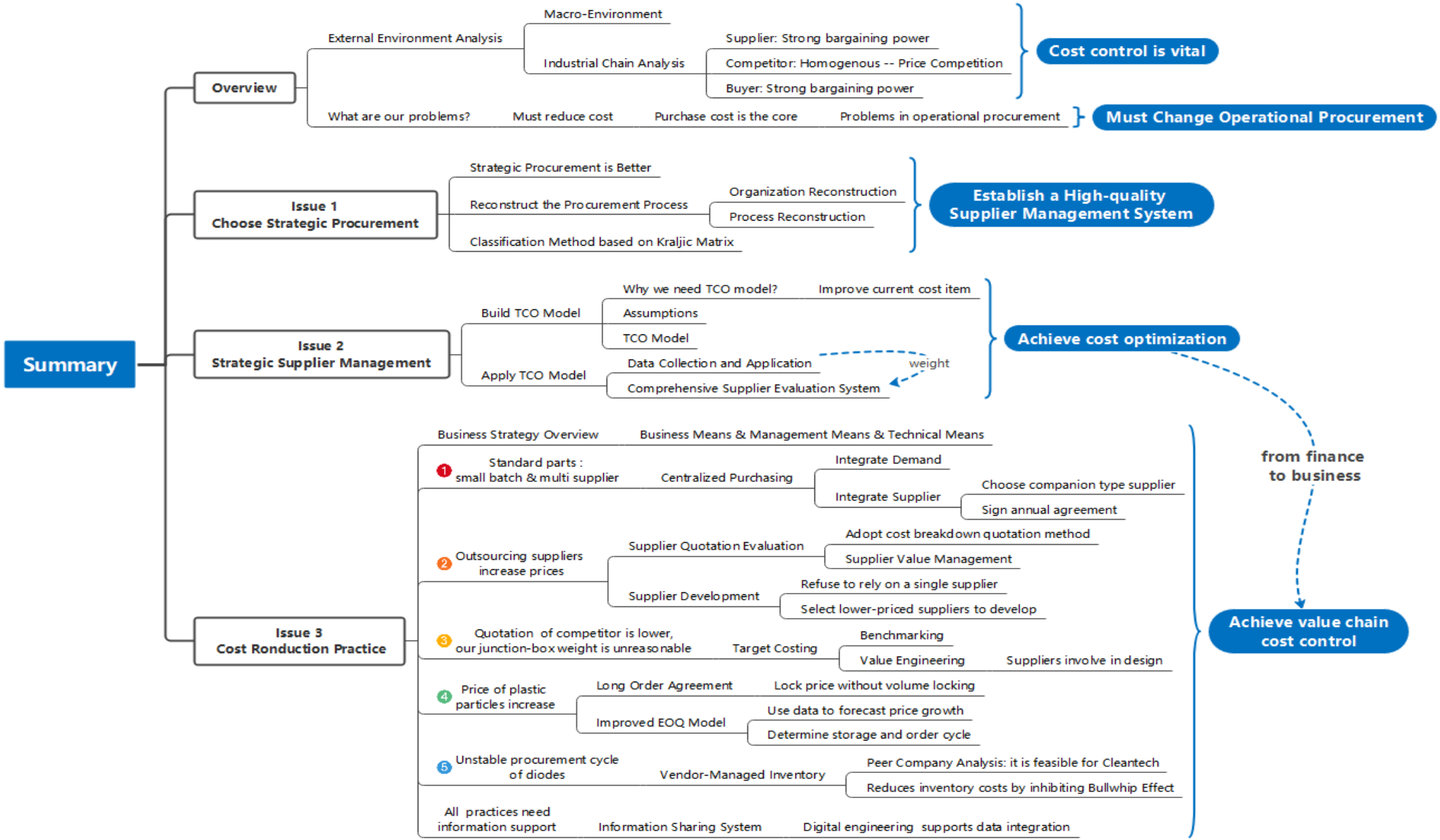
Technical Means: *Build Information Sharing System*

Problems

All practices need information support

Information Sharing System




Summary
Overview
External Environment Analysis
Macro-Environment
Industrial Chain Analysis
Supplier: Strong bargaining power
Competitor: Homogenous -- Price Competition
Buyer: Strong bargaining power
Cost control is vital
What are our problems?
Must reduce cost
Purchase cost is the core
Problems in operational procurement
Must Change Operational Procurement
Issue 1
Choose Strategic Procurement
Strategic Procurement is Better
Reconstruct the Procurement Process
Organization Reconstruction
Process Reconstruction
Classification Method based on Kraljic Matrix
Establish a High-quality Supplier Management System
Issue 2
Strategic Supplier Management
Build TCO Model
Why we need TCO model?
Improve current cost item
Assumptions
TCO Model
Apply TCO Model
Data Collection and Application
weight
Comprehensive Supplier Evaluation System
Achieve cost optimization
from finance to business
Issue 3
Cost Ronduction Practice
Business Strategy Overview
Business Means & Management Means & Technical Means
1
Standard parts : small batch & multi supplier
Centralized Purchasing
Integrate Demand
Integrate Supplier
Choose companion type supplier
Sign annual agreement
2
Outsourcing suppliers increase prices
Supplier Quotation Evaluation
Adopt cost breakdown quotation method
Supplier Value Management
Supplier Development
Refuse to rely on a single supplier
Select lower-priced suppliers to develop
3
Quotation of competitor is lower, our junction-box weight is unreasonable
Target Costing
Benchmarking
Value Engineering
Suppliers involve in design
4
Price of plastic particles increase
Long Order Agreement
Lock price without volume locking
Improved EOQ Model
Use data to forecast price growth
Determine storage and order cycle
5
Unstable procurement cycle of diodes
Vendor-Managed Inventory
Peer Company Analysis: it is feasible for Cleantech
Reduces inventory costs by inhibiting Bullwhip Effect
All practices need information support
Information Sharing System
Digital engineering supports data integration
Achieve value chain cost control

“Strategic Procurement TCO” + “Value Chain Cost Control”

From Finance to Business,
Cleantech will successfully control cost!

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Annex1: Questionnaire on the Importance of Indicators

Scale	Meaning
1	Both factors are of equal importance.
3	Compared to the latter, the former is slightly more important.
5	Compared to the latter, the former is clearly more important.
7	Compared to the latter, the former is strongly more important.
9	Compared to the latter, the former is absolutely more important.
2,4,6,8	The compromise of the above adjacent values.
Countdown	The ratio of the importance of factors m to n is A_{mn} and the ratio of the importance of factors n to m is $A_{nm} = 1/A_{mn}$.

- Please fill in the numbers below the slant in the table below, the gray part of the results can be automatically generated without filling in.
- Reference example: If the quality indicators in the table below are significantly more important than the price indicators, then fill in 5 in row B2 and column B1.

	B1	**B2**	**B3**	**B4**	**B5**
B1	1				
B2		1			
B3			1		
B4				1	
B5					1

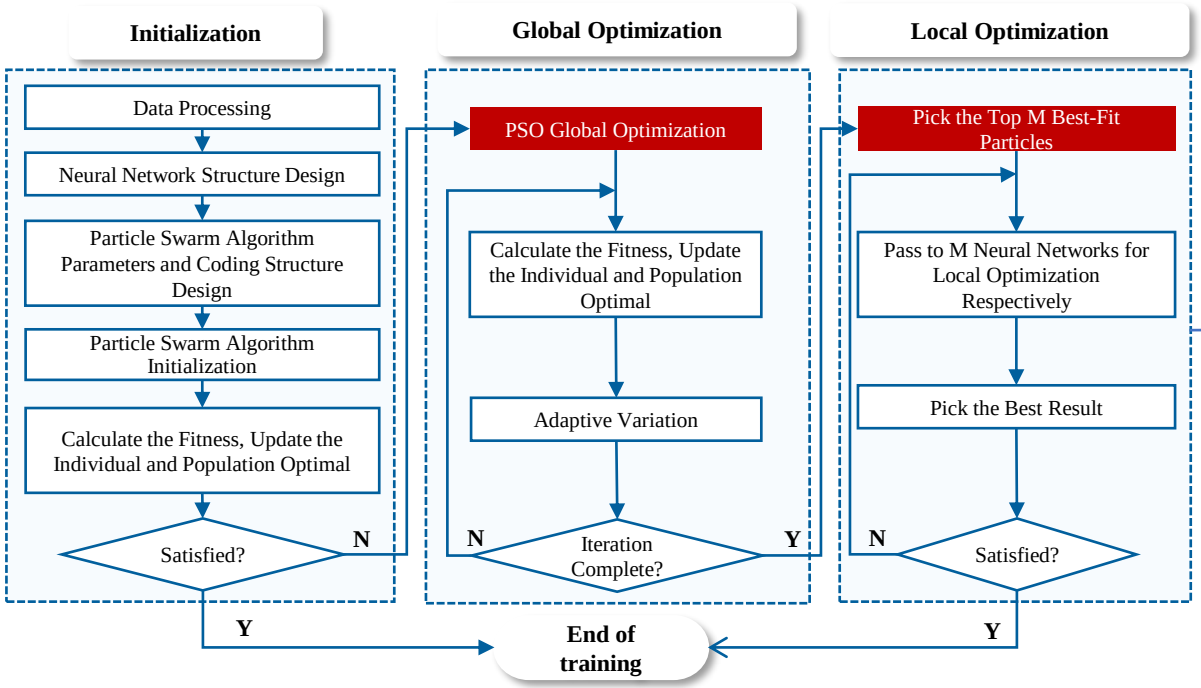
Annex2: AHP-based Assignment of Weights -- *Comprehensive Weights*

Target Layer	Guideline Level 1 Indicators	Weights	Guideline Level 2 Indicators	Weights	Combined Weights
Supplier Comprehensive Evaluation Index System **A**	Quality Cost Indicator $\mathbf{B_1}$	25.82%	External Failure Cost $\mathbf{C_1}$	46.11%	11.90%
			Internal Failure Cost $\mathbf{C_2}$	28.02%	7.23%
			Testing Cost $\mathbf{C_3}$	25.88%	6.68%
	Acquisition Cost Indicator $\mathbf{B_2}$	22.37%	Material Cost $\mathbf{C_4}$	42.44%	9.49%
			Order Fee $\mathbf{C_5}$	32.50%	7.27%
			Insurance Fee $\mathbf{C_6}$	25.07%	5.61%
	Shortage Cost Indicator $\mathbf{B_3}$	20.31%	Loss of Sales Opportunity $\mathbf{C_7}$	38.09%	7.74%
			Shutdown Loss $\mathbf{C_8}$	32.75%	6.65%
			Order Flexibility $\mathbf{C_9}$	29.16%	5.92%
	Supply Chain Cost Indicator $\mathbf{B_4}$	16.86%	Freight $\mathbf{C_{10}}$	36.12%	6.09%
			Loading and Unloading Fees $\mathbf{C_{11}}$	32.27%	5.44%
			Service Response Cost $\mathbf{C_{12}}$	31.61%	5.33%
	Storage Cost Indicator $\mathbf{B_5}$	14.65%	Warehousing Fee $\mathbf{C_{13}}$	48.30%	7.07%
			Fund Occupancy Expense $\mathbf{C_{14}}$	26.37%	3.86%
			Normal Loss Fee $\mathbf{C_{15}}$	25.33%	3.71%

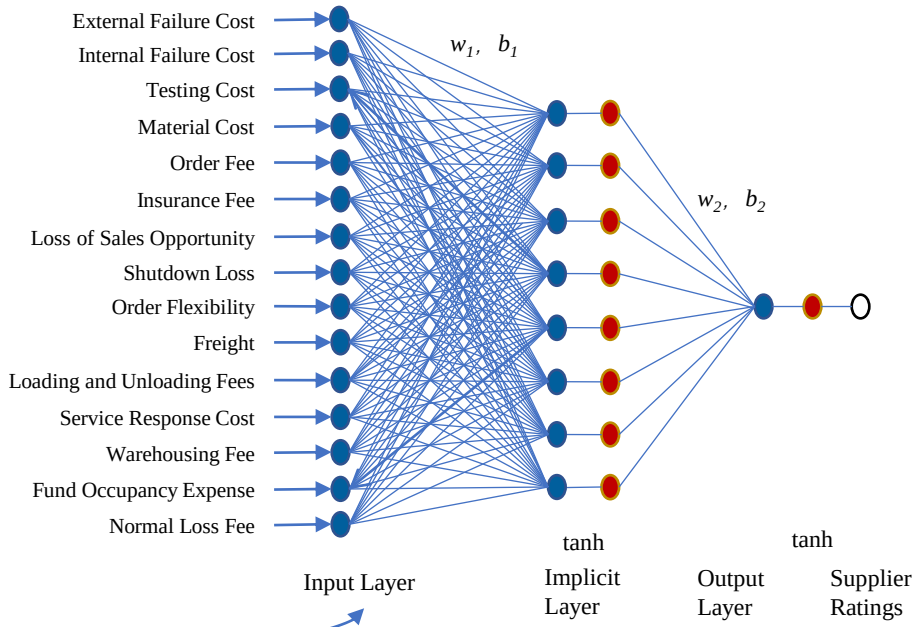
Annex3: Hybrid PSO-Adam Neural Network

- External suppliers are decentralized, diverse, dynamic and combinatorial.
- **DEA-AHP Model** is difficult to resolve **complex** environments and choices.

Block Diagram



Supplier Evaluation



Adapt to the current complex outsourcing environment and **improve** evaluation **efficiency**