Towards a reference model for building lifecycle performance measurement

Iris Karvonen, Kari Nissinen,
Timo Kauppinen, VTT
Attila Dikbas, Kerem Ercoskun, ITU
Miguel Segarra, Dragados
Contents

• Objectives & Definitions
• Existing approaches & indicators for Performance Measurement in construction
• Towards I3CON Reference model
• Case example of building Performance Measurement
• Conclusions
Definitions

• "Performance measurement is the use of statistical evidence to determine progress toward specific defined organizational objectives.” (wikipedia)

• Performance management: planning, measurement, monitoring and assessment, improvement and rewarding of performance

• Performance measures / metrics -> indicators, criteria
Definition of Building LC performance

- Performance = valuable properties of the building to the users/ stakeholders
- "Building performance is a set of measurable building characteristics including:
  - Durability
  - Moisture Management
  - Energy Efficiency
  - Indoor Air Quality
  - Structural Performance
  - Occupant Comfort"

(wikipedia)
Objectives

• Development of methods and models for intelligent performance measurement of buildings, taking into account the whole lifecycle
• Development of a reference model to guide the definition of PM of buildings in construction industry
• The focus is on buildings, not building processes
Link to performance based business models

- The aim is to improve the customer value
  -> link to performance-based business models
- The end product is the performance given by the building and related services, not the building itself
- The payments of the customer are bound to the performance
- Performance evidence is needed
Existing approaches

- Several different kinds of approaches and classifications exist for building LC metrics, for example:
  - energy efficiency classifications
  - indoor air classifications
  - sustainability/ environmental assessment (BREEAM)
  - life cycle cost effectiveness
  - comfort & soft metrics

- To be used in different phases; to support design or construction phase, commissioning or operating period
Examples of indicators

**Indoor conditions & indoor climate factors:**
- Thermal comfort: indoor and globe temperatures, air velocity and draft, air supply and exhaust temperature, stratification (layering) and Predicted mean vote (PMV), Predicted percentage dissatisfied (PPD) and actual mean votes (AMV)
- Ventilation rate: air change rate and air volume flows & Air quality: relative humidity, CO2-content, TVOC, other gaseous emissions and microbes.
- Acoustics: sound insulation, sound impact, background noise, HVAC-noise, reverberation time, noise criterion and noise rating.
- Illumination: daylight and artificial light, and glare. Vibration.

**Building envelope structural factors:**

**Energy efficiency and sustainability items:**
- Heating, cooling and ventilation: energy consumption.
- Electricity including lighting and machinery & equipment: energy consumption.
- Water and waste water: consumption. & Gas: consumption.
- Emissions: amount of CO2 during the whole life cycle.

**Life cycle cost related items:**
- Primary costs: pre-design, design and construction costs.
- Operation and maintenance costs: administration, maintenance & repair, energy, water, cleaning, waste disposal & environmental, insurances & taxes and services costs.
- Manor repairs and modifications: costs.

**Space management related issues:**
- Space programming and space use: efficiency; Services: service quality, service delivery, user friendliness, usability (by scale); Modifiability: applicability of a building for different uses.
Reference model

• “It is an abstract representation of the entities and relationships involved in a problem space … serves as an abstract template for the development of more specific models in a given domain…” (wikipedia)

• Different reference models:
  - parameterized models
  - paradigmatic solutions
  - modular components
  - mixed type
Objective is to assist in the design of building PM system, supporting value-based business models.

Three dimensions:
- WHY: building LC performance; describing the link to value-based business models
- WHAT: description of a PM entity
- HOW: PM specification & implementation process

Users: partners interested in offering PM based buildings and services to customers
I3CON PM template

- Implemented as an excel-sheet allowing filtering (by ITU)
- filled with existing measures
- presenting one way of categorisation
The school of Westendinpuisto, Espoo, Finland

- Performance measures have been applied in the Building Commissioning procedure
- The aim is to have efficient life-cycle costs
- Targets for different metrics have been set up
- Metrics for continuous monitoring have been defined
- Long term experience still missing
- New types of reporting are needed.
Conclusions & further tasks

• The aim to define, measure and validate the customer value
• Focus on the building; both quantitative and qualitative metrics
• Existing metrics definitions can be used. Which of them represent the customer value best?
• Aggregation of metrics? More intelligent metrics needed?