

From Science to Practice; List of identified Gaps

Categories of Gaps: **Scientific Gaps**, **Regulatory Gaps**, **Educational Gaps**

Reasons for Insufficient Implementation Experience

System identification and related monitoring activities are highly complex. On the other hand, field work during bridge inspection is carried out on a lower level of expertise. This makes the introduction of innovative approaches to this conservative sector difficult.

Within these asset management procedures, a major number of issues that are responsible for the current situation have been identified and are listed below:

1. Fragmented Datasets: Historically grown, each bridge owner has its own way of collecting, storing and managing data, unlike in the USA where 50 states have one national bridge inventory (NBI). *A new European standard dataset with support tools is to be created.*
2. Data handling and curation: Ordinary bridge owners do not have any personnel that is available or qualified for these specific tasks. The implemented software and tools need permanent handling and maintenance, otherwise the users will not accept them. *A Central European database, starting with the Trans-European Networks (TEN) is required.*
3. National rating scales: Rating scales are currently determined on national level. This creates a large variety. *A European rating scale is to be proposed with respective translator tools to allow national owners to compare to the usual way of practice.*
4. Monitoring creates additional costs instead of saving money: Standards do not allow the substitution of visual inspections by monitoring activities. The value created is not reflected in the costs. Only Austria and Germany currently have issued national guidelines which allow a harmonization of visual inspection and monitoring campaigns. *A respective regulation should find its way into the Eurocodes.*
5. Monitoring communication: The current monitoring communication is focussed on applications in extraordinary cases, which represent less than 1% of the bridge stock and therefore does not reach daily practice. *The value of monitoring is to be better communicated with more focus on benefits rather than sensational technologies.*
6. Gap between current practice and research interest: Research and monitoring issues are characterized by very complex technologies. Most of the research works are fundamental research where we can find excellent work. Nevertheless, the transition to higher TRLs is missing due to a lack of practical research and respective acting experts. *It is proposed to create more targeted projects of considerable size where these practical aspects are condition.*
7. Benefits of the new technologies do not reach the inspectors: Research and monitoring results are mainly focussed on application on the management level and do not cover the needs of the inspectors responsible for the last mile. *We require scaled down versions which provide the necessary support online and real time on the job.*
8. Bridge owners normally have one set of structures only: It is ignored that there are categories which should be taken out from the applied fleet processes. *It is proposed to introduce three categories of normal structures (95%), special structures (4%) and extraordinary structures (1%).*
9. Life-Cycle Engineering (LCE) does not fit into normal asset management procedures as applied now: The reason is that current procedures are budget-driven on short- or mid-term horizons. The long-term horizons of life cycles are not attractive enough. *It is proposed to demonstrate the benefits in a way that also rewards appear in shorter periods.*

10. Sustainability is not considered yet in practice: Bridge owners are used to look on safety, durability and partly on operational limit states. Sustainability indicators covering economy, environment and society are ignored. *A procedure allowing the introduction of these indicators would considerably improve decision making and allow multiple sensitivity analysis.*
11. A lack of acceptance of monitoring: Besides the arguments mentioned before, the fact that the lifetime of a monitoring system does not match the lifetime of a structure has to be addressed. The gap can be closed by adjusted monitoring campaigns where in standard cases eventually one measurement every 6 years is sufficient. *There is still a lack of tools and technologies for that.*
12. Scientific-driven research agenda: The drive for innovation, as it is asked for in the programmes of the European Commission, leads to the fact that projects with high innovation potential are awarded. Nevertheless, this innovation is in TRL 1 – 3 and does not reach the end users. *It is proposed to make provisions in future research agenda.*
13. Lack of funding of standardization: Making standards is a very long-term activity with huge effort and periods far beyond the normal research projects. This makes it difficult to bring developments into this process. In previous framework programmes (i.e. FP5) specific support for standardization has been provided. *It is proposed to think about similar instruments in the future.*
14. There are too many useful but unknown results of EC projects: Many results have already found their way into standardization (i.e. the mathematical formulation of degradation into EN 16991:2018) which are not known to the research and owners' community. Dissemination has obviously failed here. *It is proposed to look for respective instruments to close this gap.*
15. Introducing subjective input (knowledge): Bridges are prototypes each. There are still plenty of unknown unknowns which in practical life are very well covered by knowledge and intuition of respective bridge masters. This subjective input is not yet formally considered in the assessment process. *It is proposed to introduce it into a valid assessment scheme.*
16. Risk-based asset management: These procedures are very common in other industries (i.e. the chemical industry). They have standards and practices which could be adjusted to infrastructure management. *It is proposed to prepare a white book on "risk-based infrastructure management".*
17. Risk scenarios: Infrastructure managers are not used to think in risk scenarios. A good documentation of potential risks on bridge structures could be prepared with a guide how to set up proper risk management procedures. *The most promising scenarios can be introduced into the standardization process.*
18. Deterministic vs. probabilistic approaches: Only part of the community accepts that actually everything is probabilistic. Asset managers do not like this approach because they are afraid of uncertainties and the consequences on their career. It is possible now to demonstrate the benefits. *It is proposed to concentrate dedicated work directly on these benefits and provide examples that are easy to argue.*
19. Quality of structural models: Bridge managers, but also designers, are not aware that their models are considerably wrong in many aspects. There is already plenty of experience on that, but it has not found its way into daily practice and not into academic teaching. *It is proposed to produce the necessary material for that.*
20. "One-size-fits-all" does not apply to all regions in Europe: The relation to national development has to be formalized in a better way than the nationally determined parameters of the Eurocodes do. *The available tools will have to have adjustable national characteristics.*