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Implementation of Energy Management System on Campus Buildings in Indonesia

23 January 2024, Shinagawa, Tokyo

By : Sentagi Sesotya Utami, Ph.D.
Associate Professor in Engineering Physics UGM

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Education

- (Ph.D.), **Architectural Acoustics**, University Of Michigan, USA
- (M.Sc.), **Acoustics**, Brigham Young University, USA
- (S.T.), **Architectural Engineering**, Universitas Gadjah Mada

Area of Research

- Building Physics and Green Building

Research Topic

- Developing methods to achieve nZEB model in Yogyakarta and Bandung (USAID Shera)
- Implementation of Soft Sensor Technology in Building Management System for IEQ and Energy Efficiency Performances of Tropical Buildings.
- Development towards commercialization of Fit To Work Monitoring System for Workers in High-Risk Industries

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- Coordinator of University Reputation Unit
- Associate Professor in Building Physics
- Coordinator of **INSGREEB (Integrated Smart and Green Building) Research Group**

insgreeb
integrated smart and green building

http://insgreeb.ft.ugm.ac.id/

InSGreeB Profile

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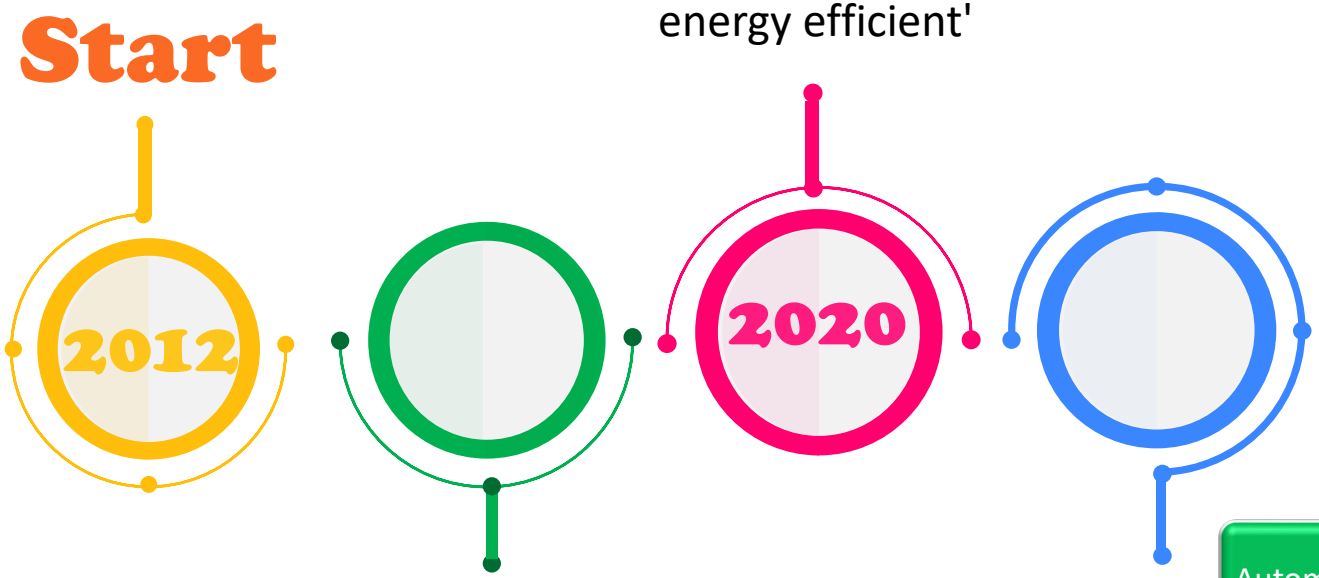
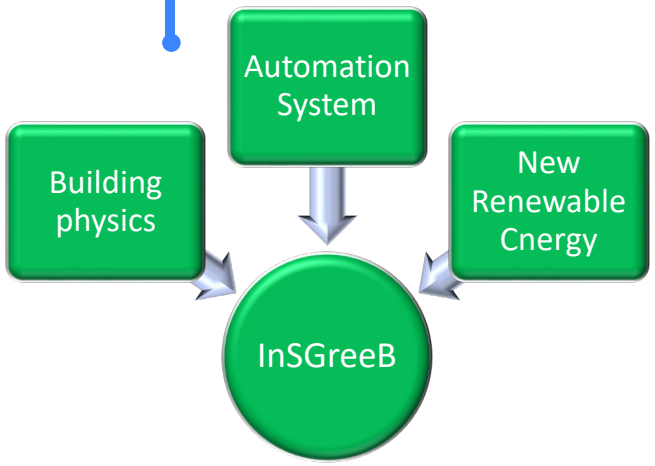
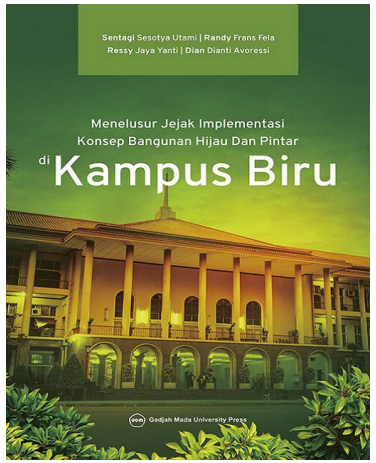
Adapted to Covid-19 conditions, the innovation continues with a new paradigm 'Healthy, but still energy efficient'



Focus on integrating building physics and acoustics using smart instrumentation and systems



Publication



Integrated Smart and Green Building Research Group

insgreeb
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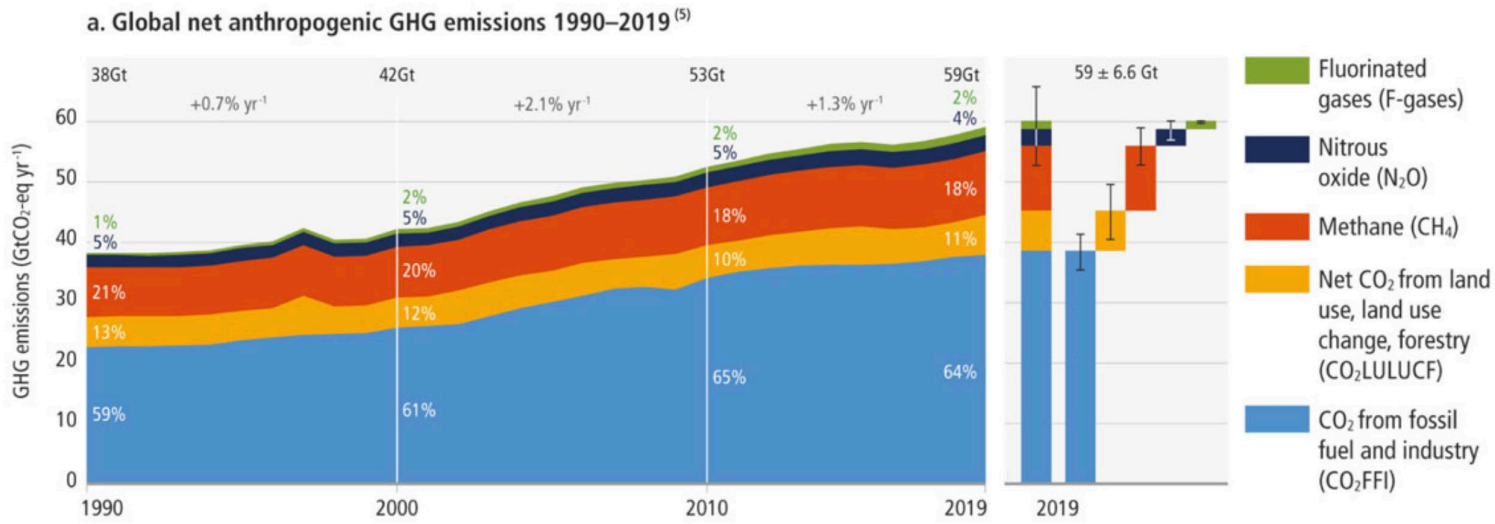
http://insgreeb.ft.ugm.ac.id/

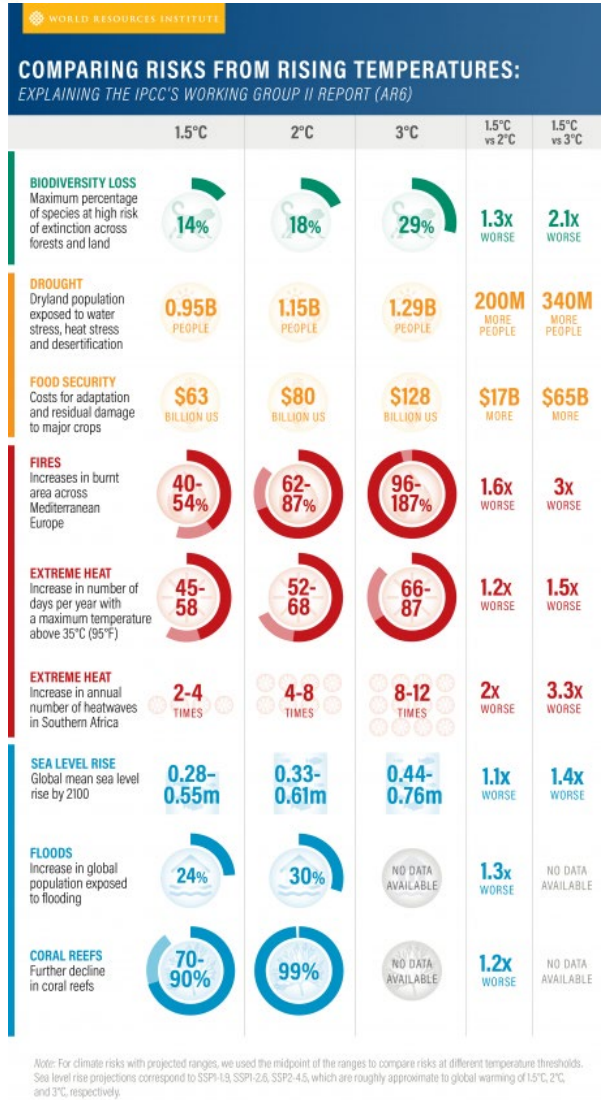
1.5°C Challenge!



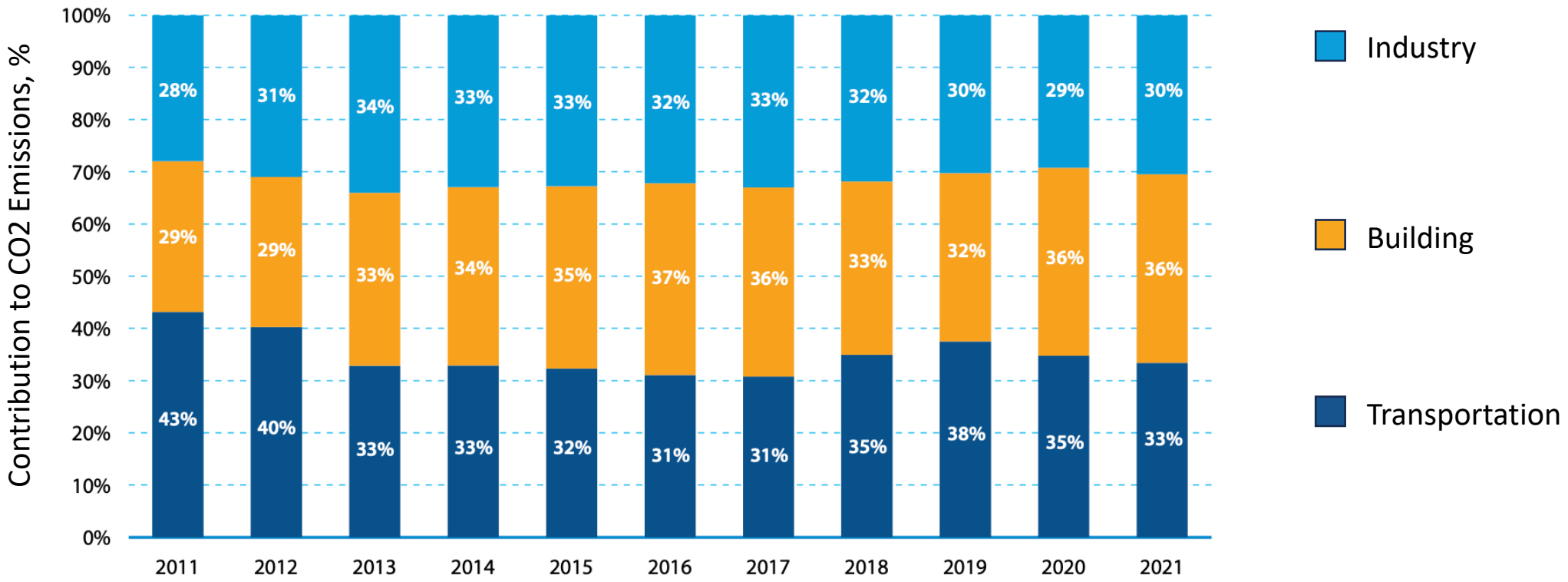
UN climate change report on 4 April 2022 :
Carbon emissions from 2010-2019 have never been higher in human history, proof that the world is on a “fast track” to disaster.

It’s ‘now or never’ to limit global warming to 1.5 degrees.

(UN News) https://news.un.org/en/story/2022/04/1115452
(World Resources Institute) https://www.wri.org/blog/2018/10/8-things-you-need-know-about-ipcc-15-c-report



Carbon Emission in Indonesia from energy usage



Distribution of Co2 Emissions by sector for energy use for the 2011-2021 period

Source: Green Building Road Map Book (2024, not yet published)

Green Building Goals in Indonesia

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Pillars of Indonesian Development 2045

Human Development and Mastery of Science and Technology

- Accelerating the education of the Indonesian people evenly
- Increasing the role of culture in development
- Increasing the contribution of science and technology to development
- Increasing the level of health and quality of life of the people
- Labor reform

Sustainable Economic Development

- Increased investment and foreign trade
- Acceleration of industry and tourism
- Maritime economic development
- Strengthening food security and improving farmer welfare
- Strengthen energy and water security
- Commitment to the environment

Equitable development

- Accelerating poverty alleviation
- Equal distribution of business opportunities and income
- Equal distribution of regional development
- Equitable and integrated infrastructure development

Strengthening Indonesia's Resilience and Governance

- Substantive democracy
- Institutional and bureaucratic reform
- Strengthening Indonesia's legal system and anti-corruption
- Free and active foreign policy
- Strengthening resilience and security

Source: 'Indonesia 2045: Ministry of National Development Planning/Bappenas, May 2019

Green and Smart Building Standards in Indonesia

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Minister for National Development Planning Regulation Number 11 Year 2020 concerning strategic plans of the Ministry of National Development Planning/National Development Planning Agency for 2020-2024

LOW CARBON DEVELOPMENT INDONESIA

Minister of Public Works and Public Housing Regulation Number 10 Year 2023 concerning Smart Buildings

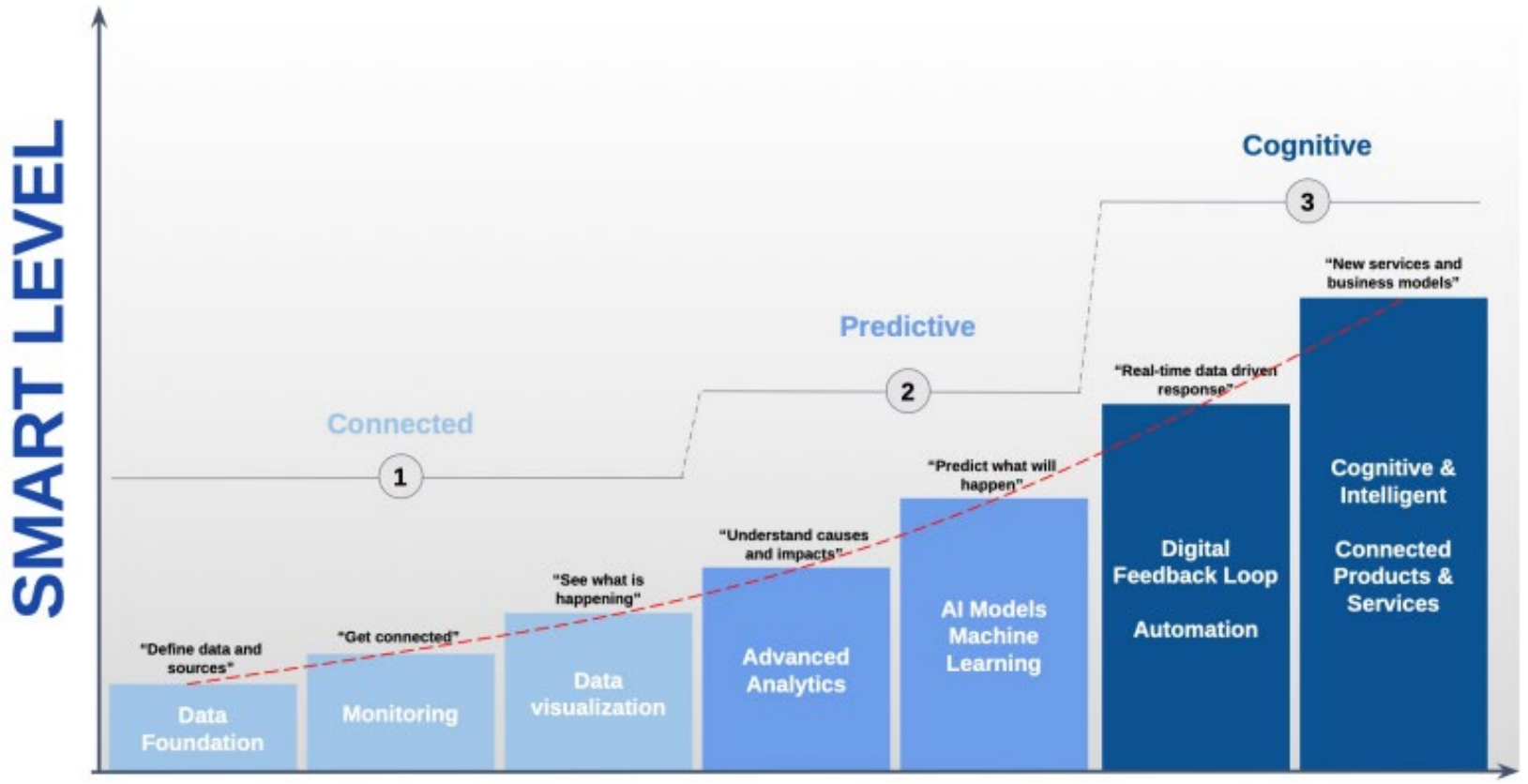
Smart Building (BGC)

Minister of Public Works and Public Housing Regulation Number 02/PRT/M/2015 Year 2015 concerning Green Buildings

BANGUNAN GEDUNG HIJAU

Green Building (BGH)

Standard for Smart Building in Indonesia



SOURCE: BGC TECHNICAL STANDARDS & ASSESSMENT, MINISTRY OF PUPR

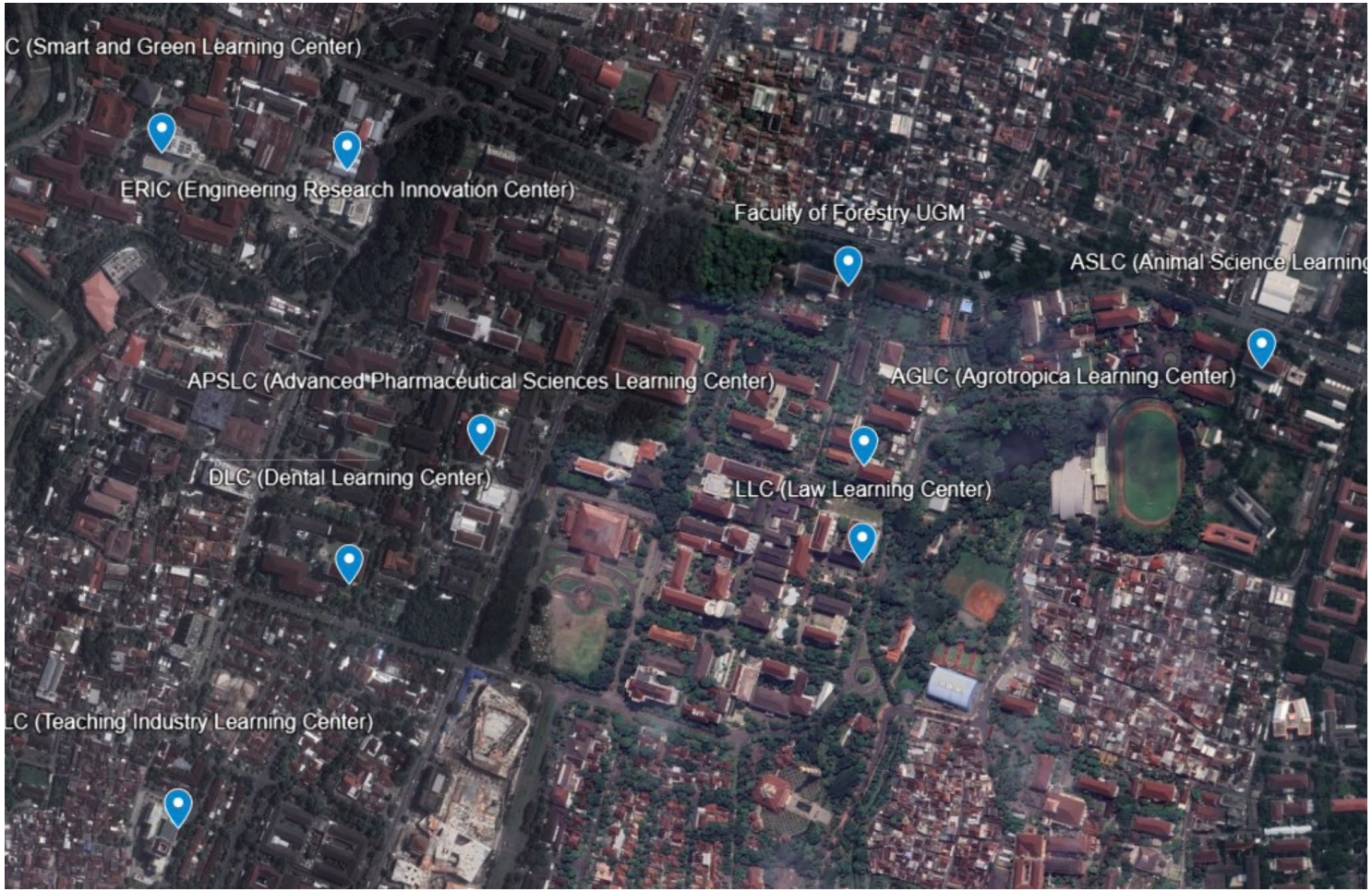
Parameters

- Cybersecurity
- Communication protocols and networks
- Data and system integration
- System capabilities

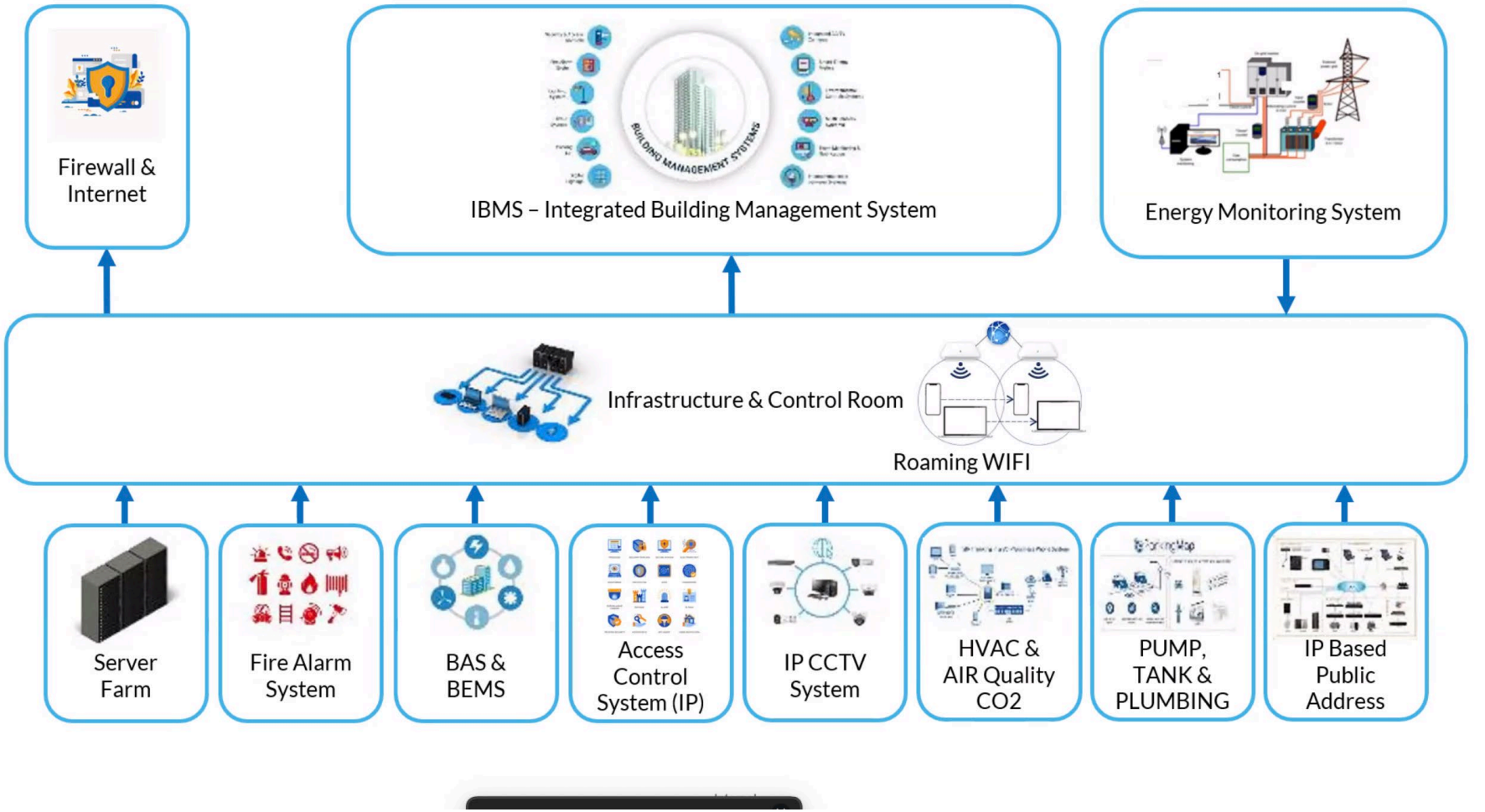
Capable of continuous development

Lessons-Learned in UGM

1. LLC (Law Learning Center)
2. IFFLC (Integrated Forest Farming Learning Center)
3. ASLC (Animal Science Learning Center)
4. AGLC (Agrotropica Learning Center)
5. FRC (Field Research Center)
6. TILC (Teaching Industry Learning Center)
7. DLC (Dental Learning Center)
8. APSLC (Advanced Pharmaceutical Sciences Learning Center)
9. **SGLC (Smart and Green Learning Center)**
10. ERIC (Engineering Research Innovation Center)



Integrated Building Management System



Energy Monitoring System

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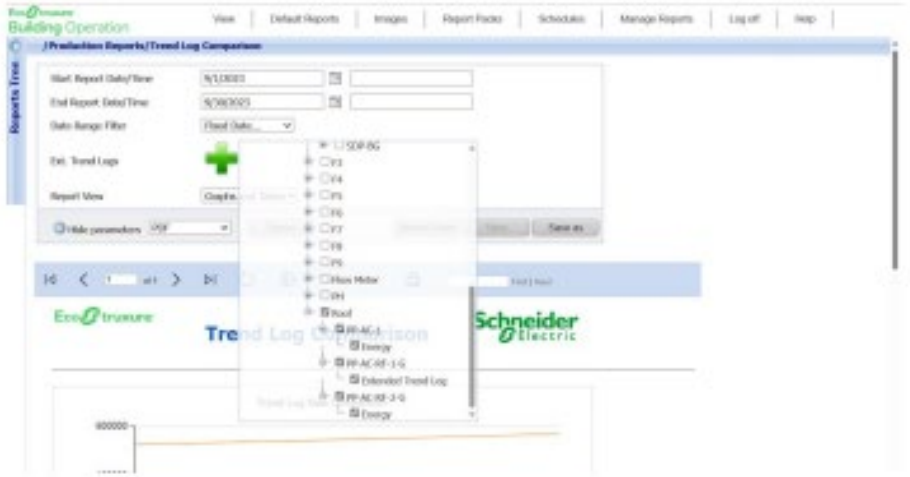
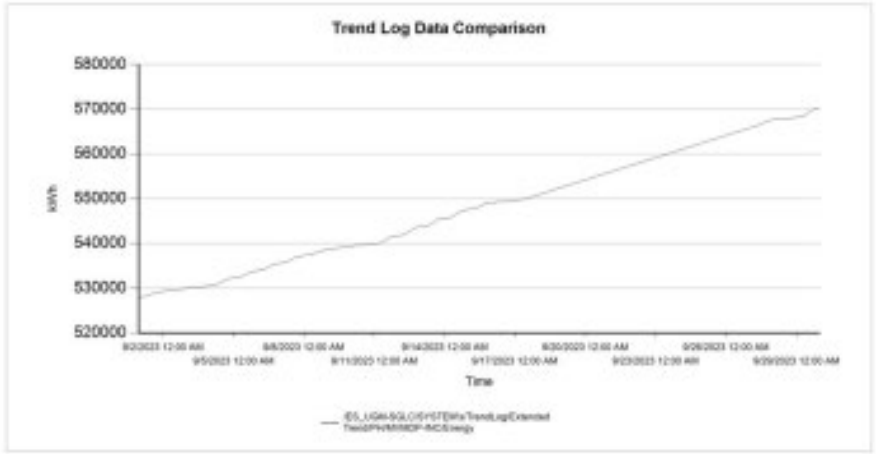
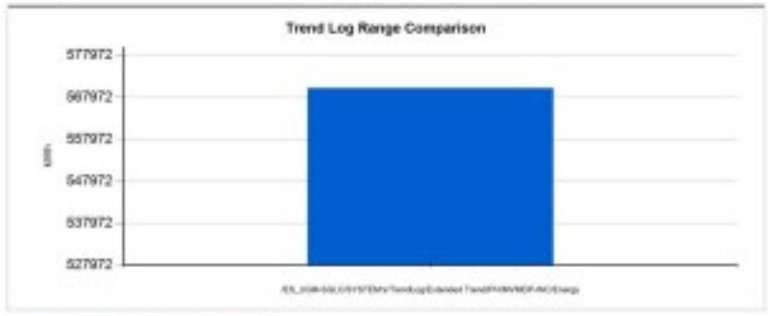




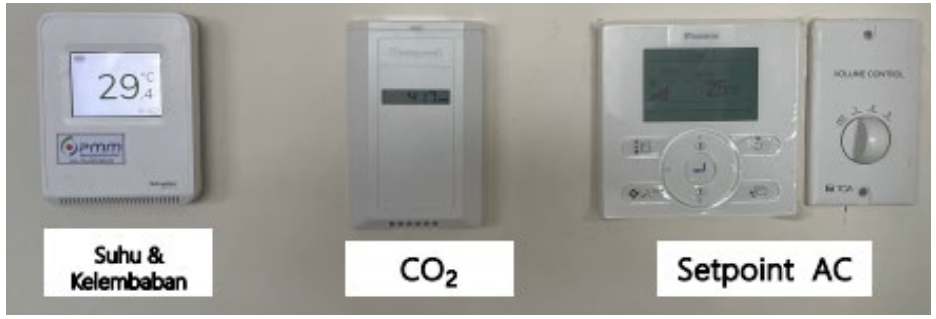


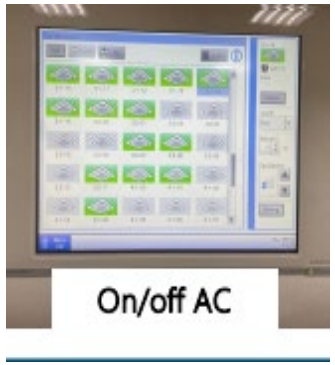
Summary	
Minimum	527972.31
Maximum	570167.69
Average	542443.09

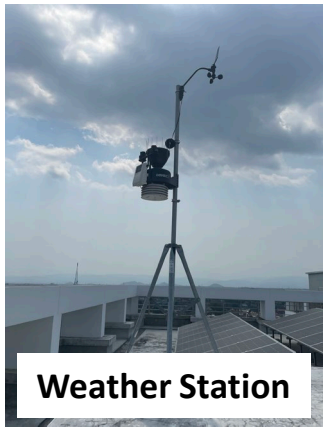
Time	
9/1/2023 12:00:00 AM	527972.31

GREEN BUILDING COUNCIL INDONESIA

Sensors and Control System- Building Management System







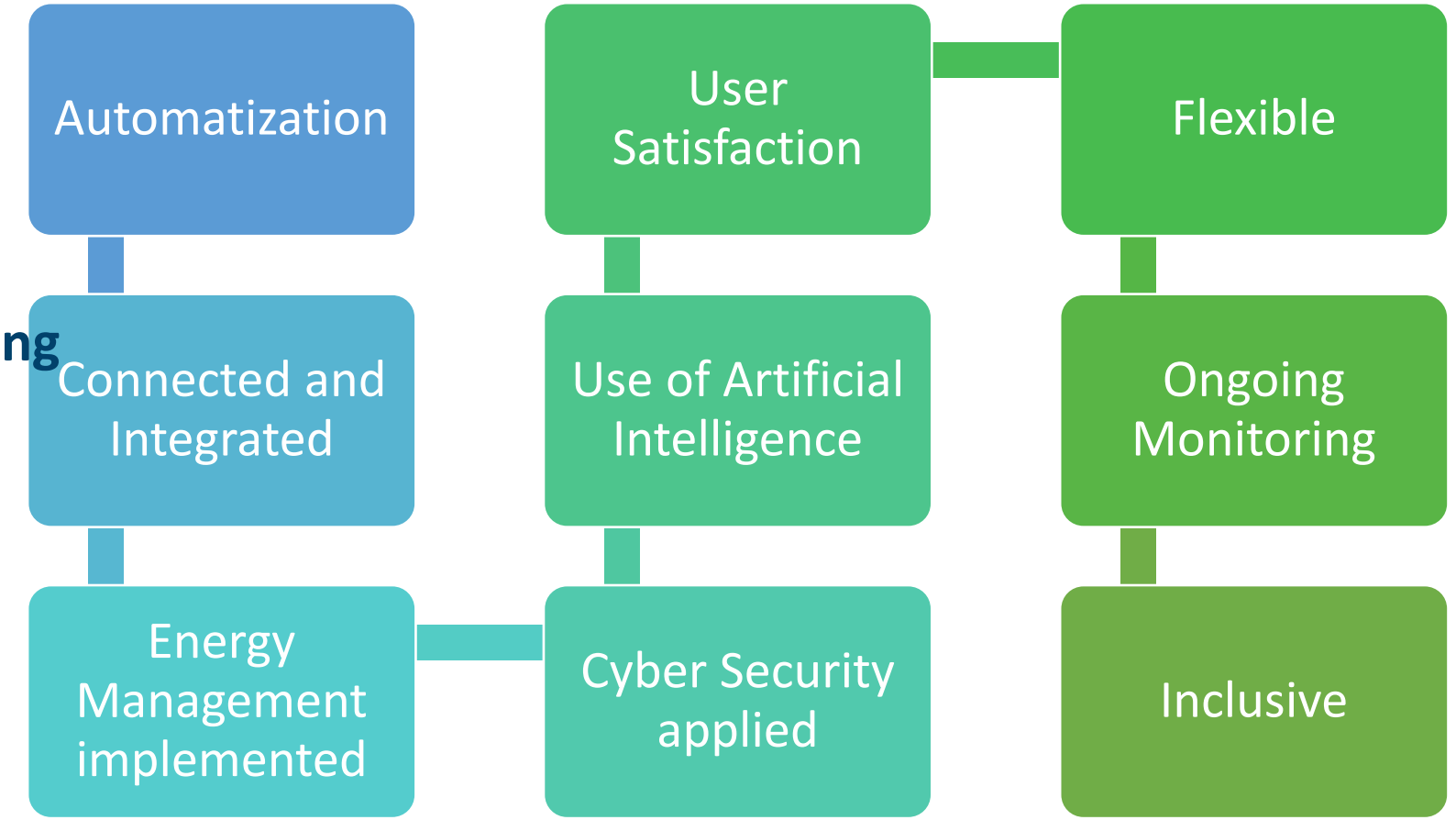
Others :

- Accelerometer
- Water meters

HVAC Automation System

Lighting Automation System

9 Principles of Smart Building System



Source: Technical Standard on BGC and Assessment Guideline, Ministry of Public Work PUPR

Automatization

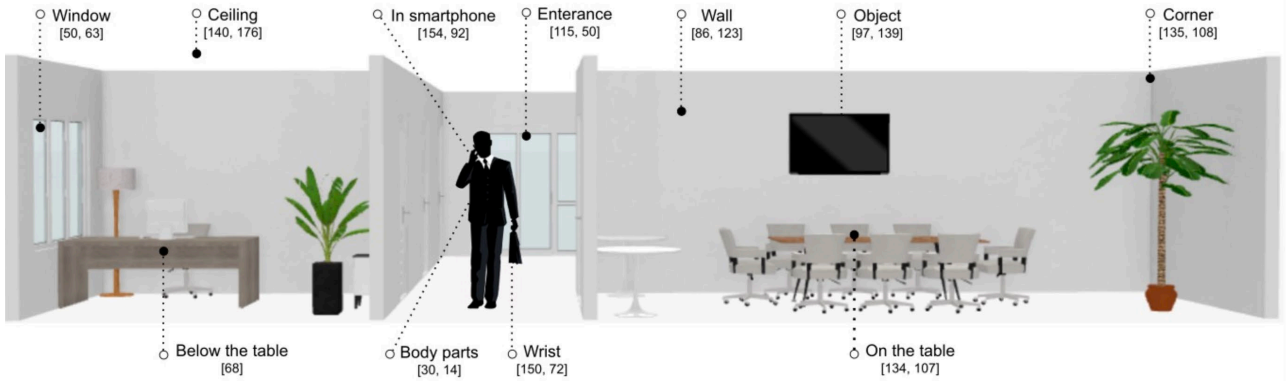
Lighting automation

Purpose of automatization:

To monitor, arrange, and control all the building systems intended for an optimal and efficient operation that is responsive to the occupant's needs

Method and Tools for measurement:

- The sensor's reading must be valid in characterizing the phenomenon of the occupant's activity areas
- Efficient, easy in utilization, and does not agitate occupants
- Depends on sensor's selection and placement



Common problem in sensor's selection and placement:

- The use of occupancy sensors to detect movement with PIR. Most are installed near the ceiling in areas where movements are difficult to detect.
- Most readings from the light intensity sensors do not conform with occupants' visual perception since measurement are at the work plane heights, meanwhile the sensors are on the ceiling.

Wael Alsafery, Omer Rana, and Charith Perera. 2023. Sensing within Smart Buildings: A Survey. ACM Comput. Surv. 55, July 2023.

Automatization

Thermal and IAQ

Purpose of automatization:

To monitor, arrange, and control all the building systems intended for an optimal and efficient operation that is responsive to the occupant's needs

Thermal Sensors Placement Requirements :

- The sensor's reading must be valid in characterizing the phenomenon of the occupant's activity areas
- The sensor's readings should comply with occupants' thermal comfort perception. Measurements should be around head heights and for sitting position at 1,1 m height.

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Original Scientific Paper
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doi:10.5937/jaes0-28985
Paper number: 19(2021)3, 836, 628-641

OPTIMAL THERMAL SENSORS PLACEMENT BASED ON INDOOR THERMAL ENVIRONMENT CHARACTERIZATION BY USING CFD MODEL

Faridah[1,2], Sentagi Sesotya Utami[1], Ressy Jaya Yanti[1], Sunarno[1], Emilya Nurjani[2], Rony Wijaya[1]*
[1]Universitas Gadjah Mada, Faculty of Engineering, Department of Nuclear Engineering and Engineering Physics, Yogyakarta, Indonesia
[2]Universitas Gadjah Mada, Graduate School, Doctorate Program in Enviromental Science, Yogyakarta, Indonesia

This paper discusses an analysis to obtain the optimal thermal sensor placement based on indoor thermal characteristics. The method relies on the Computational Fluid Dynamics (CFD) simulation by manipulating the outdoor climate and indoor air conditioning (AC) system. First, the alternative sensor's position is considered the optimum installation and the occupant's safety. Utilizing the Standardized Euclidean Distance (SED) analysis, these positions are then selected for the best position using the distribution of the thermal parameters' values data at the activity zones. On-

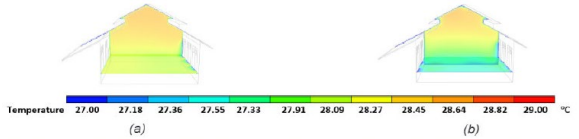
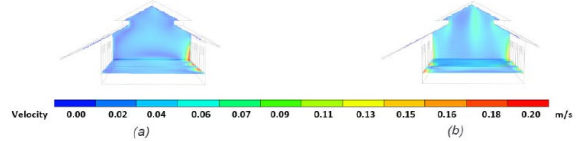


Figure 12: Distribution of air temperature in (a) R33 and (b) R40 with opened door and windows



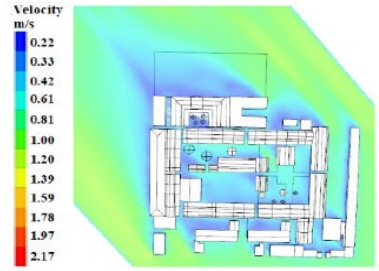
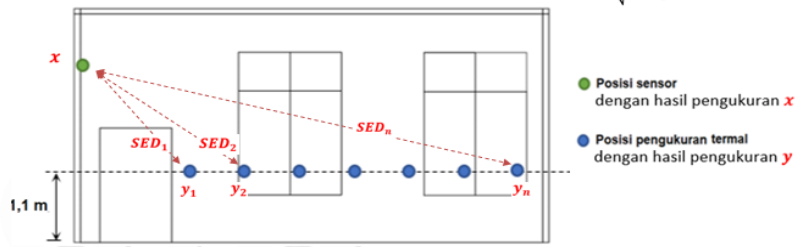


Figure 13: Distribution of air velocity in (a) R33 and (b) R40 with opened doors and windows

Tingkat keterwakilan kondisi termal pada area aktifitas penghuni oleh hasil pengukuran sensor pada suatu posisi :

Standardized Euclidean Distance (SED)

$$d_{x,y} = \sqrt{\left(\frac{x_{t_a} - y_{t_a}}{S_{t_a}}\right)^2 + \left(\frac{x_{RH} - y_{RH}}{S_{RH}}\right)^2 + \left(\frac{x_{v_a} - y_{v_a}}{S_{v_a}}\right)^2}$$



Data x dan y didapatkan dari hasil simulasi CFD dan divalidasi dengan pengukuran langsung.

Automatization

Purpose of automatization:

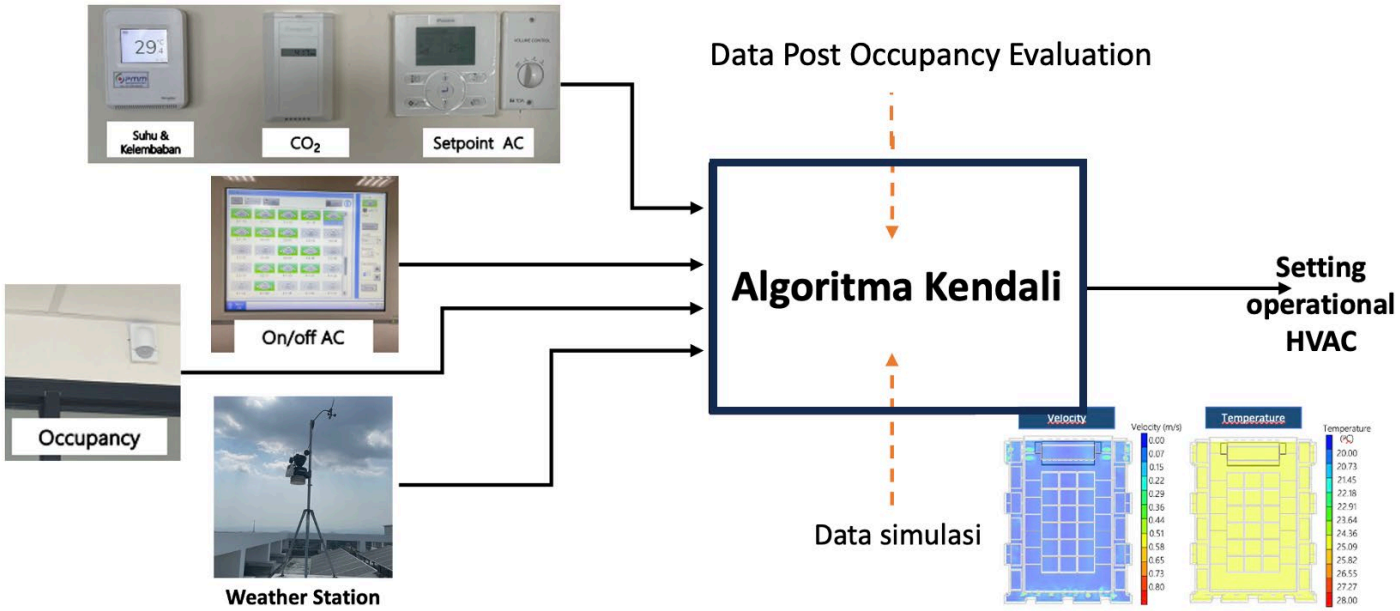
To monitor, arrange, and control all the building systems intended for an optimal and efficient operation that is responsive to the occupant's needs

HVAC automation system

- The VRV system are controlled automatically based on a **fixed schedule** for an entire year.

Control Algorithm requirements :

- Complies with the occupants' thermal comfort needs.
- Includes environmental variables (climate, occupants' behavior, and activity patterns) to accommodate dynamic response.
- The responsive system is only possible if the control algorithm integrates with the sensors.



Automatization

Data required for **Control Algorithm**

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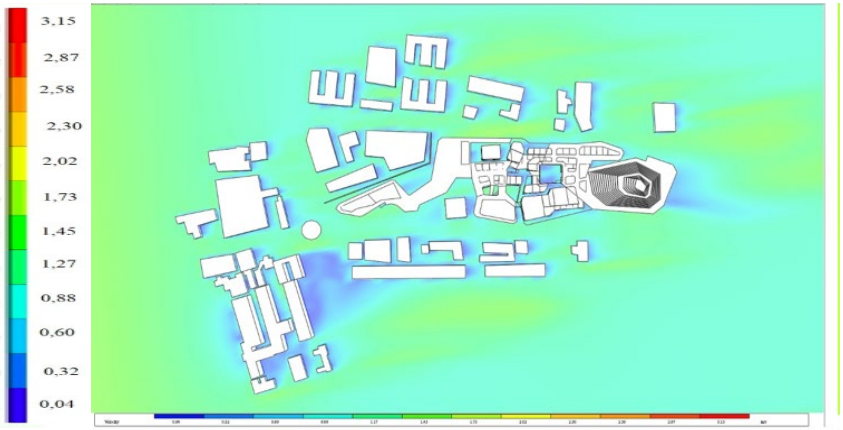
Purpose of automatization:

To monitor, arrange, and control all the building systems intended for an optimal and efficient operation that is responsive to the occupant's needs

CFD Simulation for Natural Ventilation Availability

Gelanggang Inovasi dan Kreativitas UGM



Ketinggian 1.3 m

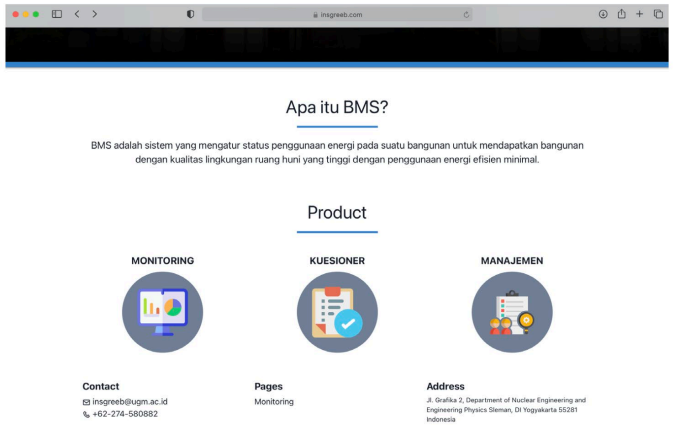
Post Occupancy Evaluation (POE)

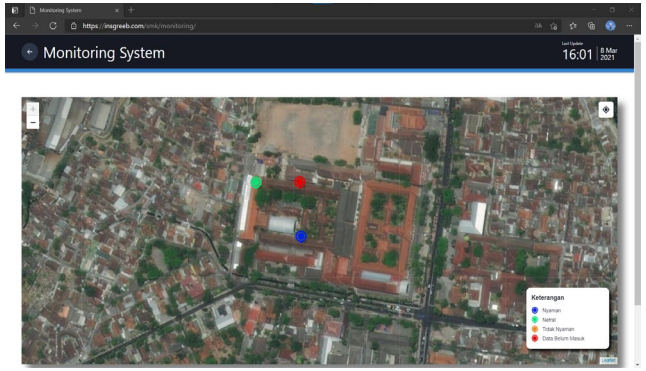
❖ Manual POE

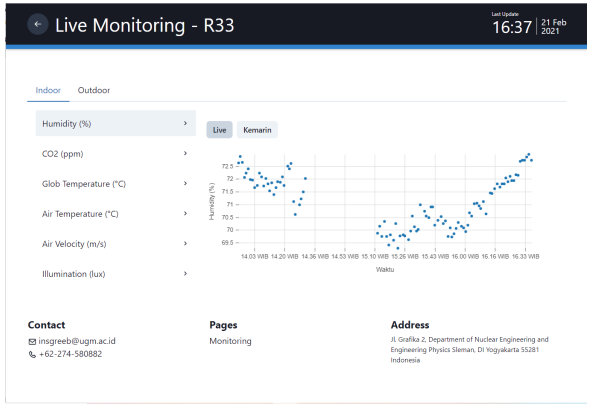
Mengukur data lingkungan yang memapar

Membagikan kuesioner untuk data respon subyektif

❖ Smart POE





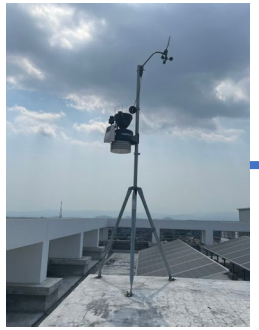


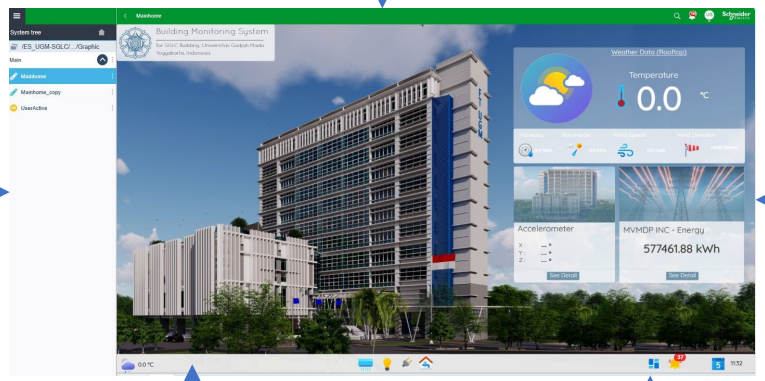
LOCALLY ROOTED, GLOBALLY RESPECTED

Connected and Integrated

Key for integration :

Open Data Structure and Information (Technology and Human wise)





Cyber-security Applied

Key for a secured system :

Regulation, technology, and culture readiness

Use of AI

Purpose for implementation :

To collect, analyze, and utilize the data to create a system that is well connected and integrated

Users Satisfaction

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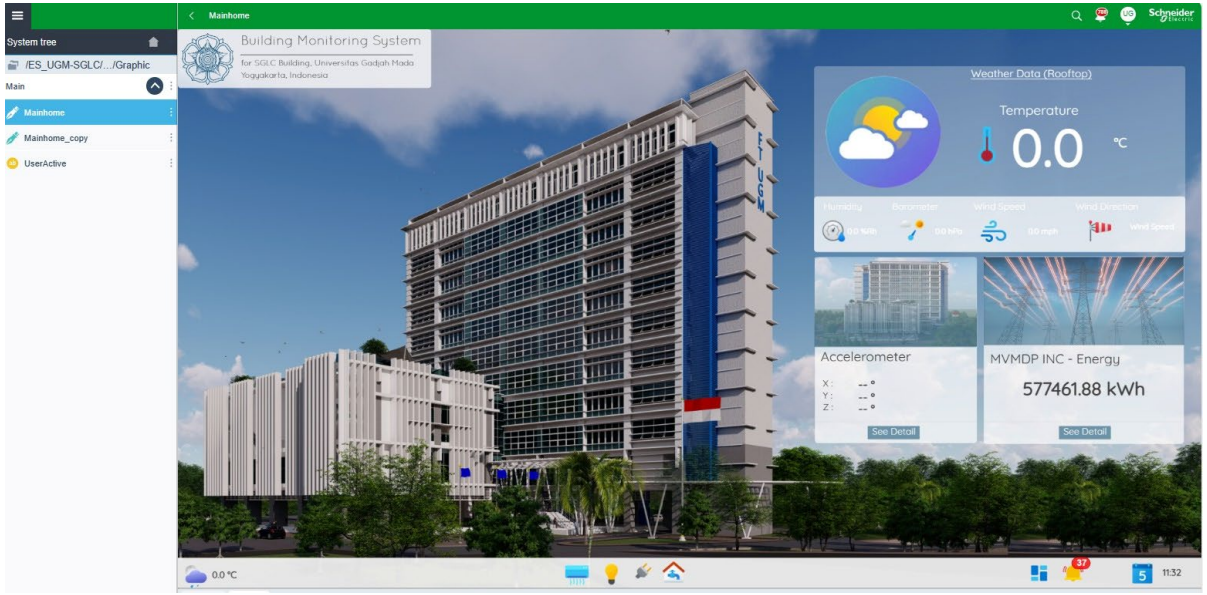
Key to achieve occupant satisfaction:

The Platform adapts and prioritizes the building occupant's needs in terms of safety, health, comfort, accessibility, security while improving life quality and increasing productivity

- Upper layer : HMI, User monitoring and control
- Middle layer : Data processing and Database
- Bottom layer : Sensors, controllers, and actuators



ISO 9241-11:2018 : Ergonomics of human-system interaction

Questions :

- How would the 'business model' be?
- Who would be involved?
- What kind of information will be delivered?
- What kind of technology should be applied?

Features :

- A user-friendly HMI (for operators, engineers, building managers).
- System security
- Data Logging
- Control Algorithm
- Remote connectivity

Thank you

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