

Performance Measures

Prof. Teresa M. Adams
Civil and Environmental Engineering
Sept. 19, 2002
CEE 694

Outline

- What is performance?
- What are performance measures?
- Performance measurement process
- Identifying performance measures
- Performance and obsolescence
- Recommendations
- References

Fragile Foundations

National Council on Public Works Improvement, 1988

- Performance--relative ability to satisfy demand.
- Performance measures--measure only certain aspects of supply or demand

Performance Measures

Physical Assets	combined public and private inventory
Service Delivery	ability to perform at certain service levels
Quality of Service	accessibility, reliability, safety, health, and congestion
Economic Performance	economic efficiency and cost effectiveness
	↓
	Benefit/cost Service/dollar

Measuring and Improving Infrastructure Performance
National Research Council, 1995
Committee on Measuring and Improving Infrastructure Performance

- **Performance** - the degree to which infrastructure provides the services that the community expects of it; a function of *effectiveness, reliability, and cost*.
- **Performance Measure** - a technical basis used for technical assessment; an indicator of how well a system meets and satisfies the expectation of its users.

What are *effectiveness, reliability* and *cost* of infrastructure?

How do they relate to performance?

- Effectiveness**- the degree to which infrastructure accomplishes the tasks set for it by its owners, users, neighbors, and society -at-large.
- Reliability**- the likelihood that infrastructure effectiveness will be maintained over an extended period of time; the probability that service will be available at least at specified levels throughout the design lifetime of the infrastructure system.
- Cost**- the resources required to build, operate, and maintain infrastructure; typically measured in monetary terms.
- Effectiveness, reliability, and cost are components of performance.**

What is “good” performance?

What factors influence “good” performance?

- Infrastructure that reliably, meets or exceeds broad community expectations at an acceptably low cost, is performing well.
- Influencing factors
 - Institutional
 - Social
 - Technical
 - Political
- Trade-offs
 - Service disruptions
 - Impact on economic development
 - Who benefits? Who pays?
 - Environmental impacts

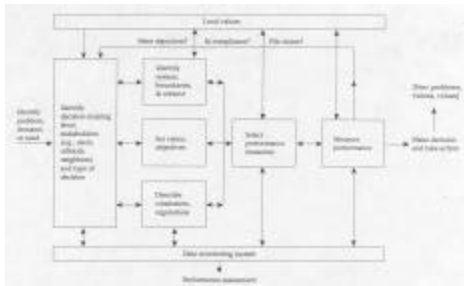
Why measure performance?

- Set goals and standards
- Detect and correct problems
- Manage, describe, and improve processes
- Document accomplishments

Generic Performance Assessment Process

1. Identify problem, demand or need
2. Identify decision level, stakeholders, and type of decision
3.
 1. Identify boundaries and character
 2. Set objectives and vision
 3. Describe constraints and influencing regulations
4. Select performance measures
5. Measure performance
6. Make decision and take action
7. Feedback

Performance Assessment as a Generic Process (Measuring 1995)



How should agencies use the process?

- Ongoing process for making decisions
- To include broad systems perspective
- Tool to project budgets needs
- Decision making tool to guide allocation of resources to produce desired outcomes

Examples

- **Effectiveness Measures**
 - Technical output, quantity delivered Seat-miles
 - Quality of Service to users Ride quality
 - Regulatory Concern Accessibility to international routes
 - Community Concern Person-hours of travel time
- **Reliability Measurements**
 - Deterministic Engineering safety factors
 - Statistical, Probabilistic Risk functions
 - Composite Peak-to-capacity ratio
- **Cost Measurements**
 - Investment, Replacement Planning and design costs
 - Recurrent or O&M cost O&M/repair/depletion costs
 - Timing and Source Timing of expenditures

Using the performance assessment process, how will we know that performance has improved?

Clearly improvement, if (Measuring, 1995):

1. Some measures of effectiveness or reliability (or both) improve and none deteriorate, while costs decrease or do not change, or
2. Some measures of costs decrease and none increase, while no measures of effectiveness or reliability change

However, if neither conditions is met, performance may be judged to have improved if the community gives sufficiently greater weight to the measures that have improved compared with those that have not.

Advantages
Formal Process for Measuring Performance

- Provides a basis for better decision making
- Promotes the collection of data and institutional relationships
- Promotes interaction among stakeholders
- Leads to a better understanding of community objectives and the role of infrastructure in realizing the objectives
- Is responsive to needs of decision makers
- Provides an orderly framework for debate when a consensus is not reached

Disadvantages
Formal Process for Measuring Performance

- The assessment process takes time and money
- The process may have little value for responding to crises or short-term problems
- Lack of data makes the process difficult to implement
- Danger that the assessment process will be intentionally drawn out so that decisions and actions are never realized

Principles that guide selection of performance measures (Measuring 1995; Neely et. al 1997)

- Acceptable to stakeholders
- Meaningful and appropriate to needs and concerns of decision makers
- Objectively measurable indicator upon which discussion can be based
- Reflect achievement of specific goals or objectives
- Reflect compliance with guidelines
- Reflect current issues, e.g. environmental concerns
- Facilitate comparisons among alternative strategies for providing the service
- Facilitate the prediction of future performance trends.
- Facilitate asset valuation and depreciation
- Facilitate comparisons of performance jurisdictional boundaries

Think about Business Goals and Objectives (NCHRP 446)

Performance Measures are quantitative or qualitative indicators for achieving business goals and objectives

- Use to identify measures
- Use to organizing measure
- Use to ensure completeness

Categories (NCHRP 446) for Goals, Objectives and Measures

- Accessibility
- Mobility
- Economic Development
- Quality of life
- Environmental and resource conservation
- Safety
- Operational efficiency
- System condition and performance.

Example for Winter Operations

Goal	Objective	Performance Measure
Post season analysis to determine changes in attachment needs for next season	Long range budgeting for replacement of attachment units	Operating hours for each attachment unit and roadway class
	Assess cost-effectiveness of attachment class	Average rate (\$ per treated mile) for each attachment class and roadway class
	Establish cost reimbursement policy	Percentage of operating time for each attachment class

"Dimensions" (NCHRP 446)
of Goals, Objectives and Measures

- Sector
- Mode
- Perspective
- Concern
- Type of Application
- Spatial Concern
- Level of Responsibility
- Use of Information
- Time Frame
- Level of Refinement

Criteria for Selecting Performance
Measures (NCHRP 446)

- | | |
|-------------------------------------|------------------------------------|
| • Computability /
Measurability | • Temporal Issues |
| • Forecastability | • Geographic Scale |
| • Collectability /
Measurability | • Multiple Indications of
Goals |
| • Multimodality | • Control |
| • Clarity | • Relevance |
| • Usefulness | • Ability to diagnose
problems |

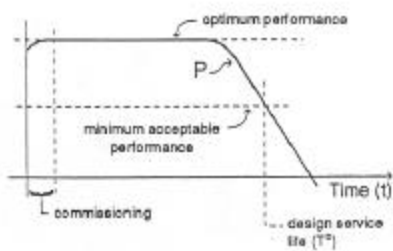
Service Life

- Service life
 - the period of time over which a system provides adequate performance
 - The expected period of time from completion of the facility to when the facility can not provide acceptable service
- Service life can be measured in terms of years or number of cycles or repetitions
- Service life can be estimated from
 - historical information: survivor techniques
 - past experience with similar structure
 - performance modeling
 - accelerated testing.

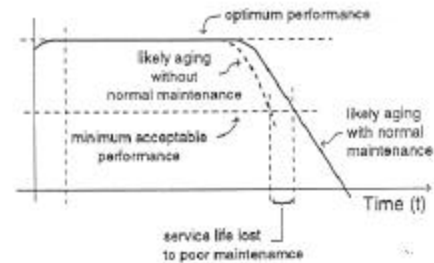
Impact of Obsolescence on Design Life
and Performance (Lemer 1996)

- Obsolescence – the inability to meet performance requirements that are changing
- Obsolescence is due to:
 - Technology change
 - Regulatory change
 - Economic or social changes
 - Changes in values or behavior of users
- Obsolescence causes the expectations for optimal and minimum acceptable performance to increase, thus causes a decrease in service life due to increased expectations.

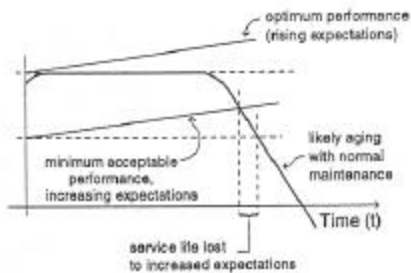
General Representation of Performance
and Service Life (Lemer 1996)



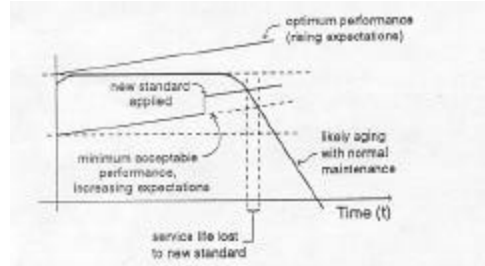
Maintenance Practices Influence
Service Life (Lemer 1996)



Expectations or Standards May Change with Time (Lemer 1996)



Regulatory Changes Causes Rapid Shift in Standards (Lemer 1996)



Recommendations (Measuring 1995)

1. Local agencies should define a set of comprehensive performance measures and allocate funds to sustain a performance assessment process.
2. Devise quantitative indicators of qualitative aspects of performance. Use quantitative measures to develop benchmarks for setting goals and comparing performance.

Recommendations (Measuring 1995)

3.
 1. Establish a system for data collection and integrate information on separate infrastructure modes.
 2. National datasets should be compatible, computerized, and made electronically accessible.
 3. Data collection should be designed to facilitate benchmarking.
 4. New data collection should give priority to areas where data currently are sparse.
4. Periodically reviewed and revised performance measures to respond to changing objectives, budgetary constraints, and regulations.

Recommendations (Measuring 1995)

5. Undertake self assessment to determine extend of regulations, organizational relationships, jurisdictional limitations, customary practices, etc. that impede adoptions of a performance measurement framework and make explicit recommendations for institutional change.
6. Federal infrastructure policy and regulations should accommodate local decision-making process and performance measurement framework.

REFERENCES

- *Fragile Foundations*
National Council on Public Works Improvement, 1988
- *Measuring and Improving Infrastructure Performance*
National Academy Press, 1995
- *Infrastructure Obsolescence and Design Service Life*
Andrew C. Lemer, ASCE J. of Infrastructure Systems. Dec. 1996
- *Designing Performance Measures: A Structured Approach*
Neely, Richards, Mills, Platts, and Bourne.
International J. of Operations & Productions Management, 1997
- *A Guidebook for Performance-based Transportation Planning*
NCHRP Report 446 Transportation Research Board, 2000
- *Transportation Performance Measures*
ops.fhwa.dot.gov/Travel/Deployment_Task_Force/perf_measures.htm