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INDOOR CLIMATE LABEL

B4B WEBINAR | PIET JACOBS & DAVID KEYSON

CONTENTS

- Why a Indoor Climate Label?
- The development of the label
  - Pilot survey & inspection in FME building
  - Monitoring sampling strategy
  - Pilot continuous monitoring provincial house South Holland
- Data platform:
  - Data Flow
  - Data Privacy and Security
  - Automated data analytics and label generation
- Inspector dashboard and notification B4B research
- Costs

Deze presentatie is uitgevoerd met subsidie van het ministerie van Economische Zaken en Klimaat en het ministerie van Binnenlandse Zaken en Koninkrijksrelaties.

BRAINS 4 BUILDINGS

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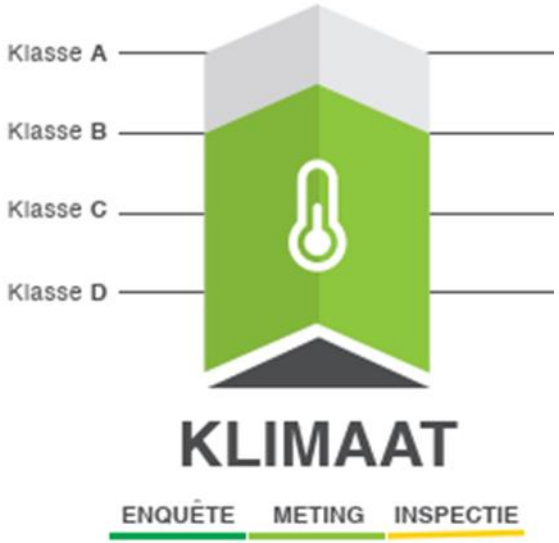
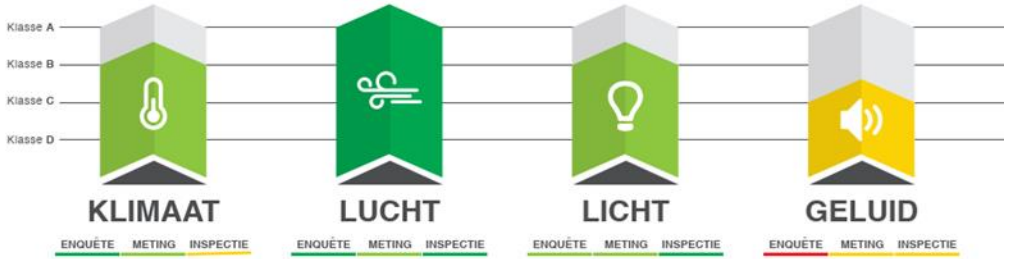
INDOOR CLIMATE LABEL



www.binnenklimaatlabel.nl



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WHY?

- A healthy and vital workplace is becoming increasingly important.
- Existing standards are mainly aimed at the design stage and are for a large part of the market not affordable.
- Follow-up Program of requirements Healthy offices (PVE Gezonde kantoren 2018/2021)

  Performance requirements for thermal comfort, air quality, lighting and acoustics

  Operational label

TVVL Techniekdag 2018

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PROGRAM OF REQUIREMENTS HEALTHY OFFICES 2021

	D	C	B	A
Temperatuur [°C]	< 19 °C > 27 °C	> 19 °C < 27 °C	> 20 °C < 26 °C	> 21 °C < 25 °C
CO_2 [ppm]*	> 1200	< 1200	< 900	< 750
RV [%]	> 70	< 70	< 70	30 < RV < 70
$PM_{2.5}$ [µg/m³]**	> 20	< 20	< 15	< 10
$PM_{2.5}$ eis I/O***	> 1	< 1	< 0,5	< 0,25

** uitgaande van buitenconcentratie van 450 ppm*

*** uurgemiddelde $PM_{2.5}$ concentratie*

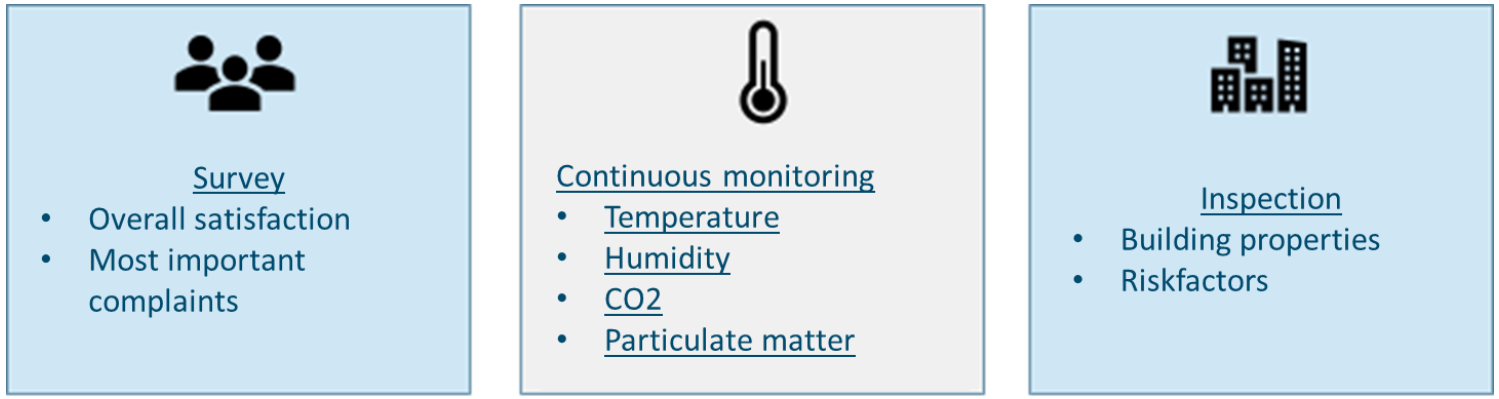
**** bepaling kan plaatsvinden via het Binnenklimaat Nederland meetprotocol fijnstof bepaling in kantoren gedurende een week*

To be met during **95% of the office hours**. Thus excluding public holidays and weeks during which the office is closed, e.g. Christmas holiday.

INSPECTORS

https://www.binnenklimaattechniek.nl/kwaliteit/binnenklimaat-label/

INDOOR CLIMATE LABEL - 3 ELEMENTS



- After 3 months, a temporary label is issued based on inspection and survey.
- The full label will be issued after 1 year continuous monitoring
- A report with the calculated label score is provided annually

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PILOT SURVEY & INSPECTION IN FME BUILDING

Zoetermeer, along A12
Survey is based on BBA healthy Building Index

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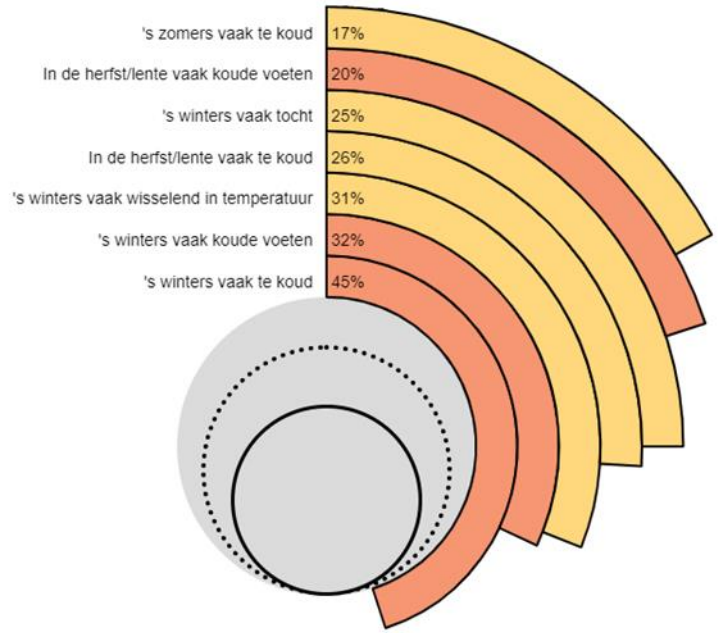
GENERAL QUESTIONS SURVEY

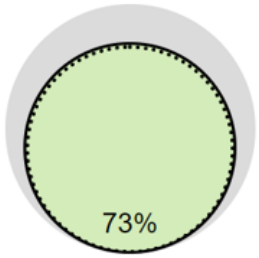
	Tevredenheid						
	Zeer ontevreden	Ontevreden	Enigszins ontevreden	Neutraal	Enigszins tevreden	Tevreden	Zeer tevreden
Hoe tevreden bent u met de temperatuur op uw werkplek?	○	○	○	○	○	○	○
Hoe tevreden bent U over de luchtkwaliteit op uw werkplek?	○	○	○	○	○	○	○
Hoe tevreden bent U over het licht op uw werkplek?	○	○	○	○	○	○	○
Hoe tevreden bent u over het geluid en de akoestiek op uw werkplek?	○	○	○	○	○	○	○
Geef aan hoe tevreden u bent over de mate van controle die u heeft over het binnenklimaat op uw werkplek?	○	○	○	○	○	○	○

IN CASE OF COMPLAINTS DETAILED QUESTIONS

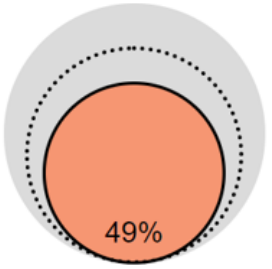


Tevredenheid bouwdeel specifiek: Geluid | VLA FME gebouw

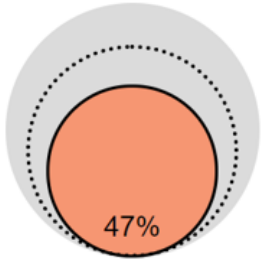
Legenda
Matig; slechter dan de referentie
Onvoldoende



Bouwdeel A
% tevredenen geluid (n=11)



Bouwdeel B
% tevredenen geluid (n=65)



Bouwdeel C
% tevredenen geluid (n=65)

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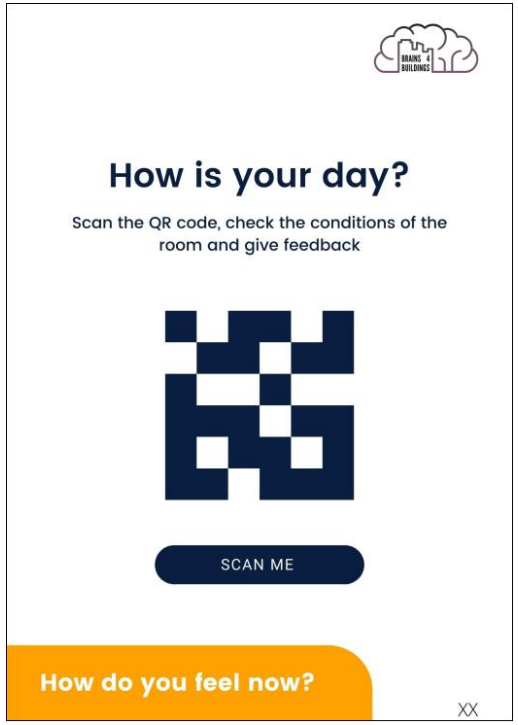
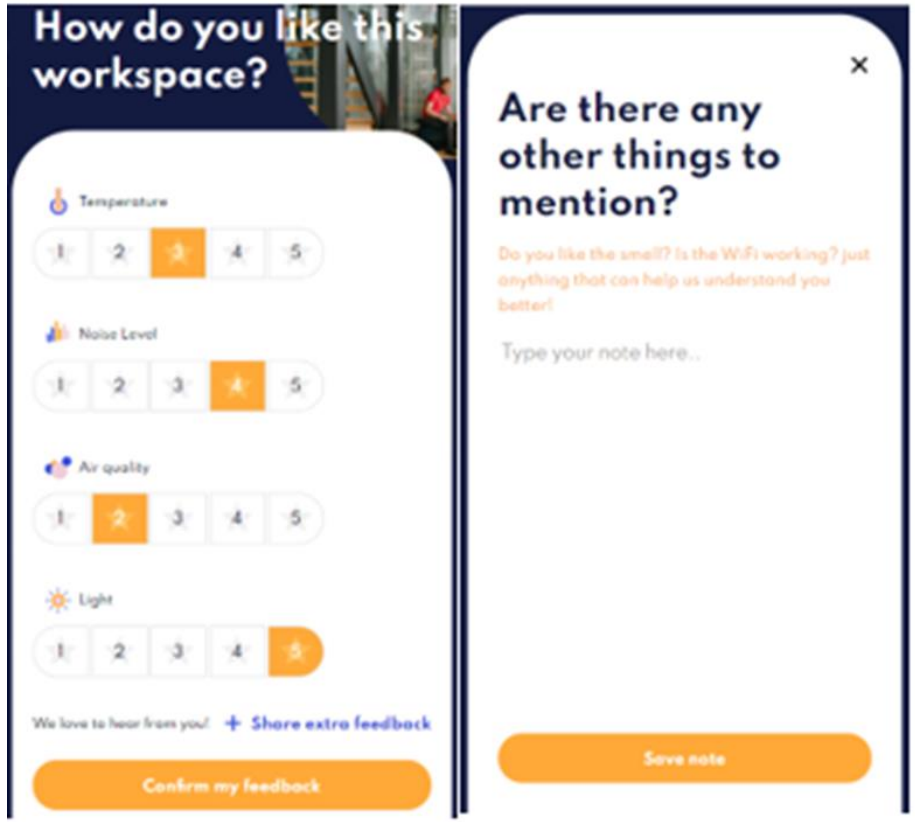
B4B RESEARCH: DIRECT FEED BACK

Comparison of feed back voting buttons and Unica feed back app

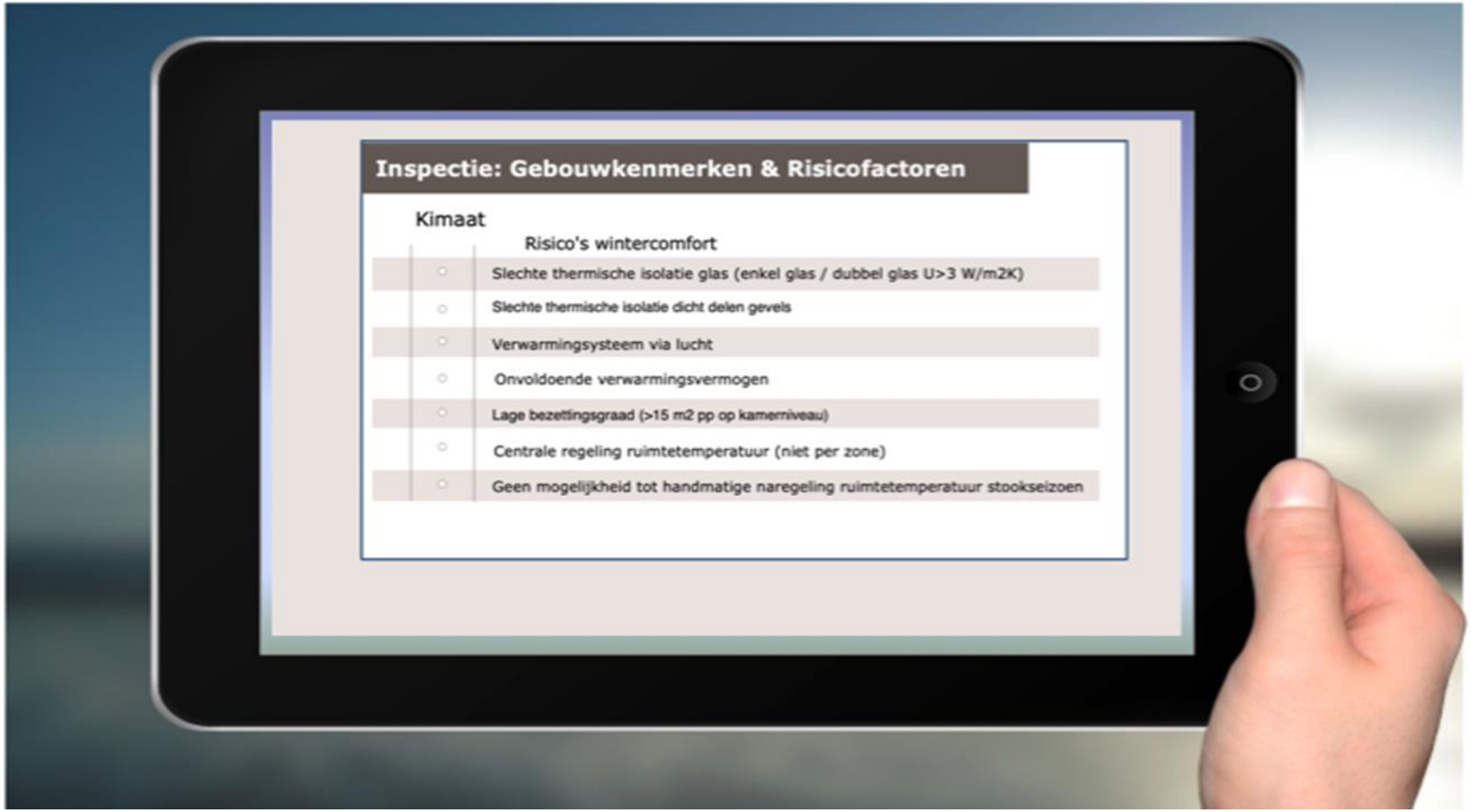
= votebox



= QR-code vote



INSPECTIE – GEBRUIKERS INTERFACE INSPECTEUR



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INSPECTION FME BUILDING: CLIMATE & ACOUSTICS

Climate score C

The main risk factors for climate are:

Winter comfort 43%
- Air heating
- Local temperature control not effective
- Insufficient heating capacity

Local thermal comfort 40%
- lack of radiators/convectors under glazing

Acoustics score C

The main risk factors for sound are:

Use of space / layout 83%
- Large open workspaces
- Insufficient space meeting and room for calling
- Coffee area in open connection with the office

Room aoustics 33%
- little acoustically absorbing material

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INSPECTION FME BUILDING: AIR & LIGHT

Air quality score **B**

The main risk factors for air quality are:

Possibilities for ventilative cooling 67%
- Windows can not be fixed in multiple positions
- large open workspaces with openable parts in opposite facades

Outdoor sources 33%
- Air quality affected location

Light score **B**

The main risk factors for light are:

Artificial light 25%
- No influence possible

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FME BUILDING: SURVEY & INSPECTION

Survey monitoring inspection

Thema	Enquête	Continue monitoring	Inspectie	Thema totaal
Climate / Klimaat	D	x	C	C⁻
Sound / Geluid	C	x	C	C
Air / Binnenlucht	C	x	B	B⁻
Light / Licht	B	x	B	B
Binnenmilieu totaal				**C**

Reasonable agreement between survey and inspection in FME building

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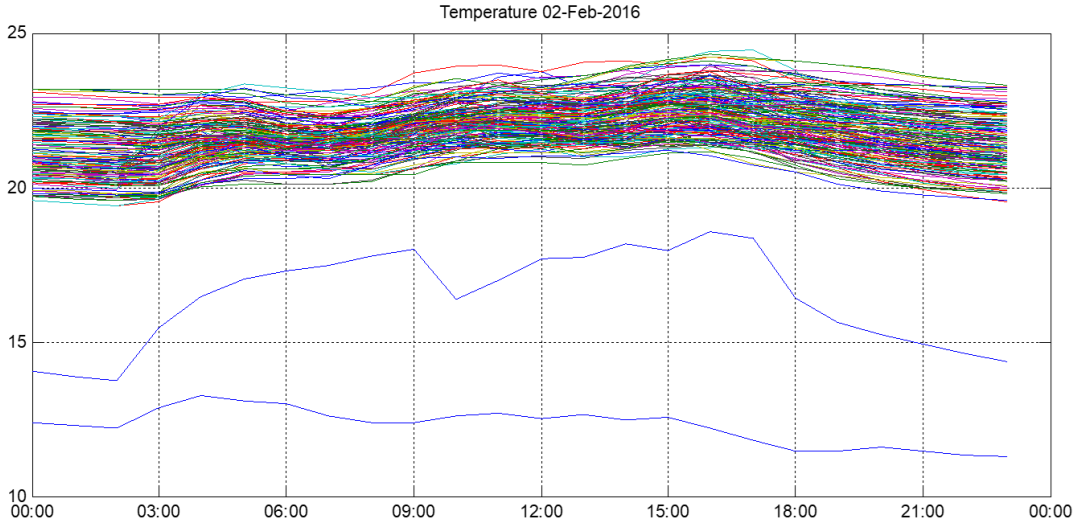
MONITORING SAMPLING STRATEGY



600 room temperatures, which one to choose?

In limited number of rooms measuring with high quality sensors

- Minimal 1 room per room type (1-pers, 2-pers, 4-8 pers, office garden, meeting room)
- # floors: minimal ground floor en top floor
- Orientation: both south as north side
- At least 1 room per air handling unit

- Make smart combinations, for example: eg north side on ground floor or south side on top floor
- Involve complaints rooms (survey or inspection) in monitoring
- Usually 4 – 6 sensor units per office building

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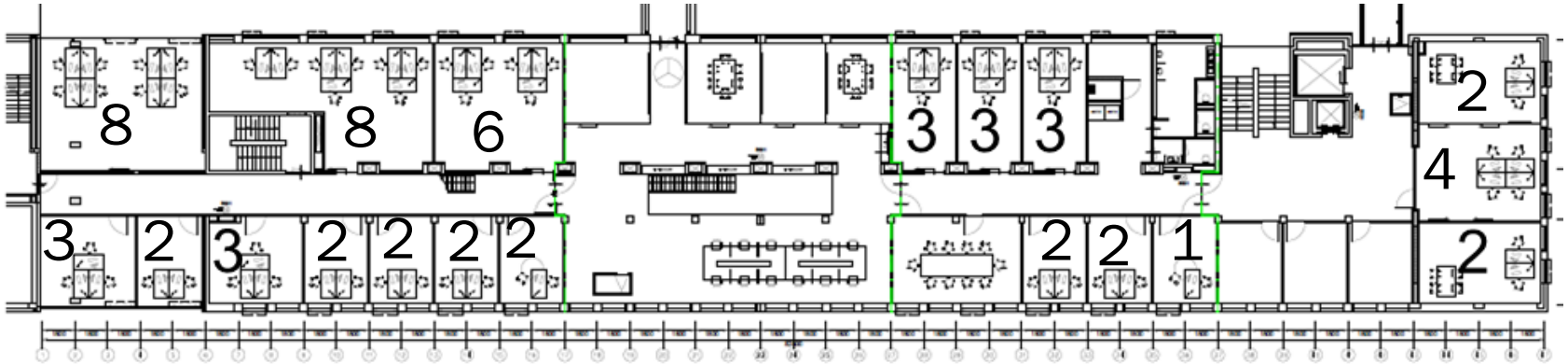
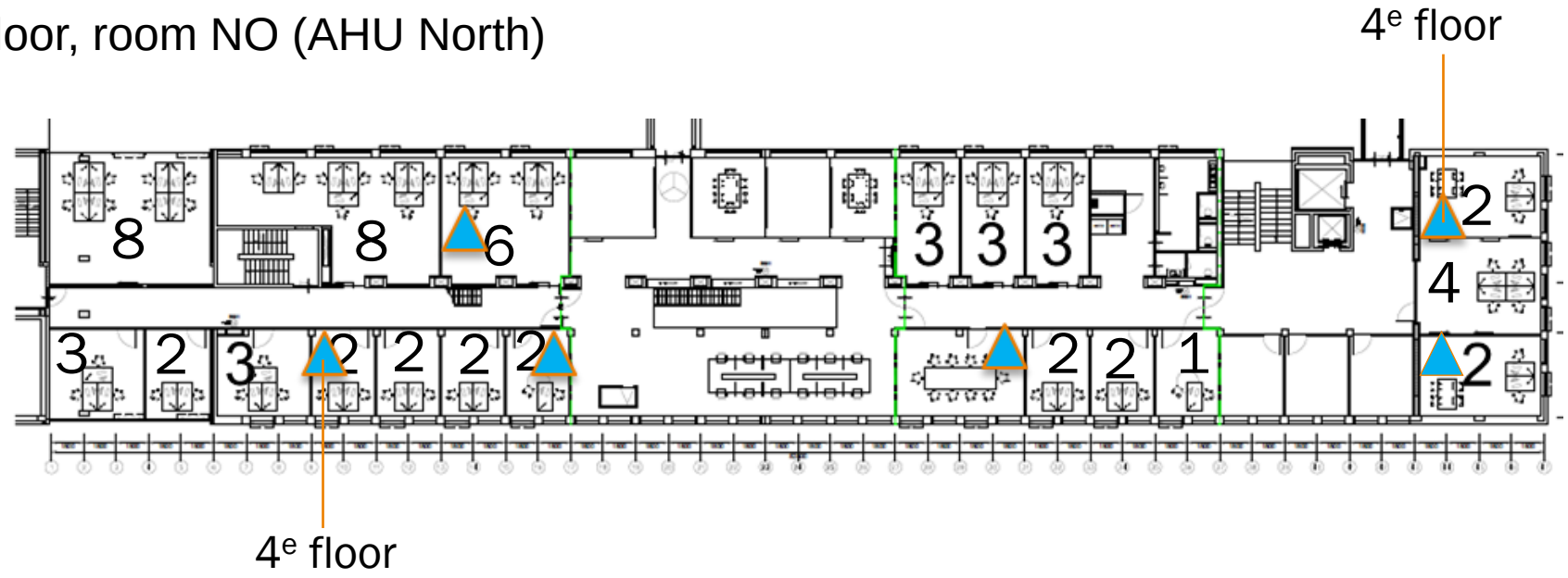
FICTIONAL EXAMPLE BUILDING

- 4 floors
- Approx. 60 persons per floor
- Total 200 persons



FICTIEF GEBOUW VOORBEELD

- 1: second floor, room SO: two side sun exposed
- 2: second floor, room N (AHU North), 6 persons
- 3: second floor South (AHU South), 2 persons
- 4: second floor 8 persons meeting room (AHU South)
- 5: fourth floor, room S
- 6: fourth floor, room NO (AHU North)



PILOT CONTINOUS MONITORING PROVINCIAL HOUSE SH

37 measurement locations: April 2019 t/m half Februari 2020

- Temperature
- RH
- CO_2

$PM_{2.5}$ measurement: 3 t/m 10 December 2019 following VLA measurement protocol

PROVINCIEHUIS ZUID-HOLLAND

Limited spread in label between rooms
→ 4 – 6 sensors would be sufficient

Temperature	C	→ C (climate)
CO_2	B	B (air)
RH	B	
$PM_{2.5}$	A	

The cause for Temperature class C was switching on the heating too late

Verdieping	Locatie	Temperatuur Klasse Winter	Temperatuur Klasse Zomer	CO2 Klasse	RV Klasse
B2	789	C	A	B	B
B2	801	B	A	B	B
B3E	821	B	A	B	B
B3E	830	B	B	A	B
B3E	838	B	A	B	B
B3E	839	B	B	A	B
B3M	809	B	A	B	B
B3M	812	C	A	B	B
B3M	813	-	A	A	B
B3M	814	B	A	A	B
B3M	840	B	A	B	B
B3M	848	B	B	A	B
B4E	941	C	-	A	A
B4E	950	B	-	A	A
B4E	957	C	-	B	B
B4E	958	C	-	B	B
B4M	905	C	-	A	B
B4M	908	C	-	B	A
B4M	909	C	-	A	A
B4M	910	C	-	A	A
B4M	914	B	-	A	A
B4M	917	B	-	A	A
B4M	925	C	-	A	A
B4M	937	C	-	C	B
B4M	938	B	-	A	B
B5E	983	C	-	A	A
B5E	991	C	-	C	A
B5E	992	C	-	B	A
B5M	959	C	-	A	A
B5M	962	C	-	A	A
B5M	963	C	-	A	A
B5M	964	C	-	A	A
B5M	968	C	-	A	A
B5M	971	C	-	A	A
B5M	975	C	-	A	A
B5M	981	C	-	B	A
B5M	982	B	-	A	B

EFFECT OFFICE HOURS (7-18 OR 8-18)

Verdieping	Locatie	Temperatuur Klasse Winter	Temperatuur Klasse Zomer	CO2 Klasse	RV Klasse
B2	789	C	A	B	B
B2	801	B	A	B	B
B3E	821	B	A	B	B
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B3M	813	-	A	A	B
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B3M	840	B	A	B	B
B3M	848	B	B	A	B
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B4E	950	B	-	A	A
B4E	957	C	-	B	B
B4E	958	C	-	B	B
B4M	905	C	-	A	B
B4M	908	C	-	B	A
B4M	909	C	-	A	A
B4M	910	C	-	A	A
B4M	914	B	-	A	A
B4M	917	B	-	A	A
B4M	925	C	-	A	A
B4M	937	C	-	C	B
B4M	938	B	-	A	B
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B5E	991	C	-	C	A
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B5M	959	C	-	A	A
B5M	962	C	-	A	A
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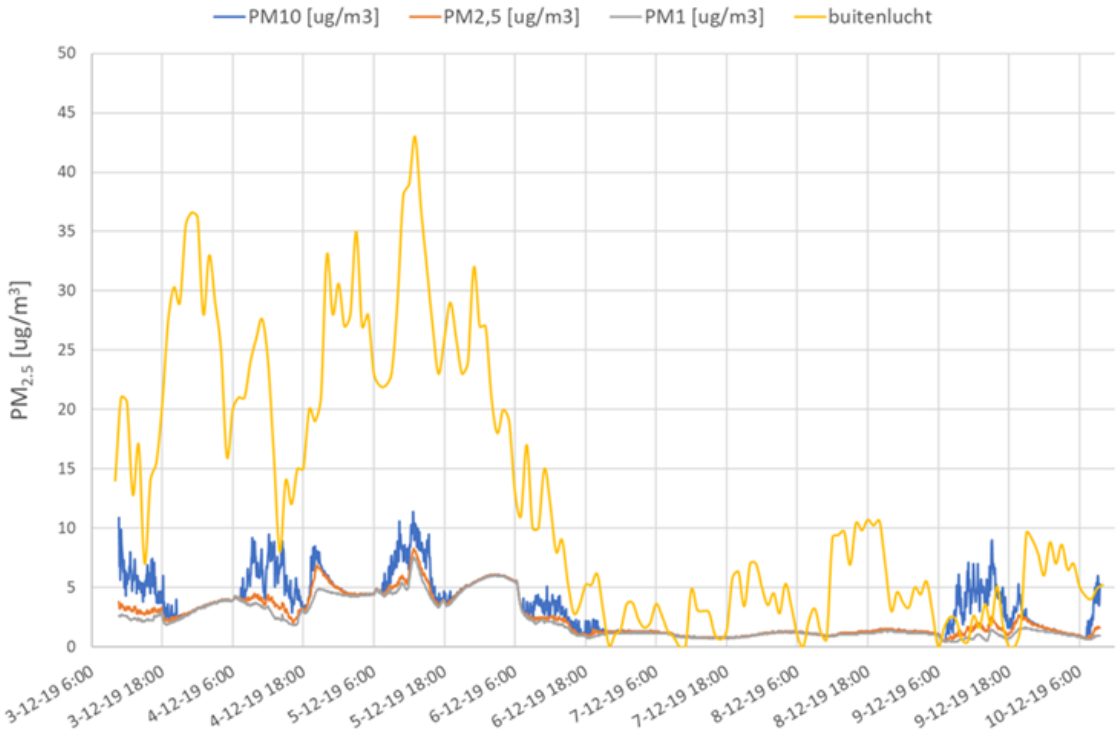
B5M	964	C	-	A	A
B5M	968	C	-	A	A
B5M	971	C	-	A	A
B5M	975	C	-	A	A
B5M	981	C	-	B	A
B5M	982	B	-	A	B

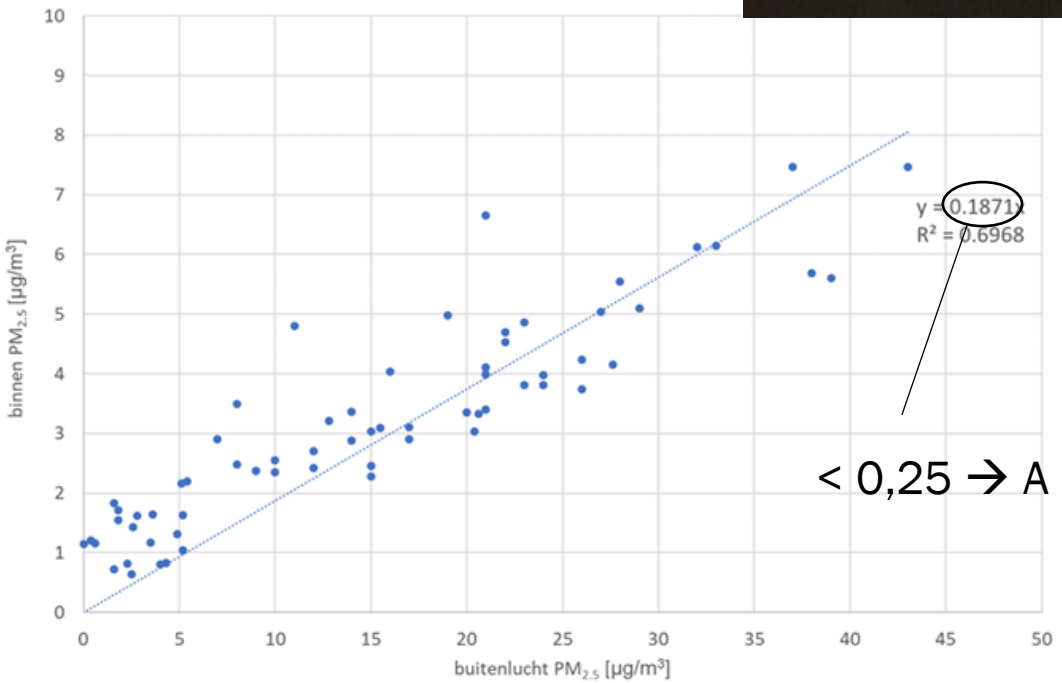
PM2.5 - FINE PARTICULATE

LUCHT	Klasse C - VOLDOENDE	Klasse B - GOED extra t.o.v. klasse C	Klasse A - ZEER GOED extra t.o.v. klasse B
Fijnstof	De uurgemiddelde $PM_{2,5}$ (fijnstof) concentratie is **maximaal 20 microgram/m³.**	De uurgemiddelde $PM_{2,5}$ (fijnstof) concentratie is **maximaal 15 microgram/m³.**	De uurgemiddelde $PM_{2,5}$ (fijnstof) concentratie is **maximaal 10 microgram/m³.**
	Aanvullende eis ten aanzien van de fijnstof penetratie via de gevel en het ventilatiesysteem (filtersectie): de $PM_{2,5}$ (fijnstof) concentratie binnen bedraagt **maximaal 1 keer de momentane buitenconcentratie** (uurgemiddelde indoor/outdoor ratio = 1)	Aanvullende eis ten aanzien van de fijnstof penetratie via de gevel en het ventilatiesysteem (filtersectie): de $PM_{2,5}$ (fijnstof) concentratie binnen bedraagt **maximaal 0,5 keer de momentane buitenconcentratie** (uurgemiddelde indoor/outdoor ratio = 0,5)	Aanvullende eis ten aanzien van de fijnstof penetratie via de gevel en het ventilatiesysteem (filtersectie): de $PM_{2,5}$ (fijnstof) concentratie binnen bedraagt **maximaal 0,25 keer de momentane buitenconcentratie** (uurgemiddelde indoor/outdoor ratio = 0,25)

Class A: Indoor/Outdoor < 0.25

PM2.5 – FINE PARTICULATE
ACCORDING TO VLA MEASUREMENT PROTOCOL





< 0,25 → A

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COMPARISON FINE PARTICULATE IN THE OFFICE WITH HOME

WHO has lowered its recommended values in 2021 from 10 to 5 µg/m^3

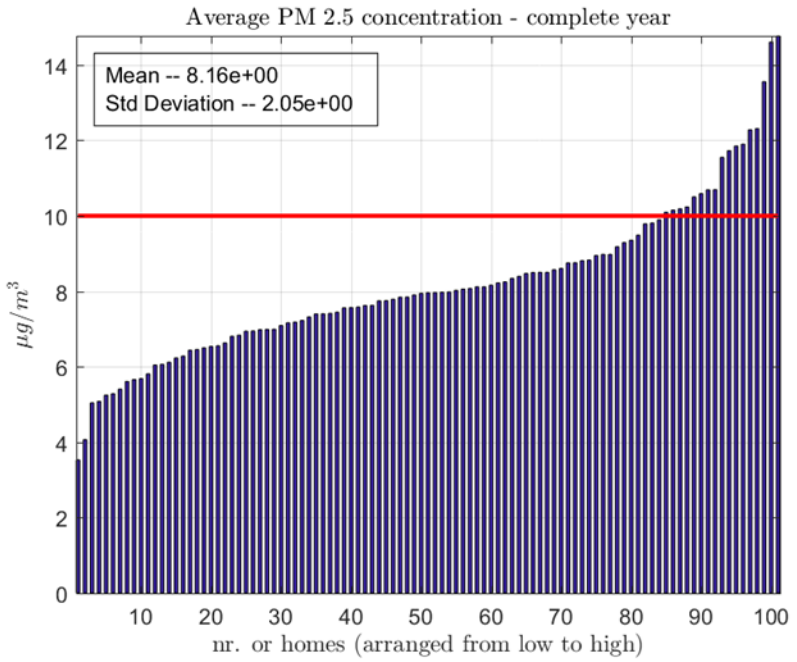
Outdoor concentration in Den Haag ca. 11 µg/m^3

In office: 0,1871 x 11 = 2 µg/m^3

Average Dutch dwelling: 8 µg/m^3

In office thus healthier than at home, by:

- Good filters
- Sufficient ventilation
- Air tight facade
- Absence of indoor sources



Source: tki Be Aware

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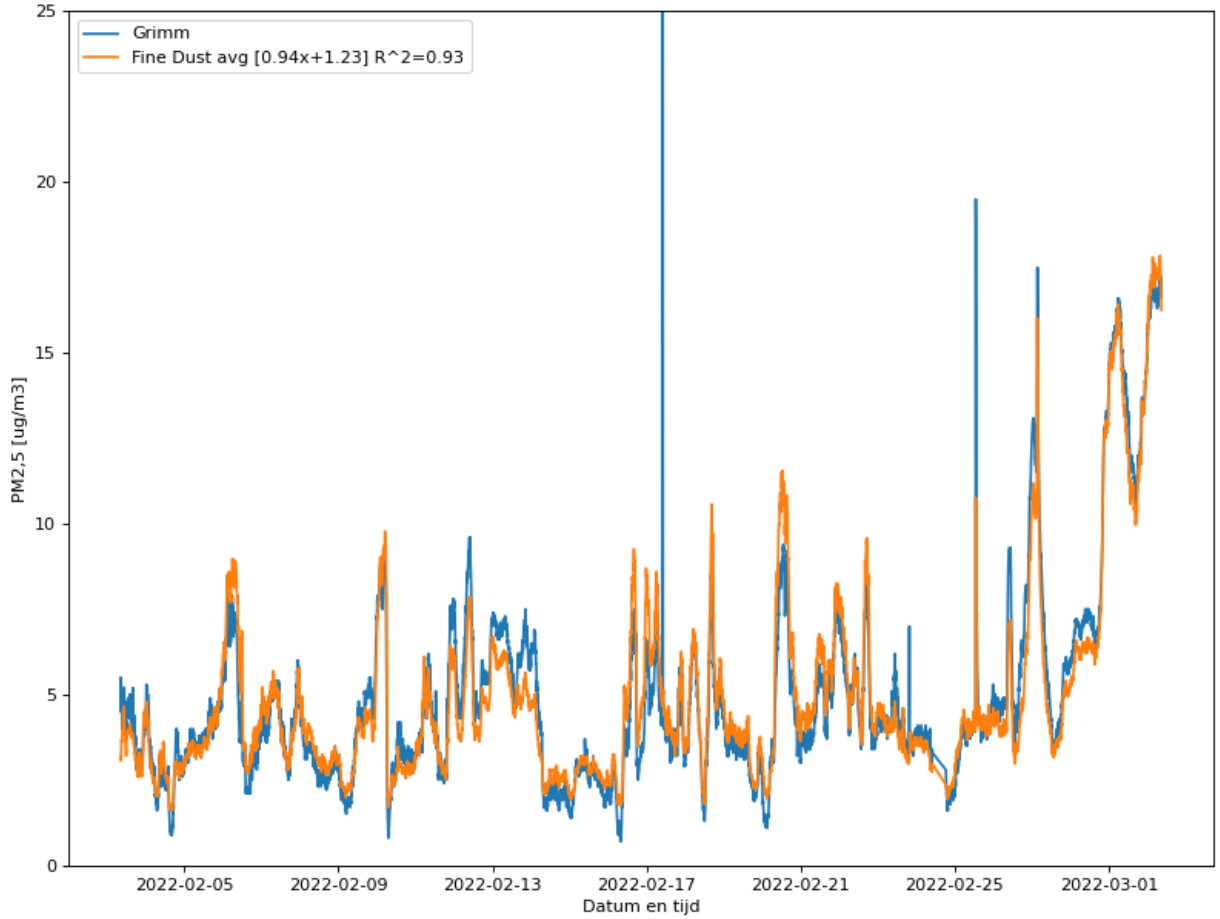
B4B RESEARCH: PM2.5 MEASUREMENT LOW COST SENSOR



Datasheet SPS30

Particulate Matter Sensor for Air Quality Monitoring and Control

- Unique long-term stability
- Advanced particle size binning
- Superior precision in mass concentration and number concentration sensing
- Small, ultra-slim package
- Fully calibrated digital output

50 euro

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LABEL DATA PLATFORM

Three data elements:

Survey
- Overall satisfaction
- Most important complaints

Continuous monitoring
- Temperature
- Humidity
- CO2
- Particulate matter

Inspection
- Building properties
- Riskfactors

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DATA PLATFORM

- Developed to support indoor climate monitoring and automated data analysis and report generation
- A scalable-multi-client platform
- User-centric applications for ease of use
- Built using MongoDB to enable rapid updates

DATA PRIVACY

- Each client has a separate database and can only view their own data with no access to other client data.
- Different user roles and different authorization levels determine access rights.
- Applications are secured with user name and passwords with two-level authentication
- There is no user name coupled to user the comfort survey.
- No data analysis, data piping, or data storage through third parties outside the Virtual Private Server in Amsterdam where the platform runs.
- Private LoRa Server on VPS Amsterdam
- Agreement based on General Data Protection Regulation (GDPR) with each client (“data verkerking oveenkomst”)

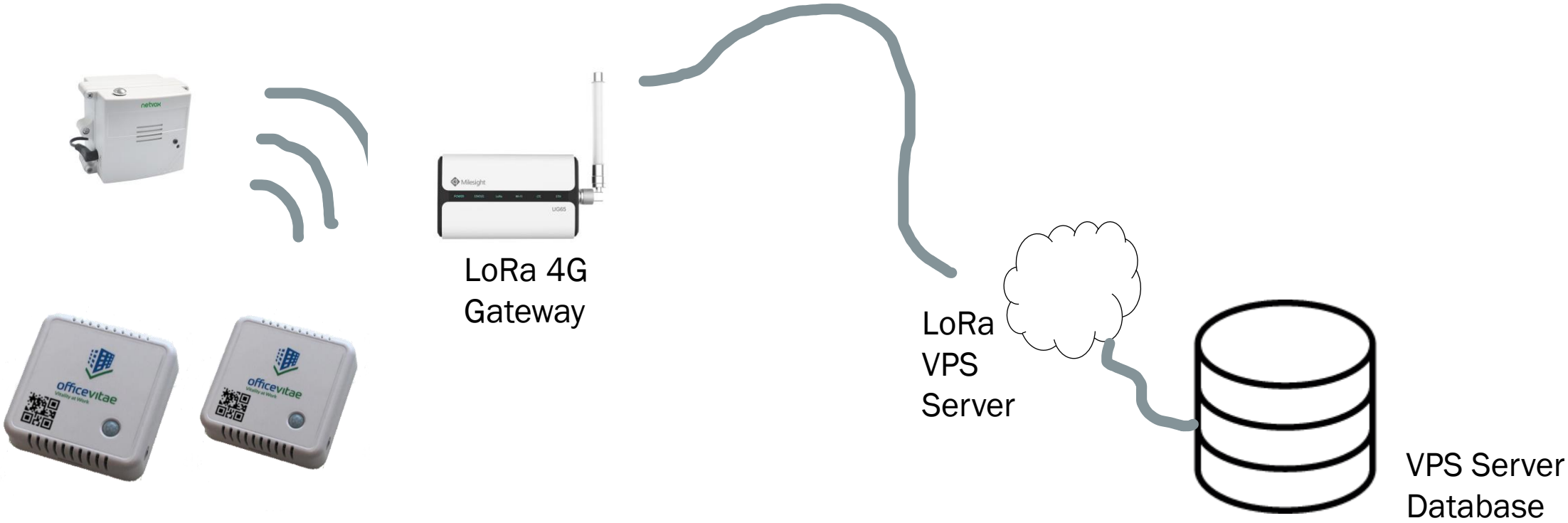
DATA SECURITY

- Access to the data base is secured via SSH (Secure Shell) key and to which a valid IP address is assigned. Access via other IP addresses is not granted.
- Each building is equipped with a private 4-g router and private LoRa-communication gateway, coupled to the VPS server in Amsterdam.
- The connection between the client and VPS server over the Internet is secured via a SSL/TLS certificate.
- There is brute-force policy in place such that client accounts are temporally blocked when multiple invalid access attempts occur.
- User applications are protected from external access via the issuing temporary access tokens.

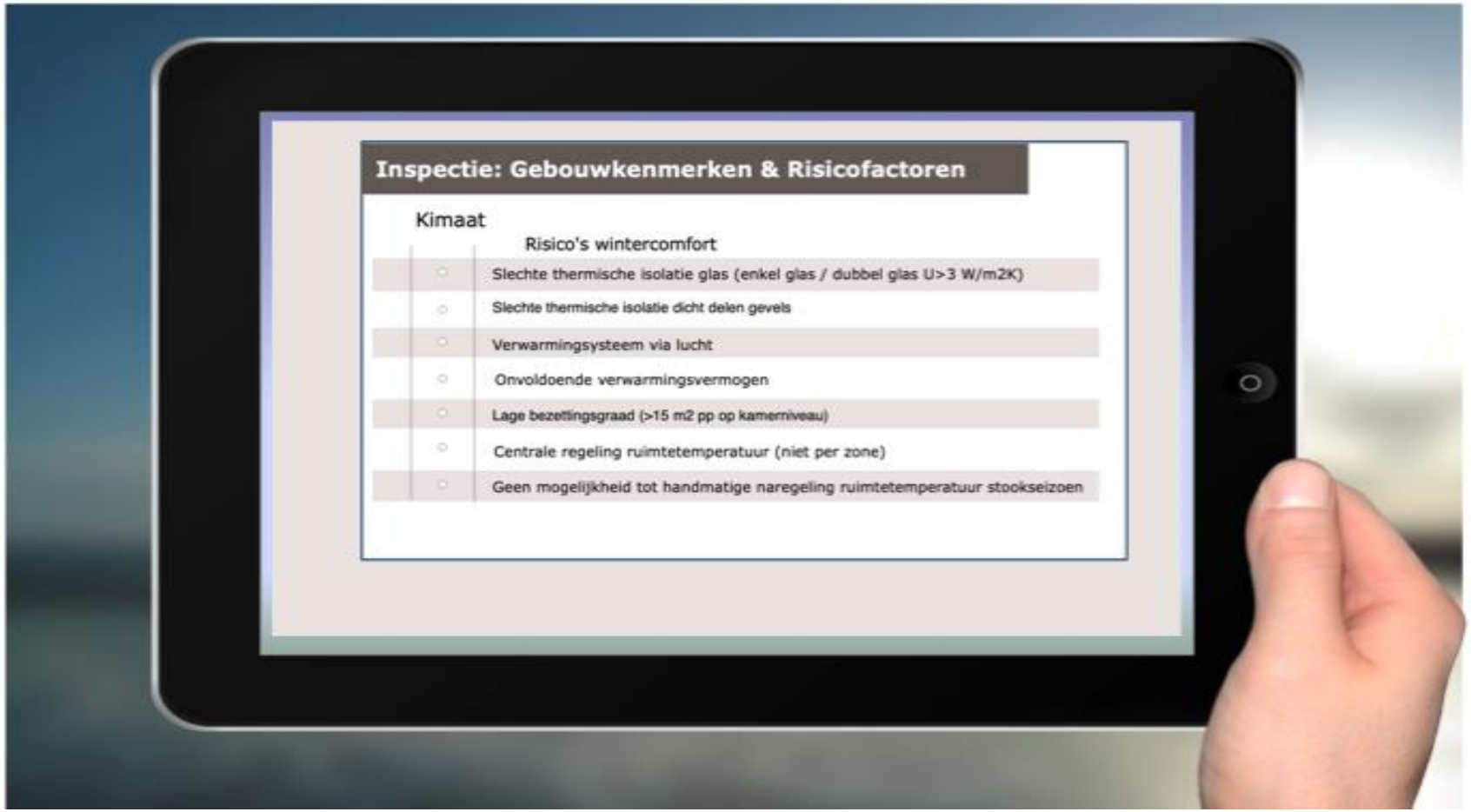
OPTIONAL PATHS FOR SENSOR DATA COLLECTION

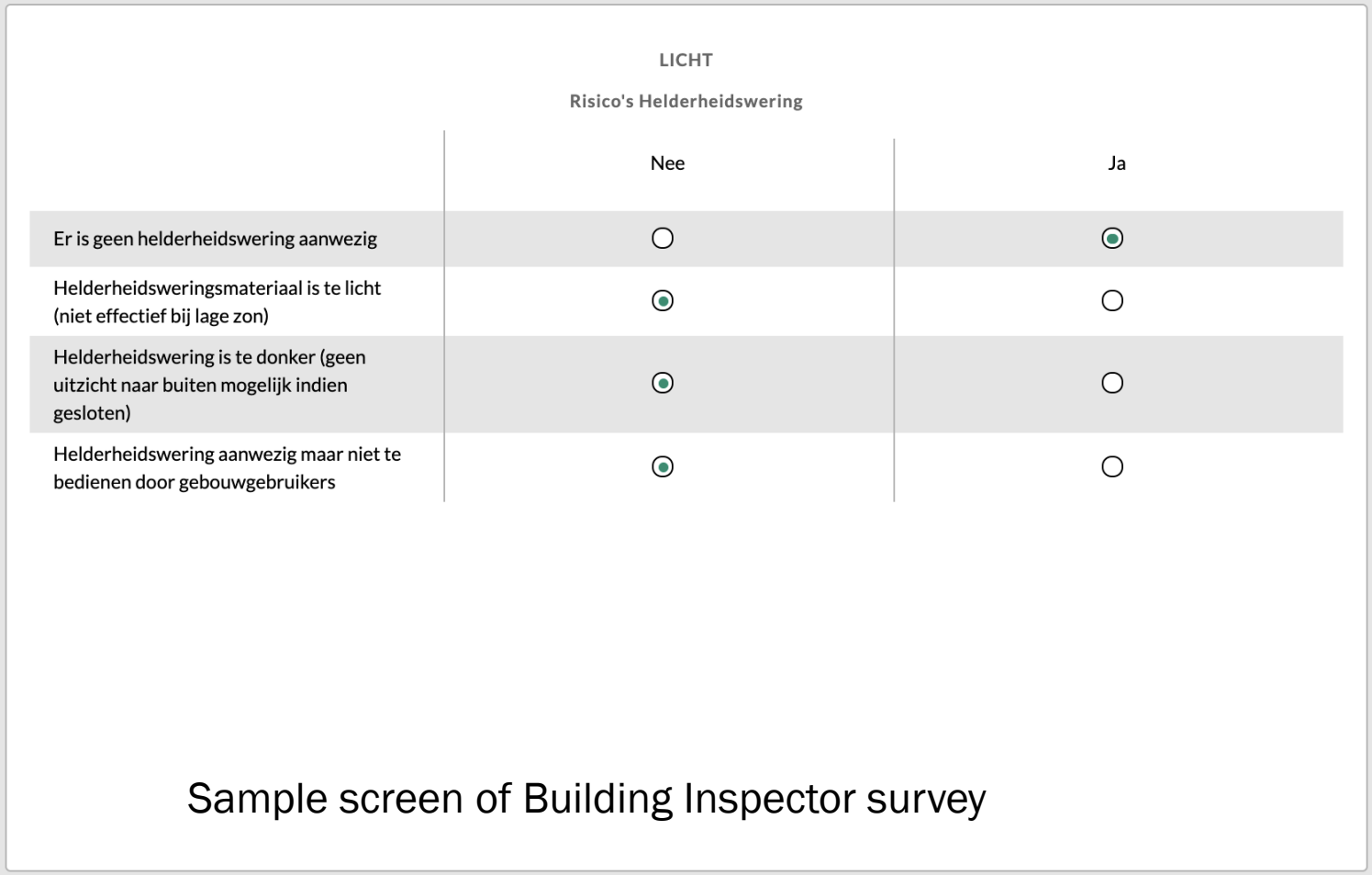
- Stored data transferred via secure link (CSV, JSON)
- Stored data transferred via secure link (CSV, JSON) + PM2.5 measurement
- API to collect live data using client sensors
- Standard sensor kit and gateway deployed with installation app

DATA STREAM



USER INTERFACE FOR BUILDING INSPECTOR SURVEY





LICHT

Risico's Helderheidswering

	Nee	Ja
Er is geen helderheidswering aanwezig	○	◉
Helderheidsweringsmateriaal is te licht (niet effectief bij lage zon)	◉	○
Helderheidswering is te donker (geen uitzicht naar buiten mogelijk indien gesloten)	◉	○
Helderheidswering aanwezig maar niet te bedienen door gebouwgebruikers	◉	○

Sample screen of Building Inspector survey

Wissen

Klik 'wissen' als je alle antwoorden wilt wissen

Klik 'verzenden' als je tevreden bent met de antwoorden en ze wilt verzenden

Verzenden

vorige

Bedankt voor het invullen van de Binnenklimaatlabel questionnaire!

Uw antwoorden zijn met succes ingediend en zullen vertrouwelijk worden behandeld.

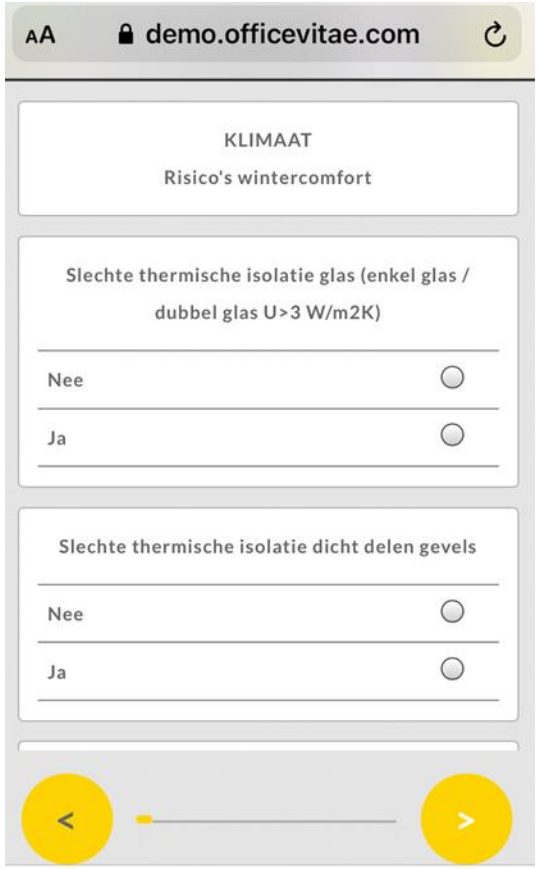
We stellen uw tijd en moeite zeer op prijs.

Toekenning van binnenklimaatlabel klassen A (best), B, C of D (slechtst) per thema.

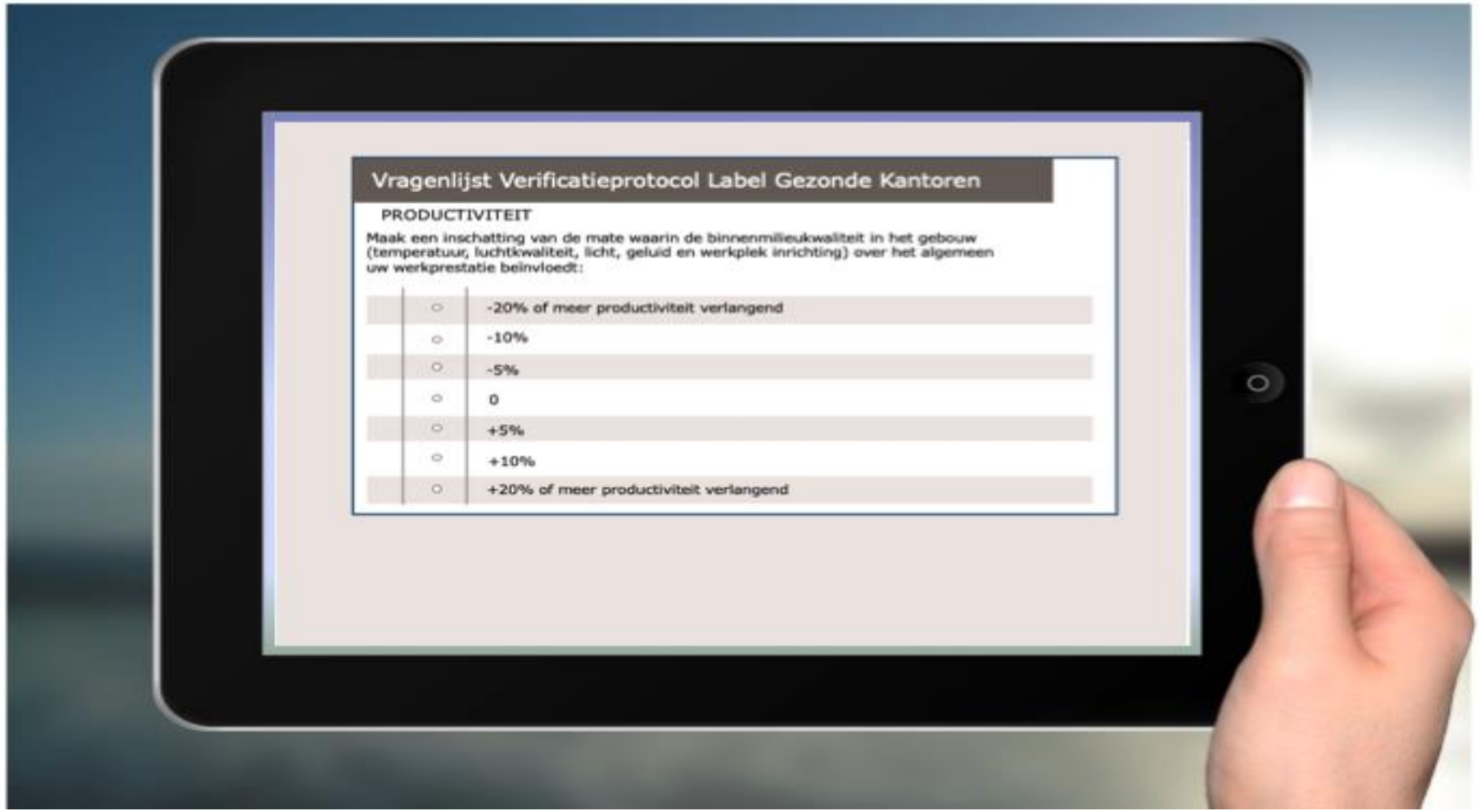
Thema	Score inspectie	Klasse
Klimaat	0,50	C
Geluid	0,39	D
Binnenlucht	0,29	D
Licht	0,33	D
(Gemiddeld)	0,38	D

Automatic scoring of survey in A, B, C, D ranks at end of survey

SMART PHONE VERSION OF BUILDING INSPECTOR SURVEY



USER COMFORT SURVEY, SAMPLE SCREEN



Bron vragen: bba binnenmilieu

BINNENKLIMAAT

	Tevredenheid						
	Zeer ontevreden	Ontevreden	Enigszins ontevreden	Neutraal	Enigszins tevreden	Tevreden	Zeer tevreden
Hoe tevreden bent u met de temperatuur op uw werkplek?	○	○	○	○	○	○	○
Hoe tevreden bent U over de luchtkwaliteit op uw werkplek?	○	○	○	○	○	○	○
Hoe tevreden bent U over het licht op uw werkplek?	○	○	○	○	○	○	○
Hoe tevreden bent u over het geluid en de akoestiek op uw werkplek?	○	○	○	○	○	○	○
Geef aan hoe tevreden u bent over de mate van controle die u heeft over het binnenklimaat op uw werkplek?	○	○	○	○	○	○	○

Sample screen of user survey

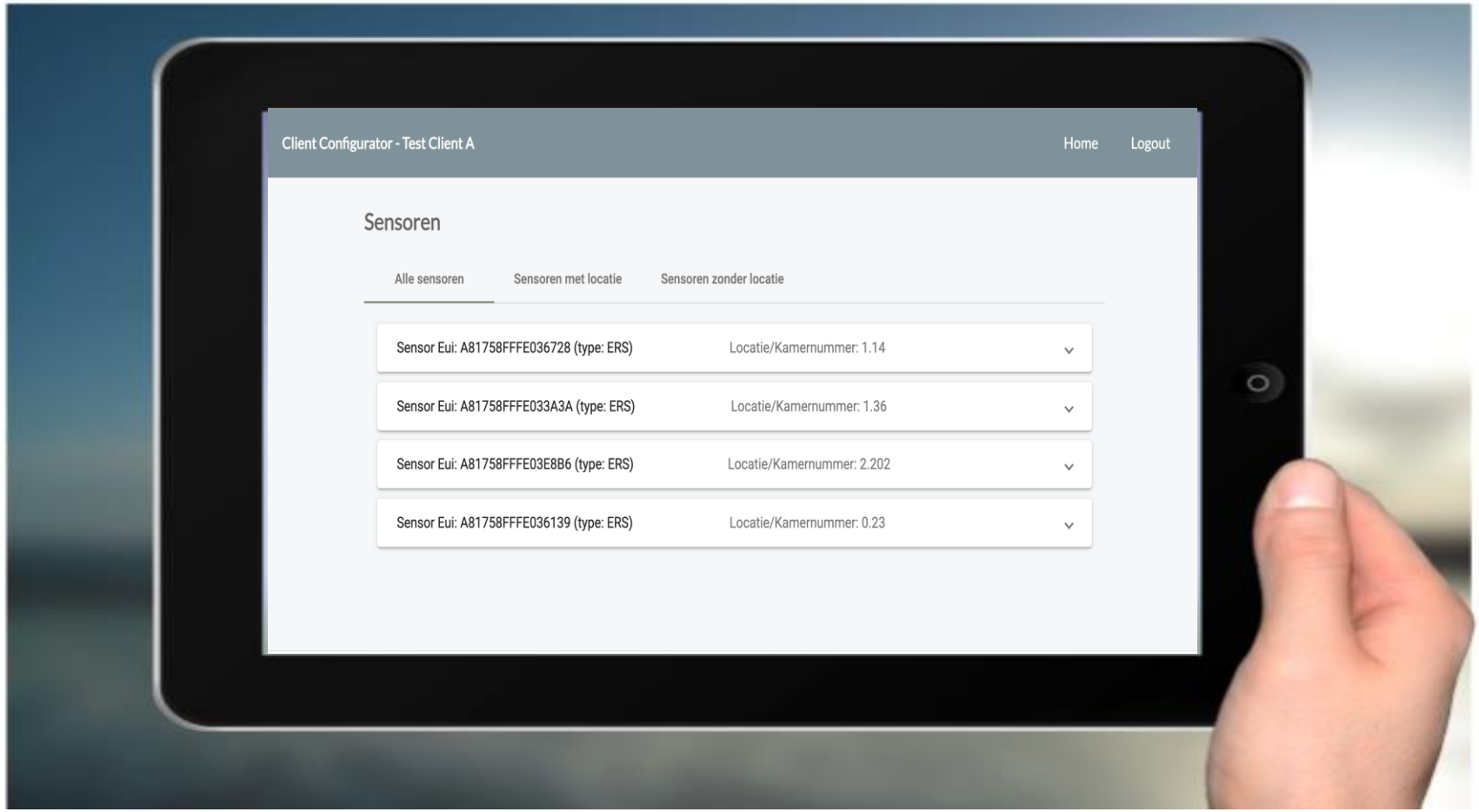
vorige

volgende

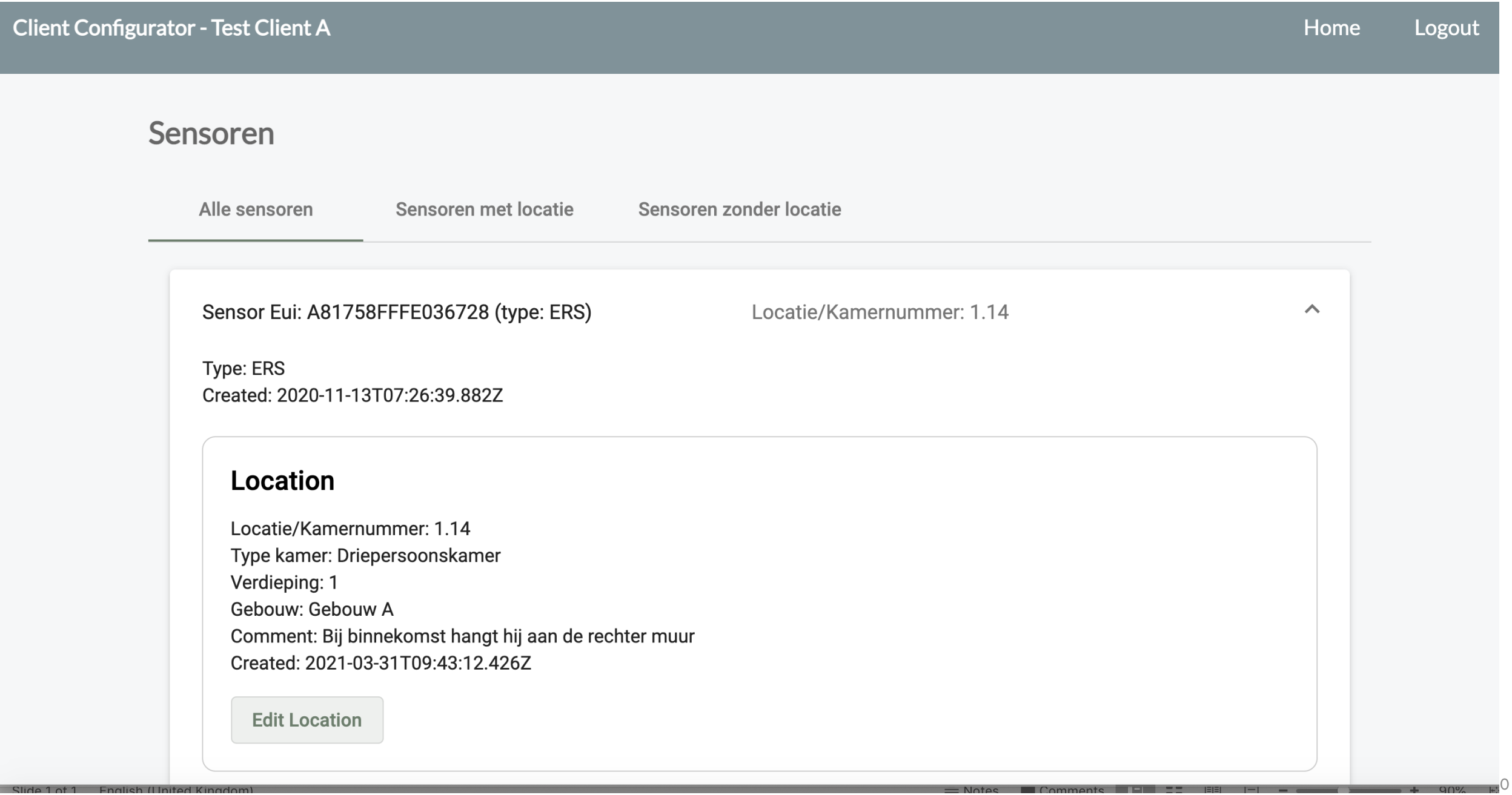
USER INTERFACE OF SMART PHONE VERSION FOR USER COMFORT SURVEY

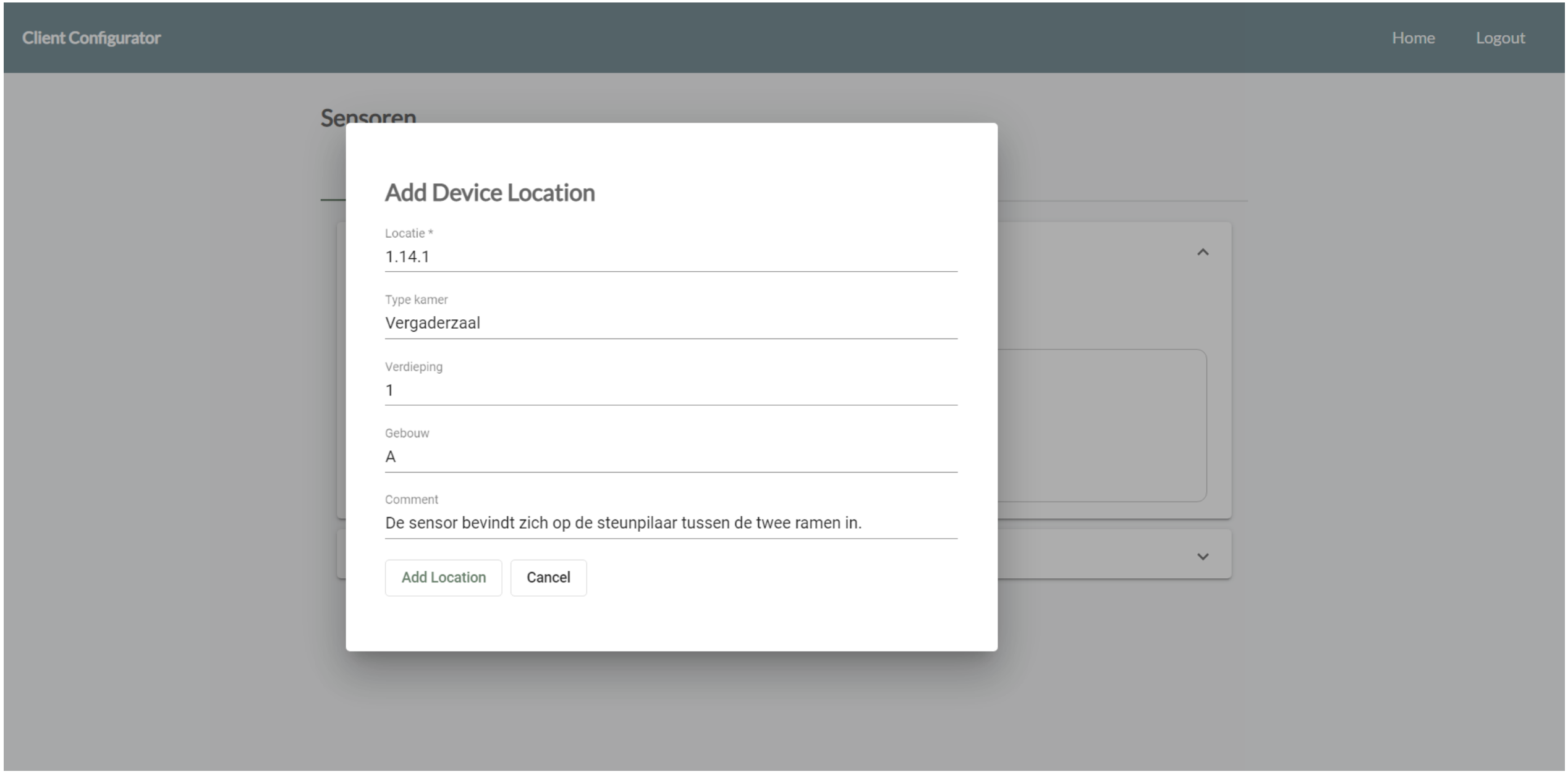
CLIENT CONFIGURATOR

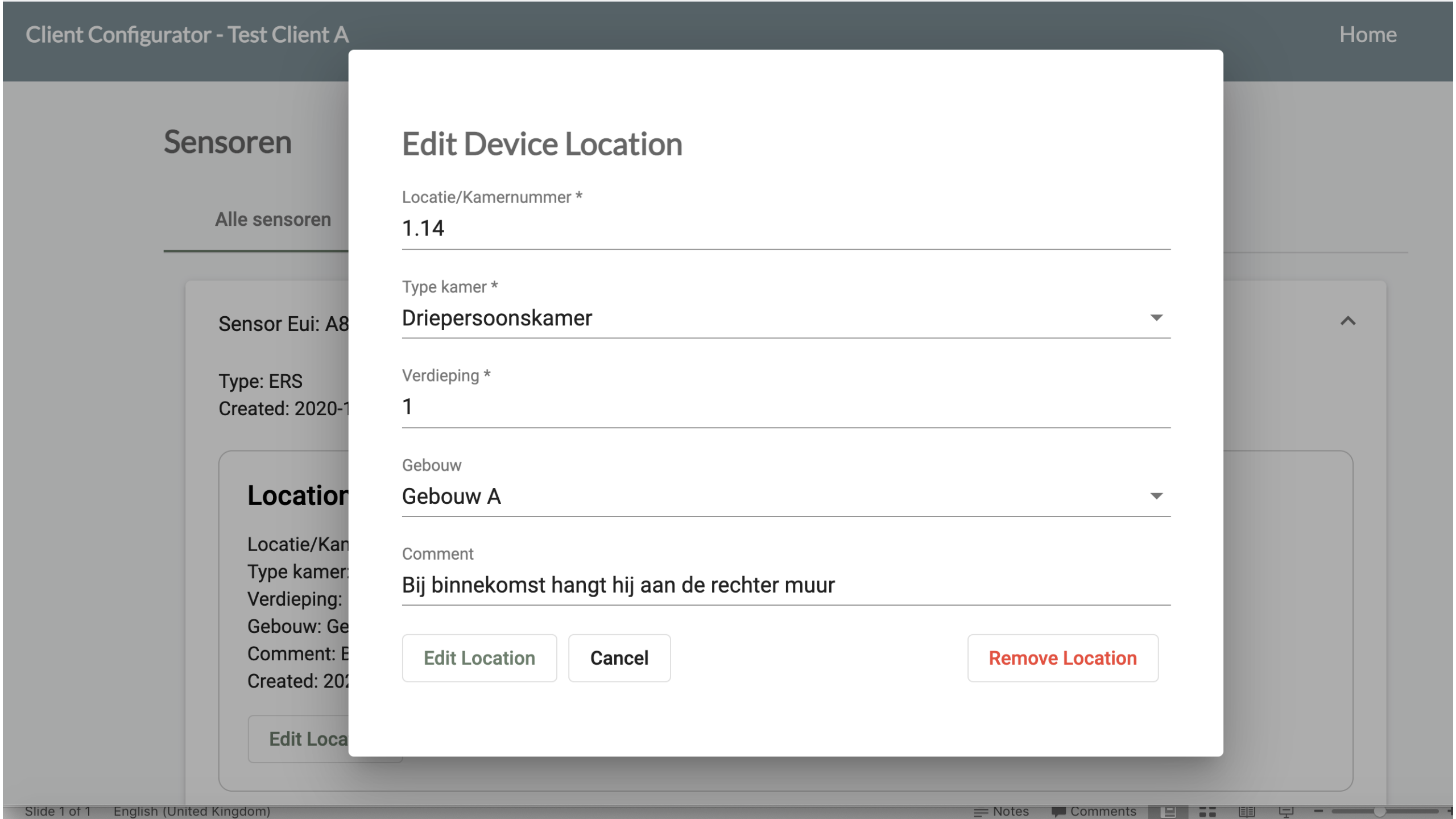
Screen capture of sensor registration application

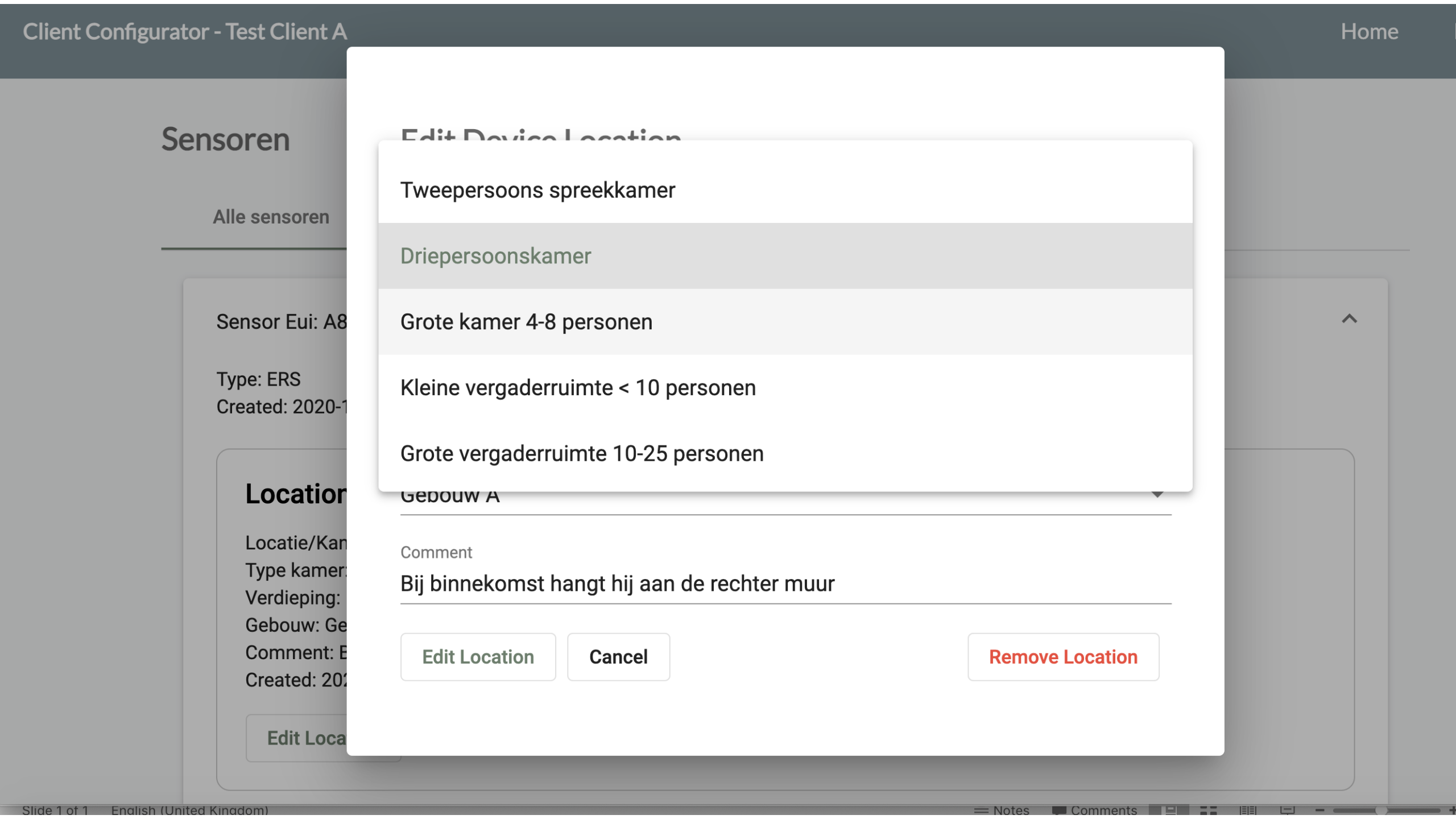


Sensors are allocated to customer project and are registered for location by client




Client Configurator
Home
Logout
Sensoren
Add Device Location
Locatie *
1.14.1
Type kamer
Vergaderzaal
Verdieping
1
Gebouw
A
Comment
De sensor bevindt zich op de steunpilaar tussen de twee ramen in.
Add Location
Cancel


Client Configurator - Test Client A
Home
Sensoren
Alle sensoren
Sensor Eui: A8
Type: ERS
Created: 2020-1
Location
Locatie/Kan
Type kamer:
Verdieping:
Gebouw: Ge
Comment: E
Created: 202
Edit Loca
Edit Device Location
Locatie/Kamernummer *
1.14
Type kamer *
Driepersoonskamer
Verdieping *
1
Gebouw
Gebouw A
Comment
Bij binnekomst hangt hij aan de rechter muur
Edit Location
Cancel
Remove Location
Slide 1 of 1
English (United Kingdom)
Notes
Comments


Client Configurator - Test Client A
Home
Sensoren
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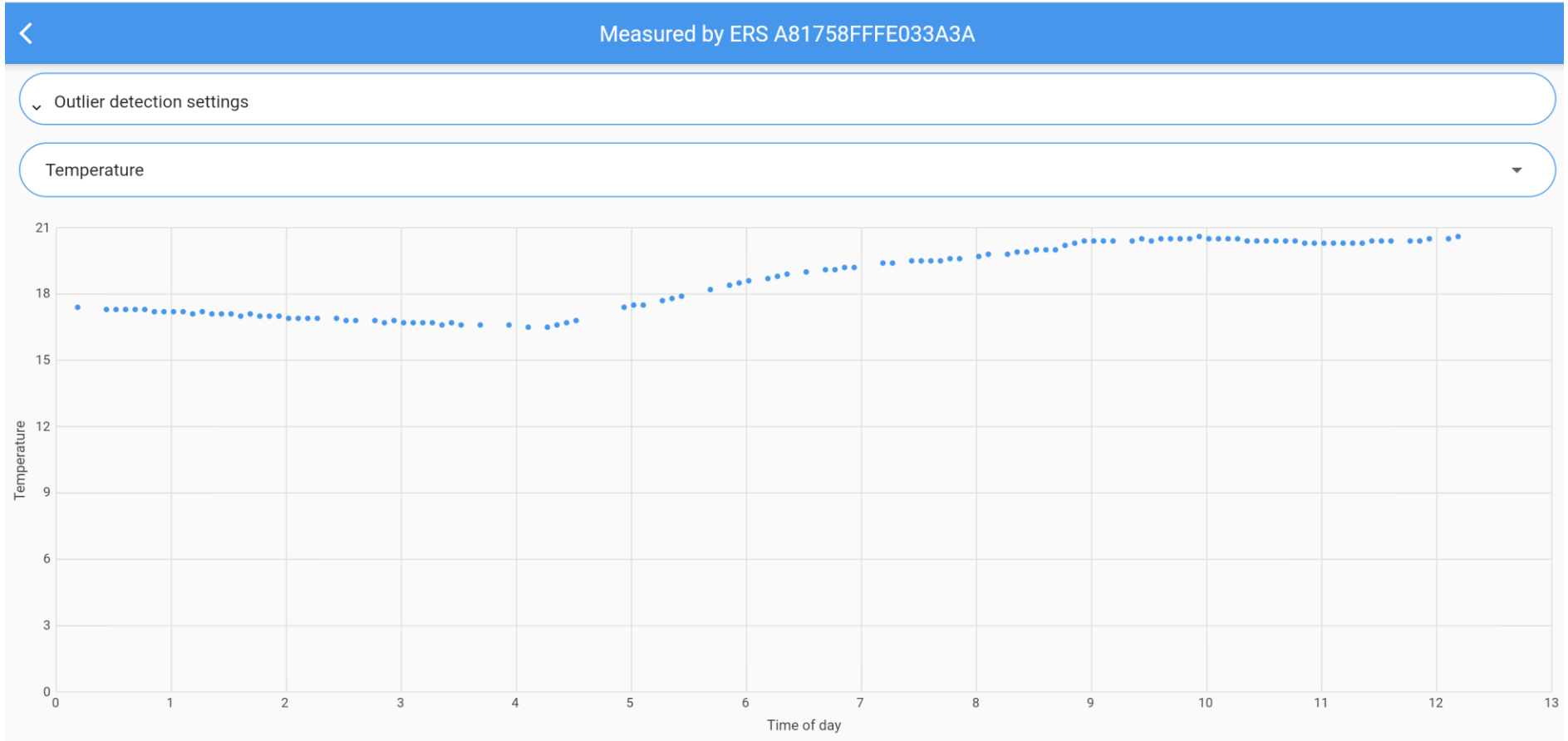
Type: ERS
Created: 2020-1
Location
Locatie/Kan
Type kamer:
Verdieping:
Gebouw: Ge
Comment: E
Created: 202
Edit Loca
Edit Device Location
Tweepersoons spreekkamer
Driepersoonskamer
Grote kamer 4-8 personen
Kleine vergaderruimte < 10 personen
Grote vergaderruimte 10-25 personen
Gebouw A
Comment
Bij binnekomst hangt hij aan de rechter muur
Edit Location
Cancel
Remove Location
Slide 1 of 1
English (United Kingdom)
Notes
Comments

Real-time data display application to check sensor data stream



PROGRAM OF REQUIREMENTS HEALTHY OFFICES 2021

	D	C	B	A
Temperatuur [°C]	< 19 °C > 27 °C	> 19 °C < 27 °C	> 20 °C < 26 °C	> 21 °C < 25 °C
CO_2 [ppm]*	> 1200	< 1200	< 900	< 750
RV [%]	> 70	< 70	< 70	30 < RV < 70
$PM_{2.5}$ [µg/m³]**	> 20	< 20	< 15	< 10
$PM_{2.5}$ eis I/O***	> 1	< 1	< 0,5	< 0,25

** uitgaande van buitenconcentratie van 450 ppm*

*** uurgemiddelde $PM_{2.5}$ concentratie*

**** bepaling kan plaatsvinden via het Binnenklimaat Nederland meetprotocol fijnstof bepaling in kantoren gedurende een week*

To be met during **95% of the office hours**. Thus excluding public holidays and weeks during which the office is closed, e.g. Christmas holiday.

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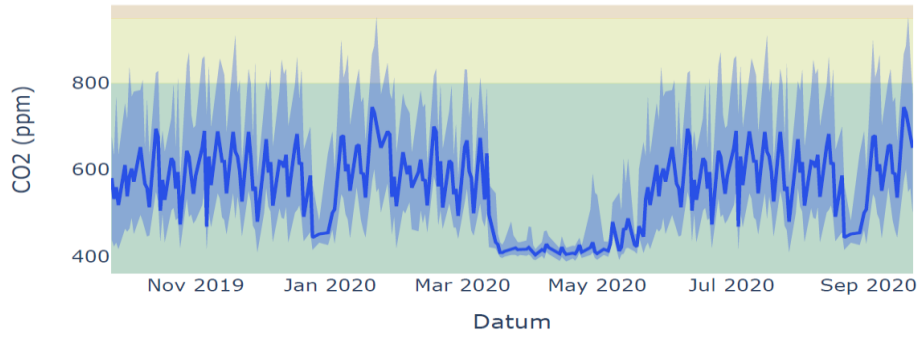
BK score
B

BK individuele scores	
CO2	A
Temperatuur	B
Luchtvochtigheid	B
Fijnstof	B

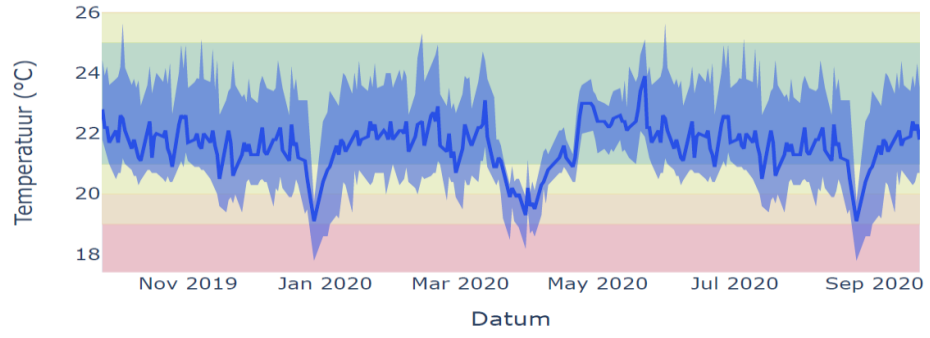
Driepersoonskamer

Ruimte: B
Sensor: 9982

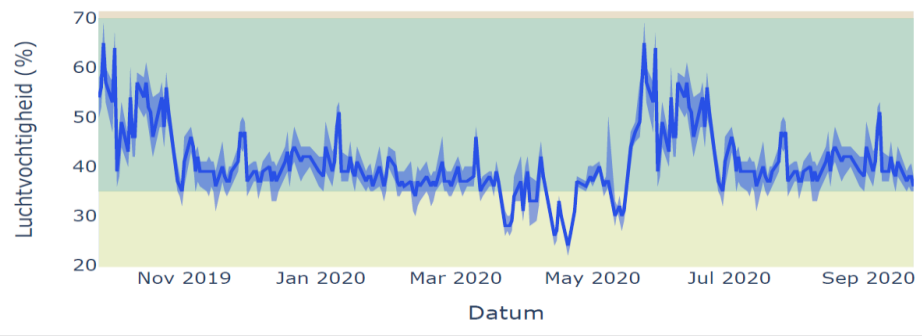
CO2



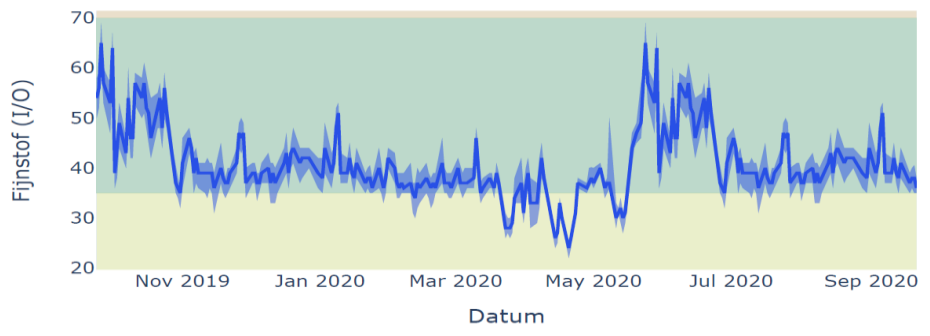
Temperatuur



Luchtvochtigheid



Fijnstof



officevitae
Vitality at Work

INDOOR FINE PARTICLES LEVELS ARE COMPARED TO OUTDOOR LEVELS FOR SCORE

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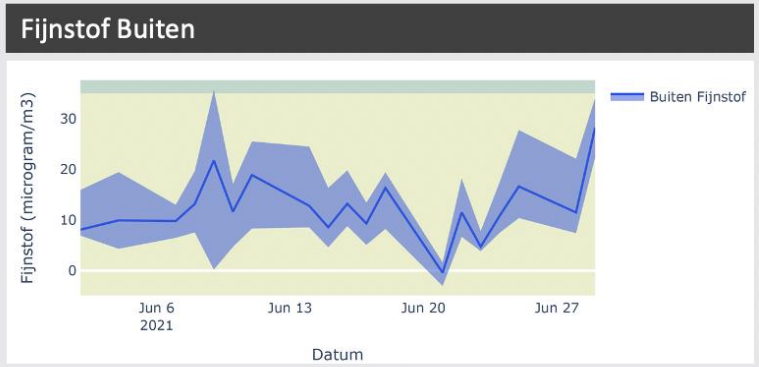
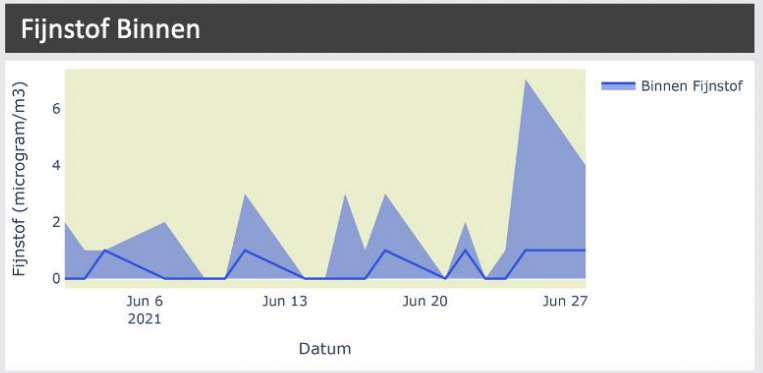


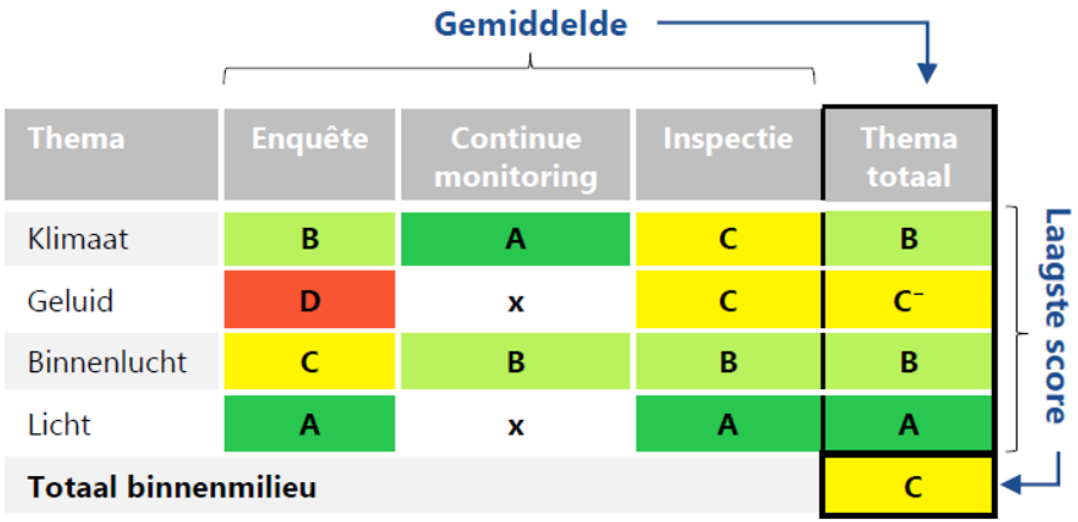
Outdoor PM2.5 Fine Particles



Indoor PM2.5 Fine Particles

INTEGRATED LABEL SCORE
BASED ON SURVEY, CONTINUOUS MONITORING AND INSPECTION DATA

Het slechts scorende thema bepaalt de score voor het gebouw: “totaal binnenmilieu”, zie onderstaande figuur uit de BBA PPT rapportage (03-04-2020).



Thema	Enquête	Continue monitoring	Inspectie	Thema totaal
Klimaat	B	A	C	B
Geluid	D	x	C	C⁻
Binnenlucht	C	B	B	B
Licht	A	x	A	A
Totaal binnenmilieu				C

Indoor air monitoring: C02 & Fine Particles ($PM_{2.5}$)
Climate Monitoring: Humidity & Temp

RESEARCH IN B4B: SMART NOTIFICATION STRATEGY

Based on
2000 hours of opening time for an average building, 5% = 100 hours

At the end of each week (40 hours) an analysis of scores compared to the beginning of continuous monitoring period is made. First period, initial goal set by inspector. Given a change in score for sensor climate, subjective comfort or inspection scores, a push notification is sent to the inspector or concerned individual.
The user-centric Dashboard can then be used to investigate why the current score has changed.

BRAINS 4 BUILDINGS

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Binnenklimaat Analytics

TNO innovation for life

127.0.0.1:8050

Update

B4B Scoring Dashboard

Last update at (D/M/YYYY): 31/10/2021

Subjective	Inspector	Climate	Total score

Select Date Range:

01/06/2021 → 30/06/2021

Select Building:

DWA Gouda

Select Location:

Whole Building

Whole Building

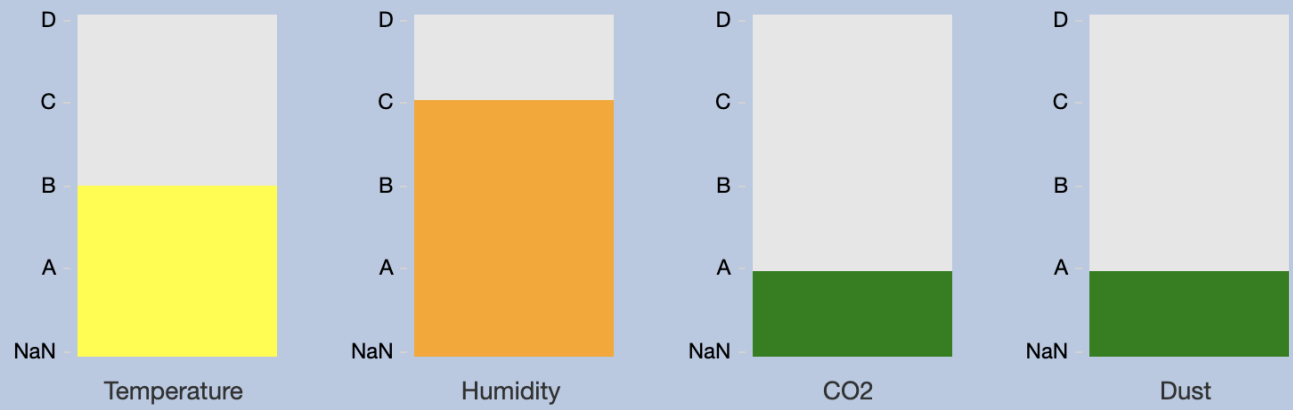
kantoortuin

kantoorruimte 4p

vergaderruimte

kantine/restaurant

kantoorruimte 2p



Generate report:

Enter your name

Enter your email

BRAINS 4 BUILDINGS

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Binnenklimaat Analytics

TNO innovation for life

127.0.0.1:8050

Update

B4B Scoring Dashboard

Last update at (D/M/YYYY): 31/10/2021

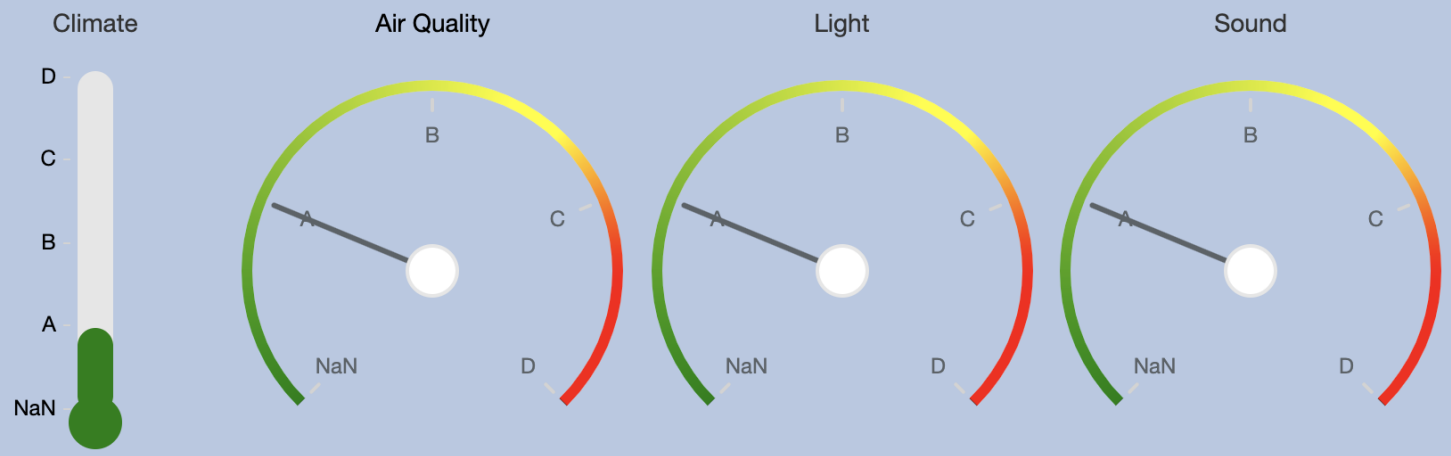
Subjective	Inspector	Climate	Total score

Select Year:

2021

Select Building:

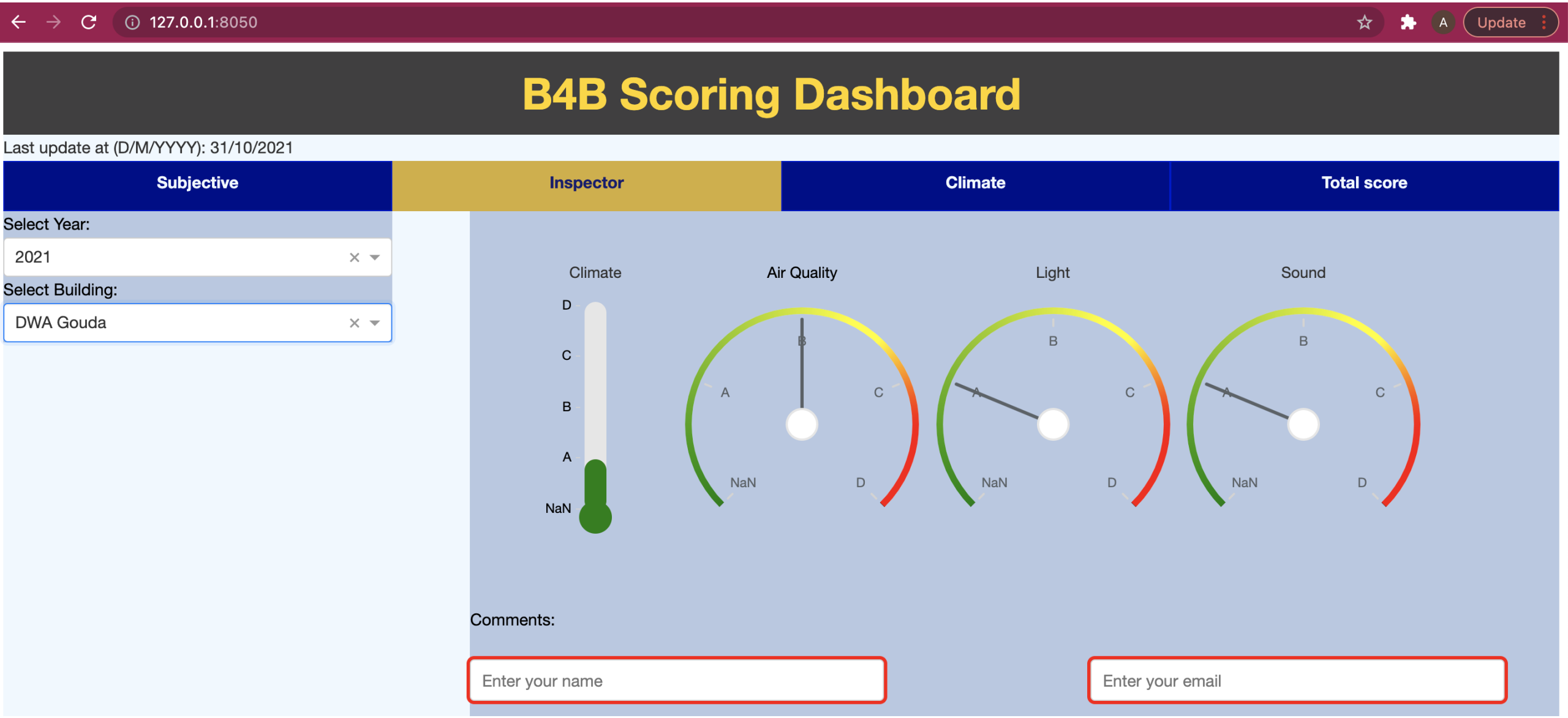
DWA Gouda



Comments:

Enter your name

Enter your email


127.0.0.1:8050
Update
B4B Scoring Dashboard
Last update at (D/M/YYYY): 31/10/2021
Subjective
Inspector
Climate
Total score
Select Year:
2021
Select Building:
DWA Gouda
Climate
D
C
B
A
NaN
Air Quality
A
B
C
NaN
D
Light
A
B
C
NaN
D
Sound
A
B
C
NaN
D
Comments:
Enter your name
Enter your email

127.0.0.1:8050

Update

B4B Scoring Dashboard

Last update at (D/M/YYYY): 31/10/2021

Subjective	Inspector	Climate	Total score

Select Year:

2021

Select Building:

DWA Gouda

Theme	Enquête	Continue Monitoring	Inspector	Theme Total
Climate	A	B	A	A
Sound	A	X	A	A
Air Quality	A	A	B	A
Light	A	X	A	A
Total Indoor Environment				A

Comments:

Enter your name

Enter your email

BRAINS 4 BUILDINGS

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Binnenklimaat Analytics

TNO innovation for life

BUSINESS MODEL BINNENKLIMAAT LABEL

- One time setup fee: 2.250,- euro
  - 5 Multi- sensors
  - Fine particle sensor
- Yearly cost: **3.500,- euro**
- One time payment per extra sensor 275,- euro
- Yearly fee per extra sensor 125,- euro
- Additional cost: building inspector fee, based on hourly rate

Foundation Binnenklimaattechniek

IT platform and data reporting cost

Foundation communication,
And knowledge development investments

Building inspection services

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Binnenklimaat Analytics

TNO innovation for life

BINNENKLIMAAT LABEL

- Meer informatie? Ga naar www.binnenklimaatlabel.nl

Bram Petri: bram@smartwp.nl

TNO innovation for life

THANK YOU FOR
YOUR TIME
TNO innovation for life