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Successful Practices and Challenges in Implementing Fair Principles for Academic Libraries

Objective. This study analyzes international experiences in implementing the FAIR principles (Findability, Accessibility, Interoperability, Reusability) in research data management in university environments. **Methods.** A comprehensive methodological approach was used, including a systematic literature review of the publications of 2020-2024, case studies of best practices from leading European and American universities, expert interviews with university library data management specialists, and analysis of institutional policies and regulatory documents. **Results**. The analysis revealed significant variability in FAIR implementation levels depending on geographical location, institutional policies, cultural factors, technical infrastructure, and the specificities of scientific disciplines. Nordic countries and the UK demonstrate leadership in FAIR implementation, while Eastern European countries, including Ukraine, show significantly lower levels of implementation. Natural sciences demonstrate more developed data sharing practices compared to humanities and social sciences. The paper identifies main obstacles to the development of this area of activity in the library environment. **Conclusions.** Successful implementation of FAIR requires comprehensive approaches, including the development of institutional policies, the creation of specialized infrastructure, raising awareness among researchers, and the development of discipline-specific guidelines to ensure full compliance with FAIR principles.

Keywords: FAIR principles; research data management; open science; university libraries; implementation challenges; international practices

Introduction

The implementation of the FAIR principles (findability, accessibility, interoperability and reusability) in research data management (RDM) has become a critical area for universities worldwide. Any research is based on data, and in most cases, there is an opportunity to make data obtained during one project available for secondary analysis, replication or reuse for further innovation. Grant providers now require transparency and data manageability as a guarantee of increasing the profitability of their investments. In the context of modern scientific communication and global challenges, there is a growing need for standardized practices to improve data exchange, reuse and interdisciplinary collaboration.

The FAIR principles, first proposed in 2016, have become a generally recognized international standard for organizing, storing and disseminating scientific data. The FAIR principles are a comprehensive concept. Each component of the FAIR acronym (Findability, Accessibility, Interoperability, Reusability) is responsible for a specific aspect of research data management. The FAIR principles are not hard and fast rules, but rather general recommendations that should be adapted to the type of data, field of knowledge, institution, nature of the project, etc. Any movement towards FAIR data is positive, as it facilitates data sharing and reuse. However, the implementation of these principles in university practice faces various technical, organizational and cultural barriers.

Methods

To analyze the status of FAIR principles implementation in the university environment, a comprehensive methodological approach was used. This included a systematic literature review

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analyzing scientific publications devoted to FAIR and RDM issues, published in 2020-2024. Case studies examined the practices of implementing FAIR principles in leading universities in Europe and the USA. The selection of cases was based on the principle of "best practices" with geographical representativeness and a focus on institutions that demonstrate specific, measurable successes in implementing FAIR principles.

Expert interviews were conducted as structured conversations with specialists in the field of research data management during a session of online meetings with librarians at the University of Sheffield (United Kingdom of Great Britain and Northern Ireland, 2024-2025) and during an internship at the library of Delft University of Technology (Netherlands, 2025). Analysis of policies and regulatory documents included studying institutional policies regarding RDM, as well as the requirements of grantmakers and scientific publishers.

This multidimensional approach made it possible to realize the goal of scientific intelligence to obtain a comprehensive picture of institutional initiatives and prospects for implementing FAIR principles in the university environment.

Results and Discussion

Analysis of the current state shows significant variability in the level of implementation of FAIR principles. This depends on geographical location, institutional policies, cultural characteristics and technical infrastructure, as well as the specifics of scientific disciplines.

The Nordic countries and the UK are leaders in implementing FAIR principles. Leading Scandinavian and UK universities are developing comprehensive approaches that include development of research data management (RDM) policies, creation of specialized units and teams with availability of specialists, and development of data steward networks.

However, a survey by the FAIRsFAIR project (Stoy, Saenen, Davidson, & Engelhardt, 2020) found that while many European higher education institutions (HEIs) have started implementing FAIR, significant gaps remain. For example, in the Netherlands, although 62.8% of researchers and 81.0% of support staff make efforts to comply with FAIR, only a small percentage achieve full compliance (Kersloot, Abu-Hanna, Cornet, & Arts, 2022). This highlights the difficulty of fully implementing FAIR principles even in research-intensive institutions.

In contrast, Eastern European countries, including Ukraine, demonstrate a significantly lower level of implementation of FAIR principles. The main reasons are lack of institutional policies on FAIR, insufficient funding for the development of data management infrastructure, and low awareness among researchers about the benefits and mechanisms of FAIR implementation.

The level of implementation of the FAIR principles also varies considerably across disciplines, regardless of country. Historically, some fields have been more advanced in data sharing practices. The natural sciences, especially genomics, astronomy and climatology, have a well-established tradition of data sharing (Pribec et al., 2023). This is due to the need for large data sets and interdisciplinary collaboration.

The humanities and social sciences have shown less willingness to openly share data. This is often due to the specifics of working with confidential information and the need to ensure the anonymity of research participants. However, there is a need to develop adapted data management solutions in these fields as well.

Research sponsors are increasingly requiring scientists to implement data sharing practices and include data availability statements in publications, and to plan for DMR at an early stage of projects. However, there is a significant lack of disciplinary guidance to support researchers in specific fields.

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The University of Sheffield project (Adams, Jones, & Foster, 2023) is a prime example of how this problem is being addressed. In collaboration with researchers from seven disciplines, subject-specific FAIR checklists were developed for use by colleagues at all stages of a research project. This highlights the importance of creating tailored tools and resources that take into account the specificities of each field of study.

The current state of implementation of FAIR principles in universities is therefore characterised by strong variability, depending on region, field of study and, of course, the size and resources of the university. Further efforts should be directed towards developing uniform policies, creating dedicated infrastructure, raising awareness among researchers and developing disciplinary guidance to ensure full compliance with the FAIR principles.

Implementing FAIR principles in university practice, despite their obvious advantages, faces a number of significant challenges. These problems can be classified as technical, organizational, legislative, and cultural.

One of the key technical challenges is long-term data storage. This includes ensuring data integrity over decades, protecting against file format obsolescence, and the need to continually update infrastructure. For example, files created today may become unusable in 5–10 years if appropriate migration and archiving strategies are not in place. Data interoperability, ensuring easy integration and understanding of data across systems remains a technical challenge, as many existing datasets do not conform to standardized formats (Henning, Bonino da Silva, Pires, van Sinderen, & Moreira, 2021).

Another important technical challenge is the lack of data storage systems. Different research groups and even individual researchers often use incompatible systems and formats, making data sharing and reuse difficult.

Libraries often lack the necessary software and databases to support FAIR data management, which can hinder the implementation of these principles (de Groot et al., 2024). Building an effective infrastructure for FAIR requires significant investment and ongoing maintenance. Limited funding and resources for training and support for FAIR data management roles can hinder libraries' ability to effectively implement these practices (Washton & Ackerman, 2023).

At the organizational level, the main obstacle is the lack of developed institutional policies and procedures for RDM. Without clear guidelines, universities cannot systematically support researchers in adhering to the FAIR principles. This includes the lack of standards for describing metadata, choosing repositories, and licensing procedures. Organizational policies may restrict the use of required software or data sharing practices, creating an obstacle to implementing FAIR principles (de Groot et al., 2024).

In addition, there is a shortage of qualified RDM specialists. Universities are acutely lacking data stewards who can provide expert support to researchers. Such advice is vital, especially on issues of intellectual property, protection of confidential information, and proper data licensing, which are complex legal and ethical aspects of data management (Namgay, Wangdi, Thinley, & Namgyel, 2023).

Cultural aspects pose a significant obstacle to open science. Researchers of the "old school" often have a habit of "closure" and a reluctance to share data. This may be due to a fear of losing a competitive advantage, or simply a lack of understanding of the benefits of data sharing. Overcoming this inertia requires significant efforts to change the mentality and demonstrate the real benefits of openness.

The need to invest effort and time to master new information and procedures is another cultural challenge. Researchers who are overloaded with scientific work often do not have the opportunity or desire to learn new approaches to RDM, which slows down the implementation of

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FAIR. Librarians share similar concerns: the perceived complexity and administrative burden associated with implementing FAIR practices may discourage libraries from implementing these initiatives (Washton & Ackerman, 2023).

Legal and regulatory constraints are also a significant challenge. Data protection (e.g. GDPR in Europe) and other regulatory frameworks can make data sharing significantly more difficult, especially in health and social research. Clear mechanisms for anonymization and de-identification of data need to be developed, as well as legal support for researchers to comply with these requirements without violating the FAIR principles.

Thus, successful implementation of the FAIR principles requires a comprehensive approach that takes into account and overcomes these technical, organizational, legal and cultural challenges. Understanding these challenges is the first step in developing effective strategies to overcome them.

Given the challenges described — from technical difficulties to cultural barriers — the path to full implementation of the FAIR principles in universities may seem daunting. However, despite these challenges, many institutions around the world are already demonstrating significant success by developing and implementing innovative practices and institutional initiatives. These successful cases not only confirm the possibility of overcoming certain barriers, but also offer valuable lessons and models to follow, showing how universities can effectively integrate FAIR principles into their research ecosystem, and how the library can participate in this process.

The experience of leading European and American institutions demonstrates a variety of successful approaches that can serve as a guide for other institutions.

One fundamental step is to develop institutional policies for research data management (RDM). These frameworks define standards and procedures for the entire data lifecycle (see, for example, the Research Data Management Policy of the University of York). Importantly, these policies are not static. Leiden University (the Netherlands), for example, introduced a RDM policy back in 2016, focusing on data accessibility and searchability. In 2019, their policy was expanded to include requirements for interoperability, reusability and the need for machine learning (Hettne, Verhaar, Schultes, & Sesink, 2020), reflecting the evolution of the understanding of FAIR.

Similar trends are observed in the USA, where institutions such as Cornell University, Duke University, the University of Michigan, the University of Minnesota, Virginia Polytechnic Institute and Washington University in St. Louis are reviewing their practices to improve the coordination of RDM services and infrastructure (Petters et al., 2024). This indicates a continuous search for optimal solutions and the need for policy flexibility.

The understanding that different scientific disciplines have unique data requirements has led to the development of discipline-specific approaches. Leiden University has implemented a RDM program supporting six faculties, transforming general rules into specific recommendations tailored to the needs of each discipline. Such collaboration between UDD specialists, policymakers and IT experts is becoming the norm, as can be seen in the examples of Delft University of Technology (Netherlands) and the University of Sheffield (UK). The latter, for example, has developed discipline-specific FAIR checklists to help researchers integrate FAIR principles into their daily work (Adams, Jones, & Foster, 2023). This allows researchers to not only become familiar with the general requirements, but also to apply good and responsible practices as an integral part of their research activities.

Effective implementation of FAIR is impossible without the development of researchers' skills. Universities are actively investing in workshops and training materials. An example is the University of Edinburgh (UK), which offers the online Research Data Management Training MANTRA platform and the joint online course Research data management and sharing on Coursera with the University of North Carolina. Similar initiatives, such as the course developed

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by UiT — The Arctic University of Norway and piloted at the Prague University of Chemistry and Technology (Czech Republic) and Karlstad University (Sweden), demonstrate the growing interest in standardized education in RDM and FAIR.

In addition to formal courses, universities provide individual consulting services, helping researchers solve specific issues related to data management and publication according to FAIR standards.

The development of institutional data repositories is critical to ensure data availability and preservation. Examples include Harvard Dataverse (Harvard University, USA) and the pan-European EUDAT infrastructure. These platforms provide support for FAIR data before, during and after research (Hettne, Verhaar, Schultes, & Sesink, 2020).

To coordinate these efforts, dedicated RDS units, such as the Research Data Service at the University of Edinburgh (UK), are being established. These units play a key role in providing expert support, policy development, and infrastructure management.

Many universities are actively collaborating internationally. The Centre for Data and Services (CDS) of Leiden University is working with organizations such as GO FAIR, the Research Data Alliance (RDA) and CODATA to develop best practices for implementing FAIR data. Such collaboration is vital for sharing experiences and harmonising standards globally.

In addition, community-based approaches are gaining ground. An interesting experience in forming a FAIR Community and a network of data stewards is demonstrated by the Delft University Library, which coordinates a network of faculty data stewards. The Maastricht University Community Data Driven Insights (CDDI) initiative brought together research data service providers to support researchers in implementing FAIR. This initiative focused on cultural change, education and the development of technical tools (Guerrero, Romero, Dolman, & Dumontier, 2023), emphasizing the importance of collective efforts. Another important step is to stimulate the publication of datasets by recognizing them as full-fledged scientific publications and including them in the assessment of researchers' scientific productivity. This motivates scientists to make efforts to prepare and deposit data.

There is a growing understanding of the need to integrate FAIR principles with the CARE principles (Collective Benefit, Authority to Control, Responsibility, Ethics). The CARE principles focus on ethical and governance aspects, complementing FAIR by emphasizing collective benefit and data sovereignty. Although there are no established models for implementing CARE yet, aligning FAIR infrastructure with the CARE principles can significantly improve ethical data management practices (Marín-Arraiza, 2023), ensuring not only technically sound but also socially responsible data processing.

Conclusions

The analysis reveals that current implementation of FAIR principles in universities varies greatly depending on region, field of study and the size and resources of the university. Nordic countries and the UK demonstrate leadership through integrated approaches, including institutional policy development, dedicated infrastructure, researcher training and international collaboration. However, significant challenges remain, including technical difficulties with long-term preservation and interoperability, organizational barriers such as lack of qualified specialists and clear policies, cultural resistance to data sharing and legislative restrictions.

Examples of successful implementation from leading universities provide valuable lessons and models to follow. Key success factors include developing clear institutional policies tailored to disciplinary needs, establishing dedicated support services and curricula, building appropriate

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technical infrastructure, promoting cultural change towards openness, and engaging in international collaboration and standards development.

Academic libraries are actively engaged in institutional initiatives to implement FAIR principles, but they also face a complex set of interrelated obstacles to their implementation. These challenges include technical barriers, organizational challenges, significant administrative burdens on staff, and low levels of trust among researchers in new data management practices. The combination of these technical, organizational, and psychosocial factors creates systemic obstacles to the effective implementation and integration of FAIR practices into academic library operations.

While these obstacles are significant, they also highlight the need for a structured approach to overcoming them, such as fostering a culture of collaboration and investing in specialized roles such as data librarians.

Future efforts should focus on developing unified policies, creating specialized infrastructure, raising awareness among researchers, and developing disciplinary guidelines to ensure full FAIR compliance. The integration of ethical considerations through the CARE principles represents an important evolution towards socially responsible data management practices.

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Успішні практики та виклики впровадження принципів FAIR для університетських бібліотек

Мета. Це дослідження аналізує міжнародний досвід впровадження принципів FAIR в управлінні дослідницькими даними в університетському середовищі. **Методика.** Використано комплексний методологічний підхід, що включав систематичний огляд літератури публікацій 2020 — 2024 років, кейс-стаді найкращих практик провідних європейських та американських університетів, експертні інтерв'ю з фахівцями з управління даними бібліотек університетів та аналіз інституційних політик і регулятивних документів. **Результати.** Аналіз виявив значну варіативність рівнів впровадження FAIR залежно від географічного розташування, інституційних політик, культурних факторів, технічної інфраструктури та специфіки наукових дисциплін. Скандинавські країни та Велика Британія демонструють лідерство у впровадженні FAIR, тоді як східноєвропейські країни показують значно нижчі рівні впровадження. Природничі науки демонструють більш розвинені практики обміну даними порівняно з гуманітарними та соціальними науками. Виокремлені основні перешкоди розвитку цього напряму діяльності в бібліотечному середовищі. **Висновки.** Зроблено висновок щодо необхідності комплексних підходів до впровадження FAIR, зокрема розробки інституційних політик, створення спеціалізованої інфраструктури, підвищення обізнаності серед дослідників та розробки дисциплінарно-орієнтованих рекомендацій для забезпечення повної відповідності принципам FAIR.

Ключові слова: принципи FAIR; управління дослідницькими даними; університетські бібліотеки; виклики впровадження; міжнародні практики

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