Digitalization and Management Innovation III A.J. Tallón-Ballesteros (Ed.) © 2025 The Authors. This article is published online with Open Access by IOS Press and distributed under the terms of the Creative Commons Attribution Non-Commercial License 4.0 (CC BY-NC 4.0). doi:10.3233/FAIA250006

# Empowering IT-Supported Research Management: Leveraging Data Science Methods for Informed Decisions

Otmane Azeroual<sup>a,1</sup>

<sup>a</sup> German Centre for Higher Education Research and Science Studies (DZHW), 10117, Berlin, Germany ORCiD ID: Otmane Azeroual https://orcid.org/0000-0002-5225-389X

Abstract. In today's landscape of research management, the integration of Information Technology (IT) methods and data science has emerged as a powerful paradigm for enhancing decision-making processes. This paper examines the central role of IT-supported research management, such as Research Information Systems (RIS), in leveraging data science methods for informed decision-making. It addresses the importance of integrating IT infrastructure with advanced analytical techniques to enable data-driven insights and optimize research management strategies. Through a comprehensive review of relevant literature and case studies, this paper elucidates how RIS enables organizations to harness the full potential of data science methods for improved decision support across various facets of research activities. Additionally, it discusses the challenges and opportunities associated with this integration and provides insights into future directions for advancing IT-supported research management practices.

**Keywords.** IT-supported research management, research information systems (RIS), data science, decision-making processes, research management, research infrastructure, research outcomes, data-driven insights.

#### 1. Introduction

In the current era of digital transformation, data plays an indispensable role across various domains, notably in research [1]. Research management, which involves organizing, planning, executing, and evaluating research endeavors, confronts the daunting task of efficiently handling the exponentially expanding reservoir of research data. Within this framework, data science methods are becoming increasingly vital as they aid research institutions in extracting valuable insights and executing informed decisions amidst this inundation of data [2].

Research management entails a multitude of tasks, including identifying research goals and priorities, allocating resources, planning research projects, fostering collaboration among researchers, and evaluating research outcomes [3]. Effectively managing these processes requires not only careful planning and organization but also

<sup>&</sup>lt;sup>1</sup> Corresponding Author: Otmane Azeroual, German Centre for Higher Education Research and Science Studies, 10117 Berlin, Germany; E-mail: <u>azeroual@dzhw.eu</u>.

the application of advanced analytical methods to optimize performance and achieve research objectives [4].

A central component of IT-supported research management is the Research Information System (RIS), serving as a database to store, organize, and manage research data [5]. These databases comprise a wealth of information, including publications, research projects, researchers, funding sources, and more [6]. The potential of data science methods in these databases lies in analyzing and interpreting this vast amount of data to gain valuable insights and make informed decisions [7].

Data science methods, as depicted in Figure 1, can contribute to enhancing the efficiency and effectiveness of RIS by, for example:



Figure 1. Effective Applications of Data Science Methods.

- Enabling data cleansing and integration to improve the quality of information stored in the database.
- Conducting pattern recognition and trend analysis to identify significant developments in specific research areas.
- Performing network analysis to visualize and understand collaboration among researchers and institutions.
- Applying predictive analytics to forecast future research trends and allocate resources accordingly.
- Utilizing knowledge graphs to model complex relationships between research entities and facilitate semantic search for research content.

• Providing user-centric recommendations to assist researchers in identifying relevant publications, projects, or collaboration opportunities.

The deployment of data science methods in research management and information systems holds immense potential for significantly enhancing the efficiency and effectiveness of research endeavors. By analyzing large volumes of data, research institutions can discern patterns, identify trends, and make predictions for future developments [8]. Consequently, they can better plan research activities, allocate resources more efficiently, and develop innovative solutions for complex scientific inquiries.

While there is already a considerable amount of literature on data science and research management, the specific consideration of the integration of IT and data science methods in this context is relatively novel [9, 10]. Some authors who have explored similar topics include Foster Provost and Tom Fawcett in their book "Data Science for Business" [11], which addresses the application of data science in various business domains. However, there are still few studies specifically focusing on the integration of data science into research management, underscoring the relevance and significance of this topic for the research community.

The objective of this paper is to examine the importance of integrating information technology (IT) and data science methods in research management and emphasize how this integration can support informed decision-making processes. We aim to elucidate the various ways in which data science can enhance research management, ranging from efficient data collection to analysis, visualization, interpretation, and decision-making.

The relevance of this topic to the user lies in the opportunity to improve the performance of RIS and advance research activities overall. By integrating data science methods into research management and information systems, research institutions can develop a data-driven approach to decision-making, thereby enhancing their competitiveness and positively impacting the scientific community.

This paper is divided into eight sections. The (1) section provides an introduction to the paper's topic. The (2) section defines the term "Research Information Systems" (RIS) and elucidates the functions and purposes of these systems in research. Furthermore, it provides a clear definition of research pursuits and their primary categories. The (3) section discusses the significance of data science for research activity management. The (4) section delves into how data science methods can be specifically employed to support decision-making processes in IT-supported research management. It includes detailed examples of how data science can improve activities such as resource allocation, project selection, and strategic planning. The (5) section explores how a holistic approach to integrating data science into all aspects of IT-supported research management can be implemented. The (6) section discusses the obstacles and opportunities associated with integrating data science into IT-supported research management. The (7) section sheds light on potential developments and trends in IT-supported research management. Finally, the (8) section summarizes the key findings of the paper and underscores the importance of data science for IT-supported research management.

#### 2. Understanding IT-Supported Research Information Systems

RIS serve as comprehensive platforms designed to facilitate and streamline various stages of the research lifecycle within the context of research management [12]. These systems encompass a broad spectrum of tools and technologies tailored to support the

diverse needs of researchers, academic institutions, funding agencies, and other stakeholders involved in the research process [13, 14]. A deeper comprehension of RIS is essential for appreciating their role in modern research endeavors.

At its core, a RIS serves as a centralized repository for storing, managing, and disseminating research-related data and information [15]. This includes but is not limited to publications, datasets, project descriptions, funding information, patents, and collaborations. By consolidating these diverse resources into a unified platform, RIS facilitate easy access to critical information, thereby enhancing collaboration, transparency, and knowledge sharing among researchers and institutions [16].

One of the primary functions of RIS is to support data collection and management throughout the research lifecycle. This involves capturing and organizing various types of research data, ranging from experimental results and survey responses to literature citations and research outputs. By providing structured data management tools, RIS enable researchers to maintain data integrity, track changes, and ensure compliance with data governance standards and regulatory requirements [17].

Moreover, RIS play a pivotal role in facilitating data analysis and visualization. These systems often integrate analytics platforms and tools that enable researchers to explore, analyze, and interpret research data effectively. By leveraging advanced analytical techniques, researchers can uncover patterns, trends, and insights hidden within large and complex datasets, thereby informing decision-making processes and driving scientific discovery [18].

In addition to data analysis, RIS support the publication and dissemination of research findings. These systems provide functionalities for manuscript submission, peer review management, and publication tracking, streamlining the scholarly publishing process. Furthermore, RIS offer mechanisms for disseminating research outputs, such as institutional repositories, preprint servers, and open-access platforms, thereby enhancing the visibility and impact of research within the academic community and beyond [5].

Collaboration is another critical aspect supported by RIS. These platforms facilitate collaboration among researchers, enabling them to share resources, coordinate activities, and work together on interdisciplinary projects [19]. By providing features such as project management tools, discussion forums, and collaborative workspaces, RIS promote teamwork and knowledge exchange, fostering innovation and accelerating research progress [20].

# 2.1 Defining Research Pursuits and Activities

To fully understand the role of RIS in research management, it is crucial to define what constitutes research pursuits and the specific activities involved. Research pursuits encompass a broad range of activities essential for the successful execution and management of research projects. These activities can be categorized into the following key areas:

- Setting Research Goals: Identifying and prioritizing research questions and objectives.
- Planning Projects: Designing research methodologies, timelines, and resource requirements.
- Allocating Resources: Distributing financial, human, and material resources to various research tasks.

- Fostering Collaboration: Encouraging interdisciplinary and inter-institutional partnerships and teamwork.
- Evaluating Outcomes: Assessing research results, impact, and overall success of research initiatives.

It is important to note that these activities can vary across different research domains. For instance, scientific research may place a heavier emphasis on experimental data and lab resources, whereas social science research might prioritize survey data and fieldwork collaboration. Figure 2 provides a visual representation of these core research activities and their interconnections, illustrating the typical workflow within a research lifecycle.



Figure 2. Core Research Activities and Their Interconnections.

In summary, RIS encompass a diverse array of tools and technologies aimed at supporting various facets of the research lifecycle. By facilitating data collection, analysis, publication, and collaboration, these systems enhance the efficiency, effectiveness, and impact of research activities, ultimately advancing scientific knowledge and innovation.

# 3. The Role of Data Science in IT-Supported Research Management

Data science has emerged as a transformative force in research management, offering sophisticated techniques to analyze and interpret vast amounts of data generated throughout the research lifecycle (see Figure 3). The integration of data science methods within IT-supported research management systems has revolutionized the way researchers extract insights and make informed decisions, thereby enhancing the efficiency and effectiveness of research management processes.



Figure 3. Foundations of Data Science.

One of the primary contributions of data science to IT-supported research management is its capability to uncover hidden patterns, trends, and correlations within large and complex datasets. Traditional analysis methods often struggle to unveil insights buried within extensive datasets due to their sheer volume and complexity [21]. Data science techniques, such as machine learning (ML) algorithms, enable researchers to sift through massive datasets and identify meaningful relationships and patterns that may not be apparent through manual examination. By leveraging these insights, research managers can gain a deeper understanding of research trends, emerging topics, and interdisciplinary connections, empowering them to make informed decisions about resource allocation and strategic planning [22].

Furthermore, data science optimizes resource allocation within research institutions [23]. By analyzing data on funding allocation, research output, and impact metrics, predictive models can forecast the potential impact of research investments and allocate resources accordingly. This ensures that funds are directed towards projects with the greatest likelihood of success [24]. Data-driven approaches also help identify inefficiencies in resource allocation processes, enabling research managers to reallocate resources more effectively and maximize research productivity [25].

Additionally, data science aids in identifying research priorities and strategic focus areas based on data-driven insights. By examining research outputs, citation patterns, and collaboration networks, data science methods can pinpoint emerging research trends and areas for interdisciplinary collaboration. This information informs strategic decisionmaking, guiding institutions in prioritizing funding, establishing research agendas, and fostering collaborations that drive innovation and address complex societal challenges.

Beyond resource allocation and priority setting, data science facilitates the assessment of research impact and effectiveness. By leveraging data analytics and visualization techniques, research managers can track and evaluate the impact of initiatives, publications, and collaborations. Metrics such as citation impact, social media mentions, and other indicators of research influence help assess the reach and significance of research outputs. Furthermore, data science methods can identify emerging trends and collaboration opportunities, enabling research managers to adapt strategies and initiatives to maximize impact and relevance.

### 4. Leveraging Data Science for Decision Support

Decision support is a critical facet of research management, involving the utilization of data-driven insights and predictive analytics to make informed decisions [26]. Data science assumes a central role in decision support by empowering research institutions to scrutinize research data, discern patterns, and forecast future trends, thereby guiding strategic decision-making processes concerning funding allocation, project selection, and overarching research strategy.

# 4.1 Enhancing Resource Allocation with Data Science

Predictive analytics, a fundamental element of data science [27], equips research managers with the capability to prognosticate the potential impact of research investments and pinpoint areas of research offering the highest return on investment. Through the analysis of research data pertaining to funding allocation, research outputs, and impact metrics, predictive models can anticipate future trends and outcomes, thereby enabling research institutions to allocate resources judiciously and optimize the impact of their research investments.

**Example:** A research institution can use predictive analytics to analyze historical funding data and research outputs. By identifying patterns in successful projects, the institution can forecast which new proposals are likely to yield high-impact results. This ensures that funds are directed towards the most promising areas of research, maximizing the return on investment. For instance, predictive analytics can aid in identifying burgeoning research domains with considerable growth prospects or areas necessitating additional investment to address pressing societal challenges.

# 4.2 Improving Project Selection through Data Science

Moreover, data science methodologies can aid research managers in project selection by evaluating the prospective success and impact of proposed research endeavors. By scrutinizing research data concerning project outcomes, funding success rates, and collaboration networks, data science models can discern promising research proposals and evaluate their likelihood of success. This empowers research institutions to prioritize funding for projects exhibiting the greatest potential for scientific breakthroughs or societal impact, ensuring that resources are allocated efficiently to advance research objectives.

**Example:** A university can employ ML algorithms to analyze past research project data, including success rates, funding amounts, and collaboration networks. By applying these models, the university can predict which new projects are likely to succeed based on similar characteristics. This data-driven approach helps in selecting projects with the highest potential, thereby optimizing the use of available funds and resources.

# 4.3 Strategic Planning with Data Science

Strategic planning represents another domain where data science can furnish valuable decision support to research institutions. By analyzing research data pertaining to research trends, collaboration networks, and emergent technologies, data science models can identify strategic priorities and avenues for innovation. This encompasses the identification of research domains aligning with institutional strengths and capabilities,

alongside the projection of future trends and challenges impacting research agendas. Armed with this intelligence, research managers can formulate strategic plans congruent with organizational goals and priorities, thereby ensuring that research endeavors are concentrated on areas boasting the greatest potential for impact and relevance.

**Example:** By analyzing collaboration networks and citation patterns, a research institution can identify key areas for potential growth and interdisciplinary collaboration. Data science models can forecast emerging research trends and highlight strategic opportunities for investment, helping institutions align their research agendas with long-term goals and societal needs.

Overall, harnessing data science for decision support empowers research institutions to make evidence-based decisions propelling scientific innovation and discovery. By scrutinizing research data, forecasting future trends, and identifying strategic priorities, data science enables research managers to allocate resources effectively, select promising research projects, and devise strategic plans fostering research goals and tackling societal challenges. This ultimately amplifies the efficiency and efficacy of research management processes, propelling scientific advancement and societal impact.



Figure 4. Leveraging Data Science for Decision Support.

Figure 4 illustrates the process of leveraging data science for decision support in research management. It delineates the various stages involved, encompassing data collection, analysis, modeling, and decision-making. At each juncture, data science techniques such as predictive analytics, ML, and data visualization are employed to distill insights and guide strategic decisions pertaining to funding allocation, project selection, and strategic planning [28]. Through this iterative progression, research institutions can refine their research management practices and propel scientific innovation and discovery.

#### 5. Implementing a Holistic Approach to IT-Supported Research Management

In the realm of contemporary research management, the integration of data science methods throughout the entirety of the research lifecycle has garnered significant importance. This holistic approach encompasses a series of interconnected phases, commencing with data collection and preprocessing, progressing through analysis and visualization, and culminating in interpretation and decision-making. By adopting a comprehensive strategy encompassing the following steps (1-5), research institutions can

effectively harness the potential of data-driven insights to inform and optimize decisionmaking processes at each juncture of the research endeavor.

- 1. Data Collection: The initial step in implementing a holistic approach to research management entails the collection of pertinent data from diverse sources. This may encompass experimental data, survey responses, literature reviews, and external datasets. Leveraging data science techniques such as web scraping, data mining, and sensor data acquisition empowers research institutions to efficiently and comprehensively amass diverse datasets. Furthermore, ensuring data quality and integrity through robust data governance practices is imperative for the success of this stage.
- 2. Preprocessing: Following data collection, the gathered data undergoes preprocessing to clean, transform, and prepare it for analysis. Data preprocessing encompasses tasks such as handling missing values, removing outliers, standardizing formats, and integrating disparate datasets. Data science methods, including data cleaning algorithms, feature engineering techniques, and dimensionality reduction approaches, assume a pivotal role in this stage. By preprocessing data effectively, research institutions can augment the quality and usability of their datasets, establishing a robust foundation for subsequent analysis.
- 3. Analysis: Data analysis constitutes a fundamental component of research management, involving the exploration and interpretation of data to extract meaningful insights and patterns. Data science methods such as statistical analysis, ML algorithms, and data visualization techniques empower researchers to unveil hidden relationships, identify trends, and formulate hypotheses. Through exploratory data analysis (EDA) and hypothesis testing, researchers can attain a deeper understanding of their data and draw evidence-based conclusions to guide further research directions.
- 4. Visualization: Data visualization assumes a critical role in effectively communicating research findings and insights. By leveraging data science methods to generate visual representations of data, such as charts, graphs, and interactive dashboards, researchers can elucidate complex information in a clear and intuitive manner. Visualization techniques facilitate the identification of trends, patterns, and outliers visually, thereby facilitating data-driven decision-making and enhancing the accessibility and impact of research outcomes.
- 5. Interpretation: The final stage of the research lifecycle entails interpreting the results of data analysis and visualization to derive actionable insights and conclusions. Data science methods support this process by furnishing tools for statistical inference, hypothesis testing, and predictive modeling. Through meticulous interpretation of research findings, researchers can formulate meaningful conclusions, validate hypotheses, and make informed decisions to advance scientific knowledge and address research questions effectively.

Utilizing the mind map presented in Figure 5 below, these five steps are succinctly encapsulated. Employing this holistic approach to research management, bolstered by data science methods, within a RIS like Elsevier's (https://www.elsevier.com/products/pure), empowers research organizations to efficiently collect, preprocess, analyze, visualize, and interpret research data. Through

the integration of these methodologies, institutions can streamline decision-making processes, enhance research outcomes, and propel scientific innovation forward.



Figure 5. Research Management with Data Science Integration.

#### 6. Challenges and Opportunities in Research Management

The integration of data science into research management, particularly in RIS, undoubtedly offers numerous opportunities to optimize decision-making processes and enhance the efficiency of scientific activities. However, it also presents challenges that need to be addressed. One of the key challenges is ensuring data quality. Since research data often originates from various sources and may exist in different formats, it is crucial to ensure that the data is consistent, complete, and of high quality [29]. Data errors or deficiencies can distort analysis results and lead to erroneous decisions [30].

Another central concern is the protection of privacy and security of research data [31]. Given the sensitivity of many research datasets, especially in areas such as medical research or social sciences, it is essential to implement adequate security measures to safeguard the confidentiality and integrity of the data [32]. This may involve implementing secure data access controls, anonymizing sensitive information, and adhering to applicable privacy regulations.

Another issue that is often overlooked is the interpretability of data science models and results. Complex algorithms such as neural networks or deep learning models can lead to "black-box" problems, where decision-making becomes opaque and difficult to understand [33]. This complicates the acceptance and application of results in research practice and requires the use of methods for model interpretation and explainability.

In addition to these technical challenges, cultural barriers within research institutions can hinder the adoption of data-driven decision-making processes. This may include resistance to change, lack of trust in new technologies, or insufficient training and resources. To overcome these obstacles, it is important to raise awareness of the benefits of data science, provide training, and foster an organizational culture of innovation and collaboration.

Despite these challenges, numerous opportunities exist for research institutions looking to integrate data science into their management practices. By leveraging advanced analytical techniques, researchers can gain new insights, identify connections,

49

and make informed decisions. Furthermore, automating routine tasks can increase productivity and free up researchers' time for creative activities and innovation. With the right strategy and investment, research institutions can fully harness the potential of data science and further enhance their contributions to scientific knowledge and innovation.

#### 7. Future Directions and Emerging Trends

The future trajectory and evolution of research management point towards further transformations as new technologies and methods continue to emerge. Some of the key trends to monitor include the integration of artificial intelligence (AI) and ML into RIS, the proliferation of Open Science practices, and the increasing emphasis on interdisciplinary collaboration. By proactively engaging with these developments, research institutions can position themselves for success in an increasingly data-driven world.

The integration of AI and ML into RIS holds promise for a variety of applications and benefits. Through the deployment of AI algorithms, RIS can develop automated decision support systems, aiding researchers in identifying relevant literature, predicting research trends, and generating tailored recommendations. Furthermore, advanced ML models enable more precise data analysis and prediction, leading to more informed research decisions.

The growing adoption of Open Science practices has the potential to fundamentally alter the research landscape [34]. Open Science initiatives aim to promote free access to scientific results, data, and methods to enhance the transparency, reproducibility, and reusability of research findings [35]. By opening up research data and results, research institutions can facilitate collaboration, accelerate knowledge transfer, and increase the rate of innovation.

Another important trend is the increased emphasis on interdisciplinary collaboration in research. Given the complex societal challenges, more researchers recognize the necessity of collaborating across disciplines to develop holistic solutions. Research institutions should thus promote the creation of frameworks and incentives that facilitate and support interdisciplinary collaboration.

By actively pursuing and preparing for these future trends, research institutions can strengthen their competitiveness and solidify their position as leading players in the research landscape. Through the integration of AI, the promotion of Open Science practices, and the fostering of interdisciplinary collaboration, research institutions can develop innovative solutions to drive scientific progress and address societal challenges.

# 8. Conclusion

In summary, data science methods offer tremendous potential for enhancing research management and decision support within RIS. By adopting a holistic approach to datadriven decision-making, research institutions can optimize their workflows, improve the efficiency of their research projects, and ultimately accelerate the pace of scientific discoveries.

The deployment of data science methods enables research institutions to gain valuable insights from a wealth of research data and make informed decisions. From identifying research goals to resource allocation and forecasting research trends, data analytics and models can help enhance research efficiency and optimize strategic alignment.

A holistic approach to data analysis and interpretation ensures that research institutions not only consider individual components of the research process but also understand their interactions and relationships. By integrating data science methods across the entire research lifecycle, research institutions can ensure that data is effectively utilized in every phase of the process to make informed decisions and drive scientific progress.

Moreover, the application of data science methods in RIS provides an opportunity to make research findings transparent and comprehensible. By employing data visualization techniques and providing dashboards, researchers and decision-makers can better understand and interpret research data, leading to improved collaboration and communication within the research community.

Overall, advancements in data science and its integration into RIS paint a promising future for research management. By fully harnessing the capabilities of data science methods and adopting a holistic approach to leveraging research data, research institutions can strengthen their knowledge generation capacity and make a sustainable contribution to scientific development.

#### References

- Kraus S, Jones P, Kailer N, Weinmann A, Chaparro-Banegas N, Roig-Tierno N. Digital transformation: An overview of the current state of the art of research. *Sage Open*, 2021; *11*(3), doi:10.1177/21582440211047576.
- [2] Ibeh CV, Asuzu OF, Olorunsogo T, Elufioye OA, Nduubuisi NL, Daraojimba AI. Business analytics and decision science: A review of techniques in strategic business decision making. *World Journal of Advanced Research and Reviews*, 2024; 21(02), 1761-1769, doi:10.30574/wjarr.2024.21.2.0247.
- [3] Barzman M, Gerphagnon M, Aubin-Houzelstein G, Baron GL, Benard A, Bouchet F, Dibie J, Gibrat JF, Hodson S, Lhoste E, Martin C, Moulier-Boutang Y, Perrot S, Phung F, Pichot C, Siné M, Venin T, Mora O. Exploring digital transformation in higher education and research via scenarios. *Journal of Futures Studies*, 2021; 25(3), 65-78, doi:10.6531/JFS.202103\_25(3).0006.
- [4] Martinez I, Viles E, Olaizola IG. Data science methodologies: Current challenges and future approaches. Big Data Research, 2021; 24, 100183, doi:10.1016/j.bdr.2020.100183.
- [5] Schöpfel J, Azeroual O. Current research information systems and institutional repositories: From data ingestion to convergence and merger. In Future directions in digital information (pp. 19-37), 2021. Chandos Publishing, doi:10.1016/B978-0-12-822144-0.00002-1.
- [6] Azeroual O, Saake G, Abuosba M. Data quality measures and data cleansing for research information systems. arXiv preprint, 2019; arXiv:1901.06208, doi:10.48550/arXiv.1901.06208.
- [7] Tonidandel S, King EB, Cortina JM. Big data methods: Leveraging modern data analytic techniques to build organizational science. Organizational research methods, 2018; 21(3), 525-547, doi:10.1177/1094428116677299.
- [8] Gepp A, Linnenluecke MK, O'Neill TJ, Smith T. Big data techniques in auditing research and practice: Current trends and future opportunities. *Journal of Accounting Literature*, 2018; 40(1), 102-115, doi:10.1016/j.acclit.2017.05.003.
- [9] Liang TP, Liu YH. Research landscape of business intelligence and big data analytics: A bibliometrics study. *Expert Systems with Applications*, 2018; 111, 2-10, doi:10.1016/j.eswa.2018.05.018.
- [10] Luan H, Geczy P, Lai H, Gobert J, Yang SJ, Ogata H, Baltes J, Guerra R, Li P, Tsa CC. Challenges and future directions of big data and artificial intelligence in education. *Frontiers in psychology*, 2020; 11, 580820, doi:10.3389/fpsyg.2020.580820.
- [11] Provost F, Fawcett T. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking. Sebastopol, California: O'Reilly, 2013.
- [12] Carr-Wiggin M, Rothfus M, Barrett A, Bourne-Tyson D. Implementing a Current Research Information System (CRIS) in Canada. Proceedings of the IATUL Conferences. Paper 3, 2019. https://docs.lib.purdue.edu/iatul/2019/value/3

- [13] Biesenbender S, Petersohn S, Thiedig C. Using Current Research Information Systems (CRIS) to showcase national and institutional research (potential): research information systems in the context of Open Science. *Procedia Computer Science*, 2019; 146, 142-155, doi:10.1016/j.procs.2019.01.089.
- [14] Subaveerapandiyan A, Ugwulebo JE. Research data management in selected East African libraries: A survey. *IFLA Journal*, 2024; 03400352231226214, doi:10.1177/03400352231226.
- [15] Dierkes J, Wuttke U. The Göttingen eResearch Alliance: A case study of developing and establishing institutional support for research data management. *ISPRS International Journal of Geo-Information*, 2016; 5(8), 133, doi:10.3390/ijgi5080133.
- [16] Sivertsen G. Developing Current Research Information Systems (CRIS) as data sources for studies of research. Springer handbook of science and technology indicators, 2019; 667-683, doi:10.1007/978-3-030-02511-3 25.
- [17] Briney K. Data Management for Researchers: Organize, maintain and share your data for research success. Pelagic Publishing Ltd. 2015.
- [18] Wang H, Xu Z, Fujita H, Liu S. Towards felicitous decision making: An overview on challenges and trends of Big Data. *Information Sciences*, 2016; 367, 747-765, doi:10.1016/j.ins.2016.07.007.
- [19] Bryant R, Clements A, Feltes C, Groenewegen D, Hoggard S, Mercer H, Missingham R, Oxnam M, Rauh A, Wright J. Research information management: Defining RIM and the library's role. OCLC Research, 2017, doi:10.25333/C3NK88.
- [20] Andersen J, Toom K, Poli S, Miller PF. Research management: Europe and beyond. Academic Press, 2017, doi:10.1016/C2015-0-00323-9.
- [21] Dresp-Langley B, Ekseth OK, Fesl J, Gohshi S, Kurz M, Sehring HW. Occam's Razor for Big Data? On detecting quality in large unstructured datasets. *Applied Sciences*, 2019; 9(15), 3065, doi:10.3390/app9153065.
- [22] George B, Wooden O. Managing the strategic transformation of higher education through artificial intelligence. Administrative Sciences, 2023; 13(9), 196, doi:10.3390/admsci13090196.
- [23] Bag S, Pretorius JHC, Gupta S, Dwivedi YK. Role of institutional pressures and resources in the adoption of big data analytics powered artificial intelligence, sustainable manufacturing practices and circular economy capabilities. *Technological Forecasting and Social Change*, 2021; *163*, 120420, doi:10.1016/j.techfore.2020.120420.
- [24] Attaran M, Stark J, Stotler, D. Opportunities and challenges for big data analytics in US higher education: A conceptual model for implementation. *Industry and Higher Education*, 2018; 32(3), 169-182, doi:10.1177/0950422218770937.
- [25] Henke N, Jacques Bughin L. The age of analytics: Competing in a data-driven world, 2016.
- [26] Sarker IH. Data science and analytics: an overview from data-driven smart computing, decision-making and applications perspective. SN Computer Science, 2021; 2(5), 377, doi:10.1007/s42979-021-00765-8.
- [27] Van Der Aalst W. Data science in action (pp. 3-23). Springer Berlin Heidelberg, 2016, doi:10.1007/978-3-662-49851-4\_1.
- [28] Fortino, A. Data Mining and Predictive Analytics for Business Decisions: A Case Study Approach, Berlin, Boston: Mercury Learning and Information, 2023, doi:10.1515/9781683926740.
- [29] Azeroual O, Saake G, Wastl J. Data measurement in research information systems: metrics for the evaluation of data quality. *Scientometrics*, 2018; 115(3), 1271-1290, doi:10.1007/s11192-018-2735-5.
- [30] Azeroual O, Saake G, Abuosba M, Schöpfel J. Solving problems of research information heterogeneity during integration–using the European CERIF and German RCD standards as examples. *Information Services & Use*, 2019; 39(1-2), 105-122, doi:10.3233/ISU-180030.
- [31] Zendulková D, Azeroual O. Legal aspects and data protection in relation to the CRIS system. Procedia Computer Science, 2022; 211, 17-27, doi:10.1016/j.procs.2022.10.172.
- [32] Foster I. Research infrastructure for the safe analysis of sensitive data. *The Annals of the American Academy of Political and Social Science*, 2018; 675(1), 102-120, doi:10.1177/00027162177426.
- [33] Hassija V, Chamola V, Mahapatra A, Singal A, Goel D, Huang K, Scardapane S, Spinelli I, Mahmud M, Hussain A. Interpreting black-box models: a review on explainable artificial intelligence. *Cognitive Computation*, 2024; 16(1), 45-74, doi:10.1007/s12559-023-10179-8.
- [34] Beck S, Bergenholtz C, Bogers M, Brasseur TM, Conradsen ML, Di Marco D, Effert A, Filiou D, Frederiksen L, Gillier T, Gruber M, Haeussler C, Hoisl K, Kokshagina O, Norn MT, Poetz M, Pruschak G, Priego LP, Radziwon A, Ruser A, Sauermann H, Shah SK, Suess-Reyes J, Tucci CL, Tuertscher P, Vedel JB, Verganti R, Wareham J, Xu SM. The Open Innovation in Science research field: a collaborative conceptualisation approach. *Industry and Innovation*, 2022; 29(2), 136-185, doi:10.1080/13662716.2020.1792274.
- [35] Schöpfel J, Azeroual O, Jungbauer-Gans M. Research ethics, open science and CRIS. *Publications*, 2020; 8(4), 51, doi:10.3390/publications8040051.