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Improving IT support for UASs' RDI activities for creating together RDI data ecosystems

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Abstract

Research, development, and innovative activities (RDI) and education are the core businesses of the Finnish Universities of Applied Sciences (UAS). The Finnish Higher Education Institutions' (HEI) Digivision ecosystem project has well-channelled the digital transformation of higher education. However, Finnish UAS does not have the same kind of digital transformation project for RDI activities. The IT barometer of Finnish HEIs' Chief Information Officers (CIO) 2024 shows that only 2 % of UAS CIOs' near-term development courses of action support RDI activities, compared to 23 % of measures to support education, teaching, and learning. We set up an RDI data management working group and conducted a qualitative survey to determine where this bias comes from and whether it needs to be corrected. Digital and data ecosystem studies reveal that organisations' digital transformation guides them to share data resources, thereby building service and data ecosystems (e.g., Altendeitering et al., 2024; Oberländer et al., 2025). Thus, we must improve our communication, collaboration, and IT capabilities to support and create national and international RDI data ecosystems. Consequently, I have listed three courses of action and three means of improving UAS RDI data ecosystems.

Keywords: RDI-activities, IT services, digital transformation, data ecosystem, universities of applied sciences

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1 Introduction

RDI activities are a statutory duty of the Finnish UAS. In 2023, total RDI funding was around 273 million euros[†], more than a quarter of the total national yearly budget for UAS. The Arene Rector's Council's key strategic objective is for the RDI activities of UAS to be firmly recognised and funded internationally and nationally. Higher education institutions are in intense digital transformation. They are already, or at least will be soon, technology-first organisations, which means that their new education and RDI business and new business models are based on technology innovations (Verhoef et al., 2021), such as AI development. Aspiring digital transformation and aiming to provide well-working business services steer us toward creating collaborating organisations' mutual digital or data ecosystems. Shared digital resources, capabilities, and data management are key constructs that keep digital ecosystems going, along with collaboration and competition (Altendeitering et al., 2024; Oberländer et al., 2025). The digital ecosystem approach is well implemented in the Digivision project in education, owned and funded by the Finnish Ministry of Education and Culture and higher education institutions, but is not as strong in the research and RDI activities sectors.

To address the discrepancy in IT development support for RDI activities, the AAPA—Finnish Universities of Applied Sciences CIO Forum launched a working group. Comprising three CIOs, three RDI leaders, and the IT secretary general, the group conducted a qualitative questionnaire to the RDI leaders' network. This collaborative effort, a single case study in an actual working life project (Yin, 2018), sheds light on how CIOs and RDI managers are developing their collaborative capabilities to improve IT support for creating digital ecosystems of RDI activities in partnership with research service providers. I have done the study alone, but as a working group member, I had the opportunity to use an ethnographic approach to deeply understand the phenomenon (Randall et al., 2007). The working group and study results improve UASs' communication and collaboration, data management, sensitive data management, scientific computing and storage, and digital preservation capabilities. In addition, the study provides practitioners with tools to strengthen the idea of building an RDI data ecosystem of UASs.

With the context of the Finnish UAS and its RDI activities, this paper aims to address the following question: How can IT support for RDI activities in Finnish UAS be improved?

This paper is structured as follows: we will begin with a review of the relevant literature, followed by a detailed description of the research method and settings, including a comprehensive overview of the research data. Finally, we will present the data analysis, findings, and conclusion, providing a clear roadmap for the reader.

2 Literature Review

RDI activities have a strong handprint in the development of UAS. RDI focuses on applied research, promotes working life, and renews the region's economic structure locally, nationally, and internationally. The RDI activities of the universities of applied sciences are mainly focused on small and medium-sized enterprises to promote the activities of private companies, public government agencies and third-sector organisations by providing researched and applied knowledge (Päällysaho et al., 2021). The open RDI activities promote collaboration and co-creation and generate new knowledge

[†] https://tki.fi/research-development-and-innovation-rdi-in-universities-of-applied-sciences/

and innovations in the interaction between the UAS sector and society (Kärki et al., 2021). Universities of applied sciences, therefore, have a solid mandate to carry out RDI activities in collaboration with local stakeholders (Salomaa & Caputo, 2021).

Digital transformation is well adapted in the HEI sector (e.g., Joshi et al., 2024), but it should be approached more integrally and holistically in many cases (Benavides et al., 2020). Verhoef et al. enlighten the semantic meaning of digital transformation: it has three development phases: the first is digitising analogue items into digital format; the second step is digitalisation, which means optimising analogical business services with digital tools and applications for improving productivity and fostering better customer experience; and the third, the most developed phase, where organisations can create new digitalised business models (2021). Thus, the new HEI businesses are based on new technologies such as AI (e.g. Sahu & Sahu, 2024), quantum computing (e.g. Vijayalekshmi, 2024) and even metaverse (Gautama et al., 2024). Prior research (Altendeitering et al., 2024; Oberländer et al., 2025) shows that gaining digital transformation leads organisations towards digital/data ecosystems. Digital ecosystems have temporal and spatial boundaries. The data ecosystem has four key elements: actors, roles, relationships, and resources. It differs from other ecosystems because it does not rely on an explicit common platform. Instead of common platform data, ecosystem actors share data resources. (Oliveira et al., 2018) On the other hand, Koch et al. (2022) define a digital ecosystem as follows: "A digital ecosystem is a socio-technical system connecting multiple, typically independent providers and consumers of assets for their mutual benefit. A digital ecosystem is based on the provision of digital ecosystem services via digital platforms that enable scaling and the exploitation of positive network effects." Thus, key constructs in data and digital ecosystems are shared data resources, digital services and capabilities. Previous research has found that enterprise architecture is suitable for building digital transformation and digital ecosystems (Korhonen & Halén, 2017; Lamana & Kurnia, 2022; Niemi & Pekkola, 2020). Regarding the enterprise architecture method, it is noteworthy that it is associated with many communication and collaboration problems, e.g. (Rouvari & Pekkola 2023; 2024). So, we cannot ignore the importance of communication and collaboration capabilities in developing RDI activities in higher education.

3 Research Methods and Research Settings

This is a qualitative single case study complemented by participatory observation. In spring 2024, we created a data management working group that included 3 RDI leaders, 3 CIOs, and an IT secretary general. The group aimed to study the need for IT services for RDI activities in Finnish UAS. The group's first analysis revealed that support for RDI activities and RDI support service production is dispersed across the organisations, such as research services, communication project economy, legal services, and data protection based on where support-related content expertise is located. For example, libraries provide data management and information services, and IT departments are responsible for IT management. Besides this, participatory observation has unveiled a lack of usability and accessibility and challenges in effectively using the Finnish national RDI services and support provided by CSC – IT Center for Science (CSC).

The Group conducted a qualitative survey of 26.8. and 8.9.2024 to determine the opinions of UAS's RDI activities leaders and specialists on these issues. The UASs were instructed to gather key stakeholders with knowledge of RDI activities to answer the questions and send one response per UAS. We got twelve answers, 50% of all UAS in Finland. According to the working group's analysis, 50% did not respond because they were satisfied with their current situation but estimated that they also face similar challenges in the RDI activities services.

The survey consisted of three main questions:

1 Please list three main concrete development issues or problems related to data management and/or IT in RDI activities that must be solved as soon as possible.

2 Do the CSC's RDI data management services sufficiently address the needs of UAS?

3 Are the CSC's research/RDI activities services sufficiently usable?

First, the author of this article analysed the answers qualitatively. Using contextualised subject headings, he coded the identified issues/problems (the first question). Every issue had at least one subject heading, but one had four different codes. Then, he listed the three most wanted of them as development courses of action. Next, the working group accepted the analysis. Third, the CIOs' and RDI leaders' networks discussed the results and redefined the third development course of action. Finally, the working group and the CSC representatives planned objectives and roadmaps to solve the problems.

4 Data Analysis and Findings

4.1 The first question: List three main concrete development issues or problems

Table 1 lists the most used subject headings, indicating the most critical problems.

Subject heading	Most significant problem	2nd most significant problem	3rd most significant problem	Total score
Secure data operating environment	5	2	3	10
Data storing	4	2	1	7
Communication	1	2	—	3
Collaboration	—	1	3	4
RDI Data management system	—	—	2	2

Table 1: Most wanted development issues

Besides this, there were subject headings which appeared only once in the analysis: RDI customer relationship management system, research data policy implementation, data management plan, RDI infrastructure, reference architecture on research data management, application portfolio, application interoperability, secondary use of health and social data, opening & publishing, Lack of data manager, discoverability, precise CSC data management services, compilation of results of RDI activities, data management training, software production management and Information security.

Most answers covered more than one development issue and were not clearly delimited; thus, the subject heading coding was necessary. In many cases, different development issues are interwoven, and in practice, it is not always possible to distinguish between different areas of development. For example, secure data storage is usually interwoven with a secure data operating environment. The following answer includes at least three most wanted development areas:

> "Provision of services related to the processing and storage of projects and other RDI data (especially sensitive data), taking into account the whole data lifecycle, to the staff and students

of UAS and raising awareness of the above services among the UAS community. Important aspects include providing user-friendly services and raising awareness of the available services suitable for the higher education sector..."

We selected the three highest-scored development courses of action: 1. secure data operating environment, 2. data storing, and 3. communication. Collaboration got a higher total score than communication. Still, communication was selected because it was marked once in the most significant category and twice in the second category. In contrast, collaboration got none in the first category and only one in the second. Communication and collaboration problems in information sciences are usually treated as single entities, e.g. (Rouvari & Pekkola, 2024; Banaeianjahromi & Smolander, 2019). In this context, I have separated them because the informants mean different things: communication refers to improving awareness of the available RDI data management services. In contrast, collaboration refers to the joint development of services.

Many development needs, particularly those that received individual mentions, have been considered in other ongoing projects: a reference architect on research data management has just been published. Together with the previously published Open Science and Research Reference Architecture 2024-2030 and Reference Architecture on Scientific Computing 2025, it forms guidelines for research data management in Finnish HEIs and research institutions. Dedicated projects will address challenges in RDI infrastructure, application interoperability, and data security, considering artificial intelligence. Thus, improving communication and increasing knowledge will solve some of the listed problems.

The responses identified 30 problems, most of which were RDI data management problems (26/37). However, 11 responses were interpreted as IT problems. Thus, seven have been seen as RDI data management and IT problems. For instance, some interpreted the development of a secure data operating environment as a data management issue, some as an IT issue, and some said that data management and IT needed to be developed to solve the problem. There was much dispersion on how problems should be solved: 19 problems should be solved nationally, 14 within the UAS sector, and 15 locally. A few answers suggested that the same problem should be solved at all levels, i.e., nationally, within the UAS sector, and locally.

4.2 The second question: Do CSC's RDI data management services sufficiently address the needs of UAS?

In the survey, we also asked for opinions on CSC's national research/RDI data management services. Figure 1 shows the distribution of whether the national services fulfil the needs of UASs. Seven UAS out of twelve were somewhat unsatisfied with the current services. However, one UAS was satisfied, and four were somewhat satisfied.

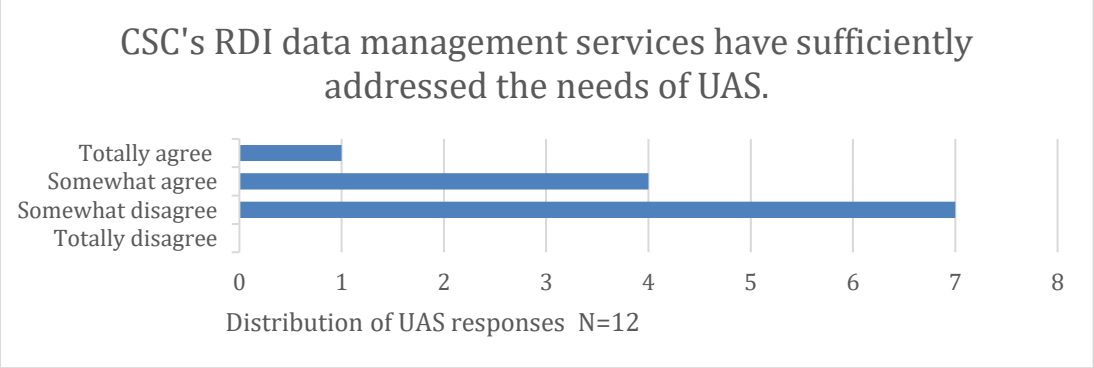

Figure 1: Satisfaction with how the needs of UAS have been considered in CSC's RDI data management services.

We received some suggestions for improvements and solutions to meet the needs better:

"Remember the terminology of the UAS sector, i.e., scientific and RDI activities. The CSC could help to find common ground and solutions between the HEIs, rather than organisational solutions."

"Communication should be more targeted, e.g., in webinars, to meet the needs of the UAS. UAS have their specialisation, and CSC research services are more oriented towards university needs."

"The needs for support services related to the CSC's RDI data management have been adequately addressed, but not for developing services. One of the reasons is that the CSC does little to involve experts from HEIs in developing RDI data management services. We propose considering the successful "co-production model" used in Digivision for service development. "

"By all accounts, the CSC has already started to address the issues involved, and we are moving forward. However, there is currently little need for things like HPC in the RDI activities of UAS, but rather for analysing data from development work, etc."

4.3 The third question: Are the CSC's research/RDI activities services sufficiently usable?

Five out of twelve UAS somewhat agreed that CSC's RDI data management services are sufficiently usable; however, seven disagreed (Figure 2). We also asked for suggestions for solutions to the problems. We received the following recommendations: clarifying services and service descriptions, raising awareness of services, providing clear instructions for use in Finnish, improving communication to RDI actors, involving UAS representatives in the design and implementation of services, and increasing communication and collaboration resources.

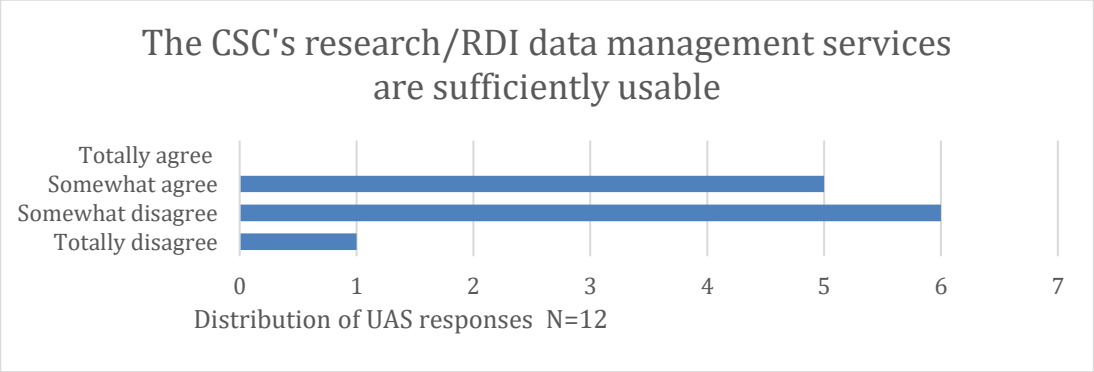

Figure 2: UAS satisfaction with the usability of the CSC RDI services

5 Discussion

The RDI data management working group and CSC's representatives concluded that there is a mismatch in the use and availability of RDI services. They listed concrete development measures to solve the data management and storage problems. The UAS will identify some specific use cases for which suitable services may not be available. Then, they will list different types of RDI datasets, their storage needs, access rights, and formats. Finally, functional and technical requirements specifications will be made. Communication and collaboration capabilities will be improved by organising webinars for RDI leaders and CIO networks to familiarise themselves with research data, scientific computing and open science and research national reference architecture definitions. These three research reference architectures refine the holistic picture of the target stage data ecosystem in the field of research of HEIs

and research institutions. The CSC's brand-new research and RDI service catalogue seem essential in improving communication and collaboration between UAS and the service provider. The CSC Scientific Computing Ambassadors program will strengthen support for research services, bring it closer to the researchers and students, and build a mutually beneficial network for exchanging information.

Besides use cases, RDI datasets and improving communication and collaboration capabilities, an important focus will be on the availability and usability of the RDI services:

- as efficiently as possible using sensitive data services, a graphic user interface on high-performance computing,
- lowering the threshold to use for high-performance computing ("use when your laptop is no longer enough"),
- Customer-oriented sensitive data services development
- improving semantic interoperability by using the national reference architecture on research data management and
- CSC's research service catalogue, including service descriptions also in Finnish

The co-production model has successfully organised elements in the Finnish HEI's seminal digital transformation project Digivision 2023, launched in 2021. Project Digivision is gaining a digital and data higher education ecosystem in which architecture, services and data-sharing patterns are co-planned and co-created. In the co-production model, the project buys the expertise and work resources of the higher education institutions, allowing the project actors, higher education experts and third-party partners to design and produce services together.

Besides the co-production model, data ecosystem solutions will build digital services for RDI activities. Oberländer et al. (2025) show how their orientation, cooperation, orchestration (OCO) theory of digital transformation creates ecosystem capabilities: 1) orientation describes relevant needed digital resources during a digital transformation project, 2) cooperation describes sharing of relevant digital resources, and orchestration describes recombining of the digital resources for a new digitally enabled value proposition. They even see data ecosystem building as a multi-level perspective. Thus, resourcing influences an organisation into an ecosystem from a bottom-up angle and a top-down view in which resourcing influences from an ecosystem to organisations. The organisations that succeed in digital transformation appear to be shifting from stand-alone entities to parts of data ecosystems (Oberländer et al.,2025). Data ecosystems' key constructs are data provider, data consumer, data sharing and data management. These constructs describe the importance of data quality tools which data providers and consumers can create. Data providers are usually responsible for the quality of data management, and consumers are responsible for the quality of data processing. They are responsible for data-sharing quality tools together (Altendeitering et al., 2024). Using the OCO (Oberländer et al.,2025). and the data quality (Altendeitering et al., 2024) theories, we should go beyond the organisational level and focus on improving RDI and research ecosystems in collaboration with UASs and service providers.

Data management, sharing, and processing are key capabilities for building a data ecosystem. Communication and collaboration capabilities are also essential. The RDI data management team and RDI data ecosystem organisations will focus on developing and acquiring the resources to build the necessary ecosystem capabilities.

6 Conclusion

I have identified courses of action and means to improve RDI activities in Finnish UASs in this article. Through the qualitative survey, we found the three most needed development actions to improve RDI data management (the 1st question): 1. secure data operating environment, 2. data storing, and 3. communication. Besides these, we unveiled the means to improve digital RDI data management services (the 2nd and 3rd questions); the first is to use a co-production model in business service development, the second is to gain digital transformation by creating RDI data ecosystems, and the third is to improve the communication and collaboration capability for the better working data ecosystems. This study has some limitations. First, because of my ethnographic approach, I had to study only one development group in one data ecosystem, i.e. one temporal and spatial environment, which may be narrow for information systems and information and knowledge management research fields. Second, instead of this kind of single-case study, a multi-case study could understand better data ecosystem creation in a real-life project (Yin, 2018) and could enable contrasting multiple cases to "augment external validity to help guard against observer bias" (Voss et al., 2002).

Based on the literature review and identified courses of action and development, considerably more work will need to be done to determine the roles of data ecosystems in the digital transformation of RDI data management services. This study raises questions about the focus on the importance of building data management, sharing, and processing capabilities and, in particular, the root cause of project problems—communication and collaboration capability for gaining functional RDI data ecosystems.

7 References

Altendeitering, M., Guggenberger, T. M., & Möller, F. (2024). A design theory for data quality tools in data ecosystems: Findings from three industry cases. *Data & Knowledge Engineering, 153,* 102333-. https://doi.org/10.1016/j.datak.2024.102333

Banaeianjahromi, N. and Smolander, K. (2019). Lack of communication and collaboration in enterprise architecture development. *Information Systems Frontiers 21 (4),* 877- 908.

Benavides, L. M. C., Arias, J. A. T., Serna, M. D. A., Bedoya, J. W. B., & Burgos, D. (2020). Digital transformation in higher education institutions: A systematic literature review. *Sensors (Basel, Switzerland), 20(11),* 1–23. https://doi.org/10.3390/s20113291

Gautama, A., Hasim, H., Iwansaputra, R., & Kristin, D. M. (2024). Metaverse Adoption in Higher Education Institutions (HEIs): A Systematic Literature Review. *2024 International Conference on ICT for Smart Society (ICISS),* 1–7. https://doi.org/10.1109/ICISS62896.2024.10750997

Joshi, S., Srivastava, A. P., Prabhu, S., Pathak, P., Chirputkar, A., & Pillai, S. (2024). Trends in digital transformation (DT) of higher education institutes (HEI): bibliometric and systematic review of 13 years. *Journal of Applied Research in Higher Education.* https://doi.org/10.1108/JARHE-02-2024-0084

Koch, M., Krohmer, D., Naab, M., Rost, D., & Trapp, M. (2022). A matter of definition: Criteria for digital ecosystems. *Digital Business (Amsterdam), 2(2),* 100027-. https://doi.org/10.1016/j.digbus.2022.100027

Korhonen J.J., Halén, M (2017) *Enterprise architecture for digital transformation. In: IEEE Conference on Business Informatics 1,* 349-358. doi: 10.1109/CBI.2017.45

Kärki, A., Päällysaho, S., Jaalama, K., Talvela, J., Lehto, A., & Hyyppä, H. (2021). Developing Open RDI and Education in Finnish Universities of Applied Sciences. *Data Intelligence, 3(1),* 162–175. https://doi.org/10.1162/dint_a_00066

Lamanna, F., Kurnia, S.: Digital transformation of superannuation and the role of enterprise architecture. In: *PACIS 2022 Proceedings 214,* (2022)

Niemi, E., Pekkola, S.: The benefits of enterprise architecture in organizational transformation. *Business & Information Systems Engineering 62(6)*, 585-597 (2020). doi:
10.1007/s12599-019-00605-3

Oliveira, M. I. S., Lóscio, B. F., Hinnant, C. C., & Zuiderwijk, A. (2018). What is a data ecosystem? *ACM International Conference Proceeding Series*, *1–9*. https://doi.org/10.1145/3209281.3209335

Päällysaho, S., Latvanen, J., Lehto, A., Riihimaa, J., Lahti, P., Kärki, A., & Puhakka-Tarvainen, H. (2021). Key Aspects of Open Data in Finnish RDI Cooperation between Higher Education and Businesses. *Data Intelligence*, *3(1)*, 176–188. https://doi.org/10.1162/dint_a_00065.

Randall, D., Harper, R., Rouncefield, M. (2007). *Fieldwork for design: Theory and practice.* Springer Verlag, London. doi: 10.1007/978-1-84628-768-8

Rouvari, A., Pekkola, S. (2023). Contextuality and Temporality of Enterprise Architecture Problems: A Comparative Case Study. In: Sales, T.P., et al. (eds) *Enterprise Design, Operations, and Computing. LNBIP, 466.* Springer, Cham.

Rouvari, A., Pekkola, S. (2024). Improving Communication and Collaboration in Enterprise Architecture Projects: Three Propositions from Three Public Sector EA Projects. In: Hyrynsalmi, S., Münch, J., Smolander, K., Melegati, J. (eds) Software Business. ICSOB 2023. *Lecture Notes in Business Information Processing, vol 500.* Springer, Cham. https://doi.org/10.1007/978-3-031-53227-6_6

Salomaa, M., & Caputo, A. (2021). Business as usual? Assessing the impact of the COVID-19 pandemic to research, development and innovation (RDI) activities of universities of applied sciences. *Tertiary Education and Management*, *27(4)*, 351–366. https://doi.org/10.1007/s11233-021-09079-z

Oberländer, A. M., Karnebogen, P., Rövekamp, P., Röglinger, M., & Leidner, D. E. (2025). Understanding the influence of digital ecosystems on digital transformation: The OCO (orientation, cooperation, orchestration) theory. *Information Systems Journal (Oxford, England)*, *35(1)*, 368–413. https://doi.org/10.1111/isj.12539

Sahu, A., & Sahu, A. (2024). Revolutionary Applications of Generative AI in Higher Education Institutes (HEIs) and its Implications. *Library Philosophy and Practice*, 1–9.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research 122*, 889-901.

Vijayalekshmi, S., Twetwa-Dube, S., Vinoth-Kumar, D., & Gumbo, S. (2023). The Role of Higher Education Institutions in Enabling the Fourth Industrial Revolution: A Bibliometric Analysis. *2023 IEEE AFRICON*, *1–3*. https://doi.org/10.1109/AFRICON55910.2023.10293692

Voss, C., Tsikriktsis, Frohlich, M., (2002) Case research in operations management, International *Journal of Operations & Production Management*, *Vol. 22*, *No. 2*, pp. 195–219.

Yin, R. K. (2018). *Case study research and applications: design and methods* (Sixth edition.). SAGE.

8 Author biographies

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