

ASECAP DAYS



COSTA NAVARINO 2019

*47<sup>th</sup> ASECAP Study & Information Days*  
**Tomorrow's Mobility...is here Today**

*House of Events, Westin Business Hotel, Costa Navarino, Greece*  
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**PROTECTING THE WEALTH OF BRIDGES**  
**(From a Bridge Engineer's perspective)**

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# PROTECTING THE WEALTH OF BRIDGES

(From a Bridge Engineer's perspective)

## 1. Preamble

Bridges constitute an asset of crucial importance in practically all transportation networks.

When bridges fail to satisfy the requirements of safe traffic the results have a considerable functional and economical impact on the network which at cases can turn into life losses and economic catastrophe.



As the average age of bridges in Greece is 35 to 40 years, the aging infrastructure is expected to deteriorate faster in the coming decades particularly under the increasing operational demands.

## PROTECTING THE WEALTH OF BRIDGES

(From a Bridge Engineer's perspective)

### 2. *What is threatening the performance of our bridges?*

Bridge performance is impaired by a number of factors of various nature:

- Design errors and omissions
- Construction flaws
- Misusage (e.g. allow overweighed trucks without special measures)
- Natural aging of materials due to environmental actions (corrosion, carbonation)
- Accidental actions (hydraulic erosions, collision, fire, earthquake)
- Inadequate or totally missing maintenance

Under the accumulation of so many adverse factors damages of varying extent and importance will eventually occur.

Safeguarding the performance of bridges against the above threats can be achieved by:

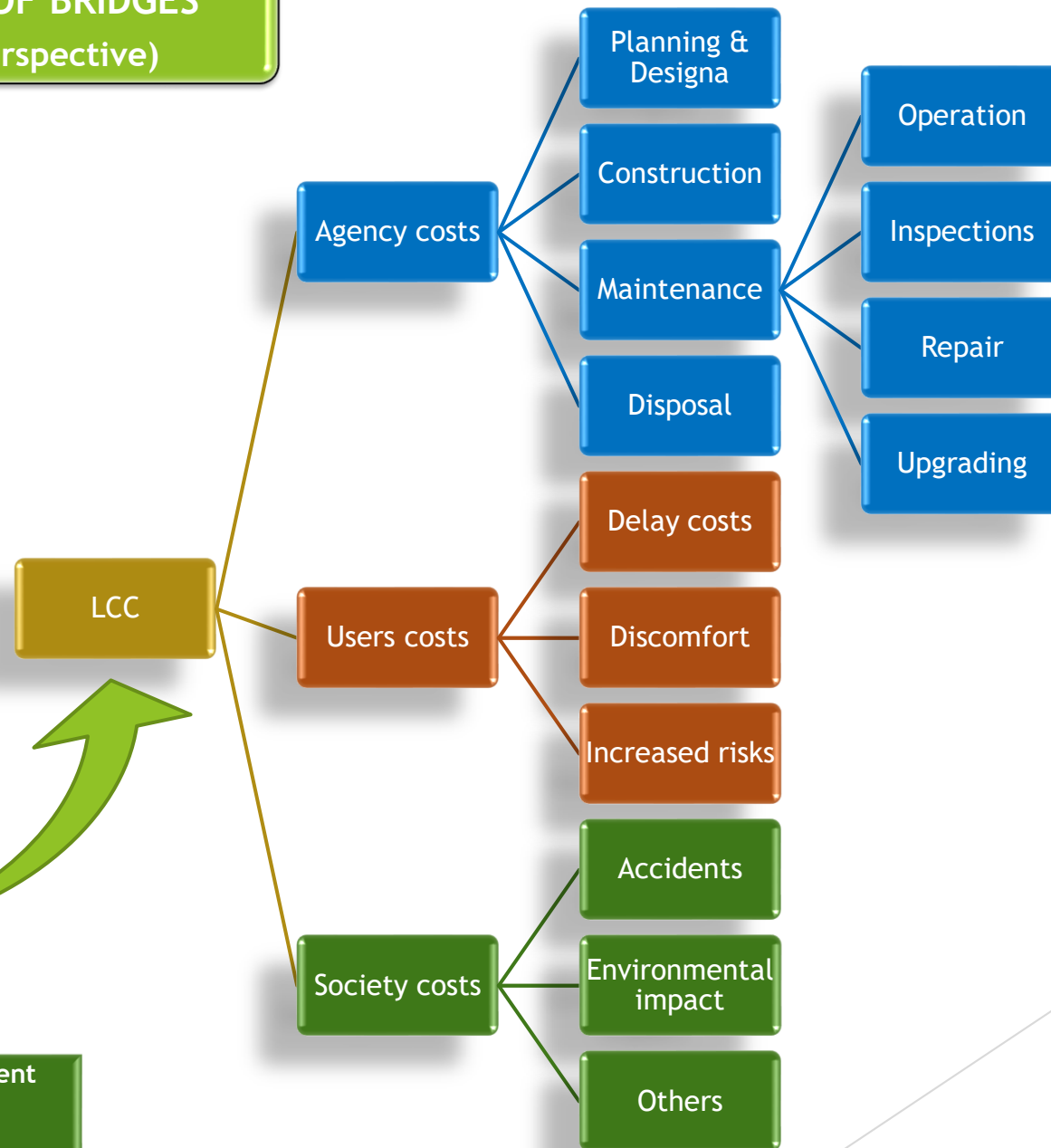
- Implementing **Life Cycle Planning (LCP)** and
- Employing an effective **Bridge Management System (BMS)**

# PROTECTING THE WEALTH OF BRIDGES

(From a Bridge Engineer's perspective)

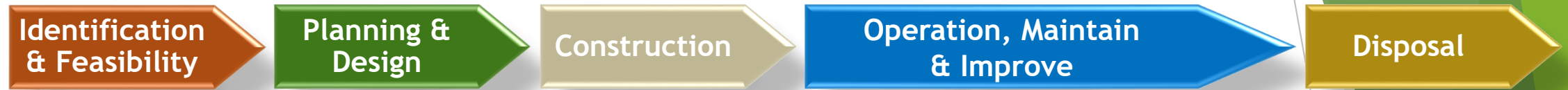
## 3. Life cycle planning

Long term strategy and systematic process of operating, maintaining and improving the asset of bridges planned to achieve and sustain a desired level of performance over the life cycle of the asset while minimizing the whole Life Cycle Costs (LCC).

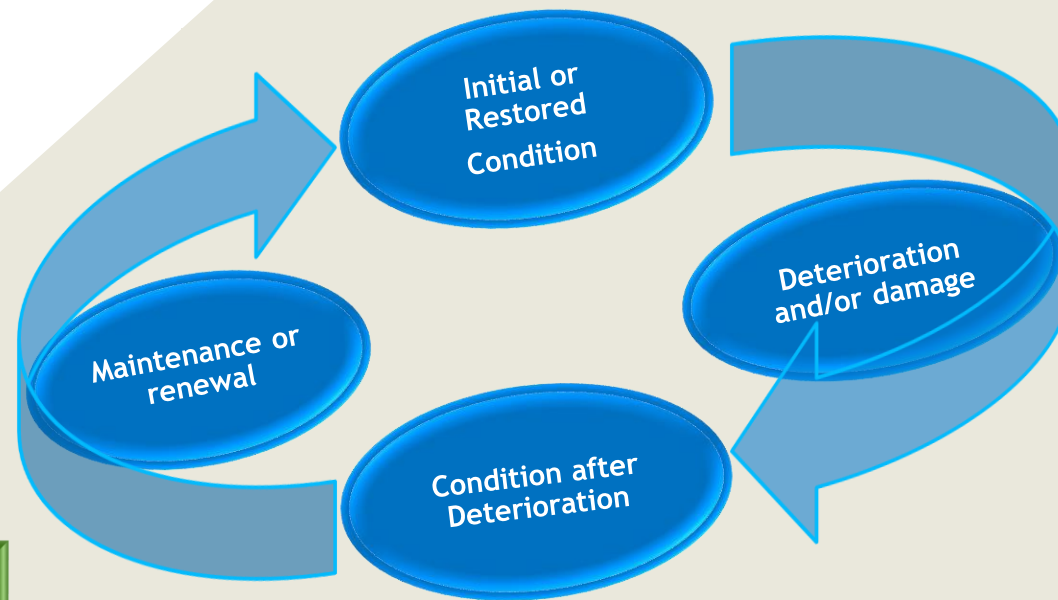


► Schematic presentation of the different items in a complete LCC analysis

In-depth understanding how a bridge is likely to behave/deteriorate is fundamental to bridge management. The typical lifecycle of a bridge is as shown below:



**Deterioration & maintenance cycle**



► Typical lifecycle of an Asset

## PROTECTING THE WEALTH OF BRIDGES

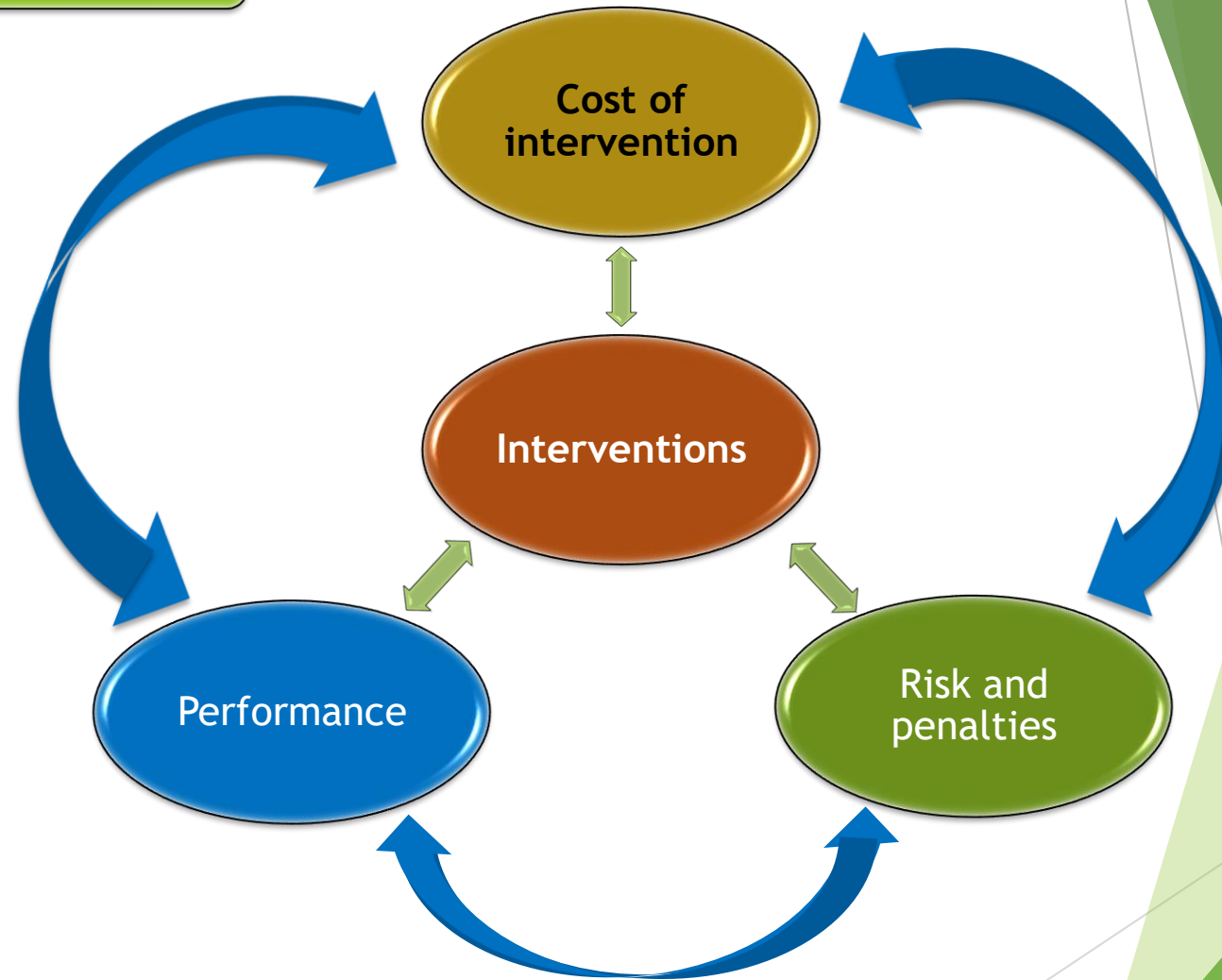
(From a Bridge Engineer's perspective)

For already in service bridges the deterioration-maintenance part of the cycle is of utmost importance.

Issues to be considered:

- Expected deterioration mechanisms and rates
- Intended service life and required performance levels
- Type timing and intervals of maintenance activities
- Cost of maintenance activities and service disruption
- Safety of maintenance crew and public in general
- Impacts on the wider social community

Understanding the relationship between the lifecycle planning components “Risk - Cost - Performance - Intervention” is of crucial importance.



➤ Balancing Risk, Performance, Cost and Interventions



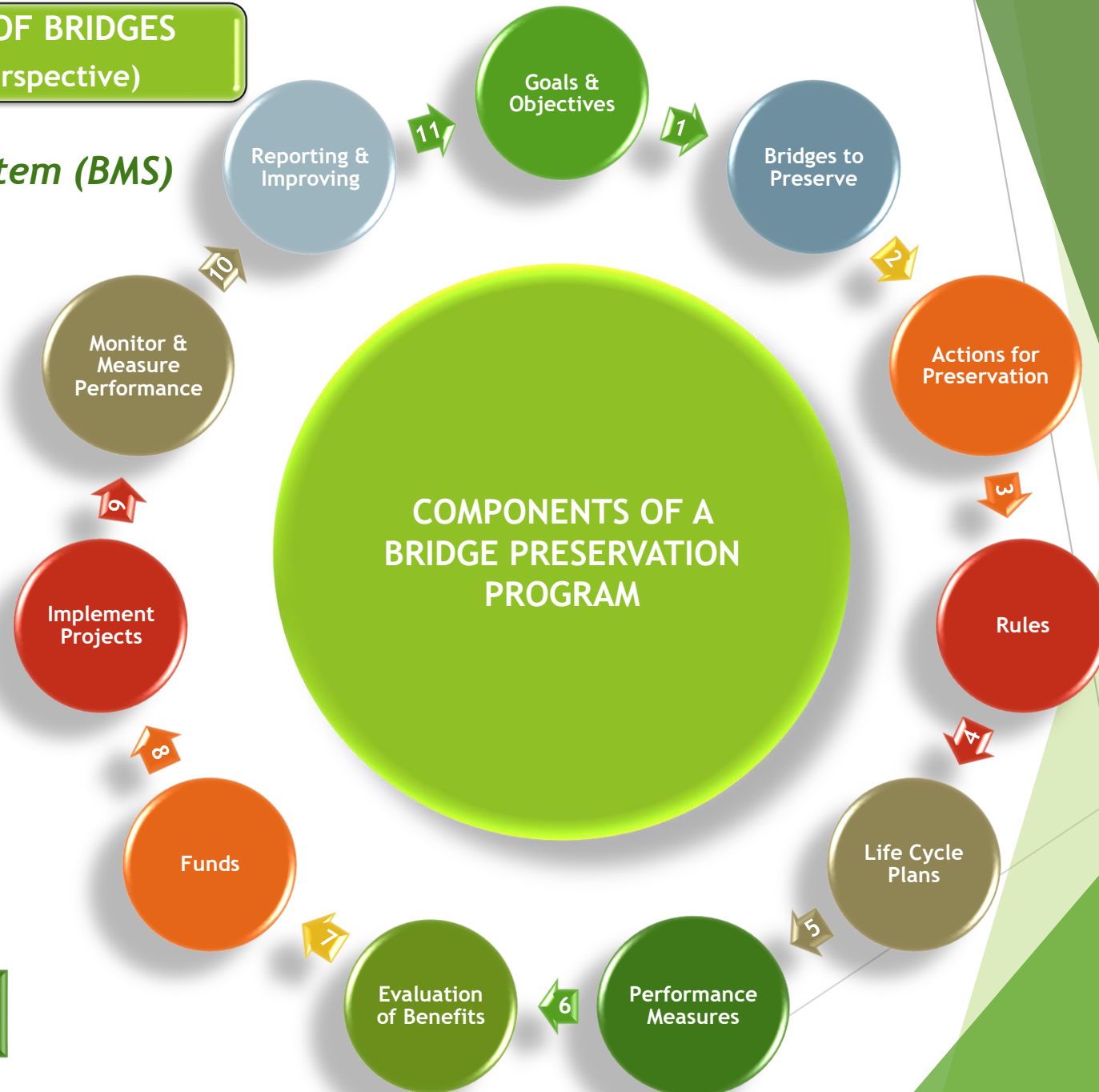
# PROTECTING THE WEALTH OF BRIDGES

(From a Bridge Engineer's perspective)

## 4. Bridge Management System (BMS)

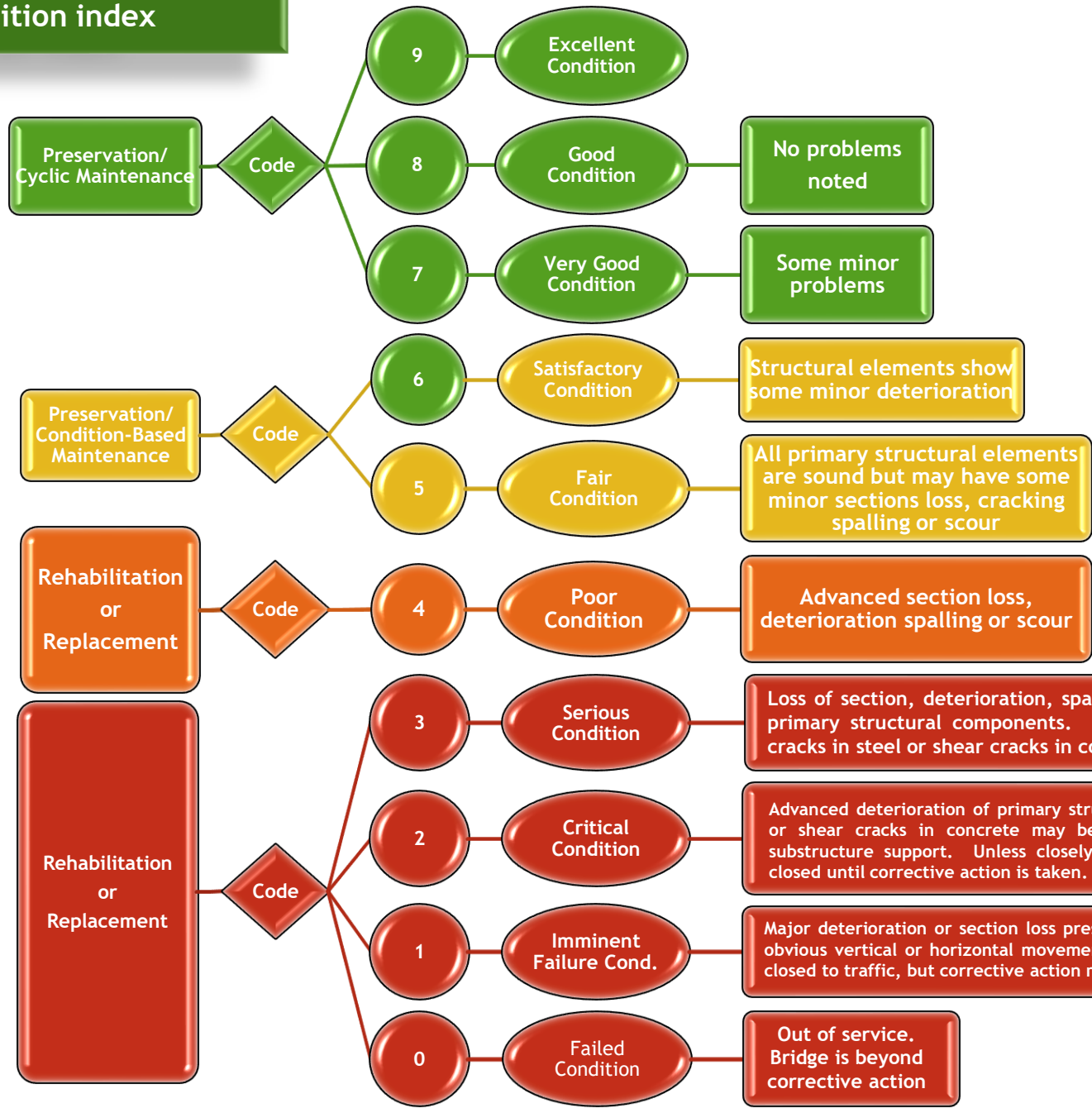
A multi component data basis which (in simple words) enables the bridge Manager:

- a. be fully informed of the health of "his" bridges
- b. be able to decide where to spend "his" funds in the most efficient way

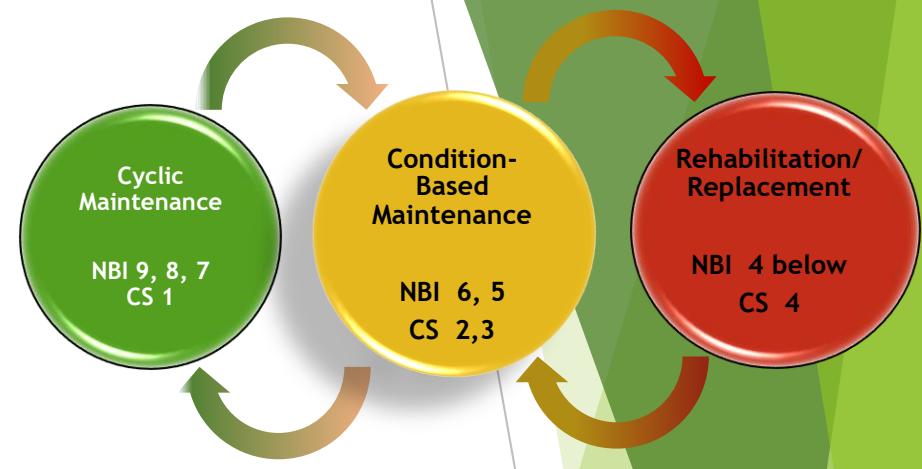


► Steps for establishing a bridge preservation program

# Condition index



# Measuring preservation performance





## PROTECTING THE WEALTH OF BRIDGES

(From a Bridge Engineer's perspective)

### 5. Proactive bridge maintenance

Typically comprises a combination of:

a. Bridge inspections

Provide a snapshot of the bridge condition at a certain point in time

b. Static loading tests

Normally not exceeding SLS

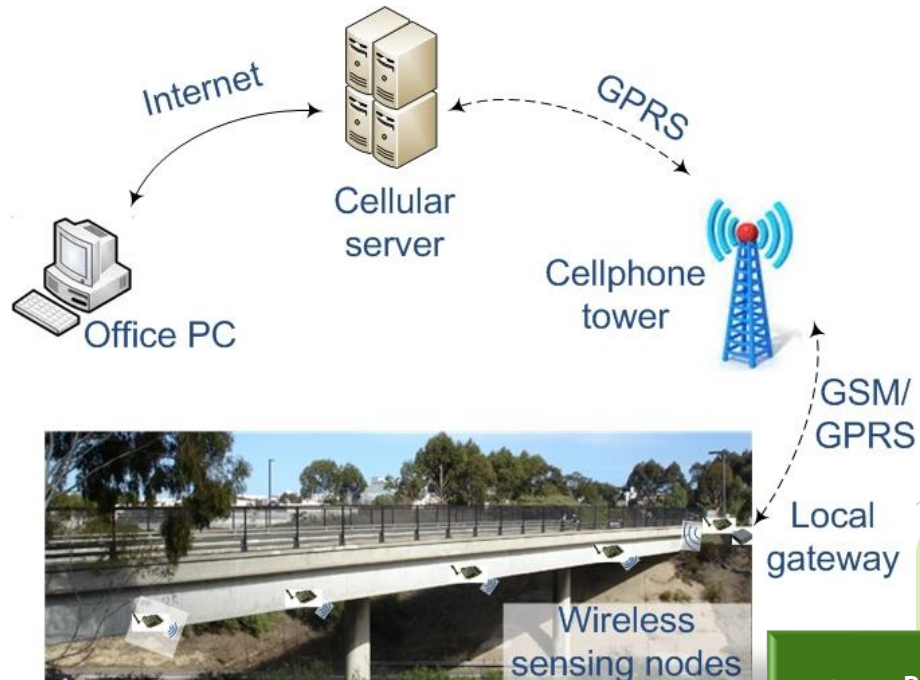
c. Structural Health Monitoring (SHM)

Continuous monitoring helps to gauge the performance and acts as a warning device in case an unusual behavior is recorded.

Information can be obtained under service include loading and/or ambient vibrations :

- ▶ Deck deflection
- ▶ Stress levels and variation
- ▶ Change of level (settlement)
- ▶ Dynamic characteristics
- ▶ Corrosion rates and crack widths

SHM is presently an expensive methods and usually confined to large important bridges



▶ Bridge performance surveillance

## PROMISING FUTURE BRIDGE MONITORING METHODS



### DRONES

Drone technology has a huge potential for bridge inspection, with many case studies worldwide in the last years. Further developments in sensor technology and data elaboration systems may lead to full-field displacement monitoring of bridges using drones.

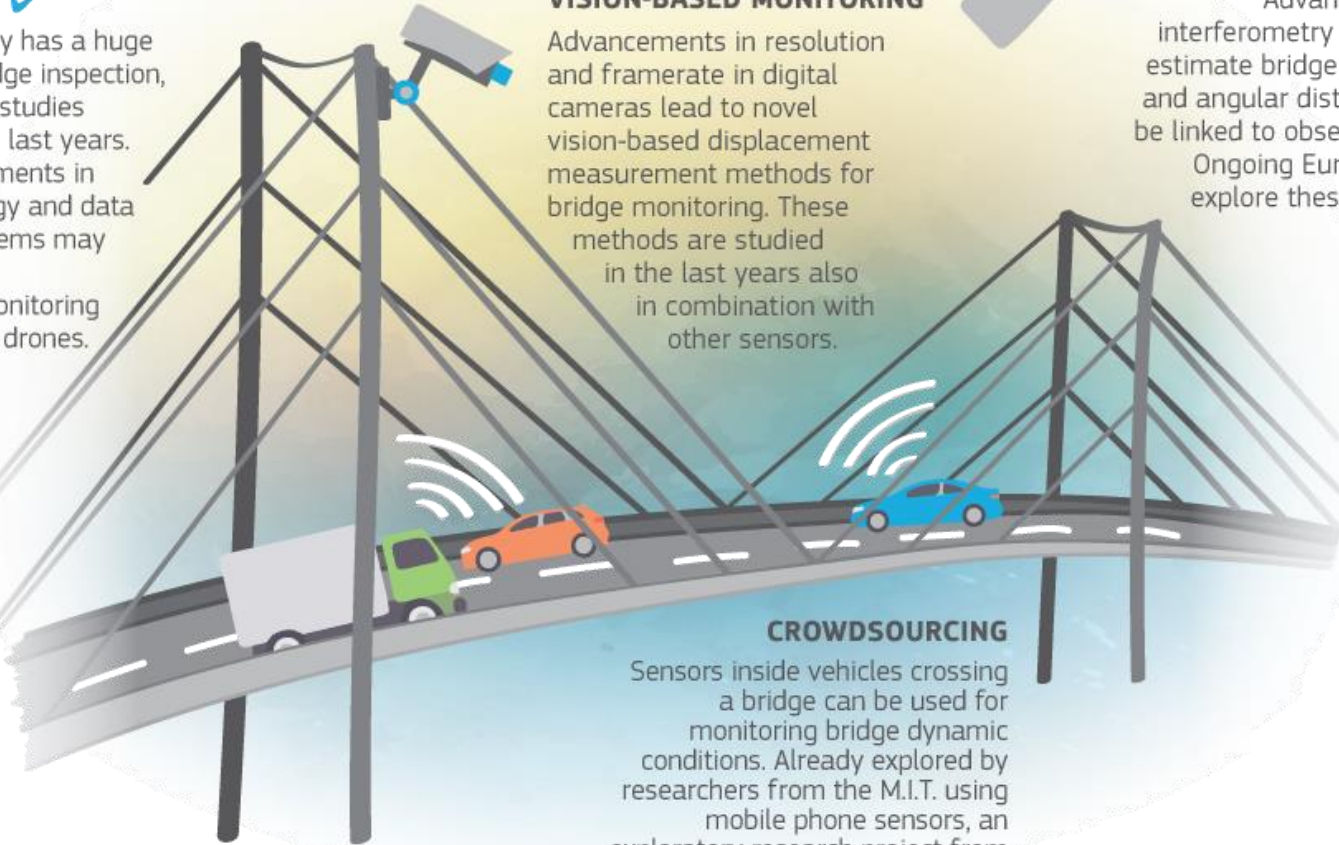
### VISION-BASED MONITORING

Advancements in resolution and framerate in digital cameras lead to novel vision-based displacement measurement methods for bridge monitoring. These methods are studied in the last years also in combination with other sensors.



### EARTH OBSERVATION DATA AND SATELLITE IMAGES

Advanced differential interferometry can be used to estimate bridge displacements and angular distortion that can be linked to observed damages. Ongoing European projects explore these technologies.



### CROWDSOURCING

Sensors inside vehicles crossing a bridge can be used for monitoring bridge dynamic conditions. Already explored by researchers from the M.I.T. using mobile phone sensors, an exploratory research project from the JRC focuses on sensors embedded in connected and cooperative vehicles.

► Source: TRIMIS, European Commission's Joint Research Centre (JRC)

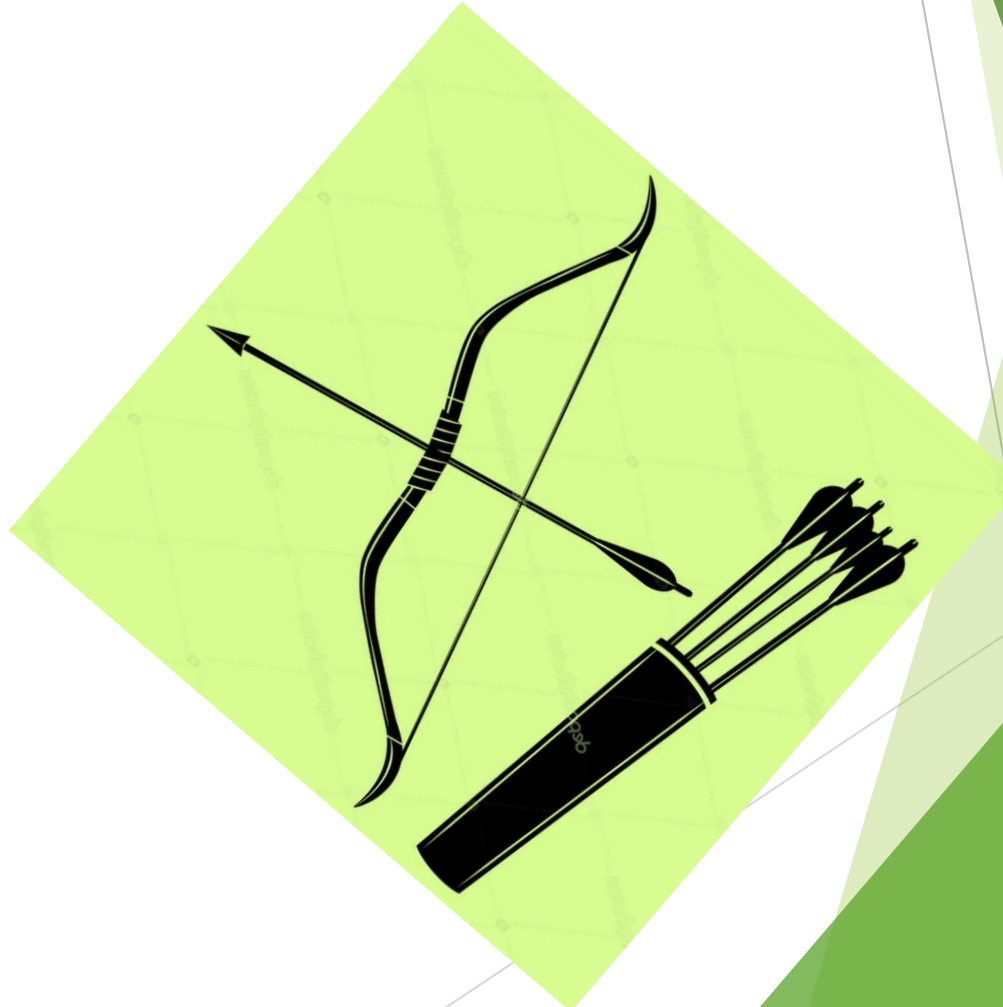
## PROTECTING THE WEALTH OF BRIDGES

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### 6. *Reactive maintenance*

In striving to achieve sustainable bridges great help is offered by:

- a. Code compliant (EN 1504) and certified materials
  - Repair grouts
  - Corrosion prohibitors/inhibitors
  - Penetration reducing admixtures (PRA) and
  - Protective painting
- b. Performance proven methods
  - Use of UHPC
  - Jacketing (concrete or FRP)
  - External posttensioning
    - standard tendons
    - non-metallic tendons
  - Cathodic protection
  - Seismic isolation



# THANK YOU FOR CHERISHING BRIDGES

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This presentation is associated with the cluster of actions currently underway in Greece to establish the State Authority for Bridges