

Assessment of the Process of Using and Sharing Research Infrastructure in Knowledge-Intensive Sectors

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ABSTRACT

Research infrastructure plays a critical role in supporting scientific research, innovation, and university–industry collaboration. As investments in research infrastructure continue to increase, ensuring effective access to, coordination of, and sharing of research resources has become an important prerequisite for enhancing research performance, innovation capacity, and university–industry cooperation. However, a major challenge lies in the fragmented management of research infrastructure, insufficient coordination among organizational units, non-standardized reservation procedures, and limited visibility of available equipment and services. These barriers reduce infrastructure utilization efficiency, create obstacles for internal and external users, and limit the potential benefits that research infrastructure can generate for scientific research and innovation activities. This study aims to assess the process of using and sharing research infrastructure in knowledge-intensive sectors and to develop recommendations for improving the efficiency of research infrastructure utilization through the integration of reservation, usage monitoring, incentive, and coordination mechanisms. To achieve this aim, the research tasks included analyzing the scientific literature on shared research infrastructure management and factors promoting collaboration; examining the current state of research infrastructure management and accessibility in knowledge-intensive organizations by identifying key process gaps and sources of inefficiency; and developing recommendations for improving research infrastructure management and sharing processes. The study employed research methods including scientific literature analysis, expert evaluation, in-depth interviews, and process analysis. Based on the research findings, key barriers to effective infrastructure utilization were identified, including fragmented management practices, limited equipment visibility, insufficient usage monitoring, lack of centralized reservation systems, and coordination challenges between organizational units. As a result, recommendations were developed for improving infrastructure accessibility, strengthening coordination mechanisms, enhancing equipment utilization monitoring, and supporting more efficient sharing of research resources among internal and external users. The proposed improvements are expected to increase equipment utilization rates, reduce resource duplication, facilitate university–industry collaboration, and contribute to a more efficient and sustainable research infrastructure ecosystem.

Keywords: research infrastructure, research infrastructure usage, research infrastructure sharing, knowledge-intensive sector.

1 Introduction

According to the European Commission (2025), one of the major challenges facing the European research infrastructure ecosystem remains the fragmented management of research infrastructures, insufficient coordination, and misaligned funding mechanisms. As a result, research infrastructures are often utilized inefficiently, while the potential for collaboration between universities and industry remains underexploited. Similarly, the Draghi Report (2024) highlights the need for the European Union to improve the effectiveness of research infrastructures in order to reduce the innovation gap with the United States and

China. Previous studies suggest that innovation performance depends not only on the availability of research resources but also on the efficiency with which these resources are utilized (OECD, 2021).

Despite increasing investments in research infrastructure at universities, utilization rates often remain suboptimal due to informal sharing practices, unclear responsibilities, and insufficient coordination mechanisms (Kos-Braun et al., 2020). Garcia-Vallejo (2023) argues that centralized management of research infrastructure can reduce operational costs, foster interdisciplinary research, and enhance institutional competitiveness. This issue is also highly relevant for businesses, particularly small and medium-sized enterprises (SMEs), which frequently encounter limited access to university research infrastructure due to a lack of information and complex access procedures. Consequently, improving research infrastructure management and resource-sharing processes has become an important factor contributing to innovation ecosystems, increasing research efficiency, and strengthening university–industry collaboration.

Although investments in university research infrastructure continue to grow, its utilization remains inefficient due to fragmented governance structures, non-standardized booking procedures, unclear responsibilities, and limited coordination among organizational units. Rossoni et al. (2024) identified difficult access to research infrastructure and insufficient information about available resources as significant barriers to university–industry collaboration. Meder et al. (2016) further note that decentralized management of laboratory infrastructure complicates access arrangements and limits the efficient use of resources by both researchers and external users. Within the contemporary research ecosystem, research infrastructure is increasingly recognized not merely as a technical asset but as a strategic factor influencing university competitiveness and collaboration with external stakeholders. Therefore, infrastructure accessibility, coordination, and efficient utilization have become essential prerequisites for strengthening university–industry cooperation (Rådberg & Löfsten, 2024).

Recent research further positions research infrastructure as a strategic institutional asset, where the key determinants of value are no longer ownership of equipment but rather accessibility, coordination efficiency, and integration into broader research networks. In this context, open access and structured collaboration with external users are increasingly recognized as essential components of high-performing research ecosystems (Rådberg & Löfsten, 2024).

The focus of this study is the assessment of the process of using and sharing research infrastructure in knowledge-intensive sectors. The aim of the study was to assess existing research infrastructure management and accessibility practices and to develop recommendations for improving the efficiency of research infrastructure utilization through the integration of reservation, usage monitoring, incentive, and coordination mechanisms that enhance equipment accessibility and utilization by both internal and external stakeholders.

To achieve this aim, the following research objectives were formulated: (1) to conduct a literature review on shared research infrastructure management and factors promoting collaboration; (2) to analyze the current state of research infrastructure management and accessibility in knowledge-intensive organizations by identifying key process gaps and sources of inefficiency; and (3) to provide recommendations for improving research infrastructure management and resource-sharing processes.

The study employed several research methods, including a literature review, expert evaluation, in-depth interviews, and process analysis.

2 Literature Review

Research infrastructure is generally defined as a system of specialized resources, equipment, data, and services that support scientific research, innovation, and knowledge creation (European Commission, 2025). Such infrastructure may be physical or virtual and can be utilized not only for research purposes but also in education and public service activities (European Parliament and Council, 2013). UNESCO (2021)

emphasizes the principles of Open Science, highlighting that research infrastructures operating under open-access principles should be accessible to diverse scientific communities and broader societal stakeholders.

The scientific literature identifies two dominant models of research infrastructure management: the traditional departmental model and the centralized core facility or shared resource laboratory (SRL) model. The traditional model often leads to duplication of infrastructure and low equipment utilization rates, whereas centralized models facilitate more efficient access coordination and process standardization. The core facility model is widely recognized as a centralized governance approach that consolidates expensive research equipment, technical expertise, and access services under a unified management structure. Such facilities operate with cost-recovery or user-fee systems and enable both internal and external users to access advanced instrumentation under standardized procedures (PMC, 2016). This model improves operational efficiency while strengthening interdisciplinary collaboration and maximizing institutional return on investment. The open-access approach defines the conditions under which external users may access the resources of higher education and research institutions for scientific and experimental activities (Haley, 2009; Meder et al., 2016).

The principles of the sharing economy provide an alternative perspective on research infrastructure by viewing it as a platform-based resource management model in which underutilized resources are allocated among multiple users without transferring ownership (Hamari et al., 2016). Recent studies further emphasize the economic and organizational advantages of shared research infrastructure. Shared instrumentation facilities enable universities to reduce equipment duplication, increase utilization rates, lower operational costs, and generate additional institutional revenue through external access models (MRS Bulletin, 2024). These findings highlight that shared infrastructure is not only a scientific resource but also a financially sustainable management model that improves institutional efficiency and resource allocation. In a business-to-business (B2B) context, this model typically involves three key actors: the resource owner, the resource user, and an intermediary platform facilitating access and coordination (Benoit et al., 2025). Such an approach enables the centralization of reservation and coordination processes while increasing the overall efficiency of infrastructure utilization.

Effective management of laboratory infrastructure encompasses access management, reservation procedures, usage monitoring, and coordination among users and infrastructure managers (Haley, 2009). Previous studies indicate that research infrastructure in universities is frequently underutilized due to challenges related to coordination, accessibility, and governance, resulting in a significant portion of its potential remaining unrealized (Kos-Braun et al., 2020; Tranfield & Lippens, 2024). The literature identifies four broad categories of barriers that limit the effective use of laboratory infrastructure and hinder interdisciplinary collaboration: technical, organizational, cultural, and systemic barriers. Sustainable research infrastructure management also requires long-term institutional planning, dedicated investments, and governance mechanisms that balance local operational autonomy with centralized oversight. Studies of university core facilities demonstrate that coordinated institutional support, strategic investment, and performance evaluation frameworks are essential for maintaining financially sustainable and effective shared research resources (Hockberger et al., 2018).

3 Research Methodology

This study employed a qualitative research design to assess the need for research infrastructure management and sharing solutions within a university environment. The research combined scientific literature analysis, expert evaluation, in-depth interviews, and process analysis. Qualitative expert interviews are considered particularly suitable for examining complex organizational and management processes, as they provide insights into decision-making practices, coordination mechanisms, and infrastructure utilization issues (Döringer, 2021).

The research was conducted in two stages. In the first stage, a literature review was performed to identify key concepts related to research infrastructure management, open access, resource sharing, and the technical, organizational, cultural, and systemic barriers affecting infrastructure utilization.

In the second stage, an expert evaluation was conducted. Experts were selected using purposive sampling based on their professional experience and direct involvement in research infrastructure management. A total of ten experts participated in the study, including laboratory managers, researchers, and infrastructure coordinators responsible for the operation, maintenance, and management of research equipment. Semi-structured in-depth interviews were conducted using a questionnaire consisting of 19 questions derived from 9 infrastructure-sharing barriers identified in the literature (Table 1).

The interviews explored infrastructure management practices, reservation procedures, usage monitoring mechanisms, equipment-sharing challenges, and the influence of organizational, financial, and governance factors on research infrastructure utilization.

Following the interviews, a supplementary expert assessment was carried out to evaluate the relative importance of the identified barriers. Experts were asked to rate each barrier using a five-point Likert scale, where 1 indicated “not significant at all” and 5 indicated “very significant.” A barrier was considered significant if it received a rating of 4 or 5. The results enabled the identification and prioritization of the most critical barriers affecting research infrastructure utilization and provided a basis for developing recommendations for improving research infrastructure management and sharing processes.

Table 1. Expert Interview Questionnaire (made by authors)

No.	Interview Question	Related Barrier
1	What systems and tools are currently used for managing laboratory infrastructure?	Infrastructure management
2	How does the absence of a unified reservation system for laboratory equipment affect equipment sharing between different university units?	Reservation system
3	How do incompatible equipment usage registration systems across organizational units affect equipment utilization?	Information systems
4	How could a centralized laboratory equipment management system improve equipment utilization efficiency?	Infrastructure management
5	How could a unified laboratory equipment management system improve coordination between university units?	Infrastructure management
6	How does dependence on specific equipment suppliers affect laboratory infrastructure management and equipment acquisition?	Supplier dependency
7	What procurement practices could improve laboratory equipment management and utilization?	Supplier dependency
8	How does the risk of equipment damage or usage conflicts affect employees' willingness to share laboratory equipment?	Technical risks
9	What measures could encourage safer and more efficient sharing of laboratory equipment?	Technical risks
10	How does the lack of clearly defined laboratory infrastructure management processes affect equipment sharing between organizational units?	Organizational processes
11	How could centralized management and clearer allocation of responsibilities improve the use of laboratory infrastructure?	Organizational processes
12	Although research equipment formally belongs to the university, how does the perceived ownership of equipment by individual researchers or departments affect equipment sharing?	Ownership mentality
13	What organizational or cultural changes could encourage more open use of laboratory equipment?	Ownership mentality
14	What factors contribute to the shortage of qualified specialists, and how does this shortage affect the use and maintenance of laboratory equipment?	Human resources
15	How could greater professional development and career opportunities for laboratory personnel improve research infrastructure management?	Human resources
16	How do current funding and compensation models affect laboratory equipment sharing within the university?	Funding mechanisms
17	How could financial incentives or compensation mechanisms encourage more efficient use of laboratory equipment?	Funding mechanisms
18	How does the absence of a clear national or institutional strategy affect laboratory infrastructure management at the university?	Strategic governance
19	How could a coordinated national or institutional strategy improve laboratory equipment utilization and collaboration between institutions?	Strategic governance

4 Results and Discussion

The expert assessment revealed that the most significant barriers to research infrastructure sharing were the shortage of qualified laboratory personnel, the lack of financial incentives and compensation mechanisms, and the absence of a unified laboratory equipment reservation and monitoring system. Each of these barriers was identified as significant by five out of eight experts. The lack of a coordinated national or institutional strategy was considered a significant barrier by four out of eight experts. A barrier was classified as significant when it received a rating of 4 or 5 on a five-point Likert scale (Figure 1).

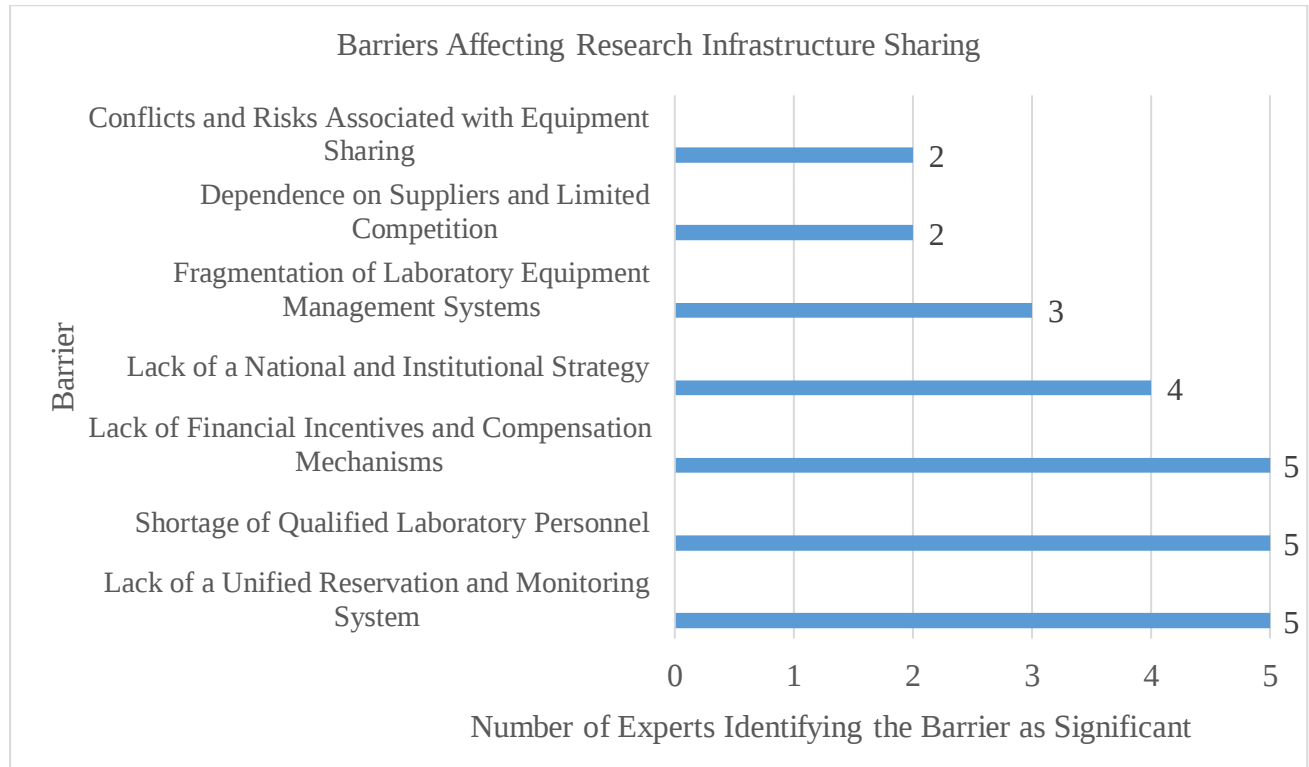


Figure 1: Significant barriers affecting research infrastructure sharing (made by the authors)

The expert evaluation results indicate that the most critical challenges affecting research infrastructure management are associated with human resource constraints, inadequate financial incentives, and insufficient infrastructure coordination. Findings from the in-depth interviews showed that 70% of experts attributed the shortage of qualified specialists to non-competitive remuneration, 60% emphasized the lack of technical personnel, and 50% identified the migration of specialists to the private sector as a significant issue. In addition, 90% of respondents reported that the absence of adequate financial incentives and compensation mechanisms discourages equipment sharing by failing to compensate operational costs and associated risks, thereby limiting the effective utilization of research infrastructure (Figure 1).

Table 2: Expert evaluation results: laboratory equipment management issues (prepared by the authors)

Barrier	Barrier Description	Expert Evaluation Results
Fragmentation of laboratory equipment management systems across organizational units	Fragmented laboratory equipment management systems reduce infrastructure coordination and hinder efficient resource allocation	70% of experts reported that different organizational units use inconsistent or informal equipment management practices, making it difficult to obtain information about available equipment and its accessibility. The most frequently identified shortcomings included the use of Excel spreadsheets or paper-based

	(Clustermarket, 2023; Zhang et al., 2023).	records for equipment management (60%), reliance on informal personal agreements (50%), and insufficient data on equipment utilization and occupancy rates (40%).
Lack of a unified laboratory equipment reservation and monitoring system	The absence of a unified laboratory equipment reservation and monitoring system reduces equipment visibility and limits its utilization potential (FASEB, 2022; Kos-Braun et al., 2020).	80% of experts stated that the lack of a centralized reservation system complicates equipment coordination across university units. Respondents emphasized that staff often lack the ability to monitor equipment availability and occupancy in real time. The most frequently mentioned issues included insufficient information on equipment utilization (60%), lost opportunities and lower utilization rates due to the absence of systematic reservation procedures (50%), and concerns that technological solutions alone would be ineffective without accompanying organizational and financial incentives (40%).

Table 2 demonstrates that infrastructure management challenges are primarily associated with fragmented information systems and the lack of a centralized reservation and monitoring mechanism. These barriers reduce equipment visibility, hinder coordination among university units, and contribute to inefficient resource utilization. The findings support the need for integrated infrastructure management solutions capable of improving transparency, accessibility, and cross-unit collaboration.

Table 3: Expert evaluation results: procurement and equipment-sharing barriers (prepared by the authors)

Barrier	Barrier description	Expert evaluation results
Dependence on suppliers and limited competition in public procurement	Dependence on specific suppliers and limited competition in public procurement increase infrastructure costs and restrict flexibility in adopting alternative technological solutions (Yu et al., 2025; OECD, 2020).	Although most experts did not perceive supplier dependence as a critical issue, 40% noted limited supplier choice in certain specialized fields. Frequently mentioned challenges included lengthy public procurement procedures (50%), a limited number of specialized equipment suppliers (40%), and difficulties related to service and maintenance availability (30%).
Conflicts and risks associated with equipment sharing	Concerns regarding equipment damage, responsibility for maintenance, and scheduling conflicts reduce employees' willingness to	A total of 80% of experts stated that the risk of equipment damage is a major factor discouraging equipment sharing. Frequently mentioned challenges included a lack of qualified users and training opportunities (60%), the need for dedicated technical operators

	share laboratory equipment (Leeds, 2025).	(50%), and issues related to material responsibility and liability (40%).
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The results presented in Table 3 indicate that organizational and operational factors continue to limit the effective sharing of research infrastructure. While supplier dependence was not perceived as a critical barrier by most experts, public procurement procedures and limited service availability were identified as factors reducing operational flexibility. Furthermore, concerns related to equipment damage, user competence, and liability significantly affect stakeholders' willingness to share laboratory resources, highlighting the importance of clear governance and support mechanisms.

Table 4: Expert evaluation results: organizational and human resource barriers affecting research infrastructure sharing (prepared by the authors)

Barrier	Barrier description	Expert evaluation results
Lack of a centralized laboratory equipment sharing process	The absence of centralized management and strategic integration prevents the achievement of higher research quality and synergy among different research groups (Kos-Braun et al., 2020).	A total of 70% of experts stated that equipment sharing between organizational units is currently based primarily on informal agreements. Frequently mentioned challenges included difficulties in identifying available equipment (60%), insufficient process formalization (50%), and significant time requirements for coordinating equipment use (40%).
Unjustified ownership mentality toward laboratory equipment	An ownership-oriented approach to laboratory equipment restricts sharing practices and reduces infrastructure accessibility for the wider research community (Cartwright et al., 2024; Ramirez-Aguilar, 2016; Meder et al., 2016).	Approximately 50% of experts indicated that equipment "ownership" is primarily associated with responsibility for maintenance and operating costs rather than unwillingness to share resources. Frequently mentioned challenges included concerns regarding responsibility for equipment (50%), fear of damage or malfunction (40%), and difficulties in organizing access to equipment located in other organizational units (30%).
Shortage of qualified laboratory personnel	The shortage of qualified laboratory personnel and limited professional development opportunities reduce the efficiency of infrastructure utilization and the quality of services provided (Daystar University,	A total of 70% of experts associated the shortage of qualified specialists with non-competitive salaries. Frequently mentioned challenges included shortages of technical staff (60%), migration of specialists to the private sector (50%), and limited career development opportunities (40%).

	2022; Tranfield & Lippens, 2024).	
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The results presented in Table 4 indicate that organizational and human resource factors significantly influence the effectiveness of research infrastructure sharing. Experts emphasized that informal coordination mechanisms, concerns regarding equipment responsibility, and the shortage of qualified personnel limit the accessibility and utilization of research infrastructure. These findings suggest that improving governance structures, clarifying responsibilities, and strengthening human resource capacity are essential for achieving more efficient and sustainable infrastructure management.

Table 5: Expert evaluation results: financial and strategic barriers affecting research infrastructure sharing (prepared by the authors)

Barrier	Barrier description	Expert evaluation results
Lack of financial incentives and compensation mechanisms	The absence of financial incentives, compensation mechanisms, and optimized pricing models limits the efficient utilization of laboratory equipment and reduces stakeholders' motivation to share resources (Yu et al., 2025; Garcia-Vallejo, 2023).	A total of 90% of experts stated that current funding mechanisms do not adequately compensate for equipment operation, reagents, maintenance costs, and staff time. Frequently mentioned challenges included insufficient coverage of operational expenses (70%), a lack of incentive mechanisms (60%), and unclear allocation of financial responsibility (50%).
Lack of a national and institutional strategy	The absence of a coordinated national and institutional strategy contributes to fragmented laboratory infrastructure management and limits effective resource planning (FASEB, 2022).	A total of 70% of experts indicated that clearer infrastructure coordination and long-term planning are needed at the university level. Frequently mentioned challenges included insufficient coordination between organizational units (60%), fragmented equipment acquisition decisions (50%), and the lack of common priorities and long-term research directions (40%).

The results presented in Table 4 indicate that financial and strategic factors are among the most significant barriers to effective research infrastructure sharing. In particular, inadequate compensation mechanisms reduce the willingness of organizational units to share equipment, while the absence of a coordinated institutional strategy contributes to fragmented decision-making, inefficient resource allocation, and limited collaboration across the research ecosystem.

The research results also showed that 80% of experts associate the absence of a unified laboratory equipment reservation system with complex interdepartmental coordination of equipment, while 60% of respondents emphasized limited possibilities to view equipment occupancy and availability in real time. In

addition, 70% of experts indicated a need for clearer coordination of research infrastructure at the university level, and 60% reported insufficient collaboration **and** coordination of activities between departments.

The obtained results suggest that the efficiency of laboratory infrastructure is primarily constrained not by technological factors, but by organizational, financial, and human resource-related issues. Therefore, the improvement of laboratory infrastructure management should focus not only on implementing a unified information system, but also on developing mechanisms for motivation, compensation, and responsibility allocation. The possible solutions for addressing these barriers are presented in the table below.

Table 6: Expert evaluation of barriers and proposed solutions (compiled by the authors)

Barrier	Proposed solutions
1. Lack of a unified laboratory equipment reservation and monitoring system	It is proposed to implement an open-source, customizable laboratory infrastructure management system that allows users to reserve equipment, monitor device status, and request assistance from technical staff and equipment owners (Ferranti et al., 2012). A representative example of such a system is NEMO, which can be adapted to the needs of any organization or laboratory. The software package includes a wide range of configurable functions, such as defining user roles and permissions, specifying types of reservable equipment and resource categories, setting maintenance alerts, and integrating with other laboratory sensors and systems. NEMO is a web-based application accessible from any internet-enabled device, enabling users to conveniently reserve equipment, check availability, and request technical support (NIST, 2023).
2. Lack of financial incentives and compensation mechanisms	It is proposed to implement an internal compensation mechanism in which laboratories granting access to other departments receive budget deductions or institutional credits (Garcia-Vallejo, 2023). Transparent and standardized pricing for equipment usage should be established, along with formal compensation mechanisms for technical staff workload. Additionally, a “sharing incentive” principle is recommended, whereby departments that actively share equipment are prioritized in receiving funding for equipment upgrades (FASEB, 2022; Yu et al., 2025).
3. Shortage of qualified laboratory personnel	It is proposed to establish a centralized laboratory personnel competency management system, including a shared “core facility” staffing structure serving multiple departments (Tranfield & Lippens, 2024). Internal training programs and qualification pathways should be introduced to increase job attractiveness in the university environment. It is also recommended to allow a balanced workload distribution that preserves time for research activities, thereby helping retain highly qualified specialists who might otherwise migrate to the private sector (Daystar University, 2022).
4. Lack of national and institutional strategy	It is proposed to develop an institutional research infrastructure management strategy covering long-term planning, priority-setting principles, and a clear distribution of responsibilities among departments (FASEB, 2022). At the university level, it is recommended to establish an Infrastructure Coordination Council

	responsible for defining a unified procurement policy and addressing coordination and collaboration issues between departments.
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The analysis of expert evaluations indicates that the main barriers to efficient research infrastructure management are systemic rather than technological in nature. The most critical challenges relate to the absence of unified coordination tools, insufficient financial incentives, shortages of qualified personnel, and a lack of coherent institutional governance structures.

Overall, the findings demonstrate that improving infrastructure utilization requires a holistic approach that integrates digital solutions with organizational reform. In particular, effectiveness depends on the simultaneous implementation of (i) a unified management platform, (ii) transparent incentive and compensation mechanisms, (iii) a centralized human resource model for technical staff, and (iv) an institutional-level governance and coordination framework. Such an integrated approach would not only improve equipment accessibility and utilization but also strengthen collaboration and long-term sustainability of research infrastructure.

5 Conclusions

The analysis of the scientific literature revealed that effective management of research infrastructure is associated with centralized coordination, clearly defined access procedures, and competent technical personnel. The literature emphasizes that infrastructure organized according to the “core facility” principle creates conditions for reducing equipment duplication, increasing utilization intensity, improving resource efficiency, and strengthening interdepartmental collaboration, while also expanding opportunities for industry engagement.

The results of the expert evaluation showed that the main problems in the management and accessibility of research infrastructure at the university are organizational, financial, and human resource-related rather than technological in nature. The most significant barriers identified by experts include the lack of a unified reservation and monitoring system (80%), insufficient financial incentives and compensation mechanisms (90%), and a shortage of qualified personnel due to non-competitive salaries (70%). This indicates that the efficiency of laboratory infrastructure utilization is primarily constrained by non-formalized processes, unclear responsibilities, and a lack of motivation mechanisms.

Based on the research findings, proposals for improving research infrastructure management and sharing processes are presented. It is suggested to implement: (1) a unified digital reservation and monitoring system (a NEMO-type platform), (2) an internal financial incentive and compensation mechanism based on an institutional credit system, (3) a centralized “core facility” personnel competency management structure, and (4) an institutional coordination system with a clearly defined distribution of responsibilities. The implementation of these measures would increase equipment utilization intensity, reduce coordination costs, and improve access for both internal and external users.

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