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Article abstract

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Research Data Management from a Hungarian Perspective: A Systematic Literature Review

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In science and education, research data is a valuable resource that can be utilized and repurposed for future use. Research data management is crucial for successful research, as it can generate reliable and advantageous results and facilitate accurate decision-making. The systematic review study followed the PRISMA Statement standards for reporting. Data regarding research data management from a Hungarian perspective was collected from SCOPUS, Web of Science, and EBSCO databases on January 5th, 2024. Forty-one records were identified from SCOPUS, Web of Science, and EBSCO databases. After screening, the remaining 13 articles were included in this study. The Hungarian authors discussed four distinct research data management activities. The activities included data sharing, data citation, data curation, and data storage. Several additional data-related concepts, such as data governance, data quality, data literacy, and research data service, were also examined in this study.

Keywords: research data management, data quality, data literacy, data governance, research data service

Introduction

In the fields of science and education, the data that is produced as a result of research is a valuable resource that can be used and reused for additional purposes in the future. Quite frequently, the lifespan of the research project responsible for generating new data is shorter than that of the data themselves. The researchers may continue to work on the data after the funding for the research project has been terminated. Additionally, subsequent projects may analyze or add to the data, and other researchers may reuse the data. Data management can assist researchers in planning and designing research by helping them think about how data will be managed during the research process and how it will be shared with the larger research community after the research has been completed.

Data management is essential to successful research processes because it can produce dependable and beneficial results and enable precise decision-making (Azeroual, 2020). It is possible that poor data quality results in incorrect decisions and inefficiencies in day-to-day operations, as well as weakening the processes associated with entire institutions. Larger projects and institutions are more susceptible to this risk because human error is more likely to occur in these settings (Eaker, 2016).

Data-related activities include data sharing, management, curation, and citation (Carlson et al., 2011). Data citation is an important part of research data management. The individual researcher and the institution they work for can benefit from increased academic visibility and reputation because research data can be cited similarly to research papers (Bor-natici & Fedrigo, 2023). The management of research data is an essential component of the scientific method, as it enables research results to be made accessible promptly on established platforms, such as repositories. In addition, research data management assists research institutions in establishing themselves as active participants in the scientific environment on both a national and international scale. It also encourages networking between research institutions and researchers.

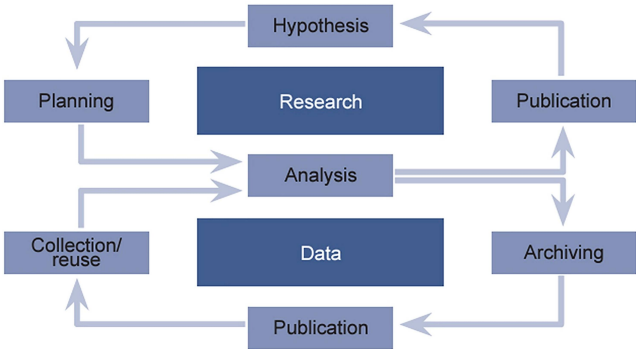
Specific policies must be implemented to apply practical and good research data management practices. Data governance provides a cross-functional framework to formalize data policies that describe standards and processes and monitor compliance (Koltay, 2020). The role of the data governor should become more like that of a librarian, driving business innovation rather than hindering it. Achieving this goal involves providing IT as a service and facilitating data retrieval and organization (Koltay, 2016b). To achieve good data quality, researchers and academics need to understand how to implement data governance and understand data literacy. Meanwhile, librarians must provide research data services and excel in data literacy.

Literature Review

The Priority Initiative "Digital Information" of the Alliance of German Science Organizations defines research data as data produced by scientific projects. Meanwhile, it defines research data management as managing data from its creation through various stages, such as preparation, selection, assessment, archiving, and analysis, to facilitate its reuse (Research Data Working Group in the Priority Initiative "Digital Information" of the Alliance of German Science Organisations, 2018).

Figure 1

Research and Data Lifecycle
(Research DataWorking Group in the Priority Initiative "Digital Information" of the Alliance of German Science Organisations, 2018)



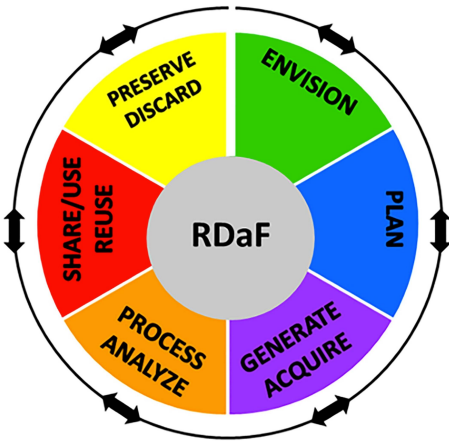
In the research data management lifecycle, every stage is connected to the others and can be approached differently by different organizations or people. An organization will likely be involved in all lifecycle phases simultaneously, albeit with varying degrees of intensity or capacity. The research data management framework aims to provide a comprehensive yet flexible framework.

Figure 2 shows the lifecycle of research data in 6 stages (Hanisch et al., 2023): envision, plan, generate/acquire, process/analyze, share/use, reuse, and preserve/discard. The stage known as "envision" is when the organization examines the strategies and drivers associated with its research data program. During the envision stage of the lifecycle, decisions and choices are made to outline a strategic plan of action that will be taken to accomplish the objectives of the organization.

The term "plan" refers to the stage in the lifecycle that involves preparing for data acquisition, choosing data formats and storage solutions, and anticipating strategies and policies for sharing and disseminating data. The generate/acquire

Figure 2

Research Data Framework Lifecycle Stages
(Hanisch et al., 2023)



stage of the lifecycle involves the creation of raw research data through the use of computations and experiments carried out within an organization, in addition to the collection of data produced by sources outside of the organization. During the process/analysis phase of the lifecycle, actions are carried out on research data to produce processed data through software utilization. This is what makes it possible to generate observations and conclusions.

The stage known as "share/use/reuse" involves the dissemination, utilization, and re-utilization of raw and processed research data within an organization, considering any limitations or incentives for using or reusing these data. Beyond the confines of an organization, it entails the dissemination, utilization, and recycling of research data that has been both raw and processed, respectively. During the preserve/discard stage of the lifecycle, the procedures for managing research data after use are outlined. These procedures include records management, archiving, and safe disposal of the data.

Methods

Information Source

The PRISMA Statement and its extensions are a minimum set of recommendations based on evidence and designed primarily to encourage the reporting of substance transparently and comprehensively (Sarkis-Onofre et al., 2021). A set of standards, the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement served as a guide for reporting this systematic review study. Records from SCOPUS, Web of Science, and EBSCO databases were obtained on January 5th, 2024, with the topic of research data management from the Hungarian perspective. These databases allow users to quickly discover a list of sources

through links that lead to articles, so it was a consideration in the selection process. The key metrics were utilized in this context to determine the significance of the resources. The planned protocol was carried out without significant modifications, and the reported methods accurately represented the performance (see Appendix A for our PRISMA flow diagram).

Study Selection

A compilation of articles relevant to the subject matter was made, and this list was used as a validation instrument for the method of searching. To conduct manual screening using the PRISMA framework, the results were exported to an Excel spreadsheet format. The keywords used for searching in the databases were ("research data management" AND "Hungary").

Selection Criteria

From SCOPUS, Web of Science, and EBSCO databases, 41 records were found. Twenty-six records were found from SCOPUS, six records were found from Web of Science, and nine records were found from EBSCO. Duplication checking was conducted to find duplicate records in those three databases, and ten records were detected as duplicates and removed. The remaining 31 records were directly sought for article retrieval, but five could not be retrieved. Twenty-six articles were downloaded to check the eligibility of the topic. Following the search, the remaining articles were subjected to manual and independent screening. Following an independent screening process that involved reading the content of the remaining articles, those that fell outside the scope of the topic were eliminated. Of 26 articles, thirteen were not in line with the topic of this study. The topic was research data management from the Hungarian perspective, so only articles about research data management, which Hungarians wrote, were included in this study. The remaining 13 articles were included in this study and will be explained further below.

Findings and Discussion

This systematic literature review focuses on research data management from a Hungarian perspective; therefore, the final articles about research data management were all written by Hungarian researchers and academicians. This study included 13 articles from 2015 to 2021.

From Table 1, it can be seen that Tibor Koltay wrote ten of the thirteen articles from 2015 to 2020. The other three articles were written by Erzsébet Tóth-Czifra and published in 2020; Andrea Nass, Kristine Asch, Stephan van Gassel et al. in 2021; and Marton Kovacs, Rink Hoekstra, Balazs Aczel also published in 2021. Ten publications are journal articles, and the other three are book chapters. Tibor Koltay and Erzsébet Tóth-Czifra wrote review papers. Meanwhile,

one paper was written in an overview format, and another used a quantitative method. Three of the thirteen articles were not published in library and information field journals.

Table 2 summarizes research data management activities in published articles by Hungarian authors. The research data management activities are data sharing, data citation, data curation, and data storage. Koltay and Tóth-Czifra wrote about data sharing, and Koltay additionally wrote about data citation and data curation from 2016 to 2020. Meanwhile, Nass et al. and Tóth-Czifra wrote about data storage.

Data Sharing

We documented two studies from 13 selected documents explaining data sharing in research data management activities, focusing on data sharing issues. Concerning the issue of data sharing, professionals working in the information field are faced with significant questions. These include situations where retrieval, storage, preservation, administration, access, and policy issues intersect (Koltay, 2016c). To prepare data for computational analysis and ensure that it aligns with the standards and data models of the repositories for data sharing, there is insufficient motivation and recognition for investing the significant amount of time, effort, and expertise required. Consequently, only a small number of users are willing to share data and participate in building metadata repositories (Tóth-Czifra, 2020).

Data Citation

Of the 13 selected studies, five studies included data citations in their publications. Tibor Koltay wrote all the publications in 2016, 2017, and 2019. One of the most important aspects of the data-sharing movement is the citation of data, which highlights the significance of acknowledging data as a valuable scholarly contribution to establish its fundamental functionality (Koltay, 2016c). Establishing standardized data citation forms is of the utmost importance because they can motivate researchers to disseminate and publish their data, which may result in recognition and rewards for their efforts (Koltay, 2017a). The granularity problem arises when dealing with data citation; this is especially true when dealing with data sets instead of print publications, where citing at various degrees of precision is typically not a significant issue (Koltay, 2016a). Academic libraries are responsible for prioritizing the support of multiple initiatives that promote data citation standards and collaborating closely with researchers to advance recognition and incentives for data citation through collaboration (Koltay, 2016d).

Data Curation

We documented five studies from 13 selected studies focused on data curation in research data management. Tibor Koltay wrote all of the studies. "Digital curation" is a term

Table 1*Studies Included in the Systematic Review*

Reference	Document type	Publication type
Koltay, T. (2015). Data literacy: in search of a name and identity. <i>Journal of Documentation</i>	Review	Journal article
Koltay, T. (2016). Are you ready? Tasks and roles for academic libraries in supporting Research 2.0. <i>New Library World</i>	Review	Journal article
Koltay, T. (2016). Data governance, data literacy and the management of data quality. <i>IFLA Journal</i> .	Review	Journal article
Koltay, T. (2016). Digital Research Data: Where are we Now? <i>Digital Information Strategies: From Applications and Content to Libraries and People</i>	Review	Book chapter
Koltay, T. (2016). Facing the Challenge of Data-Intensive Research: Research Data Services and Data Literacy in Academic Libraries. <i>Innovation in Libraries and Information Services</i> .	Review	Book chapter
Koltay, T. (2017). Data literacy for researchers and data librarians. <i>Journal of Librarianship and Information Science</i> .	Review	Journal article
Koltay, T. (2017). Research 2.0 and Research Data Services in academic and research libraries: priority issues. <i>Library Management</i> .	Review	Journal article
Koltay, T. (2019). Accepted and Emerging Roles of Academic Libraries in Supporting Research 2.0. <i>The Journal of Academic Librarianship</i> .	Review	Journal article
Koltay, T. (2019). Data Curation in Academic Libraries as Part of the Digital Revolution. <i>Zagadnienia Informacji Naukowej - Studia Informacyjne</i> .	Review	Journal article
Koltay, T. (2020). Quality of Open Research Data: Values, Convergences and Governance. <i>Information</i>	Review	Journal article
Tóth-Czifra, E. (2020). The Risk of Losing the Thick Description: Data Management Challenges Faced by the Arts and Humanities in the Evolving FAIR Data Ecosystem. <i>Digital Technology and the Practices of Humanities Research</i>	Review	Book chapter
Nass et al. (2021). Facilitating reuse of planetary spatial research data – Conceptualizing an open map repository as part of a Planetary Research Data Infrastructure. <i>Planetary and Space Science</i> .	Overview	Journal article
Kovacs, M., Hoekstra, R., & Balazs, A. (2021). The Role of Human Fallibility in Psychological Research: A Survey of Mistakes in Data Management. <i>Advances in Methods and Practices in Psychological Science</i> .	Quantitative	Journal article

Table 2*Research Data Management Activities*

Activity	Author
Data sharing	(Koltay, 2016c; Tóth-Czifra, 2020)
Data citation	(Koltay, 2016a, 2016c, 2016d, 2017a, 2019a)
Data curation	(Koltay, 2016c, 2016d, 2017b, 2019b, 2020)
Data storage	(Nass et al., 2021; Tóth-Czifra, 2020)

that encompasses both the process of data curation and digital preservation. It contributes to the enhancement of reliable data assets for use in the present and the future, serving as an important preventative measure against the loss of data (Koltay, 2017b). Data curation focuses on extracting data for general purposes rather than internal storage. The data curation process, primarily carried out in data centers, is increasingly concentrating on improving data quality to guarantee the authentication of digital assets. At the same time, data is being used and reused (Koltay, 2020). In addition to providing an essential channel for the curation and dissemination of data, data repositories also strengthen the connection between libraries and the process of data curation (Koltay, 2016d). Among the qualifications and abilities that librarians

Table 3

Research Data Management Activities

Relation	Author
Data governance	(Koltay, 2016b, 2020)
Data quality	(Koltay, 2016b, 2016c, 2016d, 2017a, 2020; Nass et al., 2021)
Data literacy	(Koltay, 2015, 2016b, 2016d, 2016c, 2016a, 2017b, 2017a, 2019a)
Research data service	(Koltay, 2016a, 2016b, 2016c, 2016d, 2017a, 2017b, 2020)

can be asked to employ are those that could be helpful for data curation (Koltay, 2019b). An intriguing facet of data curation is disposing of 'unnecessary' data. Decisions about data disposal must account not only for changes in the potential long-term value of datasets but also for any legislation governing the time certain types of data must be preserved. The nature of some data may influence this (Koltay, 2016c).

Data Storage

Of the 13 selected studies, only two publications included data storage in their writings. Data is typically stored within governmental organizations following national or even organizational regulations. This data has been stored in various data types, with varying technical and scientific categories, following portrayal guidelines, and at varying scales depending on the mapping customs and the nation's size (Nass et al., 2021). This is a critical suggestion included in the FAIR principles, designed to improve access to research data. The FAIR principles recommend storing data in dependable, resilient digital repositories (Tóth-Czifra, 2020).

Table 3 summarizes the relationship between research data management and related data concepts. The authors found four (4) data concepts: data governance, data quality, data literacy, and research data service. Tibor Koltay monopolized the literature regarding the relationship between research data management and related data concepts.

Data Governance

Two of the 13 selected studies discussed data governance. The establishment of standardized, repeatable procedures is made easier by data governance, which in turn leads to a reduction in costs and an increase in efficiency. This is accomplished through the coordination of efforts and the promotion of process transparency. When monitoring data about human subjects, governance structures are vital. Researchers, research institutions, funders, publishers, and members of the general public are all considered stakeholders in the context

of data governance in research organizations (Koltay, 2016b). The quality of data can be improved through the implementation of data governance. Implementing risk-mitigating policies should be the primary focus of data governance to effectively manage risks that may arise due to failing to adhere to information policies or a lack of control. The centrality of data governance may be affected by the significance of cloud computing (Koltay, 2020).

Data Quality

We documented 6 studies from 13 selected studies that included data quality. Data quality key factors are availability, discoverability, trust, authenticity, acceptability, accuracy (correctness and consistency), applicability, integrity, completeness, understandability, and usability (Koltay, 2016b). Many different factors can affect the quality of the data, which is an essential component of the paradigm of data-intensive scientific research. Trust is the first factor. One's level of understanding and acceptance of data, as well as its lineage, version, and error rate, all contribute to one's level of trust in the data. In addition to that, authenticity is a component of data quality. To determine the authenticity of the data, it must be understandable (Koltay, 2016c, 2016d, 2017a). Those responsible for evaluating the data quality must have access to an appropriate tool that can access the data and demonstrate sufficient integrity to be displayed. The ability to demonstrate that data is identical, at the bit level, to a state that has been accepted or verified in the past is what is meant by the term "data integrity." When it comes to ensuring the usability, comprehensibility, authenticity, and overall quality of data, maintaining data integrity is an essential component (Koltay, 2016c). For a specific field like geography, spatial data quality is assessed by examining its completeness, logical coherence, geographical accuracy, chronological accuracy, and thematic accuracy (Nass et al., 2021). The researchers themselves are the most critical stakeholders in ensuring the quality of the research data. Promoting openness and transparency is one way for publishers to improve the quality of their published data. To a significant extent, the future of data quality depends on data professionals' efficient actions (Koltay, 2020).

Data Literacy

Of the 13 selected studies, eight explore data literacy. Tibor Koltay wrote about data literacy in publications from 2015, 2016, 2017, 2019, and 2020. Data literacy is an essential component of an ongoing educational progression that begins in elementary school, continues through higher education, and culminates in learning that continues throughout one's entire life (Koltay, 2016b). Data literacy, which transcends disciplinary boundaries and the traditional organizational structures of academic libraries, emphasizes issues pertaining to ownership and rights (Koltay, 2016c). One of the most important aspects of data literacy is the emphasis

placed on data generation. Another key aspect of data literacy is utilizing data in various ways (Koltay, 2015). Graduate students need focused data literacy education because they have more independence in selecting data sets for their use and research groups.

Furthermore, there is an increasing acknowledgment that undergraduate students could benefit from instruction on data resources. Data literacy is essential for the mentioned audiences and potential data librarians who seek to acquire the skills needed to effectively assist researchers (Koltay, 2016d, 2017a). Data literacy education should encompass social and technical facets (Koltay, 2016d, 2016a). It is necessary to understand the significance of data collection and the various approaches that can be taken to teach data literacy. To understand the potential factors that could affect the data, education about data literacy should emphasize verifying the origin and reliability of the data (Koltay, 2019a). For the majority of situations, having the ability to manage data effectively can be beneficial in virtually every process that involves data management (Koltay, 2017b).

Research Data Service

We documented seven studies from 14 selected studies discussing research data services. All of the studies were written by Tibor Koltay in 2016, 2017, and 2020. In the library, conventional services are being expanded to include research data services. Research data services (RDSs) are highly complex, including research data management and curation, data stewardship, data governance, data literacy, data quality, and standardized data citation (Koltay, 2017b). In the context of research data services, consulting with faculty, staff, or students about data management plans (DMPs) and metadata standards, providing reference support for locating and citing data sets, and developing web guides and finding aids for data or data sets are all examples of what is included (Koltay, 2016d, 2017a). The utilization of data repositories, the preparation of data sets for storage, and the removal of data sets from repositories are all areas in which technical services are available to assist researchers (Koltay, 2016a). This allows academic libraries to participate in various fields by providing research data services encompassing the entire data lifecycle. These services include planning, curating, and the generation and transformation of metadata (Koltay, 2016c). By providing research data services to academic communities, which may consist of data assurance and validation, academic libraries have the potential to play an essential role as data quality anchors on campus (Koltay, 2016b, 2016c, 2020).

Conclusion

Most articles related to data management that Hungarian researchers wrote were literature reviews. Tibor Koltay was responsible for the majority of the articles. The Hungarian

authors covered four different research data management activities. These activities were data sharing, data citation, data curation, and data storage. Several other data-related concepts, including data governance, data quality, data literacy, and research data service, were also discussed in this study.

From the literature, it can be concluded that very few data stakeholders share data and actively build metadata repositories. Standardized data citation forms encourage researchers to share and publish their data, potentially earning them recognition and rewards. Data curation may require librarians to use specific skills. Data disposal decisions should consider datasets' long-term value and laws requiring data preservation. Data governance improves data quality. Researchers are the main stakeholders because they ensure data quality. Data literacy education should prioritize data source and reliability verification to understand data quality and its impact. Research data services from academic libraries can anchor campus data quality.

This study aims to help researchers, especially Hungarian researchers, deepen their understanding of research data management. It shows that Hungarian researchers working in research data management prefer to write literature review articles rather than collect data from field research. Since most of the articles collected were reviews of previous literature, the authors recommend that other research methods concerning research data management be utilized to acquire a more in-depth comprehension of the research data management practice in Hungary.

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Appendix A. PRISMA Flow Diagram (Page et al., 2021)

