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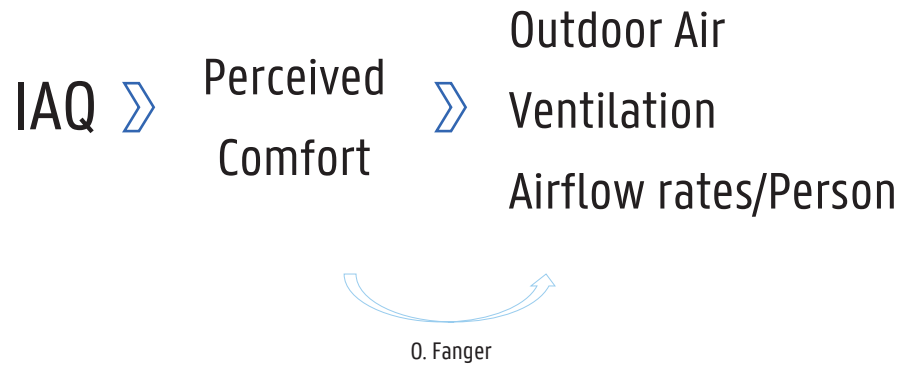
DEPARTMENT OF ARCHITECTURE AND URBAN PLANNING
BUILDING PHYSICS RESEARCH GROUP

AN (ECONOMIC) INDICATOR FOR ASSESSMENT OF SMART VENTILATION SYSTEMS

Klaas De Jonge, Dr. Ir-Arch [12/12/2023]


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A VERY BRIEF NON-EXHAUSTIVE HISTORY



A VERY BRIEF NON-EXHAUSTIVE HISTORY

Ventilation rates obtained \neq ? Good IAQ

A VERY BRIEF NON-EXHAUSTIVE HISTORY

Ventilation rates obtained \equiv Ventilation system works as designed



INDOOR AIR QUALITY

IAQ \rightarrow

Health
Sick-Building Syndrome
Comfort: Bio-effluents, Hygric
Work Performance
Sleep Quality
Acoustic
Energy Use
Comfort: Thermal
Investment cost
Resilience

\rightarrow What is optimal design?

IAQ-management strategies \rightarrow



Health

Sick-Building Syndrome

Comfort: Bio-effluents, Hygric

Work Performance

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Acoustic

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Investment cost

Resilience



What is
optimal
design?



Cost-Function
for design optimization



COST-FUNCTION

Dr. Louis Cony

Cony, Louis, and Jelle Laverge. "A Methodology to Assess Economical Impacts of Poor IAQ in Office Buildings from DALY and SBS Induced Costs." CLIMA 2022 Conference, May 20, 2022. <https://doi.org/10.34641/clima.2022.297>.



Cost-function?



Health



Sick-Building Syndrome



Comfort: Bio-effluents, Hygric



Work Performance



Sleep Quality



Acoustic



Energy Use



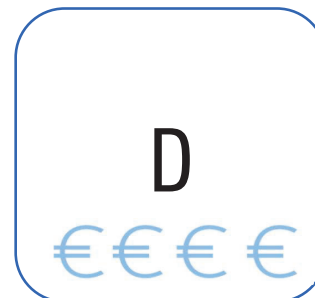
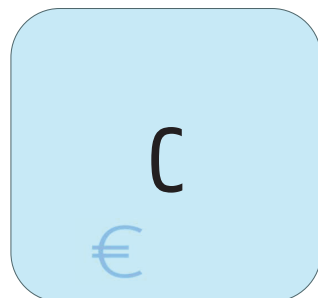
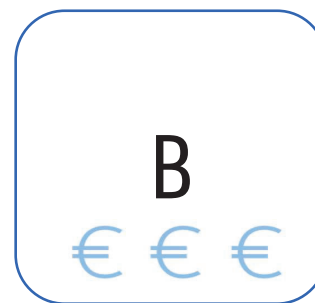
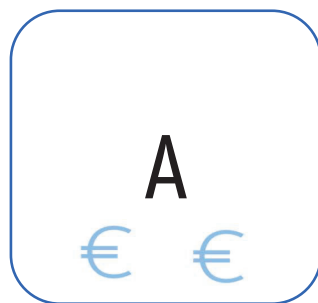
Comfort: Thermal



Investment cost



Resilience



OFFICE BUILDING

Health
Sick-Building Syndrome
Comfort: Bio-effluents, Hygric
Work Performance

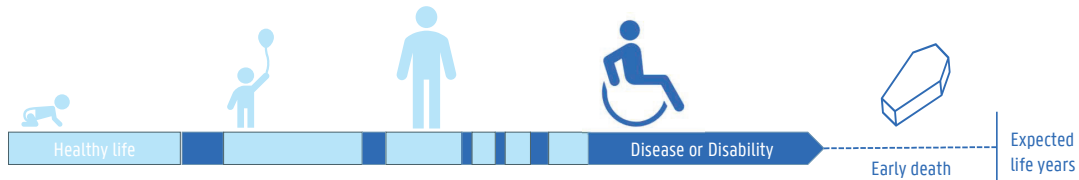


Sleep Quality
Acoustic
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Comfort: Thermal 
Investment cost
Resilience

$$IAQ_{Cost} = \sum_i^p Daly_i \times Daly_{cost_i} + SBS_{cost}$$

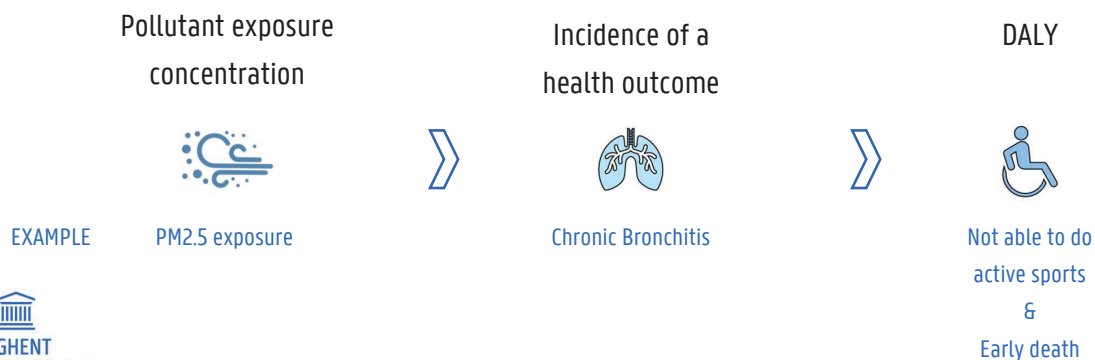
$$IAQ_{Cost} = \sum_i^p \overset{HEALTH}{Daly_i} \times Daly_{cost_i} + SBS_{cost}$$

Disability-Adjusted Life years (lost) = Metric of harm



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$$IAQ_{Cost} = \sum_i^p \overset{HEALTH}{Daly_i \times Daly\ cost_i} + SBS_{cost}$$

5 main categories:

- Mortality and life cost
- Medical costs
- Productivity cost
- ~~- Research, prevention and regulation costs~~
- ~~- Willingness to pay~~



$$IAQ_{Cost} = \sum_i^p \overset{HEALTH}{Daly_i \times Daly\ cost_i} + SBS_{cost}$$

$$= LY_{cost} + H_{cost_i} + P_{cost}$$

5 main categories:

- **Mortality and life cost (LY_{cost})**
- Medical costs
- Productivity cost
- ~~- Research, prevention and regulation costs~~
- ~~- Willingness to pay~~

In a previous socio-economical study, life year (LY) cost was estimated around **€ 115 000** per year per person.



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$$= LY_{cost} + H_{cost_i} + P_{cost}$$

5 main categories:

- Mortality and life cost
- **Medical costs (H_{cost_i})**
- Productivity cost
- ~~- Research, prevention and regulation costs~~
- ~~- Willingness to pay~~

Medical costs vary from one pollutant to another as the diseases induced are also different.

Pollutant	Medical cost (€)
Benzene	46 000
Trichloroethylene	70 971
Radon	25 526
PM	10 402
CO	1 085
Others (if unknown)	40 000

$$IAQ_{Cost} = \sum_i^p \overset{\text{HEALTH}}{Daly_i \times Daly_{cost_i}} + SBS_{cost}$$

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- **Productivity cost (P_{cost})**
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Average national productivity is estimated around **€ 145 000 per year per person** but can be recalculated for each building, based on the average productivity of the concerned company.

*We consider that the proportion of productivity loss is equal to the life quality loss (e.g, a person suffering a disease that induces a 20% life quality lost, would have a 20% productivity loss).

$$IAQ_{Cost} = \sum_i^p Daly_i \times Daly\ cost_i + SBS_{cost}$$

Sick-Building Syndrome

= Mild, temporary acute effects of (bad) IAQ that cause concentration disturbance and productivity loss while at work.

≠ Severe health effects

Combining concepts of:

"Percentage of Occupants Presenting 1 or 2 SBS symptoms – **POP1 & POP2**"

"Indoor Air Pollution Index - **IAP1**" & "Indoor Discomfort Index - **IDI**"



$$= P_{cost} \times P_{loss}(0.83 + 2.83IAP1 + 0.83IDI) \times \frac{2}{5}$$

Subjective data of employees
(questionnaires)



CAN BE MODELLED

CO, CO2, Acetaldehyde, Acrolein, Benzene, Formaldehyde, Styrene, Tetrachloroethylene, Toluene, Trichloroethylene, xylene, and Particulate Matters (PMs).

Temperature and Relative Humidity (RH)

Main reference:

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Acknowledgements

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