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3SqAir

European Regional Development Fund

SUSTAINABLE SMART STRATEGY
FOR AIR QUALITY ASSURANCE
IN CLASSROOMS

Deliverable

Case Studies (3.2.1)

Spain

Mondragon Unibertsitatea

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The 3SqAir project is a multi-partner and cross-border project. Its main goal is to design a “Smart” and “Sustainable” action plan, to ensure, through a common quality approach, the indoor air quality of French, Spanish and Portuguese educational buildings.

1-OBJECTIVES:

The Deliverable 3.1.2-Best Practices guidelines and criteria indicators for better Indoor Air Quality in classrooms - was developed within the scope of the Activity 3.1 of the project 3SqAir. The objective of this technical report is to define and present feedback on a remarkable indoor air quality (IAQ) management operation, through a reference framework of IAQ criteria in order to assess the inclusion of IAQ in school buildings.

This reference framework was established as part of the task 3.1.2 of the 3SQAIR project, the deliverable of which can be downloaded from the project website www.3SqAir.com

The approach has a dual objective:

- improve stakeholder knowledge on how to manage IAQ in their own buildings;
- propose a common methodology for comparative studies on “best practice” case studies.

1.1 – Methodology:

The objective of the 3SQAIR project is to define **RIS3**¹ strategies to improve indoor air quality IAQ in classrooms. One of the levers to achieve this objective is to share best practices (BP) with all stakeholders in order to enhance their knowledge, and consequently, their practices. To this end, we propose to identify the major action criteria to help stakeholders to improve IAQ in educational buildings.

Our work consisted in drawing up a first state of the art of methodologies for assessing the IAQ in educational buildings. This first analysis made it possible to identify a list of IAQ improvement levers considering technical and organizational. And, we propose a simplified methodology assessing a synthesis profile of the IAQ for feedback from operations.

In fact, the characterization of IAQ has many components, themselves linked to the complexity of the life cycle of a building. Such an analysis must be holistic because the IAQ of a classroom also depends on organizational aspects (maintenance and management of real estate), sociological (behavior and comfort of the occupants), economic (available resources) and even political considerations (exemplary public policies for contractors).

We propose a baseline to define common criteria for promoting best practices in IAQ in classrooms, which also lays down common guideline settings for smart, sustainable and energy efficient IAQ solutions.

¹ RIS3 = Research and Innovation Strategies for Smart Specialisation

Through a selective bibliographic study and an in-depth presentation of the modeling of IAQ pollutants, we have identified 10 major indicators for the inclusion of IAQ, classified into 2 areas:

1) BUILDING FACILITIES: “TECHNICAL SOLUTIONS ON IAQ AND VENTILATION”

- A) POLLUTANT SOURCES
- B) INTAKE AND EXHAUSTS
- C) FILTRATION
- D) AIR RENEWAL SYSTEMS
- E) AIR PURIFICATION

2) STAKEHOLDERS ORGANIZATION: “MANAGEMENT”

- F) COST
- G) OCCUPANTS' COMFORT AND BEHAVIOR
- H) COMMUNICATION AND QUALITY MANAGEMENT SYSTEMS
- I) MAINTENANCE
- J) SUSTAINABILITY (ENVIRONMENTAL IMPACT & ENERGY EFFICIENT STRATEGIES)

This report offers a common reference simplified methodology to establish comparative studies on IAQ in educational buildings. This methodology constitutes a basis for the practical resource (best practices experience feedback case studies) for stakeholders that have to be produced within the 3SqAir project, through the eponymous online platform website. It will be used to build an analysis framework for the 12 operations that are the subject of experience feedback as part of task 3.2.1 of the 3SQAIR project.

2-CASE STUDIES: [name of operation]

2.1 – General Description

This study has taken place in Orona Ideo, which is the ecosystem that gathers in one place all the agents involved in the innovation network – company (Orona), university (Mondragon Unibertsitatea) and research center (Ikerlan) - to promote a greater exchange of knowledge and ideas that will ultimately be transformed into results.

The collaboration between the three entities forms a technology alliance applied to the mobility sector and the improvement and transformation of companies and society.

This space is much more than a set of facilities, it is the place where an idea or a project needs to grow and consolidate. It is composed by:

- Orona Zero: the corporate headquarters of Orona, a leading European business group in sustainable vertical mobility of people.
- Orona Fundazioa: the building that houses the classrooms where Mondragon Unibertsitatea teaches its two degrees in Energy Engineering and Engineering in Green Manufacturing.
- A3 Research: It is an advanced building designed for the development of the integrated projects of the innovation network related to energy, managed by Ikerlan.

More information in www.orona-ideo.com.

The room where the study has taken place is:

MONDRAGON UNIBERTSITATEA

Room F1 04

MONDRAGON UNIBERTSITATEA - MONDRAGON UNIVERSITY

(43.276030, - 1.985543)

(<https://vr.mondragon.edu/bisitabirtuala/oronaideo/>)

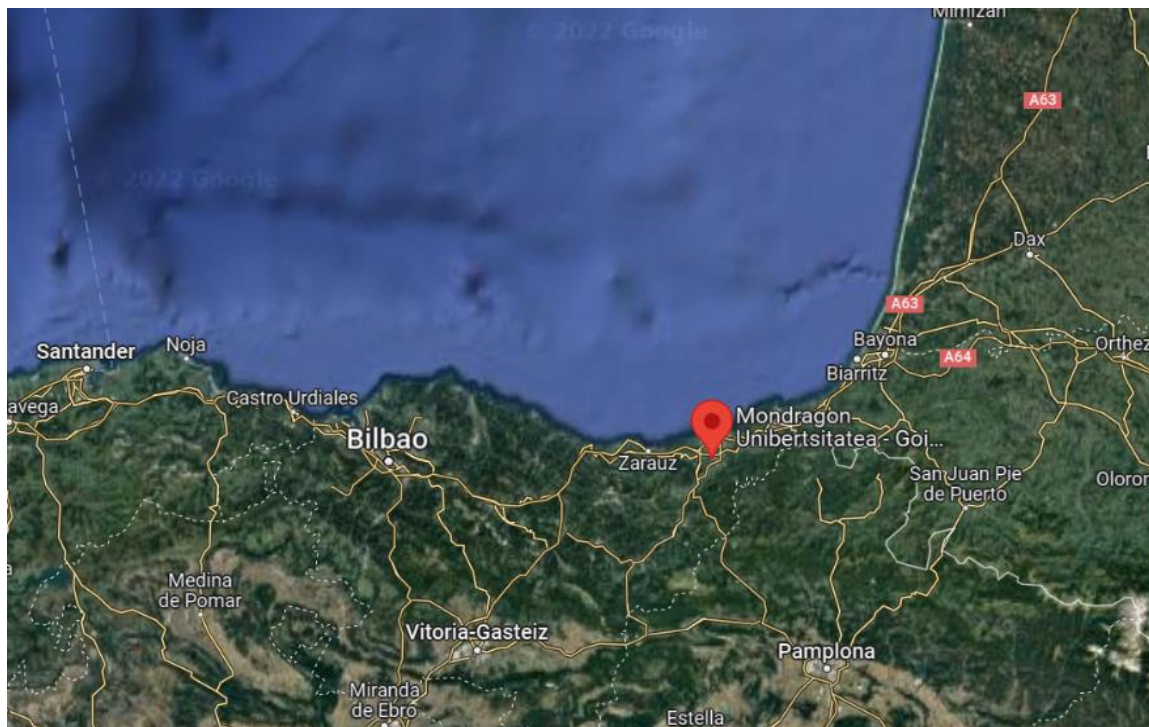


Figure 1: Map of location

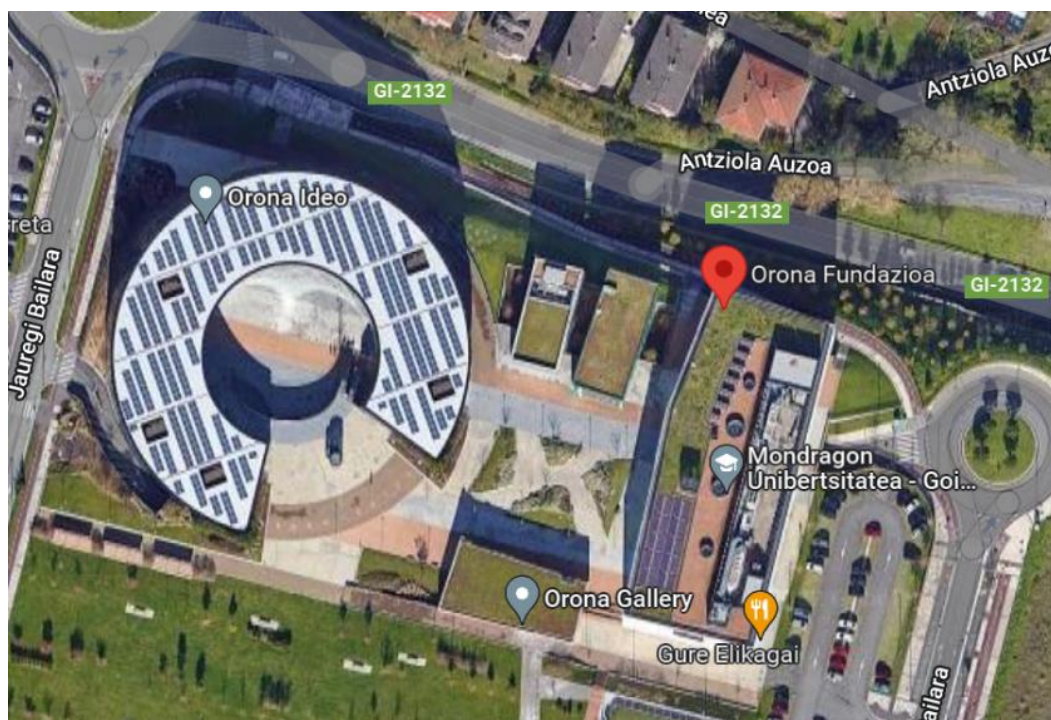


Figure 2 Photo of Orona-IDEO Innovation City.



Figure 3: Photo of Orona Fundazioa Building



Figure 4. Photo of Sala F1 04 - Aula Teoria 2



Figure 5 Location of the room at the first floor in Orona Fundazioa building

Outdoor environment data:

Local meteorological/weather station Location: 43.309419, -2.010934. C/ Andrestegi, 2. Donostia-San Sebastián. (260m of the School, Official meteorological station of the Basque Government, Name of the stations “Av. Tolosa”)

<https://www.euskadi.eus/aa17aCalidadAireWar/datohorario/contaminanteEstacion?idContaminante=&idEstacion=66&fecha=31/05/2021>

Demo-site / Name

Location	Hernani (Spain)
Year building / Renovation	2013
Number of building	Sala F1 04 - Aula Teoria 2: It is a local room of the Mondragon University sited in one building (called Orona <i>Fundazioa</i>) of four buildings. The four buildings compile what it is called Orona-IDEO Innovation City.
Total occupancy	60
Surface	136.61 m ²
Educational stage	University

2.1.1 – BUILDING FACILITIES: TECHNICAL SOLUTIONS ON IAQ AND VENTILATION

A) POLLUTANT SOURCES:

The Outdoor Environmental Zone			The Indoor Environmental Zone		
	Yes	No		Yes	No
Urban area		X	Maintenance products used for interior cleaning		X
Rural area	X		Room's Activity		X
Industrial area nearby	X		Wall and floor coverings		X
Nearest gas station (less than 1km)		X	Luminaire type (fluorescent)		X
Commercial zone	X		Heating method		X
Parking lot	X				
Presence of electromagnetic waves	X				

B) INTAKE AND EXHAUSTS:

Intake and Exhausts Information's

Self-adjusting	No
MECHANICAL VENTILATION	
humidity-controlled air inlets	Centralized 2 DOAS (Dedicated Outside Air Systems) systems for whole building ventilation. At the room there are 2 fan coils with 4 intake ports per each fan coil (thermostat control)
humidity-controlled air outlets	Centralized 2 DOAS (Dedicated Outside Air Systems) systems for whole building ventilation. At the room there are 2 outlets to return air.
NATURAL VENTILATION	
Air entry/evaluation through openings	23.6 m2 of windows West oriented

C) FILTRATION:

The first week of September

Filtration Information's

AIR CONDITING	
Type of maintenance	Review and cleaning of air filters, if the case arises
Upkeep	
Frequency	Monthly
VENTILATION	
Type of maintenance	Review and cleaning of air filters, if the case arises
Upkeep	
Frequency	Monthly
HEATING	
Type of maintenance	Review and cleaning of air filters, if the case arises
Upkeep	
Frequency	Monthly

D) AIR RENEWAL SYSTEMS:

There are two Dedicated Outside Air Systems for conditioning the primary air of the Orona *Fundazioa* building where is sited the demo site. The DOAS have 2 fans for air inlet and exhaust respectively, rotatory heat recovery heat exchanger of 62% efficiency, heating and cooling coils, free cooling performance and F6+F8 air filters.

Air Renewal System Information's

Planned air change rates	7 Air Changes per hour (ACH)	
Possibility opening windows	☒ yes	☐ no
Windows operability	☐ single-hung ☐ sliding ☐ pivot	☐ French window (casement) ☒ tilt and turn ☐
Air renewal system	☐ natural ventilation ☒ double-flow	☐ single-flow ☐ over-ventilation at night
Air System	☐ mechanical ☒ automated	☐ programmed ☐
Flowrate	The ventilation air flow rate of the room under study (sala F1 04 - Aula Teoria 2) is 2700 m3/hr	
Ventilation protocol	The ventilation is running from 6:00 to 20:00 every labor day following the programed set points, which can be adjusted by the maintenance team depending on the needs (i.e. during COVID pandemic situation the Outdoor air flow rate set points were increased)	

HEATING MODE

Summer	Set points: Temperature 25°C; Relative Humidity 60%
Winter	Set points: Temperature 21°C; Relative Humidity 40%
Air conditioning	The rooms of the Orona Fundazioa building are heated/cooled by 4-pipes fan coils. Demo-site room under study is thermally conditioned by 2 fan coils (model Airlan FPM224K1 with following nominal power of each fan coil: ■ Heating power = 13.8 kW ■ Cooling power = 11.7 kW ■ Electric consumption power 0.560 kW Winter Set points: Temperature 21°C; Relative Humidity 40% Summer Set points: Temperature 25°C; Relative Humidity 60%

OTHER

	Central heating and cooling production for the four buildings (district heating); the cooling and heating is provided from central storages which are conditioned by several equipment: absorption cooling equipment, geothermal equipment and air cooled chiller. The roof of the main Building (called Orona Zero) is covered by PV panel for self-consumption. The building was designed to be passive buildings and they obtained LEED Gold and BREEAM Excellent certifications.
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Example:

The buildings are equipped with dual-flow ventilation systems from CALADAI in educational buildings and France AIR, MODULYS DP 12/12 for the restoration room achieving:

- 2700 m3/h air flow in building 7,
- 4730 m3/h air flow in building 4 (kitchen and restoration room),
- 3120 m3/h air flow in buildings 5 and 6.

Renewable energy generation is also in place:

- 2x Viessmann Solar 25-60 solar panel on building 4,

(Since COVID-19 pandemic, 1 or 2 windows are always open in tilted position at presence of the students)

E) AIR PURIFICATION:

Air Cleaning Information's

Use and type of purifier	F6+F8 filters in the DOAS
Mode of operation	

2.1.2 ORGANIZATION OF STAKEHOLDERS – BUILDING MANAGEMENT:

Indicate the maintenance manager(s) of the site's various systems and the service providers.
Explain their role and importance in the decision chain.

The maintenance team is composed by 1 internal person that is part of the contracting authority and the maintenance services provide by external companies

Building Management Information's

Type of system	Centralizer digital platform where the set points and real data are recorded
Companies	

F) COST

Cost Information's

Consumption (kWh)	The annual consumption due to the ventilation of the Orna <i>Fundazioa</i> building is around 17600 kWh. Considering the introduced air flow ratio to the room under study is a 4% of the overall flow ratio, an annual consumption of 700 kWh could be assigned to room under study ventilation.
Surface building (m ²)	136.61 m ² (Room); 9500 m ² (Orna <i>Fundazioa</i> building)

Price (€)	
Energy (Type of energy is the site using)	Electricity
Energy's consumption	

This is to quantify the building's energy cost. Any piece of information on the cost of air renewal will be of interest.

Energy source Information's

Type	Electricity
Nominal power	
Annual Electric consumption	Due to ventilation: 1.8 kWh/m ² (Orona Fundazioa building)
Annual thermal consumption	
Renewable energy power	
Annual electric generation	

G) OCCUPANTS' COMFORT AND BEHAVIOR

Occupants' Comfort Informations

Description of activities	Sedentary activity (university classroom)
Frequency of site occupancy	5 days/week from 8:00 a.m. to 14:00 p.m.
Accommodation capacity	60 person
Presence of vegetation	[] yes [X] no
Ability for occupants to control:	
Ventilation equipment	[] yes [X] no
windows	[X] yes [] no

H) COMMUNICATION AND QUALITY MANAGEMENT SYSTEMS

Quality Management Systems Information's

Certification 1 - The building was designed to be passive buildings and they obtained LEED Gold and BREEAM Excellent certifications.	
Date of last acquisition	
Support procedures have been put in place	
Certification 2 -	
Date of last acquisition	

Support procedures have been put in place	
Certification 3 -	
Date of last acquisition	
Support procedures have been put in place	

I) MAINTENANCE

Maintenance Frequency Information's

Ventilation	
Filter	Monthly: verification and cleaning if necessary. Annual: revision and cleaning.
Air inlets	Annual revision and cleaning
Extractions	Annual revision and cleaning
Room cleaning	Every labour day
Exterior	Continuous maintenance, acting whenever is needed
Vegetation	Continuous maintenance, acting whenever is needed
Other	Maintenance plan defined based on RITE. Annually exterior facades cleaning

J) SUSTAINABILITY (ENVIRONMENTAL IMPACT AND ENERGY EFFICIENCY STRATEGIES)

Sustainability refers to the ability to maintain or support a process continuously over time. Sustainability seeks to prevent the depletion of natural or physical resources, so that they remain available over time.

Sustainability Information's

CO2 emissions reduction	
Material and equipment life cycle analysis	

Means implemented to ensure the sustainability of the facilities	Integration of renewables energies: geothermal, and photovoltaic
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IDENTITY CARD

Actions	Building designed using the best efficient technologies: PV installation Heat pump feed by geothermal energy source
Resources	Production mode: electricity generation Production mode: Thermal generation
Objectives	Energy cost saving by electricity PV generation and CO2 reduction Energy and cost savings by efficient cooling/heating equipment and CO2 reduction

Actions: *how to protect, how to restore and manage?*

Resources: *production and consumption mode*

Objectives: *ex: energy saving - use of solar panels*

3-CONCLUSION AND PERSPECTIVES

This work proposes a methodology for evaluating the IAQ in educational buildings. Through a deliberately simplified approach, we have defined a baseline based on two domains describing the building's facilities and the organization of the whole stakeholder chain actors.

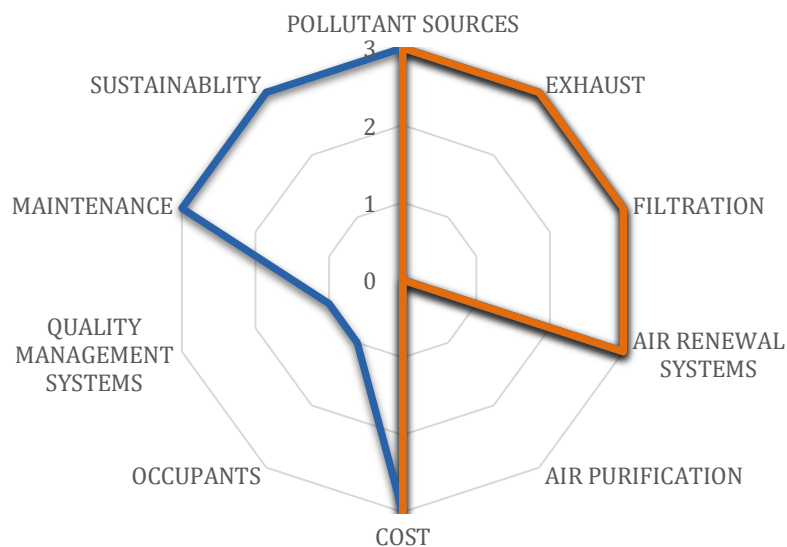
A summary of the multi-criteria analysis for this operation is presented in the form of a radar made up of the 10 benchmark indicators, established in task 3.1.2 of the 3SqAir project.

We have previously indicated that this type of analysis requires a transversal (holistic) approach, since all these criteria are interconnected and influence each other. In order to determine the relevance of taking into account the IAQ of a building, we propose to carry out a two-step approach:

- 1) First, an analytical approach: characterization of each of the 10 criteria separately, through a qualitative or quantitative approach;
- 2) Secondly, a global synthesis, through a graphic representation in the form of a "3SqAir profile", with a radar representation, according to the a "basic" or "thorough" rating scale (see below, an example of fictive radars on the basis of a 1-5 scale, with a representation mode).



For operation Mondragon Unibertsitatea-Ikerlan, the result is as follows:



This result was established after a collective analysis of all operations, during the workshop held in Coimbra (Portugal) on 08/11/2022. During this workshop, the partners presented the 12 feedbacks and voted collectively to define the level of performance for each criterion and establish the corresponding radar profile.