



Development of novel assessments for indoor air quality monitoring and impact on children's health

D1.2 - Data Management Plan

Project Details

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The LEARN Consortium

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4	Katholieke Universiteit Leuven (KUL)	BE
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7	Nanotechnology Industries Association (NIA)	BE
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Project aim

LEARNing about the status of air quality in schools and its impact on the cognition of children is a major cornerstone in LEARN. For that, we want to overcome the barriers of existing technologies and take a bold step towards developing and deploying novel sensors to detect the presence of possibly harmful air pollutants such as Volatile Organic Compounds (VOCs) and Ultrafine Particles (UFPs).

We will measure and characterize indoor and outdoor air pollutants and evaluate the presence of biomarkers of exposure and their effect on children's cognition while trying to recapitulate those effects using *C.elegans* as a biosensor. Moreover, we will use advanced human-based in vitro models of lung and skin coupled with a revolutionary multi-sensing device to investigate their mechanisms of toxicity in real time.

Novel remediation strategies will be explored to improve air quality and promote children's quality of life and life expectancy. For that, we will mobilize a group of eleven leading research teams, unrivalled in their respective fields (environmental epidemiologists, toxicologists, air quality specialists, systems biology, engineers, and citizen/social scientists).

The scientific achievements expected to result from LEARN will unlock a large technology potential in indoor air quality for decades to come, leading to disruptive societal and economic impacts steaming from a radical improvement in the quality of life of children in Europe.

Project LEARN is part of the European indoor air quality and health cluster.



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Document Details

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Purpose	The current version of the LEARN Data Management Plan is to describe the potential data which will be produced from the project and initial ideas on the management of these according to FAIR principles and ethics. A dedicated task (WP7, Task 7.3) around the FAIR principles and the ethics of the project is in place. A more detailed DMP will be produced as the project is progressing where more information on the data to be produced will be given.

Revision History

The following table describes the main changes done in the document since it was created.

REVISION	DATE	DESCRIPTION	AUTHOR (ORGANIZATION)
V.0.1	10/07/2022	Table of Contents	ENVIROMETRICS LTD
V.0.2	12/09/2022	First draft of the DMP	ENVIROMETRICS LTD
V.0.3	15/9/2022	Internal review	ENVIROMETRICS LTD
V.0.4	20/9/2022	Final version	ENVIROMETRICS LTD
V0.5	3/10/23	First issue for consortium review	Leaders from WP1, WP2, WP3, WP4, WP5, WP6, WP7, WP8
V1	17/10/23	Updated based on review comments	ENVIROMETRICS LTD

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Abbreviations	
AB	Advisory Board
API	Application Programming Interface
CEN	European Committee for Standardization
CFD	Computational Fluid Dynamics
CO	Carbon Monoxide
DMP	Data Management Plan
DOI	Digital Object Identifier
EU	European Union
FAIR	Findable, Accessible, Interoperable and Re-usable
GDPR	General Data Protection Regulation
IAQ	Indoor Air Quality
IPChEM	Information Platform for Chemical Monitoring
LBoC	Lung-Blood-Barrier
NMB	Nanomembrane
NO₂	Nitrogen Dioxide
O₃	Ozone
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Printed Circuit Board
PID	Photoionization Detector
PIDs	Persistent Identifiers
PM	Particulate Matter
QA	Quality Assurance
QC	Quality Control
SiO₂	Silicon Dioxide
SoC	Skin-on-Chip
THG	Third Harmonic Generation
UFP	Ultrafine Particle



URL	Uniform Resource Locator
VOC	Volatile Organic Compound
VUV	Vacuum Ultraviolet
WP	Work Package
WPL	Work Package Leader
WTL	Work Task Leader



Executive summary

This document constitutes the initial version of the **Data Management Plan (DMP)** in the framework of the LEARN project. LEARN aims to develop the next generation of sensors to detect Volatile Organic Compounds (VOCs) and Ultrafine Particles (UFPs) in order to identify potential risks and evaluate toxicity mechanisms. This process includes several activities of data gathering, production and/or processing with a view to generate meaningful perceptions that will feed into the project and lead to the successful development of the aforementioned sensors.

In this context, the initial version of the project's DMP establishes the overall methodological principles referring to the management of data that will be gathered and/or produced during the LEARN project, protecting the ethical aspects of them. Furthermore, it performs a first, yet still meaningful overview of LEARN's data, as identified in this early stage of the project, along with information on the methodology pertaining to their management as well as to making them **F**indable, **A**ccessible, **I**nteroperable and **R**e-usable (**FAIR**).

This deliverable constitutes the first version (v1) of LEARN's DMP to be produced in the course of the project and will serve as a living document (more developed versions of the plan will be included as additional deliverables at later stages of the project, with the second version to be delivered on M18). Due to the difficulty of the data identification in the first six months of the project, more details on the data will be provided in the next version of DMP.

1. Introduction

The current document represents the initial version of the DMP for LEARN, which has received funding from the European Union's Framework Programme for Research and Innovation Horizon Europe under Grant Agreement No 101057510.

All participants of LEARN's consortium adhere to the data management principles in order to secure the meaningful data collection and processing during the project. The data are managed, archived and preserved in line with the structure and guidelines of the [Horizon Europe Data Management Plan Template](#).

According to this, DMP aims to achieve the following objectives:

- Describe the data management life cycle for the data to be gathered, generated, stored and/or reused in the framework of LEARN.
- Outline the methodology employed to secure the management of the data as well as to make them FAIR.
- Provide information on the project's data and the way in which it will be handled during and after the end of the project.
- Describe details on how the data will be made openly accessible and searchable to interested stakeholders as well as its curation and conservation.
- Present information on the resources to be allocated so as to make data FAIR clearly identifying responsibilities pertaining to data management, while addressing data security and ethical aspects.

With the above in mind, this initial version of the DMP is structured in 8 distinct chapters, as follows:

- **Chapter 1** summarises the structure and objectives of DMP.
- **Chapter 2** presents the collected/generated types of data of LEARN and their anticipated utility by selected stakeholders.
- **Chapter 3** outlines all the processes in order to make the data FAIR.
- **Chapter 4** includes the management of other research outputs that may be generated or re-used through the project.
- **Chapter 5** entails the responsibilities of each Work Package Leader (WPL) and Work Package Leader (WTL).
- **Chapter 6** describes the data security strategy in the framework of LEARN.
- **Chapter 7** addresses ethical aspects as well as other relevant issues pertaining to the data collected/generated or re-used during the implementation of the project.
- **Chapter 8** concludes on the next steps related to the project's data management plan.

2. Data summary

LEARN will collect and also generate meaningful data that do fall into special categories of personal data (personal information like age, gender etc., and health related information) as those are described within the General Data Protection Regulation ([GDPR](#))¹. These data may be quantitative, qualitative or a blend of those in nature and will be analyzed from a range of methodological perspectives with a view to producing perceptions that will successfully feed LEARN'S activities, giving us the opportunity to deliver evidence-based results and ultimately achieve the objectives of the project.

2.1. Types and formats of collected / generated data

LEARN is set to collect and generate data of various structures and formats. There are two main aspects of the data:

- i) The process under which the underlying data are created/captured which includes electronic texts documents, spreadsheets, questionnaires and transcripts, among others.
- ii) The storage format of the data in easily accessible formats like postscripts e.g., pdf, xps, etc.), machine readable formats (xml, html, etc.), spreadsheets, (e.g., xls, csv, etc.), text documents (e.g., docx, rtf, etc.), compressed formats (e.g., rar, zip, etc.) or any other format required by the objectives and methodology of the activity within the framework of which are produced.

In order to secure the interoperability and re-use of data special attention will be paid in using open formats² (such as csv, pdf, zip, etc.) where this is applicable, and / or machine-readable formats³ (such as xml, json, rdf, html, etc.). Furthermore, the data will be easily readable and freely usable in any software program employed by third parties interested in utilizing it.

The type and formats of the data collected/generated in the context of LEARN can be divided in two categories:

- i) Data collected through input methods (existing or created data) ([Section 2.1.1](#))
- ii) Data collected/generated from dissemination, communication, stakeholder engagements, toolkits and clustering activities ([Section 2.1.2](#))

2.1.1. Data collected through input methods

Direct input data are generated from literature reviews, experimental processes and interactions between consortium partners and external stakeholders. According to this, the latter undertake the role of a data subject that is a natural person whose personal data are being processed⁴. More specific, identification and selection of suitable data subjects depends on sampling in respect to the objectives of the activity for which the data are collected. The generated data are quantitative and qualitative:

- **Quantitative data:** are numerical and gathered by counting or measuring⁵. For instance, the concentrations of chemical pollutants as well as particulate pollutants, classroom's

¹ Regulation (EU) 2016/679 of the European parliament and of the council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32016R0679>

² According to the [Open Data Handbook](#): "An open format is a file format with no restrictions, monetary or otherwise, placed upon its use and can be fully processed with at least one free/open-source software tool and it is not encumbered by any copyrights, patents, trademarks or other restrictions so that anyone may use it".

³ According to the [Open Data Handbook](#): "Machine readable formats are file formats that can be automatically read and processed by a computer. Machine-readable data must be structured data".

⁴ Regulation (EU) 2016/679 of the European parliament and of the council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32016R0679>.

⁵ Neuman, W. L. (2014). Social research methods: Qualitative and quantitative approaches. Boston: Pearson.



environment (temperature, humidity, noise) etc. These data may be represented by numeric, interval and/or ratio scales.

- **Qualitative data:** are referred as categorical data, which can be arranged into categories based on physical traits, gender, colours or anything that does not have a number associated with it⁶. Other forms of qualitative data are written documents, interviews, and various forms of in-field observations (skillsets, country of origin etc.).

Dataset 1. Current status of children and their family background

The collection of these data includes some information about the physical measurements of children and the completion of questionnaires filled by their parents for additional information about their background. Moreover, cognitive function tests will be performed to children in order to estimate the current cognitive level and related it to the Indoor Air Quality (IAQ) measurements. Some of them will be quantitative and some qualitative.

Dataset 2. Data from classrooms' environment

The selected classrooms probably will include the volatile and semi-volatile compounds, which will be determined based on existing IAQ literature and multiple regulatory and health-based institutes. These measurements will be used for the development of a sensor selective to individual VOCs. In some classrooms, LEARN will perform stationary measurements on two locations in the classrooms. Additionally, a broad screening measurement will be performed in a limited selection of classrooms to detail the chemicals of interest. The above data will be mainly quantitative.

Dataset 3. Current status of the IAQ

These data are mainly measurements or indicators of air quality in the classrooms such as concentrations of chemical pollutants (e.g., CO, NO₂, O₃, VOCs, PAHs, etc.) and particulate pollutants (e.g., PM_{2.5}, PM₁, UFPs, etc.) and parameters affecting it such as temperature, humidity, noise, light, ventilation system, window opening time, use of cleaning products etc. Furthermore, for an extra indication of the current IAQ status, urine samples from the children will be gathered. The collection of them will be performed in two steps: one before the implementation of air purification systems and one after it. Moreover, microorganisms in the filter will be collected in order to estimate the microbiological fraction present in the collected Particulate Matter (PM). The aforementioned data will be recorded in the form of spreadsheets, with some additional notes in document form linked to the lists.

Last but not least, subjective data will be collected through a short, seasonal survey with questions on 'compliments' or 'complaints' about the IAQ in order to be linked with the objective measurement data. These data will be gathered in a form of combination of qualitative and quantitative data.

Dataset 4. Current status of the outdoor air quality

For the estimation of the outdoor air quality child's geocoded residence will be recorded in spreadsheet format. These data with children's addresses will be used for the modelling of the PM exposure at their homes. These data will be gathered in a form of combination of qualitative and quantitative data.

Dataset 5. Research, design, development and prototype of innovative sensor technologies

The development of a sensor selective to individual VOCs and sensor system for UFPs, contains three main tasks, which generate a variety of data:

- A document of detailing the complete envisaged sensor system, its working principles and main design parameters in relation to the targeted sensitivity and detection range.
- Sensor system development, focusing on the engineering aspect of the sensor leading to sensor prototypes.
- Continuous testing and validation phase both in the lab and in the field to inform the status of sensor development and shape the next iterations of research and development.

⁶ Neuman, W. L. (2014). Social research methods: Qualitative and quantitative approaches. Boston: Pearson.



The above results will be provided in a detailed document by IMEC-NL and INL, which includes information about the sensor's system development like the description of electron microscopy techniques, the development of the tuneable-wavelength (Vacuum Ultraviolet) VUV light source etc.

Dataset 6. Evaluation of the toxicity

In a first-tier approach, traditional 2D cell culture models related to lung and skin models will be used for the evaluation of cellular death (cytotoxicity), oxidative stress, and proinflammatory effects. LEARN will take a step forward and work on the development of advanced in-vitro models of Lung-Blood-Barrier (LBoC) and Skin-on-Chip (SoC), which will be benchmarked against the conventional mode and establish a testing protocol to evaluate the best on-chip administration method. These models will be described analytically in reports, which describe the above processes. The advanced lung and skin models will be used to assess the toxicological effects of chemical and biological air pollutants and to identify intra-, extra-, and inter-cellular biomarkers characteristics of air pollution-associated diseases. Finally, they will be compared with commercially available lung models.

*Dataset 7. Use of *C. elegans* as a biosensor*

For further evaluation of the toxicity and neurotoxicity of the environment *C. elegans* will be used as an in-vivo model. The results will be translated/compared with the ones from the cognitive functional assessment (Work Package 2, WP2) by using the related transgenic/mutant organism at their L3/L4 larval stage. The panel of standardized new and realistic in vitro assays will be performed, matching the exposure scenario found in cohorts and preparing the ground for the definition of hazard profiles based on in silico testing. The protocol will be provided in a document format, following the standard approach to evaluate and propose items under the European Committee for Standardization (CEN).

Dataset 8. Operation concepts for air purification systems based on UFPs concentration

In the framework of the LEARN project novel air purification systems will be developed in order to improve IAQ. Real IAQ data will be used to describe the efficiency of filters and air purifiers and efforts will be done to improve the performance of particle filters as well as adsorption layers. For the development of the above, the below processes will be developed:

- Demonstration of indoor air improvement, which includes the placement of air purifiers in classrooms based on Computational Fluid Dynamics (CFD) simulations.
- Filter media and adsorption material for the particle sizes and substances identified as important for IAQ.
- Modifications to the air purifier design and operation modes to improve the subjective IAQ level with specific focus on classrooms, e.g., noise, comfort flow rate, robustness, material selection.
- Test of samples and evaluation of potential health risks and evaluation of concentrations levels regarding health impacts to derive required filtration efficiency for given volume flow rate and contaminant concentration.

These processes will be written in analytical documents, which will also include quantitative results.

Dataset 9. Organization of workshops

In the early stages of the project one FAIR data & ethical workshop will be organized when the use cases are clear and a second one before the final iteration of the innovation. These workshops will result in an overview of the FAIR data & ethical challenges within the project and possible mitigation actions. Through the implementation of the workshops, personal data from participants are going to be collected and recorded in participant lists format and spreadsheets filled with particulars. All the collected data will be aligned with GDPR.

Dataset 10. Data collected from project coordination and management

During LEARN project, different activities will take place from which data will be created and handled. These can be from consortium meetings (name of attendees) to mailing lists and other day to day activities. The project team has prepared the Project Handbook (D1.1) where key information on



how partners will store and share data is defined. Data collected by partners through the implementation of workshops are more likely to be qualitative insights and will be recorded in various types of formats, with the photographs, videos, captured minutes, participant lists and document texts being the most expected.

Dataset 11. AB feedback

During the implementation of LEARN project, there are several actions where guidance and feedback from experts is required. An AB composed of experts on the field is needed in order to provide necessary guidance and analysis of LEARN's activities and outcomes and to monitor, rate, and validate LEARN's support services and toolkit. Data collected via AB activities and involvement, such as discussions and digital validation workshops, are expected to be comments and proposals written in standard document texts and spreadsheets.

With the purpose of organizing the LEARN AB, personal data of AB members will be gathered. Collected data contain information such as name, surname, age, region, experience, education and expertise and will be saved in member lists. Finally, consent forms will be used for the ability of processing AB members' personal data and specific terms of reference will be developed to provide the basis for the activities of the AB.

Dataset 12. Testing of the alert system

The alert system will be tested through a co-creation process which includes a citizen/user-centered approach through the organization of workshops and/or interviews with the stakeholders. The expected data will be in the form of documentation containing both quantitative and qualitative data. Both qualitative and quantitative data will be collected through interview questionnaires and guidelines during the first stage.

Dataset 13. Policy insights set

In processes where desk research is included, there is an initial Policy insight set, which will be refined during the project. The generated data will be qualitative and more likely be written in a document/note form. The final Policy Insights is called "Policy Recommendations and Briefs" and will be refined according to European Union (EU) policy roundtable outcomes and comments as well as insights from other projects.

Dataset 14. Insights from EU policy roundtable

An EU policy roundtable will be organized by partners and important data and views will be gathered from conversations during its implementation. The project's data will contribute to the scale up of the final set of "Policy Recommendations and briefs". Collected data will be mostly qualitative and will be written in document texts and participant lists.

Data collected/generated through direct input methods will be stored in standard document formats. These formats, will be decided through the project and be presented in the next version of DMP, according to the FAIR principles. By doing so, it is possible to circulate raw data from transcripts, as well as text, images and other objects from other files to one document file or multiple tabs of a single spreadsheet. Moreover, the formats can be immediately converted into open and machine-readable formats (e.g. boosting the interoperability and re-usability of the data generated in the framework of LEARN).

2.1.2. Data collected/generated from dissemination, communication and clustering activities

Dataset 15. Website analytics

In the framework of LEARN a website will be designed, which will contain a description of the project objectives, the proposed architecture, the consortium and other important up-to-date information. The website will use the managing environment of Wordpress with password-protected administrative



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information and tools for updating the website, managing users' permissions and collecting website analytics.

The LEARN website will be supported by tracking and analytics software (Google Analytics and Google Search Console) for better understanding visitor's interactions with the website. In this way, the functionality of the tool will be improved and the visitor's privacy will be protected. To identify visitors on the website, cookies are used by Google Analytics to track their activity on the website navigation. Visitors will have the ability to delete or block website cookies. These cookies sometimes collect anonymous statistics about the visitor (such as gender, age, geographical location, and interests) and the data are stored by the analytics services that we use. These cookies also gather data regarding what pages they visit, and/or how long they stay on the page, and/or files they download. Tracking cookies from social media networks are also used, for customised advertising targeting visitors of the LEARN website on these platforms and to assess the performance of ads on these platforms. The data that these platforms collect is anonymised. That means that we cannot see the social media profiles of visitors.

At the same time, visitors can subscribe to the project's newsletter on the website. The newsletter mailing list is collected and managed through the Mailchimp software, integrated in WordPress. Newsletter subscribers will have the possibility to manage their subscription preferences by clicking on the link that will be available on each newsletter.

Dataset 16. Project's email address

The project's official email address is hosted and managed through Gmail (Google Mail). Newsletters will be sent from this address using the Mailchimp software. Data is collected on Gmail from the messages that are sent to that email, for the purpose of providing an answer and analysing the stakeholder connections that are achieved.

Dataset 17. Social Media statistics

A Twitter, LinkedIn and YouTube account for the LEARN project are created. The related data will be collected/generated through a periodic monitoring of the project's social media statistics (including Twitter, LinkedIn and YouTube) with a purpose to estimating and assessing the effectiveness and outcomes of the project's social media activity in terms of communication and dissemination. The data will be in qualitative and quantitative forms (e.g., followers, impressions, engagement, etc.). Moreover, these data will be used for a further analysis in order to improve the results so as to succeed the project's targets. In conclusion, the data will be stored in a Microsoft excel file (.xlsx) while at the same time the analysis of the results will be stored in a standard word document (.docx).

Dataset 18. Data collected from project events

This type of data will be gathered during the project activities: (i) the different events (e.g., workshops, final event, etc.) organised by LEARN (either alone or jointly with other projects or initiatives) consisting of the participants lists and (ii) the participation of LEARN partners in relevant third-party events in order to reach out and engage stakeholders, thus collecting general information about the events attended and their outreach. The data will be both quantitative and qualitative in nature and will be stored in a standard spreadsheet (.xlsx).

Dataset 19. Newsletter subscription (e.g., contact details of subscribers)

Project updates, results and achievements will periodically be disseminated in the form of a newsletter that will be spread via website, mail, project and institutional social media, etc. A subscription form in the project's website will facilitate the gathering of data in which any interested stakeholder can voluntarily provide their contact details in a dedicated sign-up form, so as to receive the most up-to-date news and outcomes of the project. The data will be collected in order interested stakeholders can be informed about the LEARN as well as its digital Toolkits. Along these lines, the data will be comprised of a list of stakeholders along with their basic contact information: (i) email address, (ii) first and last name, (iii) country, and (iv) type of organisation. A copy of this contact list is stored on [MailChimp's](#) (server which is used for e-mail campaigns and newsletter distribution. All personal



information included in this contact list is used and protected according to MailChimp's Privacy Policy.

Furthermore, Mailchimp stores analytic data of the performance of the mailing campaigns that are launched, including email openings, clicks on buttons, time spent reading the email, etc.

When subscribing, visitors agree with the privacy policy and accept receiving the project's newsletters. At any time, they will have the possibility to manage their preferences or unsubscribe from the newsletters.

Dataset 20. Data from dissemination and communication activities

This type of data concerns the data derived from the monitoring of the project's dissemination activities such as publications in journals, posts, etc. The data will consist of a list of publications and posts published by the consortium partners. In order to assess the efficiency of the dissemination activities, data will be collected in a template form. The data will relate with the recommended activities and will be saved in a single excel file.

Data 21. Data collected for / generated by the use of LEARN toolkit

The LEARN will produce two different toolkits. The one is under T8.1 and will be developed to raise awareness about air contaminants commonly present at schools and their impact on the health and safety of children (in the long-term). The toolkit will also recommend remediation strategies to minimize children's exposure to these factors across multiple settings. The toolkit is expected to be used by schools in the consortium countries, with children and their parents as the primary target groups. This will be succeeded by providing detailed knowledge on the significance of continuous monitoring the IAQ and its consequences on the quality of life.

The second LEARN toolkit will be part of the Exploitation Strategy (Task 8.3) and will include exploitable results describing the way in which they can be exploited in a (non)-commercial sense after the end of the project, the target users and potential customers. According to the aforementioned functionalities the toolkit is expected to be used by pupils and their parents, schools, technology providers, supporting environment agents, research and academia and policy makers which in their turn will generate valuable data for consortium partners. The data will be both quantitative and qualitative and will be open source.

Furthermore, the toolkit's digital materials will be publicly available for downloads on the project's website. As for the offline materials (such as board games), the remaining units after the distribution to schools might be sold to the public if appropriate.

More information regarding the tools of the LEARN digital toolkit and the data collected / generated through their use will be provided in future update of the DMP, as their functionalities are further specified and developed in line with the findings stemming from the project's studies and activities.

2.2. Data utility

The stakeholders that may find the data to be collected/generated or re-used by the project useful are listed in the following table.

Table 1. Potential stakeholder's and data utility

Stakeholder Groups	Data Utility
School communities (teachers, students, parents)	The aim of LEARN project, is developing and deploying novel sensors to detect the presence of possibly harmful air pollutants such as VOCs and UFPs. These sensors will equip the selected classrooms and monitor the air quality for hazard air pollutants. Through the LEARN toolkit school communities can monitor the concentrations of air pollutants in classrooms and protect themselves in case these concentrations are dangerous for their health.
Policy makers at regional, national, and EU level related to public health	In the framework of LEARN, data will be collected related to the IAQ and will be correlated with the outdoor air quality and their impact on human health. Because of the sensors sensibility, the air pollutants monitoring will be more accurate and the results more trustworthy. Thus, policy makers can be alerted urgently about public health issues and be prepared properly.
Academic community in the field of public health	During the project innovative research technologies will be developed such as sensors, testing in biosensors etc. Open Access (OA) to scientific peer-reviewed publications will be ensured in the implementation of the LEARN Project. Gold OA costs are budgeted by the project partners, Green OA will be done through self-archiving published results, either on an institutional or disciplinary repository (Open-AIRE compliant). Research data will be available for access and re-use where applicable and under appropriate safeguards.
Project partners	The data collected/generated during the LEARN project will be necessary for project partners in order to produce evidence-based results and ultimately achieve the objectives of the project. At the same time, this data may be meaningful for project partners beyond the end of the project as well, enabling them to build and capitalise upon interesting ideas and opportunities that may emerge to ensure the long-term sustainability of the LEARN toolkit.

3. FAIR data

The [Data Management Plan](#) guidelines from the Commission emphasize the importance of making the data generated by projects funded under Horizon Europe findable, accessible, interoperable as well as reusable, with a view to ensuring its sound management.

3.1. Making data findable, including provisions for metadata

3.1.1. Data discoverability and identification mechanisms

LEARN uses standard identification mechanisms in order to make the collected/gathered data findable and re-useable. More specifically, LEARN will assign globally resolvable Persistent Identifiers (PIDs) on open data.

At this early stage of the project, besides the FAIR principles, the consortium has also identified the FAIR Digital Object (FDO) registry approach which enables the technical implementation of the FAIR principles to digital objects (such as code, models, workflows, services, etc.). The idea is to provide, for instance, explanations about interpreting and processing relevant digital artefacts, metadata standards, and validation rules for describing metadata.

In parallel, data that are not open will be stored in a searchable resource, i.e., the cloud web storage service of the project (MSTeams, Sharepoint). For storage, a name convention mechanism will be followed as described in [section 3.1.2](#).

3.1.2. Naming conventions and versioning

Following a consistent set of naming conventions in the development of the project's data files can greatly enhance their searchability. With that in mind, LEARN creates consistent data file names that provide clues to their content, status and versioning, while also increasing their discoverability.

With that in mind and to facilitate the reference of the datasets that will be generated during its implementation, LEARN employs a standard naming convention that integrates versioning and takes into account the possibility of creating multiple datasets during an activity that entails data collection/generation.

In particular, the naming convention employed by the project is described below.

[Name of project] _ [Name of Study] _ [Number of dataset] _ [Issue Date] _ [Version number]

- **Name of project:** LEARN
- **Name of Study:** A short version of the name of the activity for which the dataset is created.
- **Number of dataset:** An indication of the number assigned to the dataset.
- **Issue Date:** The date on which the latest version of the dataset was modified (YYYY.MM.DD.).
- **Version number:** The versioning number of a dataset.

3.1.3. Metadata allowing discovery

In addition to compatible naming conventions and versioning, the project follows a metadata driven approach in order to allow further discovery and increase the searchability of the data. In simple lines, it is a tool that helps people discover, manage, describe, preserve, and build relationships with and between digital resources.



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Data generated/used during LEARN are discoverable with metadata suitable to their content and format. The project employs metadata standards to generate rich and consistent metadata with a view to supporting the long-term discovery, use and integrity of the data.

3.1.4. Standards for metadata creation

LEARN employs standards for creating metadata for the project's collected and generated in order to improve their discoverability and searchability. Moreover, the applied metadata standards enable the integration of metadata from various sources into other technical systems.

LEARN's available open research data will potentially be published in [Zenodo](#). These metadata can be exported in different standard and are stored by Zenodo. Closed project data, will also be interpreted with open and machine-readable metadata. Will be used metadata, which are compatible with Zenodo and in this way any initially closed data may become open at the later stages of the project will not lose their metadata.

3.1.5. Search keywords

The data generated through the project will be provided with suitable key words in order to optimize their reuse by interested stakeholders. Keywords are used to add information to the gathered data and also to enable the easier description and interpretation of its content and value.

The choice of suitable keywords should follow the below principles:

- The who/what/when/where/why should be covered
- The consistency among the different keywords should be ensured
- The keywords should be relevant, clear and understandable

The keywords should be related to LEARN objectives (sensors, toxicity etc.). The keywords will describe the content of the datasets and avoid words used only once or twice within them.

3.2. Making data accessible

3.2.1. Repository

The data generated by LEARN and will be available for sharing and reuse and will be deposited to Zenodo ([Section 3.1.4](#)). Data in the Zenodo will be preserved long-term and the Digital Object Identifiers (DOIs) will function as perpetual links to the resources. They will remain valuable since they are future proofed against Uniform Resource Locator (URL) or even protocol changes, through resolvers.

3.2.2. Data

LEARN, in line with the FAIR principles of data management in the context of Horizon Europe, adopts the good practice of making data open where this is possible and ensuring the proper protection of GDPR is followed. For this reason, LEARN asks from the partners to disseminate their data that potentially can be offered long-termly to external stakeholders and respect the confidentiality and privacy of stakeholders that contributed to the collection of this data.

Only anonymised and aggregated data will be made open to ensure that data subjects cannot be identified in any reports, publications and/or datasets resulting from the project. The relevant project partner in each case will undertake all the necessary procedures to anonymise the data in such a way that the data subject is no longer identifiable from public.



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Data accessibility and availability

Public access to the open data will be made available and free of charge through Zenodo. The closed data will be stored and shared among authorized members of the consortium through cloud storage (i.e., MSTeams) according to GDPR requirements.

Restrictions on use

As concern the project's open data, there are different levels of accessibility taking into account different issues (such as ethical, rules of personal data, intellectual property, commercial, privacy-related, security-related, etc.).

The different levels of data accessibility are:

- **Open access:** These data are available for reuse (according to their accompanied license).
- **Embargoed status:** These data will be available after an “embargo” time period.
- **Restricted access:** These data will not be public and they will be shared only if the responsible partner allows it.
- **Closed access:** These data are accessible only by the members of the consortium.

While the project is evolving, we will specify in the next version for each dataset whether will be open or closed.

3.2.3. Metadata

Metadata of deposited publications will be open under a **Creative Common Public Domain Dedication (CC 0)** or equivalent, in line with the FAIR principles for data management. Such metadata will include information about the following:

- The publication at hand (author(s), title, date of publication, publication venue);
- Reference to the Horizon Europe funding;
- The name of the project, including its acronym and Grant Agreement number;
- Any particular licensing terms which may apply (depending on the chose license);
- PIDs that have been attributed to the publication;
- Authors involved in the action, their organisations and the project itself.

Whenever there is the possibility, the metadata will also contain PIDs for any research outcome or any other tools and instruments needed to endorse the publication's conclusions. In case Zenodo will stop its operation and service providing, all data, metadata, code and documentation uploaded will be transferred and stored to other available repositories. Meanwhile, the project's data with limited access will be deposited, along with their supplementary metadata, code and documentation (if exist), to the cloud web storage service employed by the project.

3.3. Making data interoperable

In order to succeed in this, LEARN uses metadata vocabularies, standards and methods that will increase the interoperability of the data collected/generated through its activities in its data management methodology.

The interoperability of the open-accessed data will be enabled through Zenodo containing community-endorsed practices, since its metadata are stored in JSON format according to a defined JSON schema.



3.4. Making data reusable

3.4.1. Documentation for validating data analysis and facilitating data re-use

In order to increase the reuse of the data according to FAIR principles Zenodo follows the following principles:

R1: (meta)data are richly described with a plurality of accurate and relevant attributes

Each record contains a minimum of DataCite's mandatory terms, with optionally additional DataCite recommended terms and Zenodo's enrichments.

- R1.1: (meta)data are released with a clear and accessible data usage license

License is one of the mandatory terms in Zenodo's metadata and is referring to an Open Definition license. Data downloaded by the users is subject to the license specified in the metadata by the uploader.

- R1.2: (meta)data are associated with detailed provenance

All data and metadata uploaded are traceable to a registered Zenodo user. Metadata can optionally describe the original authors of the published work.

- R1.3: (meta)data meet domain-relevant community standards

Zenodo is not a domain-specific repository, yet through compliance with DataCite's Metadata Schema, metadata meet one of the broadest cross-domain standards available.

3.4.2. Availability for re-use

The re-use of data is a key component of LEARN's methodology for making data FAIR. It is expected that data will be available for re-use for some period after the end of its processing in the framework of the project.

3.4.3. Data provenance

Data provenance is the documentation of the data's origin as well as its producing methodology⁷. LEARN will use specific elements to record in a structured way the provenance of data.

LEARN metadata provenance will be provided through the DOI metadata record provided by Zenodo.

3.4.4. Data quality assurance processes

Quality Assurance (QA) and **Quality Control (QC)** are major parts of LEARN's DMP and are the first step before the publication of any data to Zenodo. They ensure the transparency, consistency, comparability, completeness and accuracy of the data.

QA is the review of the procedures, which are contacted without developing a dataset, by personnel not directly involved in the dataset development process⁸. In the framework of LEARN project, it takes the form of peer-reviews of methods and/or data summaries for the estimation of the dataset's quality and the identification of any need for improvement.

QC is a system for checking and maintaining the quality of the collected dataset⁹. The relevant procedures of LEARN are designed to implement technical checks measuring and controlling the data

⁷ <https://ardc.edu.au/resource/data-provenance/>

⁸ 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1 General Guidance and Reporting, CHAPTER 6 Quality Assurance / Quality Control and Verification.

⁹ 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1 General Guidance and Reporting, CHAPTER 6 Quality Assurance / Quality Control and Verification.



consistency, integrity, correctness and completeness as well as identifying and addressing errors and omissions. Some types of checks are:

- i) If there are transcription errors in data input
- ii) If scale measures are within the range of acceptable values
- iii) If proper naming conventions are used



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4. Other research outputs

It is expected that data will be available in the Data and Health Hub. During the implementation phase of LEARN project, data will be gathered from management and coordination activities. An Application Programming Interface (API) and a user interface will be developed, handling all data related functionalities. During the process of the design and implementation of the Air Quality and Health Data Hub, data will be collected for the formation of the data formats that will be handled by the Hub. The health-related data will be investigated in order to conform with the GDPR legislation and the chemical monitoring data in the Information Platform for Chemical Monitoring (IPCHEM) portal through the implementation of the API. The above data are expected to be both qualitative and quantitative and will be stored as written in standard document texts along with spreadsheets.



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5. Allocation of resources

5.1. Data management responsibilities

For the effective, proper and secure handling of the collected/generated data in the frame of LEARN, specific data management roles have been established within the data management methodology and procedures of the project. In this context, the following table represents the allocation of data management responsibilities among the members of the LEARN consortium per data collected/generated or re-used under each WP.

Table 2: Data management responsibilities of LEARN's partner per data collected/generated under each

WP	WPL	Data	Dataset	Tasks	Task Leader	Contributor(s)
WP1	INL	Data collected from project management and coordination	10	1.1	INL	All consortium
		AB Member list	11	1.1	INL	INL
		AB Feedback	11	1.1	INL	INL
WP2	UH	Questionnaires on personal data of children and their parents	1	2.1	UH	ENV, AU, VUB
		Results from five different cognitive function tests in school children	1	2.2	UH	AU
		Concentrations of VOCs and PM pollutants after the collection of environmental classroom's samples	2	2.3	UH	AU, M&H, KUL, INL
		Collection of urine and blood samples as an indicator of classroom IAQ	1	2.3	UH	AU, KUL, INL
		Measurements of classroom's temperature, light, humidity and noise	2	2.3	UH	AU, M&H, KUL, INL
		Measurements of school conditions (ventilation system, window opening time, use of cleaning products)	2	2.3	UH	AU, M&H, KUL, INL
		Records of children's geocoded residence	1	2.3	UH	AU, KUL, INL
		Collection of subjective data through a short, seasonal survey with questions on 'compliments' or 'complaints' about the IAQ in order to be linked with the objective	1, 3	2.4	VUB	AU, M&H, UH
WP3	KUL	Desk research based on existing IAQ literature and multiple regulatory and health-based institutes	3	3.1	KUL	AU, INL
		List of chemicals of interest in classrooms	2	3.1	KUL	AU, INL
		Actual measurements of VOCs, Aldehydes, PAHs in the classrooms	2	3.2	KUL	AU
		Actual measurements of all PM fractions	3	3.4	AU	KUL, INL, M&H
		Modelling of PM exposure at the home address of children	4	3.4	AU	KUL, INL,

		List, type and abundance of microorganisms in classrooms	3	3.5	INL	KUL
		Documentation of structural and chemical analysis of collected PM from the filters	3	3.6	INL	KUL
WP4	IMEC-NL	Analysed characteristics of envisaged sensor systems, description of working principles and main design	5	4.1	INL	IMEC-NL, M&H
		Description of VUV and its application on PID set-up	5	4.2	IMEC-NL	INL
		Quantitative measurements for the molecular ionization in a gaseous sample volume depending on the photon wavelength or equivalently the PID ionization energy	5	4.2	IMEC-NL	INL
		Comparison of UFPs performance with commercial needle-tip sources	5	4.2	IMEC-NL	INL
		Assessment of particle charging performance as function of voltage and air flow using controlled particle generation and reference monitors.	5	4.2	IMEC-NL	INL
		Description of Nanomembranes (NMBs)	5	4.3	INL	IMEC-NL
		Results of the production of photonic crystals suitable for Third Harmonic Generation (THG) at different wavelengths over the same wafer, after the successful demonstration of THG in SiO ₂ photonic crystal NMBs.	5	4.3	INL	IMEC-NL
		Results from the research of the designs for multiwavelength THG generation using a single nanostructure	5	4.3	INL	IMEC-NL
		Results from the Simulation of charged particle flow geared towards a low-cost PCB-based sensor system design and considering the ionization source	5	4.3	INL	IMEC-NL
		Description of the design of Printed Circuit Board (PCB)-based electronics with selected components for low power, high resolution and current measurements.	5	4.3	INL	IMEC-NL
		Results from VOC sensor's testing after the use of single wavelength designs what will allow the determination and optimization of the main parameters of the VUV source: damage threshold, total VUV power generated and nanopatterned area needed.	5	4.3	INL	IMEC-NL

		Results from Testing the ultra-fine particle sensor prototype outside the lab related to its performance and robustness	5	4.4	IMEC-NL	AU, UH, KUL, INL
WP5	INL	Evaluation of cellular death, oxidative stress and proinflammatory effects of skin and lung cell lines using 2D cell cultures.	6	5.1	KUL	INL, NIA, AU, AL
		LBoC models for assessing the toxicological effects of PM and VOCs air pollutants	6	5.2	AL	INL, NIA, AU, KUL
		Chip design	6	5.2	AL	INL, NIA, AU, KUL
		Cell culture protocol developments	6	5.2	AL	INL, NIA, AU, KUL
		Protocol for the evaluation of the best on – chip administration methods.	6	5.2	AL	INL, NIA, AU, KUL
		Outcomes from the implementation of the testing protocols and qualified endpoints to assess the toxicity	6	5.3	INL	NIA
		Outcomes of the comparison of the analysis of LBoC models to commercially available lung models.	6	5.3	INL	NIA
		Skin – on – chip model	6	5.4	INL	NIA
		Protocol for using biosensors for air pollutants	7	5.5	INL	NIA, KUL, AU
WP6	M&H	Results/description of the placement of air purifiers in classrooms	8	6.1	M&H	UH, AU
		Description of filter media and adsorption material for the particle sizes and substances identified as important for IAQ	8	6.2	M&H	KUL, IMEC-NL, INL
		Results/description of the modifications of air purifier design and operation modes in order to improve the IAQ level and adapt it to classrooms	8	6.2	M&H	KUL, IMEC-NL, INL
		Results from the test of samples and evaluation of potential health risks – Measurements of concentration levels regarding health impacts	8	6.3	M&H	KUL, INL
WP7	ENV	Collective data for the design of the data formats that will be handled by the Hub	9	7.1	ENV	All consortium
		Data integration plan and investigation of the ethics for the health-related data	9	7.1	ENV	All consortium
		User requirements for the functional and technical design of the Data API and Interface of the Data Hub	9	7.2	ENV	All consortium

		FAIR and ethics workshop (audio or video recording)	9	7.3	VUB	ENV, INL
		FAIR and ethics workshop (audio or video recording)	9	7.3	VUB	ENV, INL
		Chemical monitoring data	9	7.4	ENV	M&H
		Results from user testing of the alert system in the Data Hub. The test includes a citizen/user-centered approach through the organization of workshops and/or interviews with the stakeholders.	12	7.5	ENV	VUB, UH, M&H, INL
WP8	VUB	Website analytics	15	8.1	FI	All Consortium
		Social media statistics	17	8.1	FI	All Consortium
		Project events data	18	8.1	FI	All Consortium
		Project's email address	16	8.1	FI	All Consortium
		Newsletter subscriptions	19	8.1	FI	All Consortium
		Data from dissemination and communication activities	20	8.1	FI	All Consortium
		Participatory policy making	21	8.2	VUB	NIA, INL, UH, AU
		Exploitation Strategy and Sustainability Plan	21	8.3	NIA	All Consortium
		Policy recommendations	10	8.4	NIA	All Consortium
		IDEAL Cluster	10	8.5	FI	All Consortium



6. Data security

LEARN will handle any collected/generated or re-used data securely against any accidental loss and unauthorized access through the whole's project duration. In this way, the risk for a data breach is minimized. Especially, for cases of personal data collection/generation it is important that these data can be only accessible by those who have the respective authorization to do so.

Data collected/generated from partners should be processed using means (e.g., private servers) according to GDPR, which will ensure the data protection. Moreover, any necessary data security controls should be implemented in order to reduce any risk of information leaking/destruction to the minimum. Moreover, the data will be backed up regularly taking into consideration the data's update and cruciality. The backed-up data will be saved in suitable storage media including external hard drives, flash drives, NAS devices and reputable cloud services in order to ensure its preservation, recovery and access. Lastly, frequent checks will take place for the data integrity.

Access to closed data will only be permitted to authorised project partners. In case there is a personal data breach, the responsible project partner will notify, without undue delay and, where feasible, not later than 72 hours after having become aware of it, its competent national supervisory authority (e.g., data protection authority) as well as the data subject(s) that may be affected by the breach. Moreover, the responsible partner will document any personal data breaches, including information such as the facts relevant to the breach, its effects and the remedial action(s) taken.

In the context of the project the identification and authentication access control are major components for the data's protection. In these lines, each project partner is responsible for enabling the application of appropriate access control to the data. For safety reasons, privacy policies will define the collection of online storage spaces, the processes and use of personal data, the security procedures followed, the user's rights as well as the employed policy about cookies.



7. Ethics and other issues

This section describes the ethical aspects of the LEARN DMP and the ethical consent of the collected/generated/reused data of the project. The project's data will be processed according to the relevant data protection legislation (e.g., GDPR). In accordance with the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 (GDPR), all personal data processed for project's activities should be:

- processed lawfully, fairly and in a transparent manner in relation to the data subject;
- collected for specified, explicit and legitimate purposes relative to project's objectives and not further processed in a manner that is incompatible with those purposes;
- adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed;
- accurate and, where necessary, kept up to date;
- kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the personal data are processed;
- processed in a manner that ensures appropriate security of the personal data.

Additional details about the scope of activities that involve data processes (collection, generation, reuse) through the project along with the procedures for identifying the suitable stakeholders to participate in them should be defined by the respective WP Leaders. Furthermore, partners should process the data according to relevant EU and national regulations. Finally, it is not anticipated any data transfer outside the EU. In cases of data storage, the providers are committed to safeguard their compliance with the relevant GDPR requirements before start using their services.

Ethical challenges from the perspective of stakeholders will be collected during the workshops. These challenges are the result of a discussion about the positive and negative images of clearly defined pilot use cases and should lead to the determination of values that stakeholders find important (think of privacy, justice, applicability, reliability, solidarity, respect, autonomy). Next, action points to mitigate previously identified challenges on a technical, organisational and user level will be defined.

It is important to highlight that each partner is responsible for ensuring that the templates for any data gathering, like consents forms, are appropriately adjusted according to (i) the needs of the activity for which they are being used by them as well as to (ii) the relevant data protection laws and regulations applicable to their respective countries and / or organisation. All partners should keep records to demonstrate that data subjects have consented to the processing of their personal data and use consent management mechanisms that make it easy for individuals to withdraw their consent.



8. Conclusions and next steps

This document is an initial version of LEARN's DMP aiming at the protection of the collected/generated data according to the FAIR principles. It presents the processes of LEARN data management, collection, process and generation in compliance with GDPR guidelines. DMP is a living document, which is updated continually through the project, based on the latest outcomes and developments.

Due to the complexity of data a Fair Air Quality and Health Data Hub will be developed for air quality and health data based on the basic FAIR data principles in WP7. Due to the high data's sensitivity two workshops are planned to engage relevant stakeholders and to identify challenges concerning FAIR data and ethical principles (according to task 7.3). LEARN workshops will result in an overview of the FAIR data & ethical challenges within the project and possible mitigation actions.



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