

Metrics and Performance Measurement System for the Lean Enterprise



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October 24, 2005**



Overview

- **Metrics and Performance measurement**
 - Why measure? What is performance measure? What are good metrics?
- **Performance measurement and Lean Transformation**
- **Current practices and Performance measurement frameworks**
- **Performance measurement system for the lean enterprise**

Why Measure?

- ***“Performance control systems can serve two purposes, to measure and to motivate.”***

- H. Mintzberg,

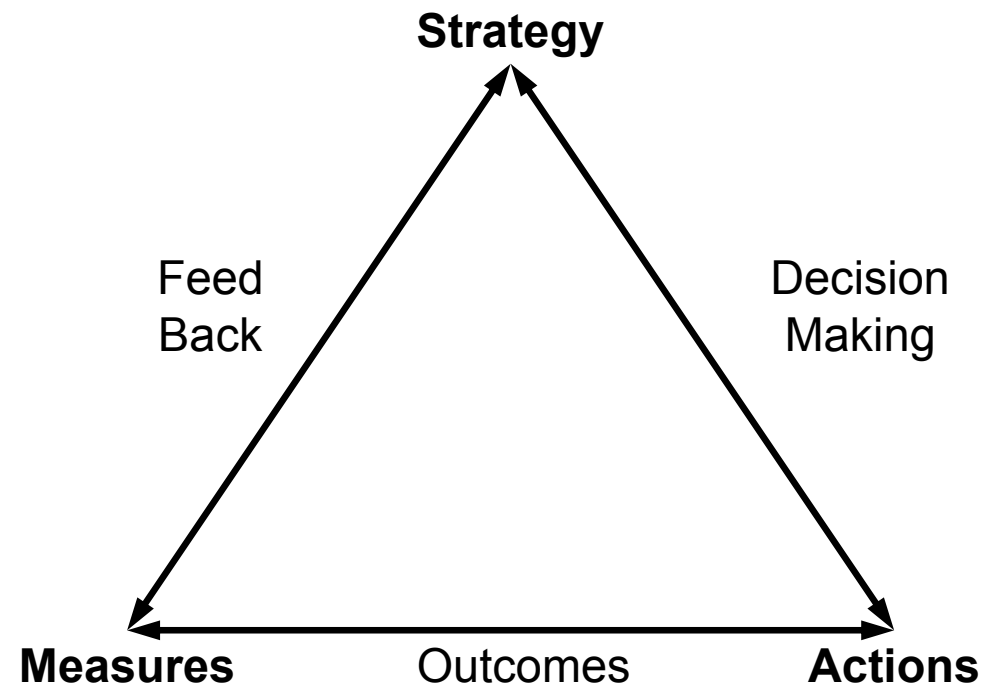
The Structure of Organizations, 1979

- ***“The firm becomes what it measures”***

- Hauser and Katz,

You are What You Measure, 2002

- ***Metrics serve multiple purposes!***



Robert Nixon (1990)



What is performance measurement?

- **Performance measurement is the process of measuring efficiency, effectiveness and capability, of an action or a process or a system, against given norm or target.**
- **Effectiveness is a measure of doing the right job - the extent to which stakeholder requirements are met.**
- **Efficiency is a measure of doing the job right - how economically the resources are utilized when providing a given level of stakeholder satisfaction.**
- **Capability is a measure of ability required to do both the job right and right job, in the short term as well as the long term. This can be tangible, such as, resources, technology, or intangible, such as a corporate culture.**



Characteristics of good metrics

- **Metrics are meaningful, quantified measures**
- **Metric must present data or information that allows us to take action**
 - Helps to identify what should be done
 - Helps to identify who should do it
- **Metrics should be tied to strategy and to “core” processes - indicate how well organizational objectives and goals are being met**
- **Metrics should foster process understanding and motivate individual, group, or team action and continual improvement.**



A “Good” Metric Satisfies Three Broad Criteria

1. Strategic

- **Enable strategic planning and then drive deployment of the actions required to achieve strategic objectives**
- **Ensure alignment of behavior and initiatives with strategic objectives**
- **Focus the organization on its priorities**

2. Quantitative

- **Provide a clear understanding of progress toward strategic objectives**
- **Provide current status, rate of improvement, and probability of achievement**
- **Identify performance gaps and improvement opportunities**

3. Qualitative

- **Be perceived as valuable by your organization and the people involved with the metric**



Metric Elements

Metric Elements	Explanation
Title	Use exact names to avoid ambiguity
Objective/purpose	The relation of the metric with the organizational objectives must be clear
Scope	States the areas of business or parts of the organization that are included
Target	Benchmarks must be determined in order to monitor progress
Formula	The exact calculation of the metric must be known
Units of measure	What is/are the unit(s) used
Frequency	The frequency of recording and reporting of the metric
Data source	The exact data sources involved in calculating a metric value
Owner	The responsible person for performance of that part of the organization, collecting data and reporting the metric
Comments	Outstanding issues regarding the metric

Adapted from Neely, A., et al. (1995a) Performance measurement system design. 15, 80.



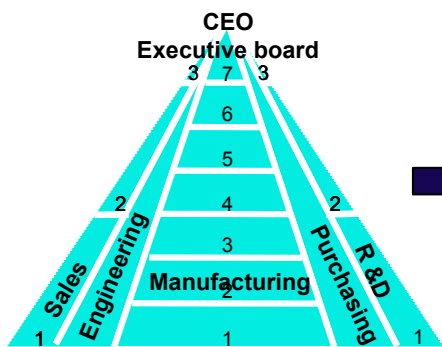
Role of Performance Measurement

- **Monitoring**
 - Measuring and recording actual performance
- **Control**
 - Identifying and attempt to close the gap between planned target and actual performance
- **Improvement**
 - Identify critical improvement opportunities
- **Coordination**
 - Information for decision making – Leading Indicators
 - Internal communication across processes
 - External communication with stakeholders
- **Motivation**
 - Align Behavior and encourage transformation

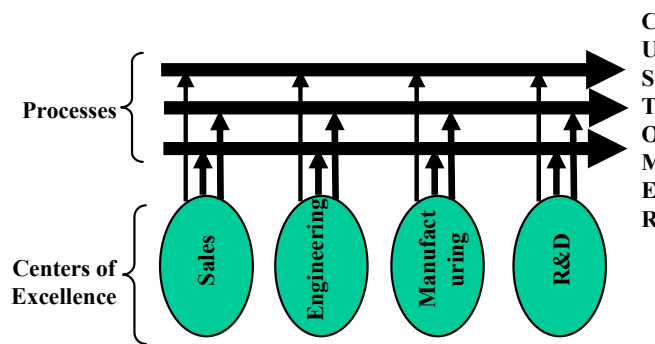
Source: Vikram Mahidhar

Transformation to the Lean Enterprise

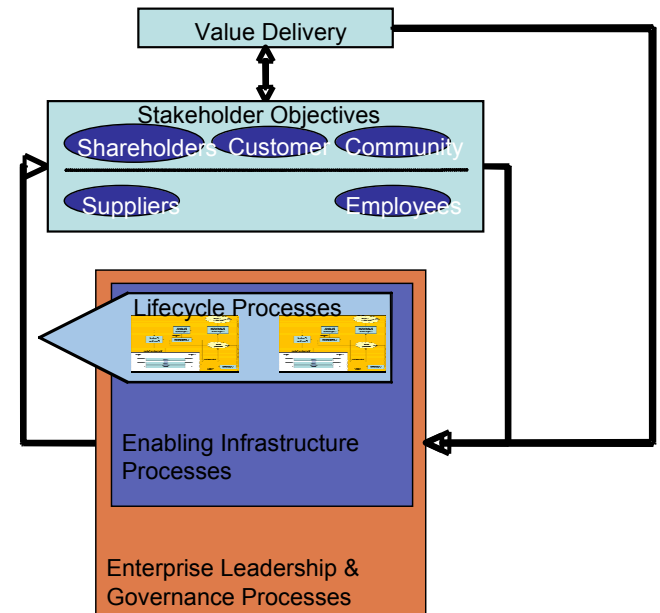
Functional Enterprise



Process Enterprise



Lean Enterprise



Source: Vikram Mahidhar



Metrics Challenge Today

- ***Hierarchical* organizational architectures giving way to *networked* enterprise architectures**
- **The evolving structure and dynamics of networked enterprises display immense complexity**
- **Metrics response to such complexity has been a disappointment:**
 - Hierarchical metrics mindset still continues
 - Response to greater complexity has been a metrics explosion
- **Challenge: How best to design metrics systems for networked enterprises?**



Performance measurement system for Lean Transformation

Knowledge and Behavior

New enterprise capability

Integration of processes/methods & tools supporting transformation across the value stream enabling new enterprise capabilities

New local behavior

Shift in thinking and behavior

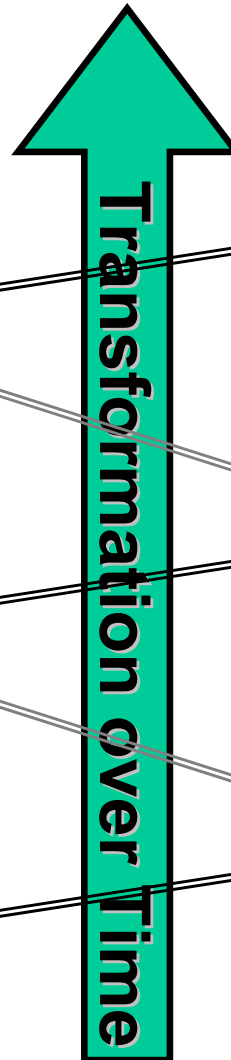
New routines and ways of doing business

Organization and group culture change

New approaches (training and introduction of new methods)

Engagement in "LAI-venue" with like-minded people

Enterprise simulation, Lean Now and LAI knowledge area teams



Metrics and Assessments

Enterprise impact and results

Industry
ROIC

Government
ORPIC

Local results and visible indicators

Industry

Government

Cycle time, quality, WIP, on-time delivery, customer satisfaction, employee turnover and attitude, organizational climate and LESAT maturity

Local efforts and new capabilities

Industry

Government

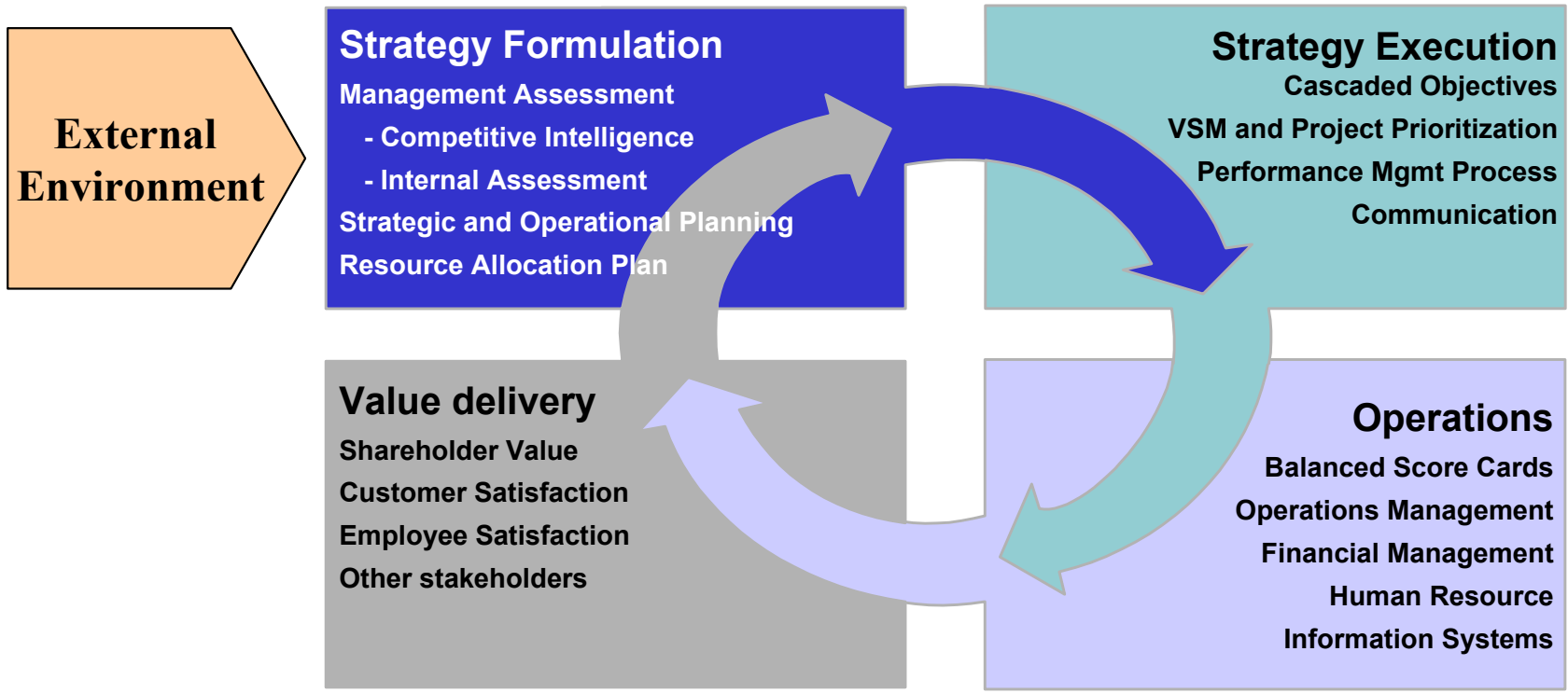
Skills, training hours, certification, lean deployment, joint assessments and efforts

ROIC = Return on Invested Capital

ORPIC* = Operational Readiness per Invested Capital

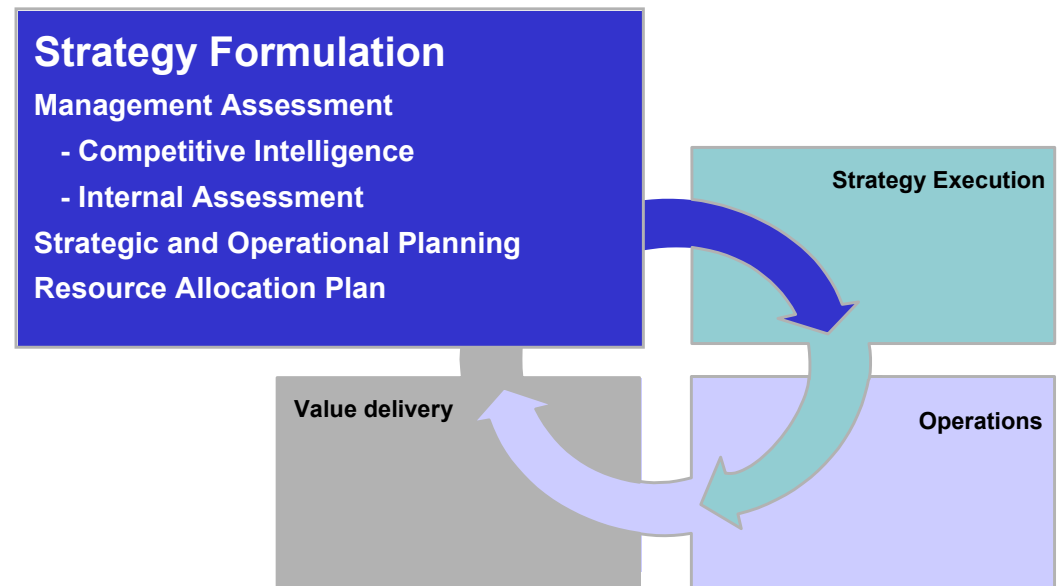


Generic Enterprise Management Process



Strategic Metrics

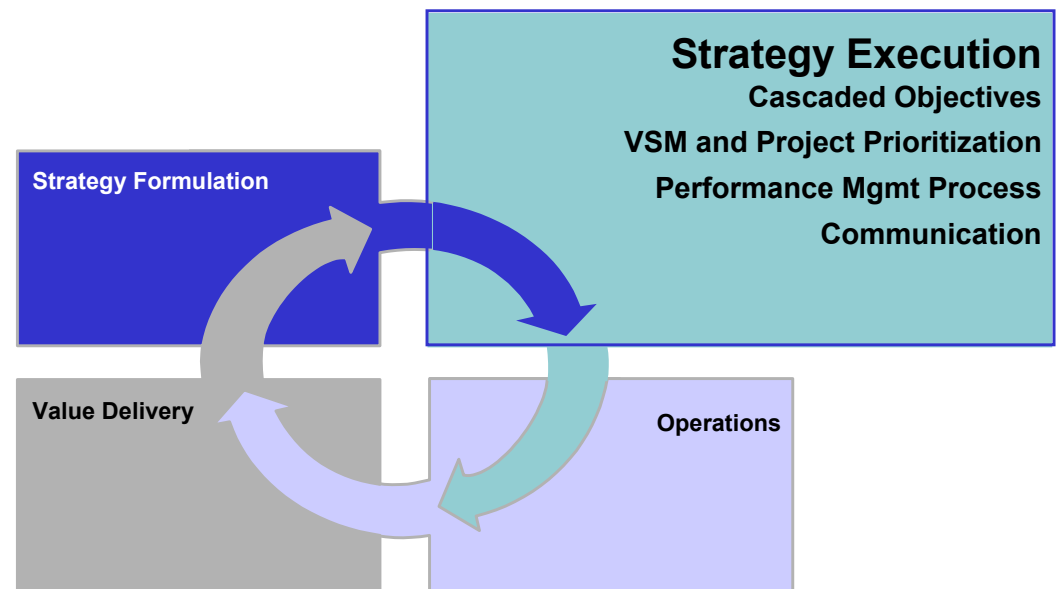
- ROIC (Return on Invested Capital)
- Economic Value Add (EVA)
- Net Operating Profit
- Inventory Turnover
- Revenue
- Cash flow
- Market Position
- Wall Street Expectations



Efficiency metrics and Lagging indicators

Tactical Metrics

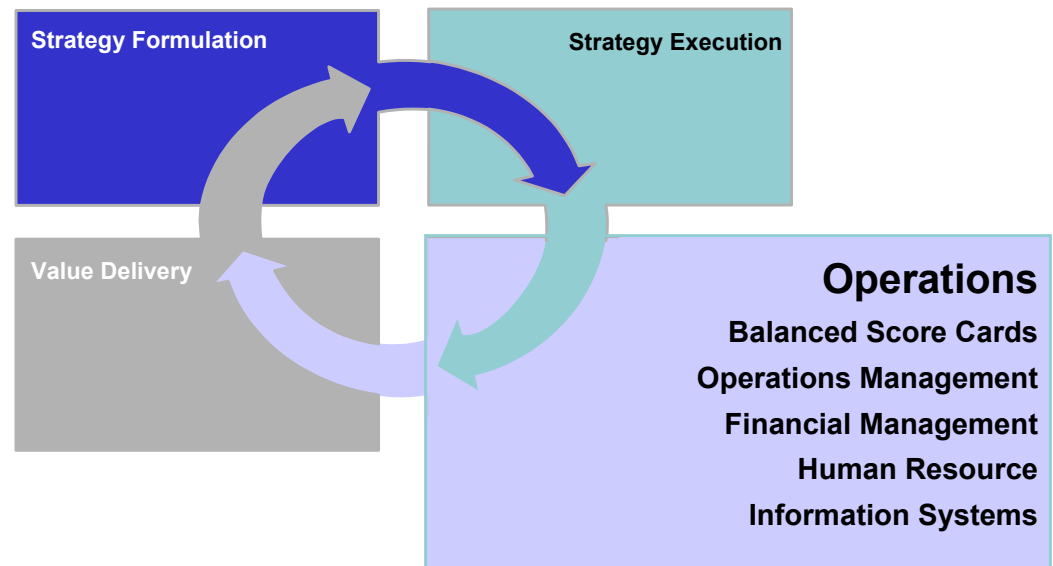
- **Financial Turnover**
- **Budget/Cost and Expenses**
- **Cost of quality**
- **Productivity**
- **Supply Chain Excellence**
- **Regulatory and social compliance**



Accuracy and timeliness of reporting and control

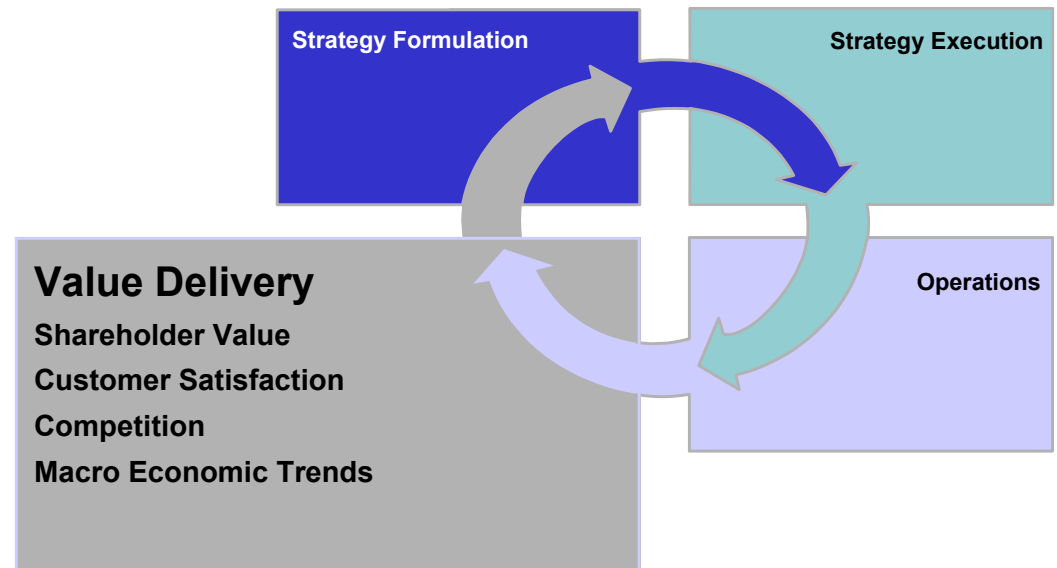
Operational Metrics

- **Safety**
- **Quality**
- **Environment**
- **Cost/Manufacturing Efficiency**
- **Delivery**
- **Time to market**
- **Education and development**
- **Time to Hire**

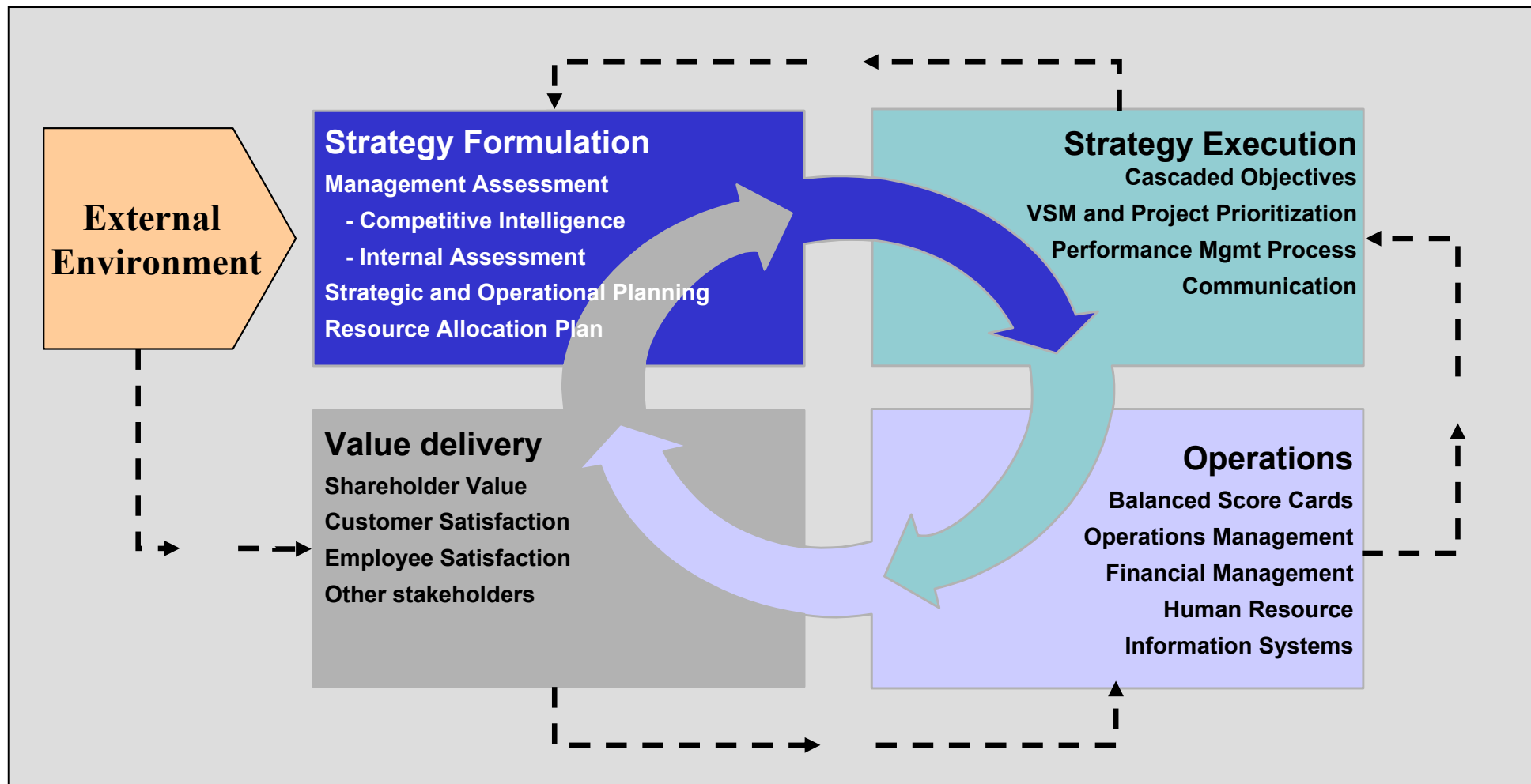


Value Delivery Metrics

- **Stock Price**
- **Revenue**
- **On time delivery**
- **Customer satisfaction and loyalty**
- **Employee Satisfaction**
- **New product Introduction**

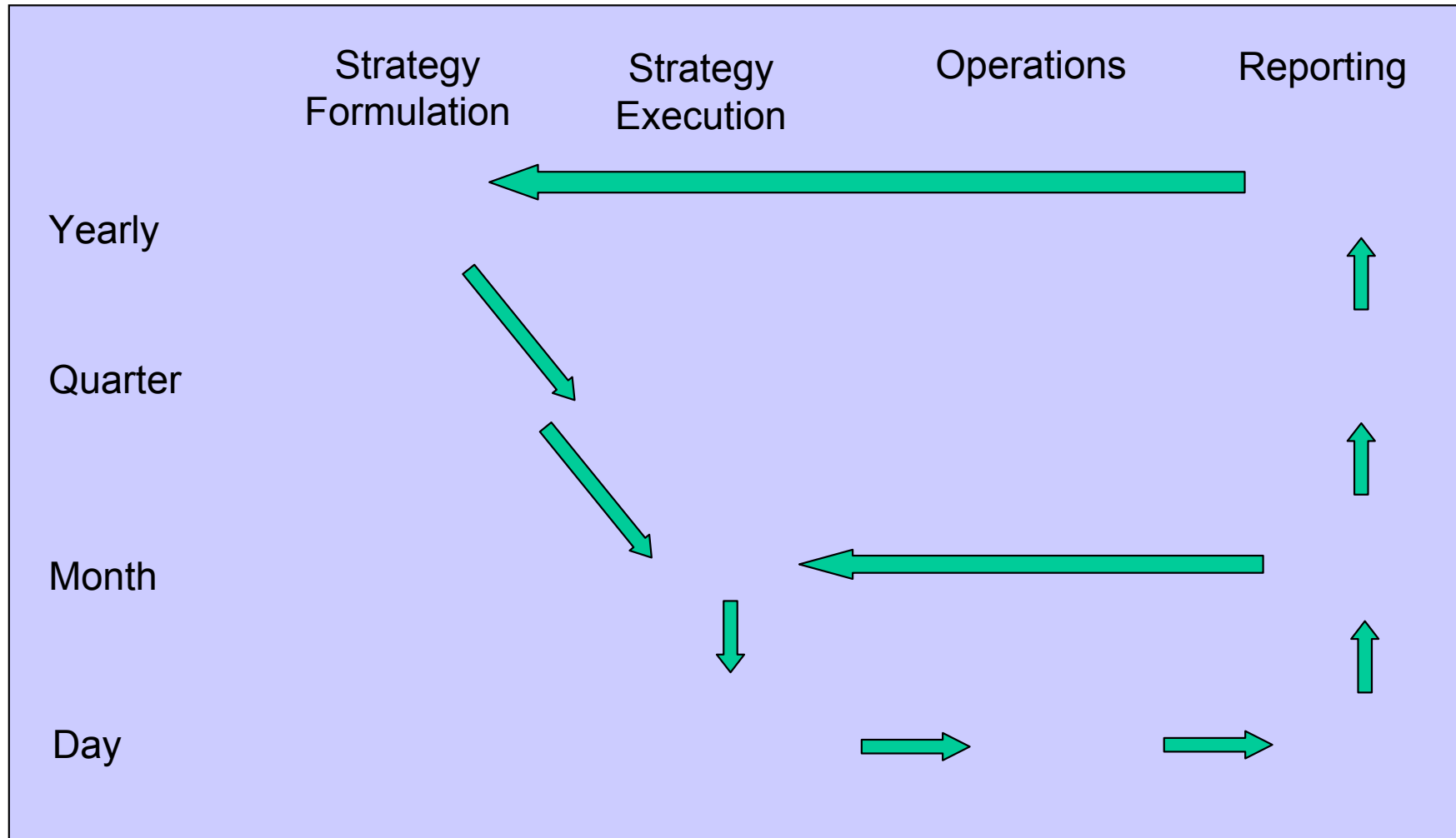


Time lags - Performance Management Process





Time lags - Performance Management Process

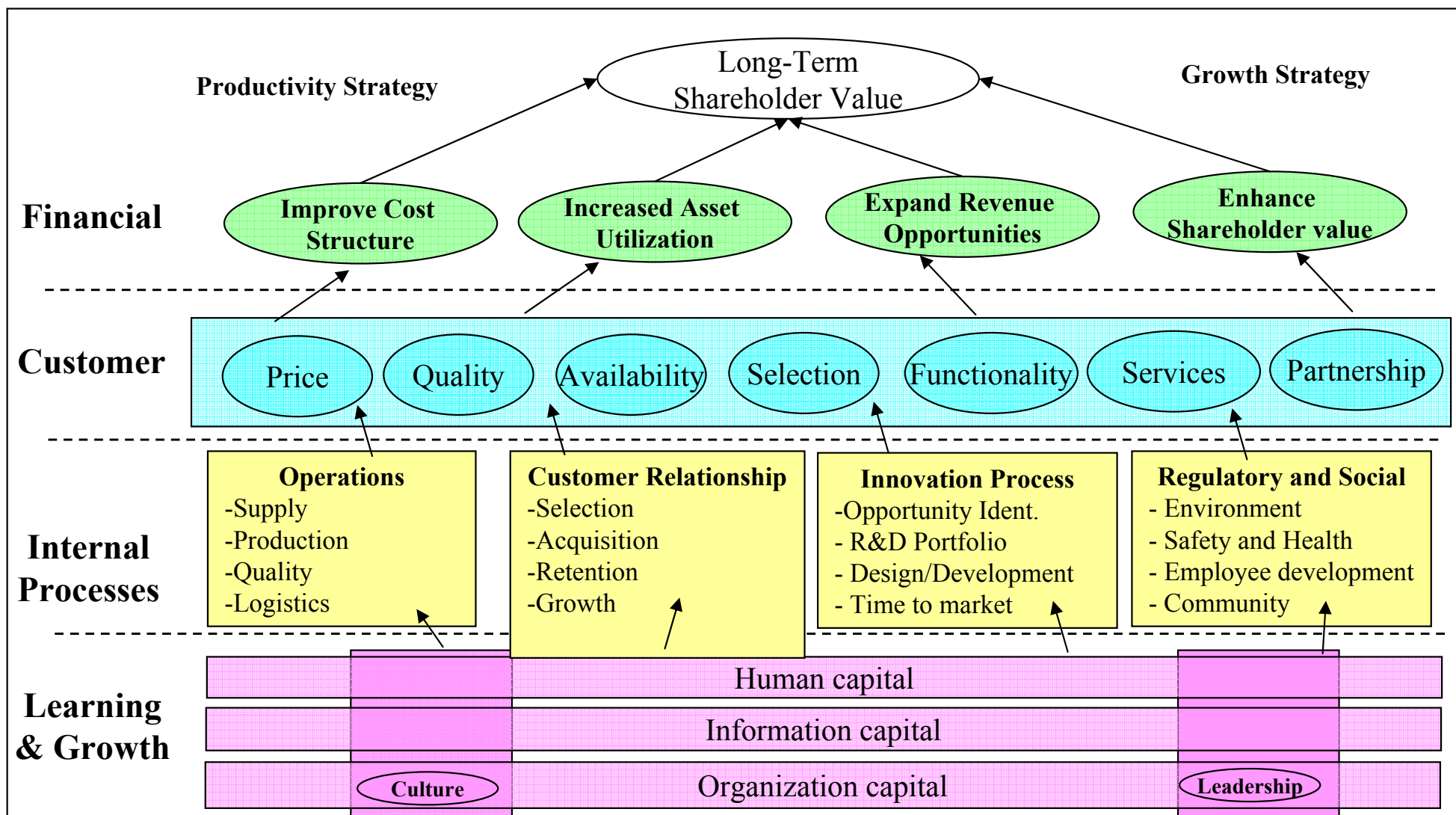




Performance Measurement & Management Frameworks

- **Balanced Scorecard – More than 50% companies have implemented in the US**
- Performance Prism
- European Foundation Quality Framework
- X-Matrix (EV SMA)

Balanced Scorecard/Strategy Map



Adapted from : Kaplan and Norton, (2000) "Having Trouble with your strategy? Then Map it!" Harvard Business Review Sept_Oct 2000



Primary Purposes of the Balanced Scorecard

- **Align a balanced set of performance metrics with business strategy and vision**
- **Provide management and work teams with the information necessary and sufficient to meet their objectives and goals**
- **Create “line-of-sight” at lower levels of the organization**
- **Foster and support process continuous improvement initiatives**

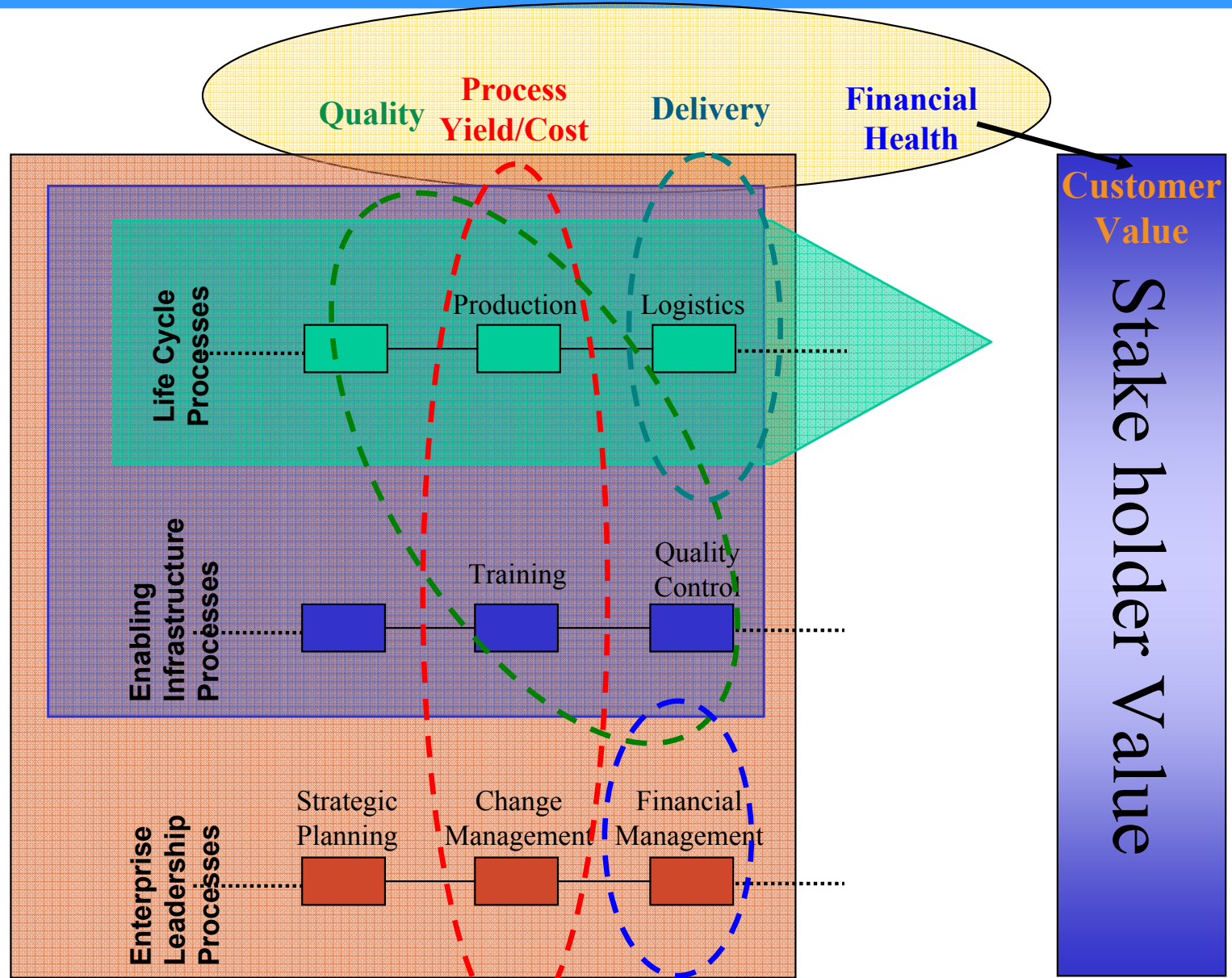


Desired Characteristics of Performance Measurement Systems

- **Performance Measures should support the strategic intentions of the organizations**
- **Managers at all levels should understand both drivers and results of their activities.**
- **Explicating Cause-Effect relationships between drivers and results**



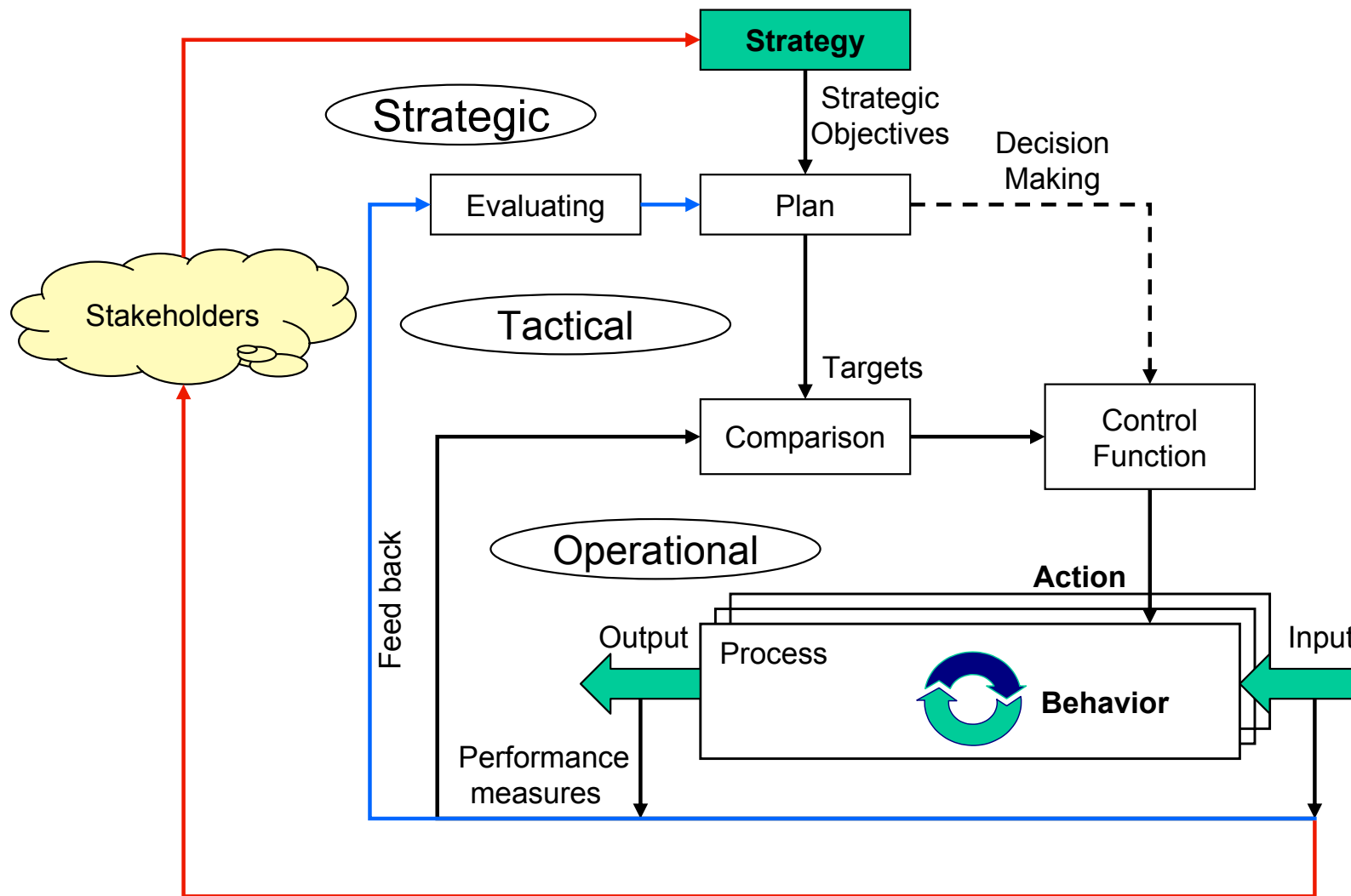
Lean Enterprise Metric Interdependencies



Source: Vikram Mahidhar



Process Control View – Performance Measurement System



Source: Vikram Mahidhar

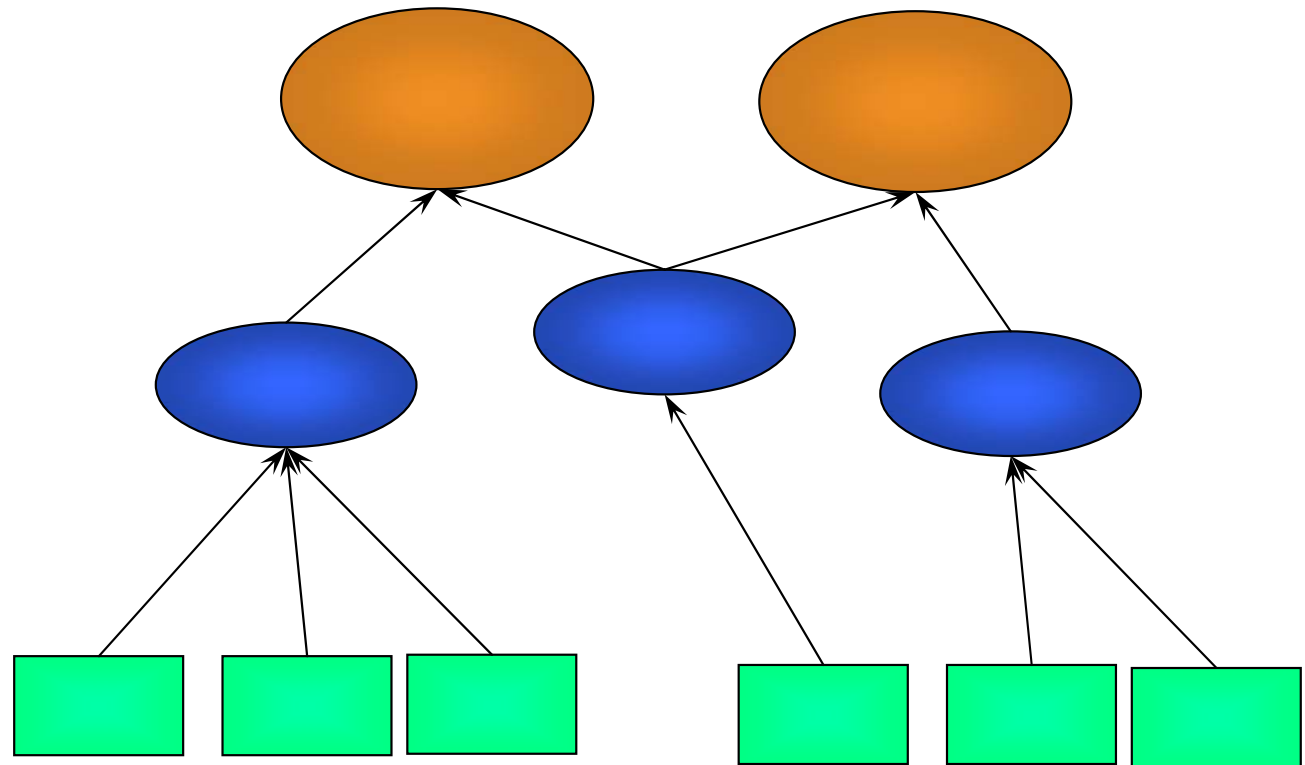
Understanding Performance Measurement Structures – Causal Models



Metric Cluster

Metric Set

Individual Metric





No One “Right” Set of Metrics

- **The balanced scorecard has to be tailored to each specific company**
- **The resulting scorecard of indicators should be driven by the firm’s strategy if it is not to consist merely of a listing of indicators:**

“...although there may be a potentially long list of non-financial indicators, individual firms have to be selective by linking explicitly their choice of indicators to their corporate strategy.”



Assessing a Performance Measurement System

- Does it clearly define what constitutes business excellence?
- Does it provide the information required to set aggressive yet achievable strategic objectives and stretch goals?
- Does it accurately portray our progress and probability of achieving both long-term strategic objectives and near-term milestones?
- Does it identify the root causes of barriers?
- Does it focus the organization on the priority improvement needs?
- Does it drive the behavior and actions required to achieve the objectives?
- Does it align work with value?
- Is it easy to use?
- Does it involve everyone?



Metrics Will Change Over an Item's Life Cycle

Entity	Phases	Attributes
Business	Emerging Growth Mature Declining	<ul style="list-style-type: none"> • Cash flow • Competitive advantage • Market share • Critical Mass
Product	Concept Development In market Phase-out	<ul style="list-style-type: none"> • Creative backlog • Potential product revenue • Cost per feature • Time to market • Performance requirements • Predicted product quality • Design to cost • Profitability • Market expansion rate • Volume impact on cost • Inventory • Customersupport
Core Competency	Recognition Learn Practice Expert	<ul style="list-style-type: none"> • Inventory of skills and capabilities • Competitive advantage • Acquire knowledge • Cycles of learning • Use • Apply • Levels of use in organization • Deployment • Teach • Leverage advantage • Combine and evaluate



Process and Metric Maturity Model

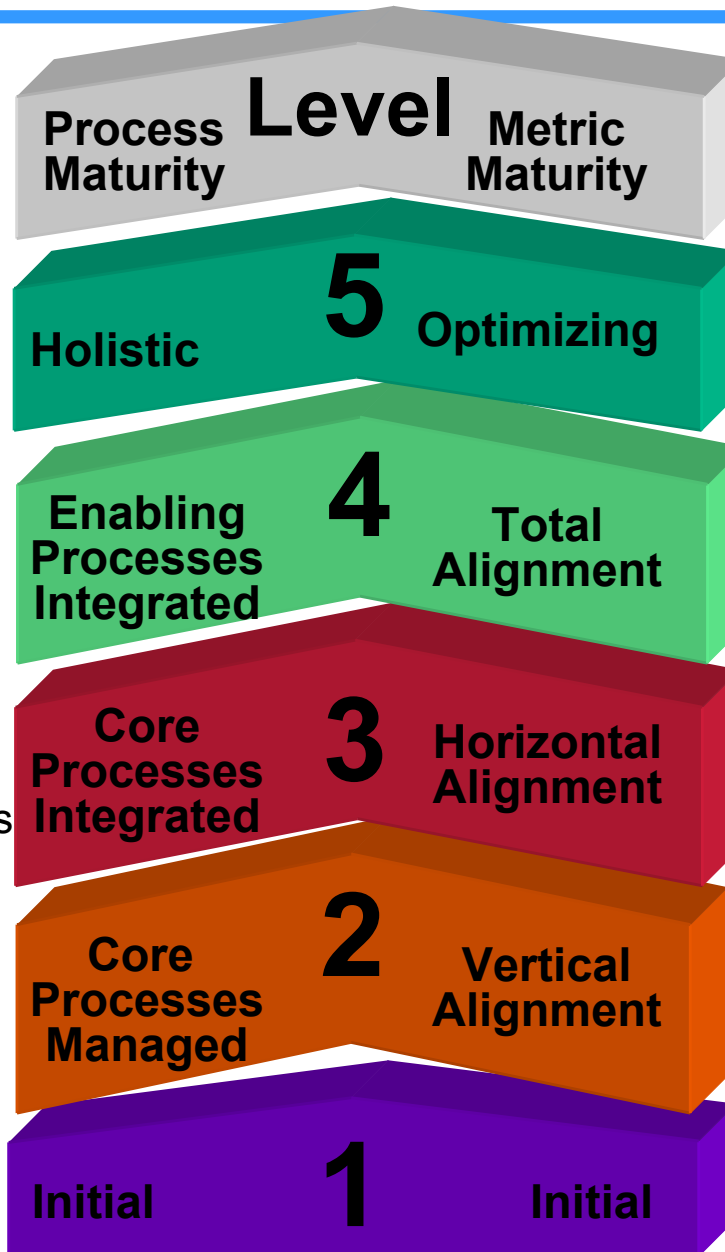
Process management has provided world-class competitive advantage (e.g., nodal influence, agile & forward looking)

Support processes are integrated with and enable core business processes to provide competitive advantage. Customer-focused process management is applied unconsciously

Common process language & specs Integrated core processes allow a seamless flow of work across process boundaries

Business process management, which begins & ends with the customer is established, in control, and in the conscious thinking of management.

Little or no process focus. That which exists is primarily directed internally toward local operations



Metric-driven actions simulated during strategy setting process to ensure organizational alignment before metrics are implemented

All metrics (process, results, organizational, geographic, etc.) align with strategic objectives, provide competitive advantage & optimize the whole

Metrics reinforce & leverage activities across all core business processes Local interests are subordinated to the good of the whole

Process metrics added & integrated with result metrics Metrics aligned between strategy & daily activities in core processes

Metrics are ad hoc and primarily results oriented.



Level One: Initial

- **Enterprise does not manage its business with a process focus**
 - **Many metrics sub-optimized by local organizational interests rather than having them aligned with customer interests and with the strategic objectives of the enterprise**
 - **Organizations measure the results of past actions**
 - **Results-oriented metrics cannot provide the leading indicators needed for timely corrective action to change outcomes**



Level Two: Vertical Alignment

Definition

***Vertical alignment* is the alignment and reinforcement of strategic objectives with supportive goals and progress measures at all levels of the organization.**

- The business enterprise applies a process focus so it can measure leading indicators of the expected process output
- Defective process output is viewed as a process-capability problem, not a people problem
- Carefully chosen metrics ensure that all levels of the organization align with strategic objectives



Level Two Example

A core process related to product development activities might be documented, be in control (repeatable), be consistently deployed across the organization, and have measurable improvement gains. If so, that process is probably at or near Level 2 maturity. If the metrics indicate variations in the process results, then they are still at Level 1 because the process is not in control.



Level Three: Horizontal Alignment

Two phases:

1. *The global optimization of work flow across all process boundaries.* These boundaries become transparent to the flow of work. Metrics are customer-focused and assess the enterprise-level capability of a process to provide value from the customer's perspective.
2. *The global optimization of work flow across all organizational boundaries that support or use a particular process.* Metrics are customer-focused and assess how well the infrastructure enables execution of customer-focused processes.



Level Three Example

The enterprise may have several core customer-related processes such as winning new business and developing new products. Also, the enterprise may have many functions that support or execute these core processes.

Level 3 characteristics include:

- Integrated core processes that customers see as seamless**
- Minimized hand-offs or delays as work moves among processes and sub-processes**
- Management focus primarily on early process activities in a product life cycle**
- Metrics insure local organizational interests (functional or business unit) are subordinated to customer needs and what is best for the entire business**



Level Four: Total Alignment

Definition

***Total alignment* is the synergistic interaction of metrics from all support processes with metrics from all core process to reinforce the strategy and to drive business excellence.**

- **All employees clearly see where the business is headed and how they can make a difference.**
- **Horizontal integration (Level 3) provides employees with “line of sight” to customer value. Dramatic performance improvements can occur at this level.**
- **Total enterprise-level alignment (Level 4) is required to overcome the major systemic barriers to great performance and to embed the long-term gains into the fabric of the organization’s culture.**



Level Four Example

At Level 4, the enterprise begins asking how enabling processes create competitive advantage for the core customer-related processes, rather than what they do to improve themselves.

- **Total enterprise alignment is required to overcome the major systemic barriers to great performance**



Level Five: Optimizing

- From a process perspective, the enterprise will have much greater influence on the market than its size might indicate. The agile and forward-looking enterprise will be able to foresee events and respond to those events before they occur.
- From a metrics perspective, the enterprise will be able not only to simulate and predict the outcome of a strategy before its deployment, but also to predict the effect of specific metrics on the outcome of that strategy before choosing metrics.



Case Study: Nike

- **The study focuses on European Operations of Nike.**
 - **The company is organized around three lines of business: Apparel – 60,000 SKU, Footwear – 25000 SKU, and Equipment - 1000 SKU.**
 - **90% of the business comes from 6 countries in Europe.**
 - **The product life cycles are short.**
 - **Uncertainty of demand is an important characteristic.**
- **Company was continuously improving its supply chain management through a better integration of operations across subsequent echelons and separate functions in the value chain.**
- **As part of these efforts management decided to assign some of their resources for improvement projects to performance management. The integration of various local performance indicators into a company-wide consistent system was required.**

Lohman, C., et al. (2004) "Designing a performance measurement system: A case study". *European Journal of Operational Research*, v.156, pp.267-286.



Case Study: Nike

The project objectives:

- To develop a set of high-level performance metrics tailored to the specific business needs for use by the senior supply chain management team, i.e. Operations, while including existing local metrics as much as possible and sensible.
- To design a format, i.e. a scorecard, displaying the metric scores at the level of Nike as well as that of the business units.

Lohman, C., et al. (2004) "Designing a performance measurement system: A case study". *European Journal of Operational Research*, v.156, pp.267-286.



Case Study: Nike

- **A structure with three layers is used for displaying the information**
 - High Level
 - Mid Level
 - Lower Level
- **Normalization -**
 - All the metrics were normalized based on a linear 0–10 scale.
- **Usage -**
 - Senior supply chain management team : director Operations, the functional directors of Transportation, Warehousing, and Customer Service and the three business unit Operations directors. They will use the scorecard on a monthly basis to facilitate review of the organizations performance.
 - General Manager Nike Europe to facilitate a quarterly review of Operations
- **Maintenance**
 - Monthly scorecard reviews
 - Yearly redesign of the scorecard and its contents when launching new business plans

Lohman, C., et al. (2004) "Designing a performance measurement system: A case study". *European Journal of Operational Research*, v.156, pp.267-286.



Case Study: Nike

Developing and Embedding Performance Measurement System

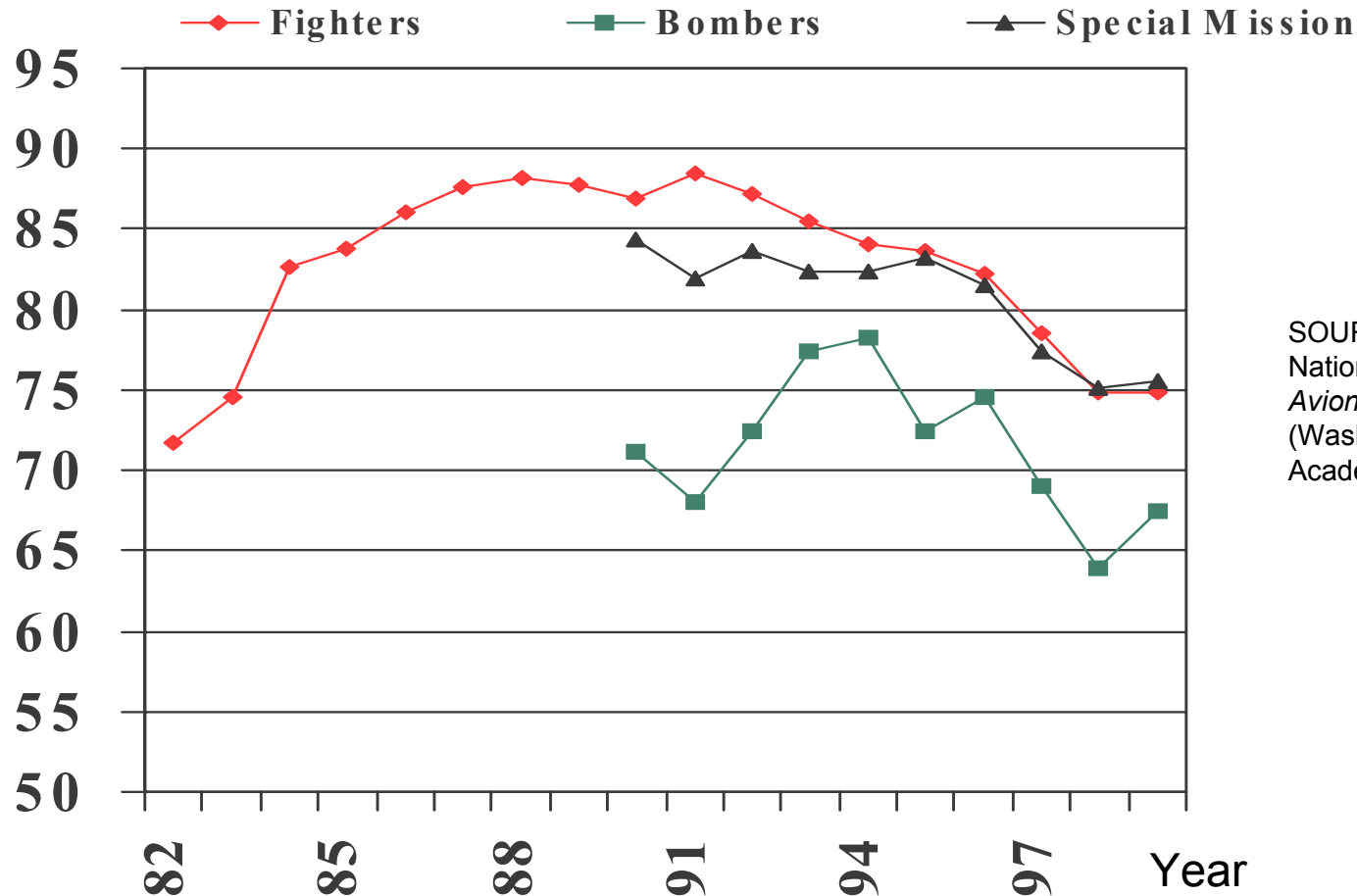
- Defined a metrics dictionary with some 100 fixed metrics combined with an overview of existing initiatives, while being much more flexible regarding the structure.
- Used a hierarchical structure within each cluster, thereby using so-called “engineered indicators” i.e. metrics based on two or more lower-level metrics.
- Brought together all people working on parallel initiatives in the field of PM within the organization.
- Experimented with different ways of clustering the metrics and presenting the scorecards.
- Gathered the data required for actually measuring and reporting all metrics in a reliable way.
- One person of the cross-functional initiatives group managed the performance reporting process.
- The PM manager has authority to make changes in the definition, to make sure that metrics remain consistent between various areas and with the global scorecard.

Lohman, C., et al. (2004) “Designing a performance measurement system: A case study”. *European Journal of Operational Research*, v.156, pp.267-286.

Case Study: Air Force Sustainment

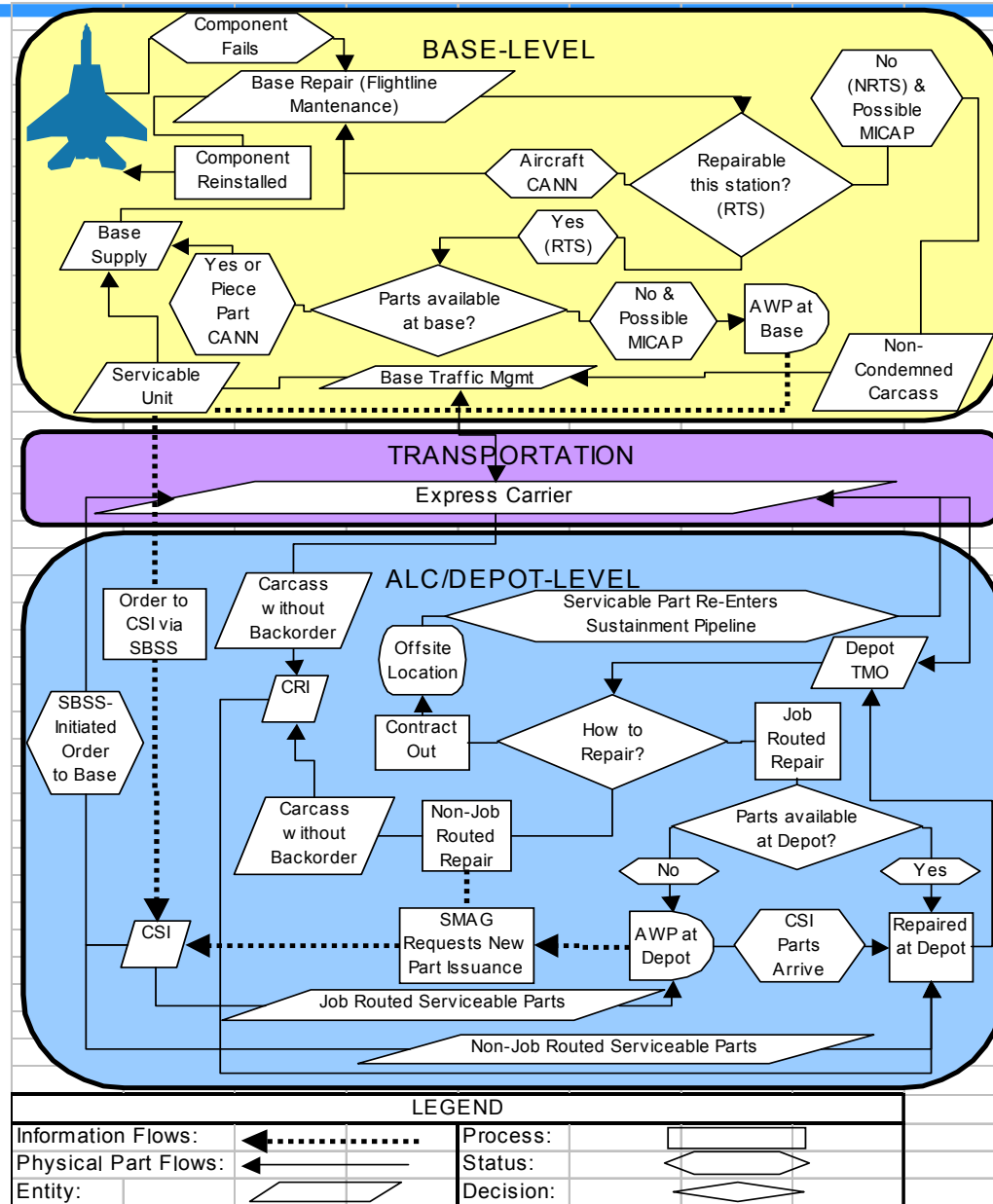
Decline in Mission Capability Rates

“Material condition of an aircraft indicating it can perform at least one and potentially all of its designated missions. Mission-capable is further defined as the sum of full mission-capable and partial mission-capable. Also called MC”. - DOD Definition of Mission Capability



SOURCE: Compiled from data in National Research Council, *Aging Avionics in Military Aircraft* (Washington, DC: National Academy Press, 2001)

Air Force Sustainment System





Case Study: Air Force Sustainment

Initial Field-Study Observations

- **Current metrics generally foster local optimization rather than global optimization**
 - Depot maintenance metrics are primarily focused on financial and related measures of performance
 - Metrics conflict with delivery of best customer support
- **Current metrics generally do not allow measures of progress towards the achievement of system-wide goals**
 - Impossible to trace incremental impact on the warfighter of improvement actions at local level (e.g., incremental investment in more parts and materials)
 - Informed tradeoff decisions cannot be made at system-level
- **Current metrics drive the “wrong” behavior**
 - Big example is cannibalization (removal of a serviceable component from one end-item waiting for parts to repair another)



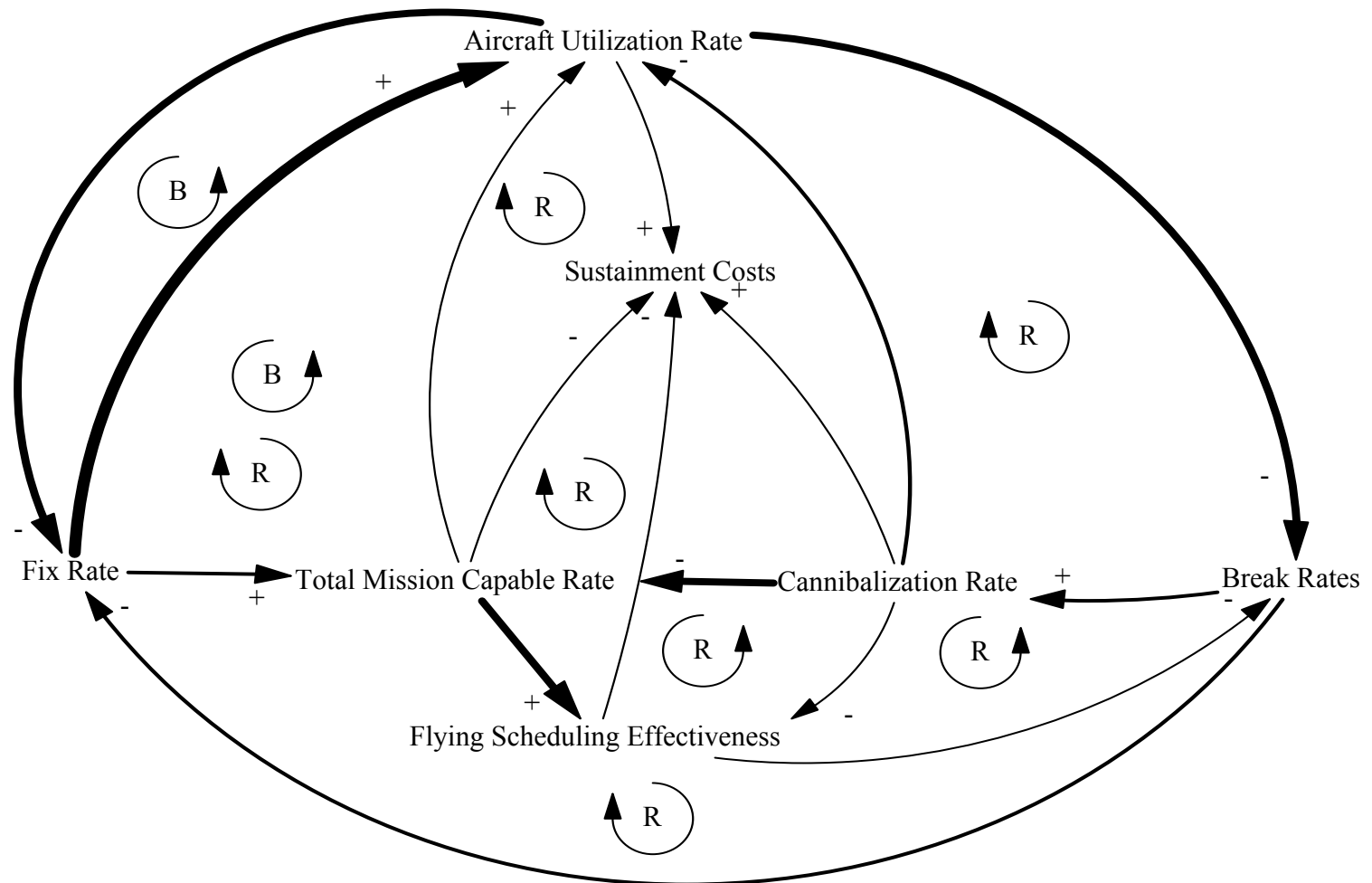
Regression Model: Mission Capability Rate

Effect of key strategic metrics and action variables (below) on the F-16 fully-mission-capable (FMC) rate

<p>Fully-mission-capable (FMC) rate as a function of: →</p> <p>Adjusted R² = 0.47</p>	Utilization rate	0.08
	Flying scheduling effectiveness	0.14
	Break rate	-0.06
	Cannibalization rate	-0.15
	Repeat discrepancy	0.03
	Unscheduled maintenance	-0.12
	Temperature (control variable)	-0.09
	Precipitation (control variable)	0.05
	Active duty “dummy”* variable	1.36
	National Guard “dummy”* variable	-0.32

* “Dummy” variable captures the impact of special characteristics peculiar to each user group.

Complex Causal Loop Structure Representation



R = Reinforcing loop
B = Balancing loop
+/- = Sign of coefficient
width = magnitude

Active Duty Mission

Reserve Mission

Guard Mission

Research Findings

“Metrics Thermostat” research reveals a far more complex metrics structure than indicated by top-down hierarchical metrics structure currently being used

- **AFMC Metrics Handbook: Presents hierarchical metrics structure (command; mission element board (MEB); center-process metrics)**
- **US Air Force Logistics Transformation Team “Balanced Scorecard” approach**

Complex feedback loops show system behavioral dynamics not otherwise well understood

- **Increased fix rates lead to higher aircraft utilization, higher FMC rates, and increased flying effectiveness**
- **But this also results in increased break rates, leading to lower fix rates by tapping limited resources, and therefore lowering FMC rates**
- **Model quantifies net effects of complex interactions**

Model provides new insights into the prevalence and effects of “cannibalization” not available before

- **Quantitative evidence provides new shows that cannibalization at field level has net negative effect on the overall F-16 mission capability rate**
- **Shows how cannibalization (an emergent system property) is driving “wrong” behavior**