

Smart Buildings to Maximise User Comfort



**REHVA Brussels Summit Conference
13 November 2018**

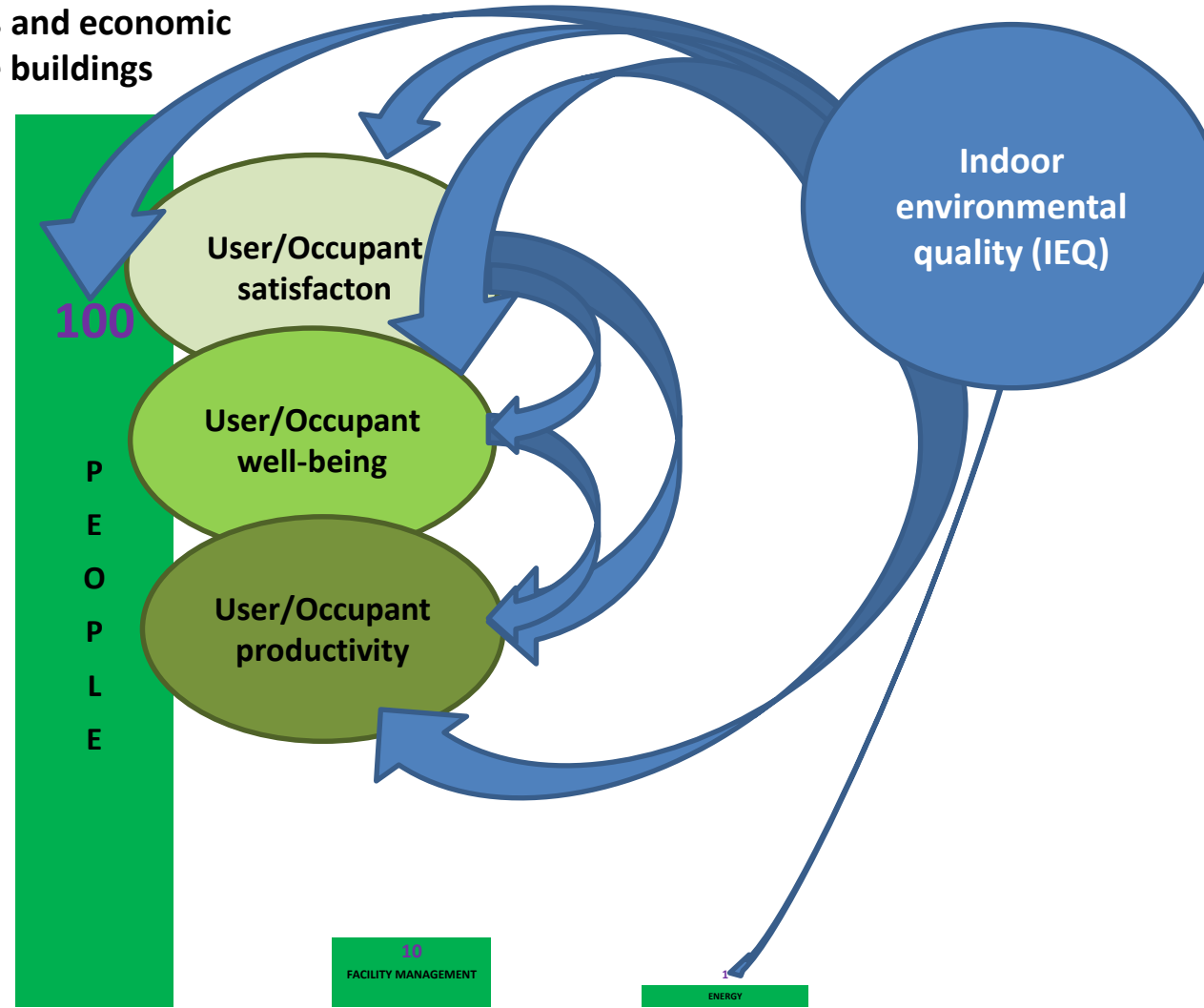


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Building-related costs and economic performance in office buildings



Buildings are (mainly) for people

Importance of good IEQ for building performance and occupant satisfaction – an integrated approach to building performance management is needed.



REHVA seminar Light + Building 2018, Frankfurt: **Indoor Environmental Quality & the EPBD recast**

Dr. Eng. Atze Boerstra, REHVA vice-president

What is stopping us from using and acting on existing "knowledge"?

Despite the fact that the importance of indoor climate for occupant satisfaction, well-being and productivity, as well as the impact and cost of "dissatisfaction", "unwellness" and "non-productivity" has been known for a long time, still today:

- We have no clear-cut metrics for determining the marketable value ("price") of good IEQ and good BPM.
- We have no practicable mechanisms for integrating these values or trading with them within the context of our business plans. Markets recognize and can work with clearly established values, and well estimated risks.
- Indeed, most often we do not have an adequate real-time understanding of the interrelationships between BPM, IEQ and occupant benefits.

What is stopping us from using and acting on existing “knowledge”?

- As a rule we do not measure (continuously or at all), and we consequently do not know how our buildings perform.
- Without quality-assured data, we cannot adequately analyze or optimize building performance, and therefore we do not get what we need and/or have contracted (paid for).
- “Knowing” that BPM, IEQ and occupants benefits are interrelated does not automatically lead to good BPM. The interrelationships need to be accurately assessed and translated into better control signals, better BPM, better performance, and better occupant benefits.

Indoor climate and energy performance in office buildings – a knowledge synthesis

Swedish Energy Agency (Project-no. 42639-1) and SBUF (the Swedish construction industry's organization for research and development; project-no. 13293), (2017/2018).

Summary

Key needs in the building sector (office buildings) to be addressed:

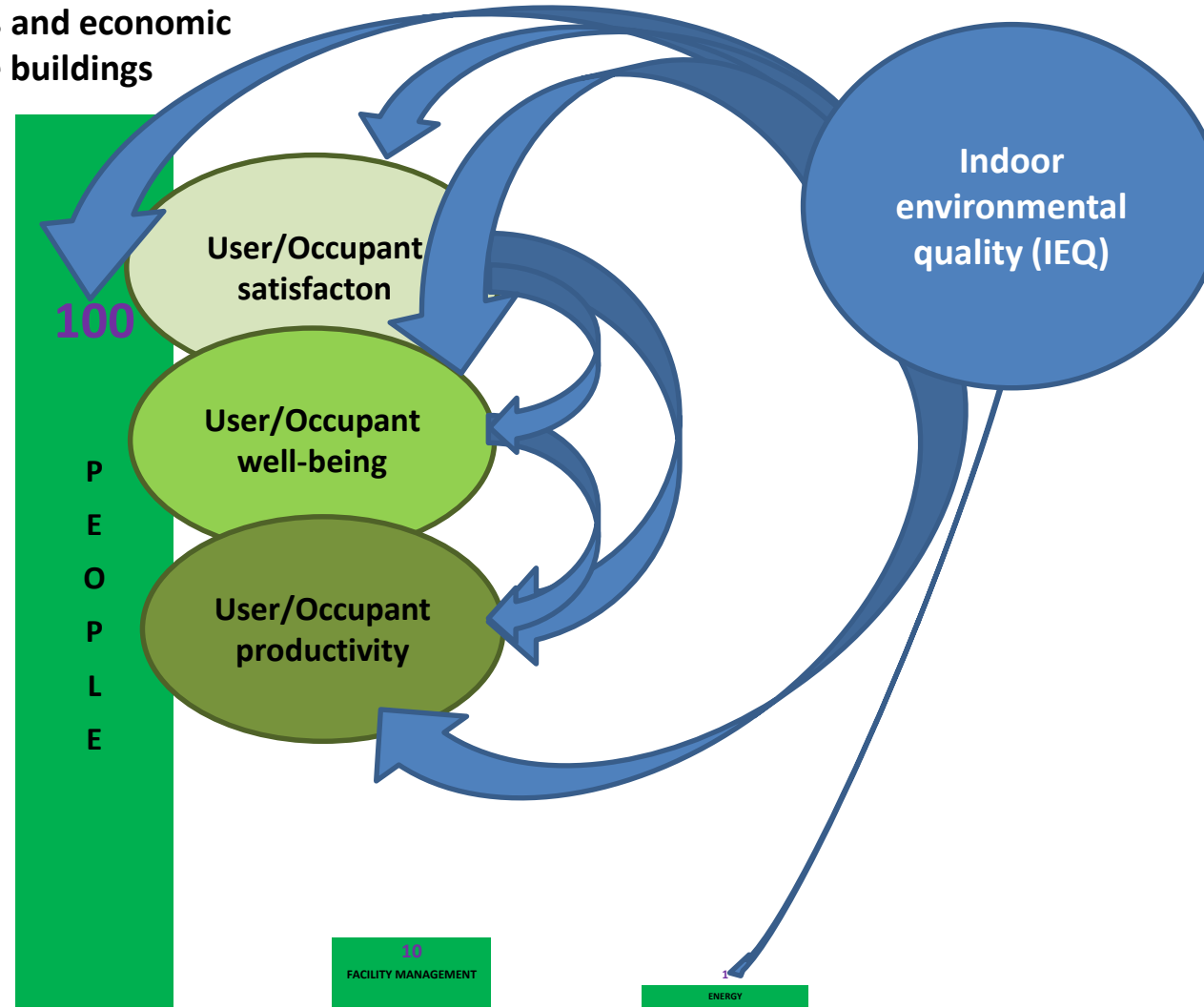
- “Knowledge lift” relevant to user-adapted, smart BPM at all building sector levels,
- User-/occupant-centric approach to BPM,
- A comprehensive understanding of building performance, based on long-term, high-quality and high-relevance (resolution) measurement data,
- Continuous and comprehensive monitoring, analysis and optimisation in real-time (control-relevance) to meet dynamic user and building needs,
- Integrated building performance metrics (KPIs) clearly relating to performance and “product quality” – replacing the myopic focus on energy performance and “connecting the dots”,



Key needs in the building sector (office buildings) to be addressed:

- A deep, integrated understanding of the inter-relationships between building performance management, user needs, indoor environment, energy efficiency and other aspects of building performance,
- Establishing marketable, business-plan compatible building performance metrics (KPIs) clearly relating to e.g. certification value, customer satisfaction, market value,
- Digitalization in the building sector to provide new tools for smart BPM – **paradigm shift** (Big Data, IoT, connectivity, cloud services, data processing and optimization tools, automation/AI).

Building-related costs and economic performance in office buildings





From: "Financial Case for High Performance Buildings". Stok, <https://stok.com/> (2018)

High Performance Building Benefits

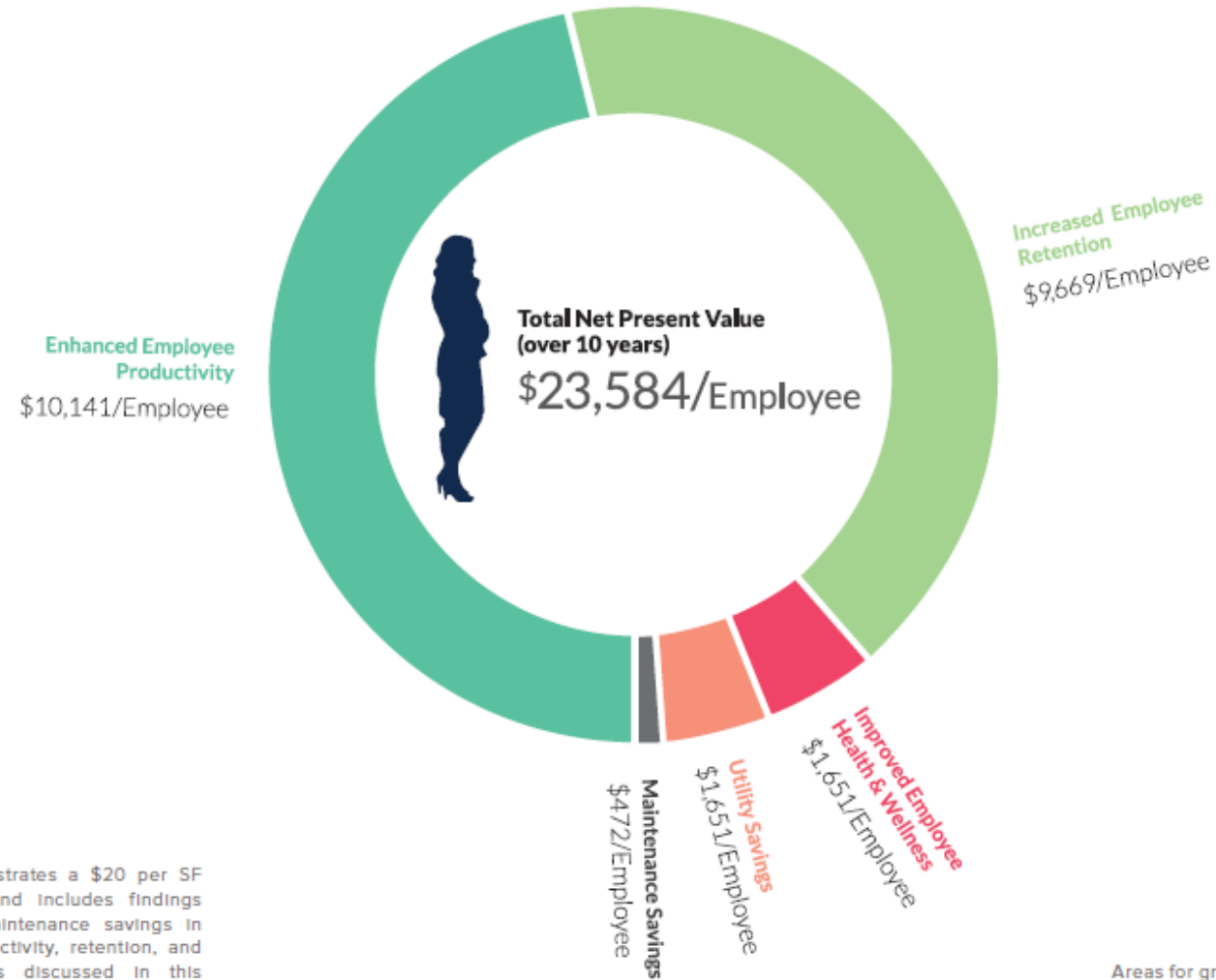
“Although utility and maintenance cost savings are the most frequently cited benefit of High Performance Buildings, they offer some of the smallest financial value.

As shown below, 43% of the total value comes from enhanced employee productivity, 41% from increased employee retention, 7% from improved employee wellness, 7% from utility savings, and 2% from maintenance savings.

Given this breakdown, human-centered design should be a critical consideration when creating an HPB.”

High Performance Building Benefits

NPV PER EMPLOYEE OVER 10 YEARS**



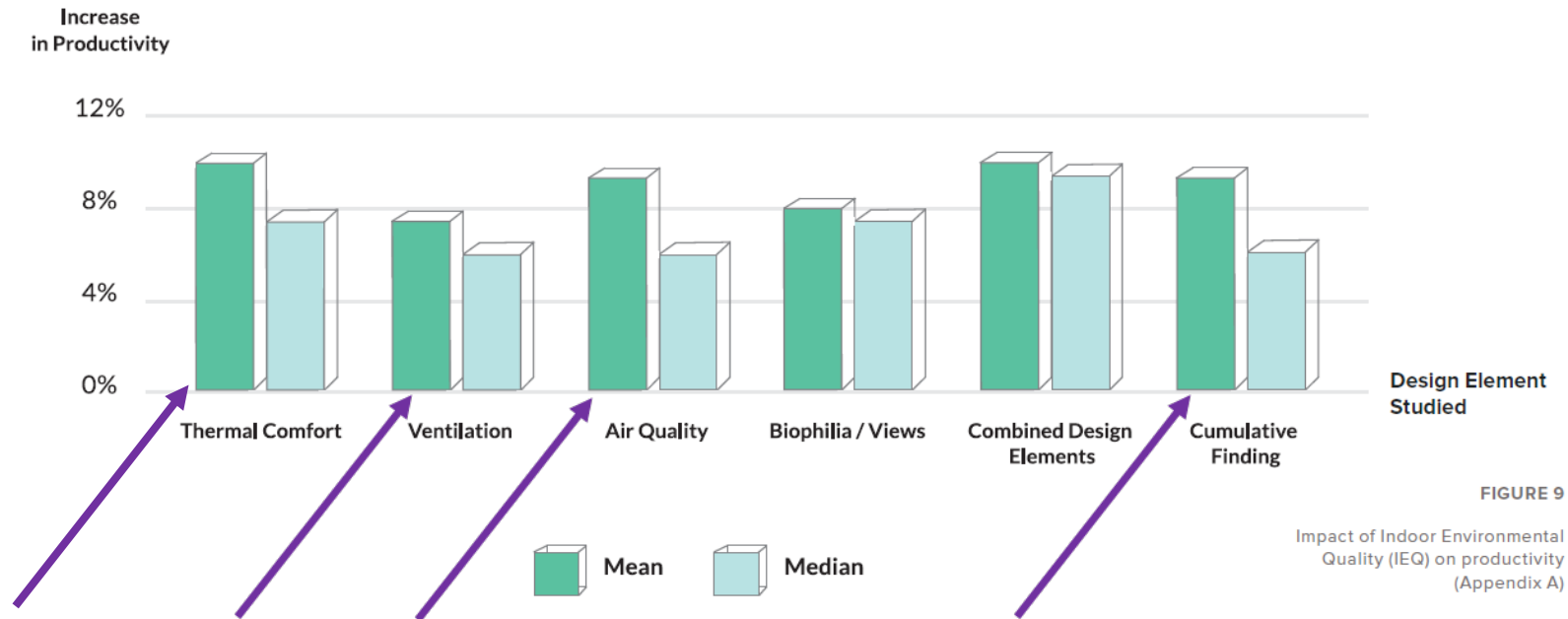
**Analysis demonstrates a \$20 per SF cost premium³ and includes findings of utility and maintenance savings in addition to productivity, retention, and wellness benefits discussed in this report.

FIGURE 1

Areas for greatest financial impact due to HPB benefits, per employee

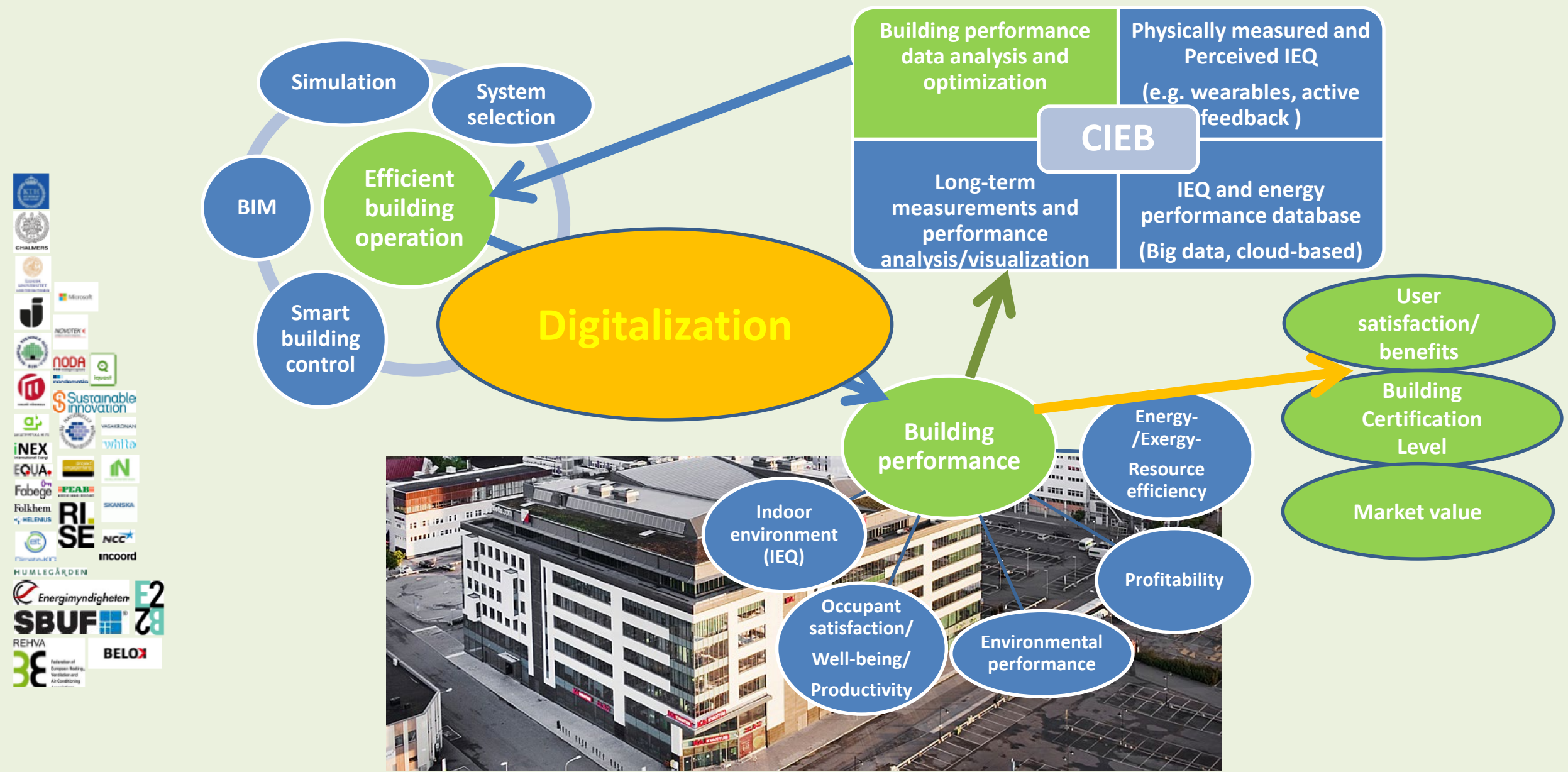
High Performance Building Benefits

RESEARCH FINDINGS COMPARISON: PRODUCTIVITY ENHANCEMENT



From: "Financial Case for High Performance Buildings". Stok, <https://stok.com/> (2018)

Integrated approach to building performance management





An integrated approach to BPM – Connecting the dots:

1) Center for IEQ and Energy Performance in Buildings – CIEB:

Long-term, multi-disciplinary, national collaboration and innovation platform for user-adapted, sustainable BPM with key focus on indoor environment and energy performance in buildings.

2) Research School "Smart Buildings"

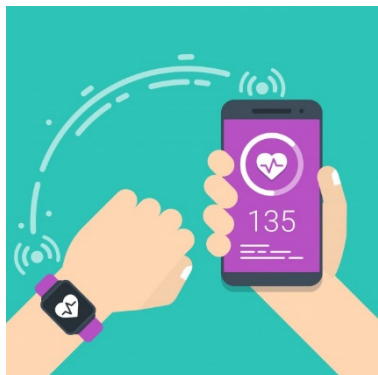
Expected outcomes

- Comprehensive understanding of building performance in a system- and life-cycle-perspective with key focus on user satisfaction, well-being and productivity,
- Better compliance with (contractual or legal) building performance requirements, higher certification levels, higher market value, lower operating risks and costs,
- Improved ability to deliver user-adapted and cost-efficient system solutions for newbuild and retrofitting projects; more efficient production,
- Better adaptation of building design and function for specific user needs,
- Improved indoor climate and energy modeling, decreasing the gaps between simulated and measured/perceived performance ,
- More efficient (real-time, continuous) building commissioning,

Expected outcomes

- More user-friendly, standardized communication between BPM-systems and building subsystems (e.g. RealEstateCore),
- More comprehensive, wholesome building performance metrics (KPIs) that better reflect product quality, customer benefits and market value; KPIs should be business-plan compatible; current narrow focus on (some aspects of) energy performance is inadequate,
- Higher user satisfaction and well-being, higher productivity and profitability; better conditions for contracting and delivery of user-adapted services,
- Better adaptation to nZEB requirements and (real-time) performance monitoring; ever tighter energy performance margins will require increasingly accurate monitoring,
- Digitalization of building performance management (big data, IOT, cloud-services, advanced automation tools, AI) – smart/intelligent buildings,
- Etc.

Occupant-centric BPM



Occupant Satisfaction
Well-being
Productivity



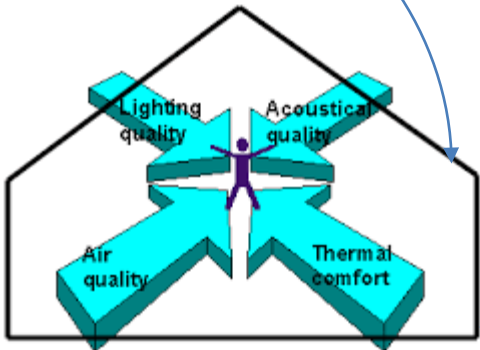
Big Data
Cloud Services



Machine Learning/AI



Internet of Things
Connectivity



Indoor Environmental Quality
Assessment, Analysis, Optimisation



Building Performance Management

Research School "Smart Buildings"

Currently 7 on-going good-BPM- and smart-building-related research projects (collaboration between KTH Royal Institute of Technology, Jönköping University and Blekinge Institute of Technology).

Goal: 15-20 PhD-projects over the next 3 years

We are looking for new international academic and corporate partners!

Contact: Ivo Martinac, im@kth.se



Andrei Litiu, PhD-Candidate

Co-Chair, REHVA TF "Smart Buildings"

User-adapted, smart building performance management

Prodao & University of Timisoara

CIEB (Skanska, EQUA +)

REHVA (Federation of European Heating, Ventilation and Air Conditioning Associations) –
new REHVA European Guidebook on Smart Buildings

MOBISTYLE



David Hälleberg, PhD-Candidate
Team Leader - Energy, Akademiska Hus

Smart load and energy performance management for building clusters/districts

Akademiska Hus, Jönköping University
CIEB, machine learning, smart controls +
HTW-Berlin (A Badura)

From Building (BPM) to District Performance Management using Machine Learning and AI



THANK YOU!