

Infrastructure asset management

Micro lectures

- 1) Organisations are responsible for the management of infrastructure assets and can also possess intangible assets.

Infrastructure systems have a long design and service life. 50-100 years in place.

Many infrastructure sectors are natural monopolies

Infrastructure includes for example: hospitals, roads, and sports stadiums.

Infrastructure systems are:

- fixed capital assets
- have a long life time
- part of a system / network
- evolutionary systems
- providing services for communities
- important for social and economic welfare

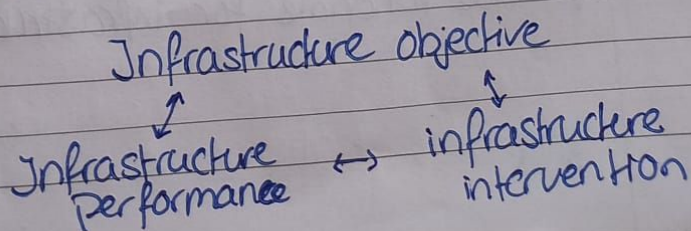
- 2) Important questions in IAM:

- To whom is the infrastructure important in providing a service?
- does the infrastructure allow the required service delivery?
- What should be done to ensure the required service delivery?

to determine the performance level when an intervention is needed is the challenge when deciding on the timing for an intervention

IAM involves activities and decisions that enable infrastructure to provide services for defined communities over certain periods of time taking into account performance and costs of the infrastructure.

- 3) Decision context:
strategic, tactical and operational decisions.



external context related to decision making is: factors are demand, technology, policy, environment

Internal factors: strategy, organization, knowledge, finance

- 4) Infrastructure objective is defined by first defining these:
- 1) organizational goals
 - 2) infrastructure management policy

Infrastructure performance is defined by

- 1) risk analysis
- 2) performance prediction
- 3) performance monitoring
- 4) risk evaluation

Infrastructure intervention

- 1) intervention analysis
- 2) intervention optimization $\rightarrow$ resource allocation
- 3) ~~resource~~ intervention implementation

- 5) Strategic decisions - Asset owner - organizational goals, finance, policy, stakeholders

Tactical decisions - Asset manager - objectives, risk, performance, intervention

Operational decisions - Service provider - implementation, data collection, project management

- 6) Infrastructure objectives ~~establish~~
- relate assets and organizational goals
 - describe required service function and performance
 - represent criteria for evaluating infrastructure performance
 - provide rationale for infrastructure interventions

~~categories~~ categories:

1. Service-related objectives → economy, environment, society
2. Asset-related objectives → function, performance
3. Intervention-related objectives → technical and non technical interventions

7) Objectives for infrastructure should be based on satisfaction of stakeholders with services delivered. Influenced by satisfaction is influenced by importance, expectation and experience of services delivered.

Priorities are determined by satisfaction and importance of stakeholders.

8) Things to hold in mind while formulating objectives

- alignment ~~between categories~~ of objectives
- measurability of the objective
- conflicts between objectives
- constraints that influence success of objective
- possible secondary effects

9) Decision making process by multi criteria decision making:

- 1) identify ~~the~~ alternatives
- 2) establish criteria
- 3) establish relative importance of criteria
- 4) establish commensurate scale for measuring levels of each criterion
- 5) Quantify level of each criterion for each alternative
- 6) establish combined impact of the different criteria for each alternative
- 7) determine most satisfying alternative
- 8) Sensitivity analysis

10) Derive ^{single} utility function

2. establish the relative importance of utilities
3. combine utility functions

} multi criteria utility for different risk attitudes

11) Failure is an event that terminates the ability of an asset to perform its required function.

Physical failure → asset can not fulfil its function
norm failure → asset does not fulfil the norm

Deterioration is the time-dependent process through which an asset loses the ability to perform its ^{required} function

Failure mode describes the way a failure occurs

Failure cause describes the reason of failure occurrence

Failure effect describes the consequences of failure occurrence

Failure risk is the possibility of failure and the severity

reliability is the probability of the asset fulfilling its function over a certain period of time and under certain conditions

vulnerability describes the ability of the asset to withstand certain events

resilience describes the ability to react and recover from unanticipated events

12) Failure mode, effect and criticality analysis is a method that aims at identifying and assessing potential failure modes, effects and causes of systems, in order to determine possible actions to reduce or eliminate the chance of failure occurrence.

1. describe asset structure

2. describe asset functions

3. identify potential failure modes

4. describe effects of failures

5. determine causes

6. determine criticality

7. identify interventions

13) Service life is the period until the infrastructure asset ceases to provide the required performance

economic life is the period until the asset ceases to be the lowest cost alternative to provide the required Performance

- technical end of life is reached if the performance of an asset is insufficient due to a deteriorated structure
- functional end of life is reached if the performance of an asset is insufficient due to changed functional requirements
- economic end of life is reached if keeping an asset in place is more expensive than replacing it with an alternative

14) Markov chains is a discrete-time stochastic process with a finite number of possible states. It predicts the probability of being in any state after a period of time. The transition from one state to another state only depends on present state.

15) Infrastructure interventions are the treatment that are applied to assets in order to improve the performance.

Asset related interventions
Non asset related interventions

Interventions:

- maintenance / repair
- rehabilitation / replacement
- upgrading / expansion

16) Life cycle cost analysis is a tool for the economic based comparison of alternatives of a certain period. With this analysis you can determine the total agency and non-agency cost over the life of an asset, in order to compare competing intervention strategies. And evaluate procurement options of new assets. And to benchmark the cost-performance of assets.

Cost and benefit of alternatives can be expressed as the monetary impact on stakeholders.

- Economic calculations are sensitive to discount rate which means the present value of a given future cost decreases as the discount rate increases.

- The farther into the future any cost occurs the smaller the present value will be

ICC methods:

- present worth of cost
- net present value
- equivalent uniform annual cost
- equivalent uniform annual return
- internal rate of return
- benefit cost ratio
- incremental benefit cost ratio

17) An intervention contract can cover different types of tasks.

- operational tasks : maintenance & rehabilitation
- management tasks : monitoring & planning

Contracts specify in performance a service provider has to deliver

- task-related performance : detail of what should be done and how
- asset-related performance : what the result should be
- service-related performance : outcomes of interventions stakeholders, comfort etc.

Payment mechanisms

- unit price mechanism $\rightarrow$ price is determined by adding all prices of the objects
- lump sum mechanism $\rightarrow$ fixed performance criteria and fixed price
- cost-plus fee mechanism $\rightarrow$ fixed price but with the extra performance comes extra money

118/1

(18)

Strategy 1

Strategy 2

Strategy 3

outsourced activities	Single intervention tasks are brought from separate service providers	Single and integrated inter. tasks are brought from separate service providers	Single AM tasks and all intervention tasks are brought from separate SP
in-house activities	All AM tasks and single intervention tasks	All AM tasks	Single AM tasks
Performance Specification	task-related	Asset-related	Service-related
Payment Mechanism	unit price	lump-sum	cost-plus fee
contract duration	short-term	medium-term	long-term
tender evaluation	Price-only	Price & quality	Quality & costs
performance monitoring	direct & frequent	direct but infrequent	indirect but frequent

Public organisations need to ensure that the team has a sufficient level of:

- contractual capabilities
- Relational capabilities
- technical capabilities