

Establishment of Sustainability through Open Access to Research Infrastructure in a Calibration Laboratory for Extreme Electrical Metrology

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Abstract. The laboratory sustainability aims at reducing environmental impacts of laboratory activities, like energy and water use, waste production, and greenhouse gas emissions, benefitting in cutting costs, improving laboratory reputation, supporting the UN SDGs of environmental protection, social justice, collaboration among laboratory staff and stakeholders. This can be achieved by inclusiveness and openness of the laboratory infrastructure towards different users, through defined procedure of “open access” to the laboratory research infrastructure. The sustainability measures implementation in the Laboratory for Electrical Measurements (LEM) at the Ss. Cyril and Methodius University in Skopje, is described. It is a calibration laboratory for instruments for electrical quantities, accredited according to EN ISO/IEC 17025:2017. The LEM sustainability maturity evaluation, through mapping and gap analysis is presented, enabling creation of strategic documents like the Quality and Sustainability Policy, Quality and Sustainability Manual and the Access Policy to the Research Infrastructure. Conflicting issues arise between openness and confidentiality, but these challenges are overcome. Two outputs are delivered by deploying risk-based thinking: 1) successful extension of the LEM accreditation scope in calibration of extreme electrical quantities, complying with EN ISO/IEC 17025:2017, including the point 4.2 (confidentiality requirements), and 2) strategic documents adoption, imposed by public funding conditions.

1 Introduction

The concept for laboratory sustainability aims to reduce the environmental footprint of laboratory activities, such as energy and water use, waste production, and greenhouse gas emissions, [1], improving the quality, safety, and efficiency of lab operations, but also the social and economic aspects of the laboratory practice, [2, 3]. This provides cutting costs, improved lab reputation and credibility, support of the global goals of environmental protection and social justice, promotion of innovation and collaboration culture among lab staff and stakeholders, [1]. However, a sustainable lab is expected to maintain efficient operations, and in the case of an accredited lab, to fulfill the quality assurance requirements of the international standard EN ISO/IEC 17025:2017, [4]. This can be achieved through creative activities, like inclusiveness and openness towards different users and stakeholders, by a defined procedure of “open access” to the laboratory Research Infrastructure (RI), [5]. One of the elements of the Horizon Europe, the EU’s key funding programme for research and innovation, is the Open science policy, with mandatory open access to publications and open science principles applied throughout the programme, [6]. At international level, the General Conference of the United Nations Educational, Scientific and Cultural

Organization (UNESCO), at its 41st session from 9 to 24 November 2021, has identified the needs and has provided the Recommendation on Open Science, [7]. To achieve the UNESCO recommendation on open science, several actions are foreseen, like enabling open access RIs (virtual or physical, including major scientific equipment or sets of instruments) needed to support open science and serve the needs of different communities. Open science infrastructures are often the result of community-building efforts, crucial for their long-term sustainability and therefore should be not-for-profit and guarantee permanent and unrestricted access to all public to the largest extent possible as addressed in [8]. The open approach contributes to some of the United Nations Sustainable Development Goals (UN SDGs): 1-No poverty, 4-Quality Education, 9-Industry, innovation and infrastructure, 10-Reduced inequalities and 17-Partnerships for the UN SDGs, [1], [5]. Here, the sustainability measures implementation in the Laboratory for Electrical Measurements (LEM) at the Ss. Cyril and Methodius University in Skopje (UKIM), by “open science” approach, will be provided. The LEM is a calibration laboratory for instruments for electrical quantities of extreme values, accredited according to the EN ISO/IEC 17025:2017. Due to accreditation, conflicting issues arise, like contradictions of openness and confidentiality. The developed methodology within

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the project "Development and Upgrade of Laboratory Resources for Research and Introduction of Novel Analytical Methods in Electrical Metrology", financed by the Ministry of Education and Science of Republic of North Macedonia, resolves these challenges.

2 Methodology and Tools for Establishment of Sustainability Measures through Open Access to Laboratory Research Infrastructure

Recently, the awareness on the lab environmental impact and the trend toward "sustainable laboratories" are rising, and diverse original methodologies for evaluation of the lab sustainability maturity are developed [9]. Some international initiatives, such as the MyGreenLab in the USA, [10] or the Sustainable European Laboratories network (SELS) in Europe, [11] are implemented. Several guidelines for introduction of laboratory practices contributing to the UN SDGs are published [12]. Another aspect of the laboratory sustainability, is the transformation from Industry 4.0 towards Industry 5.0, as re-humanization of the race towards automation, [13]. The laboratory sustainability directly contributes to the evolvement of the Metrology 5.0 and the laboratory of the future. Here a circular methodology for establishment of the laboratory sustainability measures is proposed as given in Figure 1.

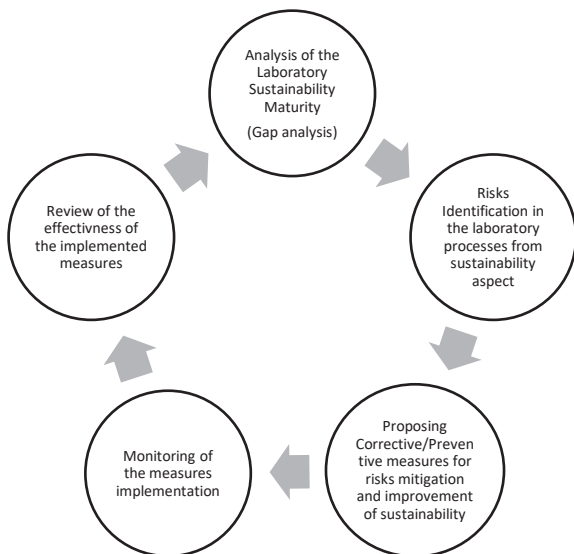


Fig. 1. Circular methodology for establishment long-term laboratory sustainability through gap analysis

The process of establishment long-term laboratory sustainability starts with analysis of the laboratory sustainability maturity, by mapping and gap analysis thoroughly presented in [1]. Based on the findings from the gap analysis in [1], one of the measures for achievement of fast and evident impact on the lab sustainability is the intervention the laboratory strategic documents, like the quality policy, the quality manual, as well as creation and adoption of access policy to the laboratory RI. This approach demonstrates potential for long-term determination of the laboratory to practice working processes oriented towards sustainability.

KnowSDGs (Knowledge base for the Sustainable Development Goals) is a web platform that provides tools and organises knowledge on policies, indicators, methods and data to support the evidence-based implementation and addressing of the SDGs, [14]. It maps policy documents with the SDGs and targets through specific keywords, [15, 16] as in Figure 2. The analysed documents in this on-line platform are processed using text mining and natural language processing techniques to identify relevant SDG targets within the text. The documents are uploaded in the SDG Mapper, and the tool is run to identify relevant SDGs in the text. Some SDGs are more prevalent than others along with their associated targets and indicators. The tool provides several visualisations showing how the SDGs are addressed in documents. The flowchart of the EU SDGs Mapper is given in Figure 3.



Fig 2. EU KnowSDGs - Knowledge base for the Sustainable Development Goals web platform [14]

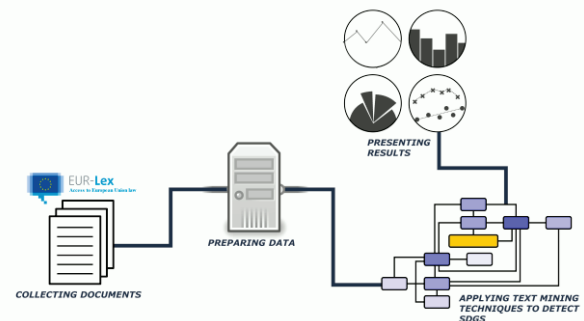


Fig. 3. EU KnowSDGs – SDGs Mapper flow-chart [14]

The circular methodology for introduction of the sustainability in the LEM starts by mapping of the already created and adopted strategic documents like the LEM Quality Policy and Quality Manual, in the EU KnowSDGs tool, with the results presented in [1]. These documents consider the specific operations of the electrical calibration laboratory, the requirements for confidentiality of the international standard EN ISO/IEC 17025:2017, and some general regulation like the EU GDPR, i.e. the harmonized national legislation. Based on the findings derived from the EU KnowSDGs on-line tool, these documents are thoroughly revised and submitted for a second check in the EU KnowSDGs tool, with significantly more positive results as in [1]. Another identified possibility for increasing the laboratory sustainability is the adoption of the Access Policy to the RI of the accredited LEM, which after the creation will be subjected to the assessment by the EU KnowSDGs on-line tool.

3 Challenges in Opening the Lab Research Infrastructures and Resolving Conflicting Issues in LEM

Some testing and calibration labs are an integral part of a more complex research facility, especially those metrology labs within public universities or research institutions opting for 'open access'. The labs, accredited according to ISO/IEC 17025:2017, have to fulfill the standard's requirements on confidentiality, i.e. clause 4.2. The confidentiality requirement tangles the laboratory personnel, too. In general, the laboratory and its personnel are responsible for the information obtained or created during the performance of laboratory activities, and all information is considered proprietary information and shall be regarded as confidential, with exception to what is required by law. In the context of confidentiality in the laboratory practice, are also the requirements of the Regulation (EU) 2016/679 GDPR, [17], which have to be fulfilled by some labs. Balancing the requirements for 'confidentiality' and 'open access' introduces implementation challenges in the lab documentation and practice. In the paper, the example of the LEM, accredited calibration lab, and a RI within the UKIM Faculty of Electrical Engineering and Information Technologies (FEIT), public higher education and research institution, will be demonstrated through the process of development and implementation of the procedure for confidentiality and the Policy for Open Access to the Research Infrastructure of the Laboratory for Electrical Measurements. Independent faculty laboratories are established at UKIM-FEIT for practical implementation of the teaching-educational, scientific-research and application activities. LEM is one of them. The LEM is accredited since 2015, as a laboratory for the calibration of instruments for electrical quantities, electrical power and energy.

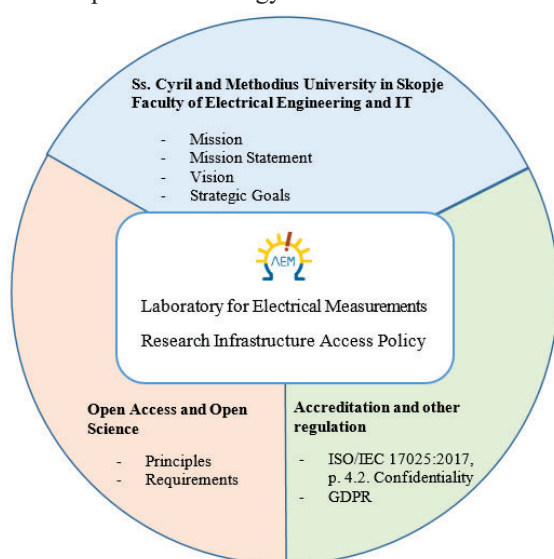


Fig. 4. LEM RI Access Policy-constraints

As a publicly funded RI, the LEM belongs to the category of smaller research infrastructures, [5], [18], with the objective of promoting cooperation between science, technology and industry, and providing a

platform for the education of young scientists and engineers, with a strong motivation for development and adoption of a Research Infrastructure Access Policy in line with the Open Science approach. The RI Access Policy of LEM, as in Figure 4, has to comply with:

- the Mission and corresponding Mission Statement of the FEIT, the Vision of FEIT, as well as the strategic goals of FEIT publicly published in [19]
- the strategic agenda of the European Union for "open science", [6], and
- the accreditation requirements for confidentiality according to the ISO/IEC 17025:2017, p. 4.2., [4] and other applicable regulation, e.g. GDPR, [17].

Considering the contradictory requirements, the creation of the Access Policy to the LEM RI, is based on the already adopted university, faculty and LEM documents. The following terms and definitions are applied according to [5] and [18]:

Principles of open access – conditions under which a higher education institution creates access to its RI for use by different groups of users, inside and outside the organization.

Research infrastructure (infrastructure for conducting research) – physical structure (scientific institutes, laboratories, etc.), instruments, tools and other material, virtual resources and related services, necessary for conducting modern fundamental and applied scientific research.

Resources - RI, scientists and other researchers working with the infrastructure, personnel providing infrastructure services, infrastructure operation, maintenance and development, and infrastructure time.

Services – Open access services approved by the Dean of FEIT, based on the consent of the Head of LEM.

Recipient of open access services – a user (internal or external) who requested and received access to the RI.

User – a natural or legal person who orders services from the RI or requests access to this RI to perform research.

Working time of the RI – the total RI working time.

Experimental time – a period of time during which the RI can be used to perform scientific research and development work.

Technical time – the period of time during which the RI is technically maintained and users cannot use the RI to perform scientific research and development work, time reserved for maintenance and repairs.

Open access time – the period of time during which the RI is available to users either free of charge or for a fee.

Guaranteed time – the time period reserved for external users who made a real financial contribution to the development of the RI or participated in its support, which is regulated by a special agreement within the FEIT partner program.

Commercial time – the period of time during which the RI is available for payment.

The drafting of the LEM RI Access Policy, complies with the recommendation stipulated in [5] and [18], comprising the essential information and regulation on:

1. General provisions and definitions
2. Management of the LEM RI
3. Users of the LEM RI
4. Access to the LEM RI
5. Prices formation for LEM RI services

6. Income and use of funds received for providing RI services
7. Obligations related to confidentiality and protection of intellectual property
8. Resolution of disputes

The management of the LEM RI complies with the internal quality assurance documents and accreditation requirements. The services of the RI of LEM are used by the authorized members of LEM, and are provided to both internal and external users. Authorized members of LEM have access to the RI according to the decisions on appointment and authorization, and the Matrix of competence and responsibility of LEM. The users of the RI of LEM are classified as **internal users** - students of FEIT (of all three cycles of studies and students at the Lifelong Learning Centre), as well as employed scientific and research staff of FEIT, and **external users** – students or researchers (of all three cycles) at other faculties of UKIM, at other public or private universities/scientific institutions, employees in commercial research centres, researchers in government institutions, as well as members of the civil sector.

The procedure for granting access to laboratory resources by all types of users is described in the FEIT quality management system procedures and in Figure 5, [5]. For all users, the decision on access granting is based on risk-based thinking following the methodology for risk analysis prescribed in the LEM procedure, [20], including the risks related to the confidentiality requirements of ISO/IEC 17025. The LEM follows the methodology of Failure Mode and Effects Analysis (FMEA), [20]. The LEM RI is accessible to users according to the procedures defined by the time of access to the RI as in Figure 5. The working time of the LEM RI is divided into **experimental time** and **technical time**. Experimental time is divided into: free access time, guaranteed time and commercial time. Priority can be given to small and medium-sized enterprises (SMEs).

The prices of LEM's RI services are established according to the principle of reimbursing RI costs. The prices of the services for scientific researchers and development purposes are based on the principle of covering only material costs. The price of RI services is determined by the type of user, with an estimate of the duration of the operation of the equipment and human resources, consumables and other materials needed to perform work and other possible costs as given in Fig.5. For educational purposes within the accredited study programs of FEIT, the use of the RI of LEM is free and according to the number of hours of practical teaching within the subject programs. Access to LEM's RI for educational purposes is of the highest priority and is consistent with the FEIT lectures schedule. Access to the RI of LEM is enabled for students under the supervision of a subject teacher in charge of the realization of the specific course program or research, and in the presence of authorized member of LEM. Any material costs incurred for this purpose are covered from FEIT funds or from LEM's own funds, or from a dedicated educational or scientific research project. For educational purposes within the courses and training offered by FEIT through the FEIT Career Centre, prices

are established according to the approved program and the number of hours of practical work within the course/training published on the FEIT website. Access to the LEM RI for lifelong learning purposes is a high priority and is consistent with the FEIT course/training schedule. Access to the RI of LEM is enabled for the students of the course/training under the supervision of teaching staff from FEIT in charge of the implementation of the specific training, and in the presence of an authorized member of LEM. Any material costs incurred for this purpose are covered by the income from the course/training and are an integral part of the price of the course/training. The prices of LEM's RI services are published publicly. Prices are revised taking into account changes in economic conditions, maintenance costs, administration and other costs related to RI activities. The income received from the provision of services through the RI of LEM is used for the sustainable development of the RI of LEM.

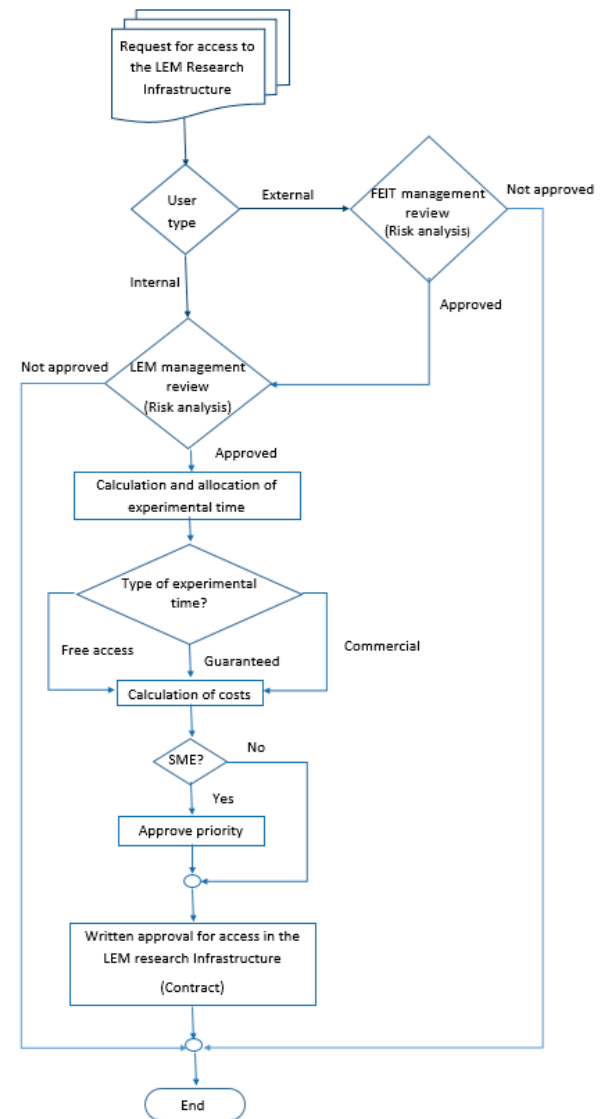


Fig. 5. Procedure for granting access to the LEM RI

The confidentiality of the results of any scientific research and/or experiment performed using the resources and/or services of the LEM RI must be insured. Exceptions may be specified by written agreement between FEIT and the external user. Pursuant

to the Quality Policy and it is prescribed in the LEM RI Access Policy, that all members of LEM, including top management of FEIT, commit to confidentiality and protection of intellectual property arising from activities in the LEM RI. For this purpose, each of the participants in the processes of using the RI sign an appropriate Statement of Independence, Impartiality and Confidentiality. This complies with the item 4.2. of the LEM Quality Manual. Ownership and management of the intellectual property created in FEIT and confidentiality obligations are regulated by the legal regulations of R. N. Macedonia and the internal lab documents. In the case of research performed by external users, all intellectual property produced by the external user during the open access period shall be the intellectual property of the external users, unless otherwise specified in the mutual agreement between FEIT and the external user. In the case of research performed by external users as part of guaranteed or commercial access time, all intellectual property issues will be specified in the agreement or separate agreement signed for the specific access to LEM's RI. In the case of research conducted by internal users, a discussion may need to be held to make the results available Open Access, adhering to the principles of Open Science.

4 Evaluation of the LEM Access Policy Against the UN SDGs and Outcomes

The contribution to the laboratory sustainability by creating and adoption of the Research Infrastructure Access Policy of LEM is conducted by subjecting this strategic document for evaluation in the EU KnowSDGs on-line tool, [1]. In Figure 6 are the obtained results from the SDGs Mapper on the LEM Access Policy, indicating that the SDG 9-Industry, innovation and infrastructure is mostly addressed with 56 %, SDGs 1-No poverty and 4-Quality Education are represented with 20%, and SDG 17-Partnerships for the goals is present with 4%. In Figure 7 the particular SDG targets of the LEM Access Policy are displayed. After thorough drafting and inclusive discussion among the participants of LEM and other interested parties at FEIT, the Access Policy to the Research Infrastructure of the Laboratory for Electrical Measurements at UKIM-FEIT was officially adopted by the FEIT Management Board with Decision from 26.10.2023. In parallel regular assessment for re-accreditation and extension of the accreditation scope of LEM was conducted by the Institute of Accreditation of Republic of North Macedonia (IARNM) on 22.09.2023, during which the latest updated quality assurance documentation of LEM was assessed as well the drafted Access Policy to the Research Infrastructure of the Laboratory for Electrical Measurements was deeply analyzed by the accreditation assessment team. During the assessment it was confirmed that the Access Policy to the Research Infrastructure of the Laboratory for Electrical Measurements complies to the requirements of the ISO/IEC 17025:2017 as well the other documentation of the LEM quality assurance system, and in particular the requirement for confidentiality.

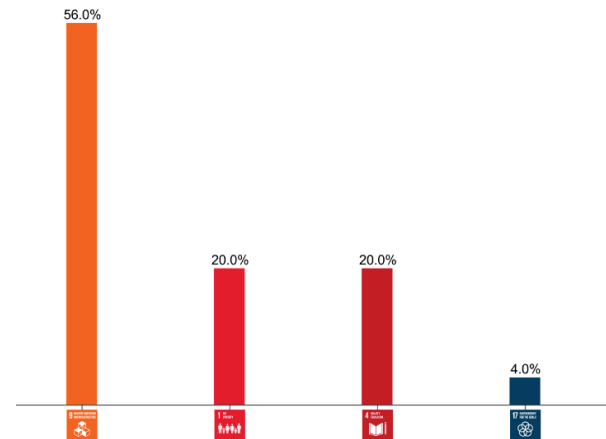


Fig. 6. UN SDGs tangled by the LEM Access Policy derived by the EU SDGs Mapper

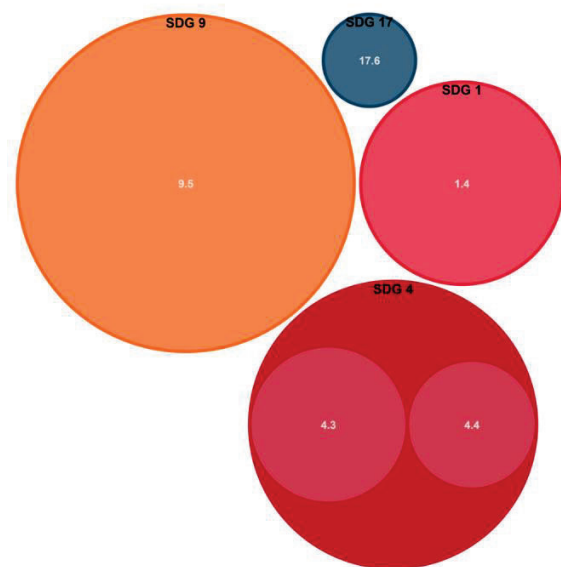


Fig. 7. SDGs targets addressed by the LEM Access Policy identified by the EU SDGs Mapper

The resolution of the contradictory issues has been successfully achieved in the procedures, documentation and best laboratory practice of LEM. This has led to realization of the main expected project outcomes, one of which is the adoption and implementation of strategic document ‘Access Policy to the Research Infrastructure of the Laboratory for Electrical Measurements’, imposed by the funding conditions of the public scientific grant. The evident benefits from the implemented approach are:

- defined transparent procedure for “open access” to the laboratory infrastructure,
- precisely defined users of the laboratory infrastructure,
- prescribed inclusiveness for entities from the academia, but also wider in the society, in particular users with insufficient access to cutting edge metrology facilities,
- most efficient usage of the laboratory infrastructure and fastest return of publicly invested funds,
- increased awareness on the “open access” approach contributing to the laboratory sustainability and the UN SDGs in general.

From the results obtained from the EU SDGs Mapper tool, the introduced strategic changes and the integrated approach to comply to the quality assurance requirements of the standard ISO/IEC 17025:2017 and the orientation towards the UN SDGs, contribute visibly to the fulfilment of the UN strategic development goals.

5 CONCLUSIONS

The paper presented the methodology for achieving long-term laboratory sustainability by the approach of open access to the RI in an accredited calibration laboratory. It is gained by strategic intervention in the laboratory policy master documents defining the overall laboratory operations and practices. The effectiveness of the conducted procedure changes is evaluated by a verified EU software tool assessing the documentation against the UN SDGs. The implemented open access to a laboratory within a public university promotes the culture of inclusiveness and confirms contribution at micro-level to some of the SDGs like: 9-Industry, innovation and infrastructure, 1-No poverty, 4-Quality Education, 10-Reduced inequalities and 17-Partnerships for the goals (UN SDGs) the quality education.

The long-term performance and the efficiency of the undertaken systematic measures for sustainability, can be evaluated in a periodic time interval, synchronized to the period of regular laboratory management reviews, when most of the laboratory key performance indicators, including the sustainability indicators can be compared and chronologically benchmarked against posed targets. This is also in line with the proposed circular methodology for evaluating the effectiveness of the implemented measures for laboratory sustainability.

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