Review Article

Indian Journal of Library and Information Science
Volume 17 Number 3, September - December 2023
DOI: http://dx.doi.org/10.21088/ijlis.0973.9548.17323.3

Studies on Research data Management Systems and the Organization of Universities Research Institutes: A Systematic Review

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How to cite this article:
R. Padmavathi, P. Sethuraj/Studies on Research data Management Systems and the Organization of Universities Research Institutes: A Systematic Review/ Indian J Lib Inf Sci 2023; 17 (3):195–208.

Abstract

New technological developments, the availability of big data, and the creation of research platforms open a variety of opportunities to generate, store, and analyze research data. To ensure the sustainable handling of research data, the European Commission as well as scientific commissions have recently highlighted the importance of implementing a research data management system (RDMS) in higher education institutes (HEI) which combines technical as well as organizational solutions. A deep understanding of the requirements of research data management (RDM), as well as an overview of the different stakeholders, is a key prerequisite for the implementation of an RDMS. Based on a scientific literature review, the aim of this study is to answer the following research questions: "What organizational factors need to be considered when implementing an RDMS? How do these organizational factors interact with each other and how do they constrain or facilitate the implementation of an RDMS?" The structure of the analysis is built on the four components of Leavitt's classical model of organizational change: task, structure, technology, and people. The findings reveal that the implementation of RDMS is strongly impacted by the organizational structure, infrastructure, labor culture as well as strategic considerations. Overall, this literature review summarizes different approaches for the implementation of an RDMS. It also identifies areas for future research.

Keywords: Data handling; Information infrastructure; Organization; Organizational change; Research data management; Research data management system.

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Received on: 15.04.2023

Accepted on: 31.05.2023

INTRODUCTION

The growing influence of the digital revolution and its concomitant advancements in Information and Communication Technologies (ICT) are reshaping how research is practiced; so also, is the ethos of science changing. Research is increasingly becoming more computational,

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data intensive and collaborative over virtual and networked platforms (Wang, 2013)[43] leading to the so-called fourth paradigm (Hey, Tansley & Tolle, 2009).[18] These present new opportunities and challenges for Higher Education Institutions (HEIs), including the effective and sustainable management of the research data generated during research (Procter, Halfpenny & Voss, 2012). HEIs – mainly in the developed countries have begun to develop capabilities to support this emerging research culture. There is a growing body of literature on RDM, and the surge can be ascribed to the increasing awareness and recognition of the data deluge phenomenon and its implications, the prospects for data reuse and the need to maximise the return on investment for research (Wong, 2009).[48] HEIs and research institutions are also beginning to approach RDM strategically, considering the research data emanating from internally funded research as assets rather than by products of research (Cox & Pinfield, 2014:300; Lynch & Carleton, 2009).[13]

Several case studies (Chiware & Becker, 2018)[9]; Chigwada, Chiparausha & Kasiroori, 2017; Jones *et al.*, 2015; Ball, 2013; Rice & Haywood, 2011; Takeda *et al.*, 2010)[23] on institutional RDM implementation involves some institutional assessment. Whyte *et al.* (2014)[46] indicated that such assessments are important to establish what capabilities exist, their adequacy and how well they are being deployed to support RDM. These case studies also provided insight on the approaches and strategies adopted by institutions to implement RDM. The context of these studies are vastly different from and many developing countries. For instance, the legal and policy landscape of most developed countries provide the impetus for RDM uptake. Data mandates from government and funding organisations are a major driver for RDM initiatives in many HEIs (Henderson & Knott, 2015).[18] There are no official government mandates, neither are the private and international organisations funding research on the continent strict on data management as they do elsewhere. Also, such an assessment of RDM capabilities is almost non-existent. This research, therefore, investigated an HEI in a developing country (Ghana) the University of (UG). According to van Deventer and Pienaar (2015) it is important to contribute to the RDM literature from developing countries like because this can provide some insightful perspectives even for experienced colleagues in the global north.

For UG, this study fits well into its vision and aspirations of becoming a world-class research intensive university (UG, 2014).[41] The issues, challenges and expectations of a world-class research oriented HEI will include a strategic and systematic approach to supporting the management of the research data from research enterprises. Doing this opens such institutions up to opportunities for funding and partnerships (Hiom *et al.*, 2015).[21] But developing RDM must first start with an understanding of the current situation (Davidson *et al.*, 2014: 217; Jones, Pryor & Whyte, 2013: 6).[33] The study was, therefore, conducted to assess existing RDM capabilities at the University which can be harnessed for future RDM development and support.

OBJECTIVES

This paper reports on the results of a research study. On the basis of the problem outlined, the objectives of the study were to:

a. Identify what elements are necessary for assessing institutional RDM capabilities.
b. Assess what RDM capabilities currently exist at the University of.

Literature Review

The literature shows that the responsibility for RDM development is most emphasised at the institutional level (Awre *et al.*, 2015)[4]; Jones, Pryor & Whyte, 2012), even though one can point to some national level infrastructure investments (e.g. Data Intensive Research Initiative of South Africa [DIRISA], Australian National Data Service [ANDS] and UK Data Archive) and capacity building support (*e.g.* the Digital Curation Centre [DCC]). Fortunately, HEIs who wish to develop RDM today have a second mover advantage following several documented experiences from RDM pioneers (Henderson & Knott, 2015: 49).[18] Earlier developments were exploratory, allowing for a variety of approaches (Hodson & Molloy, 2014).[22] Also, institutional context influenced the approach adopted (van Deventer & Pienaar, 2015 Cox & Pinfield, 2014: 300).[42] However, these previous and continuing experiences are enabling the development and refinement of best practices and transferable toolkits by which late adopters can be guided (Davidson *et al.*, 2014). A critical part of most RDM implementation initiatives is assessing

institutional capacity or preparedness to implement a feasible RDM infrastructure. According to Jones, Pryor and Whyte (2012: 142)[46], institutional RDM capabilities denote the ability of an institution to articulate and attain RDM objectives. One of the implications of the fourth paradigm of science has been the growing necessity for HEIs to develop capabilities to handle complex data intensive science (Lyon *et al.*, 2012: 9).[30] Several models have been postulated in the literature for assessing data management capabilities and their maturity. Some are at the institutional level like the Australian National Data Service (ANDS) adaptation of the Capability Maturity Model for assessing institutions research data capability maturity level (ANDS, 2017)[2], and those for assessing data capabilities at the project level (Sallans & Lake, 2014; Lyon *et al.*, 2012)[37]; Crowston & Qin, 2011).[16] Using the maturity model to assess current levels of institutional data management capability enables institutions to identify pressure points that need to be enhanced. The ANDS model assesses five key capability elements (Policies and procedures; IT infrastructure; support services; managing metadata; managing research data) along five levels of maturity.

Another model, the Cornell Three Legged Stool model, was originally developed to evaluate HEI's response to digital preservation along three dimensions (organisation, technology and resources). These have been adopted and adapted as elements essential for a workable and sustainable RDM effort, first, through the AIDA self-assessment tool and later the Collaborative Assessment for Research Data Infrastructure and Objectives (Cardio) tool by the UK Digital Curation Centre (DCC) (Jones, 2014)[25]: slide 8; Whyte & Allard, 2014 Pryor, 2013).[34] What is peculiar about the CARDIO tools is that, the model allows for local level adaptation: it specifically emphasises research data management and the three dimensions can be assessed to different degrees of granularity according to the level of engagement desired project, departmental or institutional level (Whyte & Allard, 2014). A variant of the tool (Cardio RDM Matrix) has also been used to assess institutional readiness to comply with.

Engineering and Physical Sciences Research Council (EPSRC) Policy Framework for RDM. The tool addresses three thematic issues essentially encapsulating nine point expectations:

a. RDM policy, strategy, governance and sustainability.
b. RDM support services and skills development.
c. Technical infrastructure to facilitate storage, preservation and sharing of research data (Jones *et al.*, 2015).[23]

These capability elements also represent the aspects that institutions need to consider when planning for an institutional RDM programme and must be developed in the light of adequate resources provision (financial and staffing), well defined roles and responsibilities and commitment from senior management (ANDS, 2017: 2; Whyte *et al.*, 2014: 285).[46]

A few studies report on institutional RDM capability assessments in the literature. Takeda *et al.*, (2010)[40] used the AIDA self-assessment tool to benchmark the level of data management capability at the University of Southampton. The findings of the assessment revealed among other things, limited RDM guidance and incoherent policy framework, a lack of formal training around data management, and limited support and guidance for researchers, varied capabilities across campus with pockets of best practices, and limited awareness about existing capabilities and resources.

Jones *et al.*, (2015)[25] reported on how four institutions in the UK (University of East London, University of Edinburgh, University of Leeds, and University of St. Andrews) complied with the EPSRC mandate on RDM. Using the Cardio Matrix framework, they report that three of the four universities adopted a policy-first approach, while University of St. Andrews started their RDM implementation with a strategy document (roadmap) instead and developed a policy later on. Overall, technical infrastructure was focused on storage solutions in the form of data repositories, but University of Edinburgh also had a high-performance computing (HPC) infrastructure in place. RDM was generally promoted through service offerings and relationship building. Support included guidance on writing data management plans (DMPs) and training, which were generally done by embedding RDM trainings into graduate programmes. On-demand trainings were also offered to faculty members and students. Guidance was also provided through library websites and links to relevant resources on the web such as the University of Edinburgh's online management training (Mantra) resource.

Chigwada, Chiparausha and Kasiroori (2017)[8] explored RDM practices across Zimbabwean HEIs and found that there was a general lack of policies and guidelines on RDM, limited financial and human resources, lack of robust and secure technological infrastructure and a general lack of support from the management of the institutions on the issue of RDM. They recommended that trusted data repositories be established to encourage best data practices among researchers.

Chiware and Becker (2018)[9] conducted a study to determine the readiness of HEIs in Southern Africa to lead and participate in institutional RDM development. They found that most institutions were not fully ready to comprehensively support RDM in their institutions due to a number of resource, infrastructure and human capacity constraints. There is disparity among countries in terms of developing policies and guidelines for RDM, with most of the institutions having no policies at all. Institutional repositories were also not fully harnessed to manage datasets and their metadata. There was a skills gap, but some institutions are working at bridging the gap. They recommend training for librarians and organizational restructuring to align existing library research services to RDM.

These studies reveal that librarians play a critical role in developing RDM and it is absolutely important that investments are made into their capacity development to be effective. It is also evident that the level of development is disparate and environmental factors and organisational culture tend to shape institutional response and challenges. What is more, these studies help to understand which capability elements tend to be emphasised in such assessments. In this case, they are the policy framework, technological infrastructure, skills development and support services.

METHODOLOGY

In this study, the qualitative approach and case study strategy were adopted. According to Yin (2009), case studies are most appropriate for exploring contemporary issues within specific and bounded contexts. Creswell (2009)[15] also asserted that the case study strategy is appropriate for exploring processes and activities. Accordingly, this research is about exploring RDM capabilities at UG; it is a new area of engagement for academic institutions and is still evolving in terms of its practices and responsibilities in this part of the world.

In line with the rationale for purposive sampling and to avoid unnecessary duplication of responses, seven respondents, comprising five respondents from research support units (University of Library System University of Computing System (UGCS) [two] and Office of Research, Innovation and Development (ORID) (one) and two senior researchers, were selected to participate in the study. This sample size is in consonance with the recommendation by Creswell (2013)[15] who asserted that a sample size in the region of five is appropriate for a single case study research.

Selection of respondents was done through "priori criteria sampling" (Pickard, 2008)[21] by this method, a set of criteria were set as baseline for including information-rich respondents. For the respondents from the research support units, the following selection criteria were applied: they must be senior members (this is a management/ administrative level rank), and should have worked in that capacity for not less than three years. The researchers believe that this provides ample time for the respondents to have acquired rich information about the capabilities, programmes and policies of the university in their respective units. For the researcher participants, they must be a senior researcher in UG, a previous recipient of research funding (internal and external), and must have extensive research experience with at least ten published scholarly works. Discussions were held with them on their expectations and perceptions about current capabilities, infrastructure and support for RDM at UG.

Data was collected using semi-structured interviews and document analysis. Pickard (2008)[31] asserted that interviews are the most used data collection method in Library and Information Science (LIS) research and is the most appropriate technique for qualitative and in-depth studies such as case study research. The following institutional documents were also analysed and used to corroborate the primary data: "UG Strategic Plan 2014-2024", "UG Research Policy", "UG Research Policy Guideline on Good Practices: Record Keeping and Data Management", "UG Institutional Repository Policy", "UG Research Ethics Policy", "UG Intellectual Property Policy" and "UG Library

System Draft Strategic Plan 2014-2019". Combining data collection method and sources is also consistent with the practices for qualitative case study research in extant literature on qualitative inquiry (Creswell, 2013; Pickard, 2008).[15] The researchers used the United Kingdom's Engineering and Physical Sciences Research Council's (EPSRC) Cardio matrix capability elements as the criteria to assess RDM capabilities at UG. The Cardio framework informed the questions for the assessment.

Data should be retained for a reasonable period of time to allow other researchers to check results or to use the data for other purposes. There is, however, no common definition of a reasonable period of time.[1]

Data should however not be shared without the permission of the University.[2]

Policy documents[3] of the institution also capture data related issues. For instance, the Institutional Repository (IR) policy stipulates that "datasets" are one of the acceptable content formats to be deposited. It also outlines clearly the metadata schema for describing items (including data sets), institutional services and support for deposited items as well as the standards of operation. The intellectual property policy also defines data as a tangible research property and addresses the terms of data ownership:

Research data[4] shall be jointly owned by the University and researcher(s) or determined on a case by case basis. Either party shall have a right to use the data for its research purposes. In spite of these provisions, entitlement to the ownership of primary data, software, and other products of research may vary, depending on the circumstances under which the research is conducted.

The ethics policy[5] as well addresses the risk and integrity issues about research and data collection. It highlights the issues of confidentiality and privacy as it pertains research subjects. In the policy, the ethics committee is tasked to:

RDM knowledge and skills among service providers analysis

Respondents were asked to comment on whether they consider research support staff possess adequate knowledge and skills to support RDM and these were some of their comments:

Most people should have a fair idea, but again this is not a system that has been introduced fully in the University. Once that is fully introduced, staff will be trained on how to do things

IT Infrastructure and Support Services

The researchers enquired about existing IT infrastructure that can support researchers' data storage, preservation and backup, data processing and analysis, data sharing and data security needs. The results revealed a number of IT systems and applications that can be harnessed and extended to support data management. Necessarily provisioned for RDM, but they represent potential for data storage and preservation, analysis, access management, publishing and sharing.

As for storage we have about 120 Terabyte on the cloud infrastructure.

Per the IR policy it is written that it permits the deposit of datasets but in actual fact we are not at the moment accepting datasets. The system itself can accept datasets but for now we are not accepting it, it is more of a future thing that we are thinking of doing, but for now we are more or less taking the end products of research, that's the PDFs and other formats. We are not accepting the raw data formats.

We have been smart to move students to the Google cloud which is virtually limitless storage, Google has given us gigabytes and we can always ask for more, in fact, we have that clause that we can negotiate for more.

Respondents were also asked to comment on institutional support for collaborative research, data analysis and computational science and these were some of their comments:

Apart from the resources that we have, we also have this package for data analysis; the NVivo, for example, is for qualitative data analysis.

We have a training unit in UGCS, that does training for faculty for specific software to use for their research activity, SPSS and the like and then when faculty (members) have issues with how to handle such.

We've also done a bit of training in using research software like reference managers, and then we have also collaborated with publishers and done author workshops for researchers just to enhance the research process.

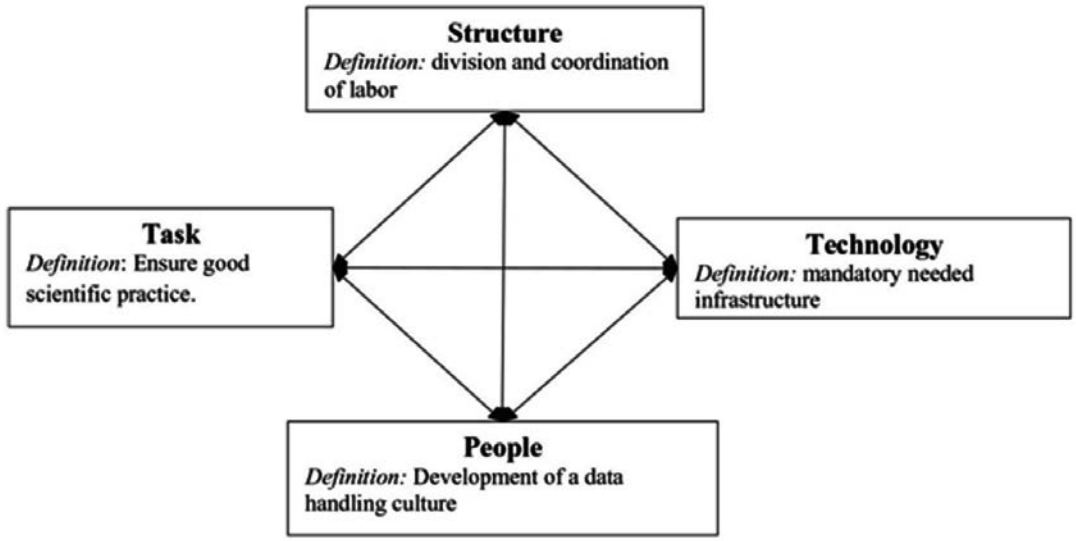

Fig. 1: Leavitt's classical model of organizational change supplemented by the definition of the components for the literature review.

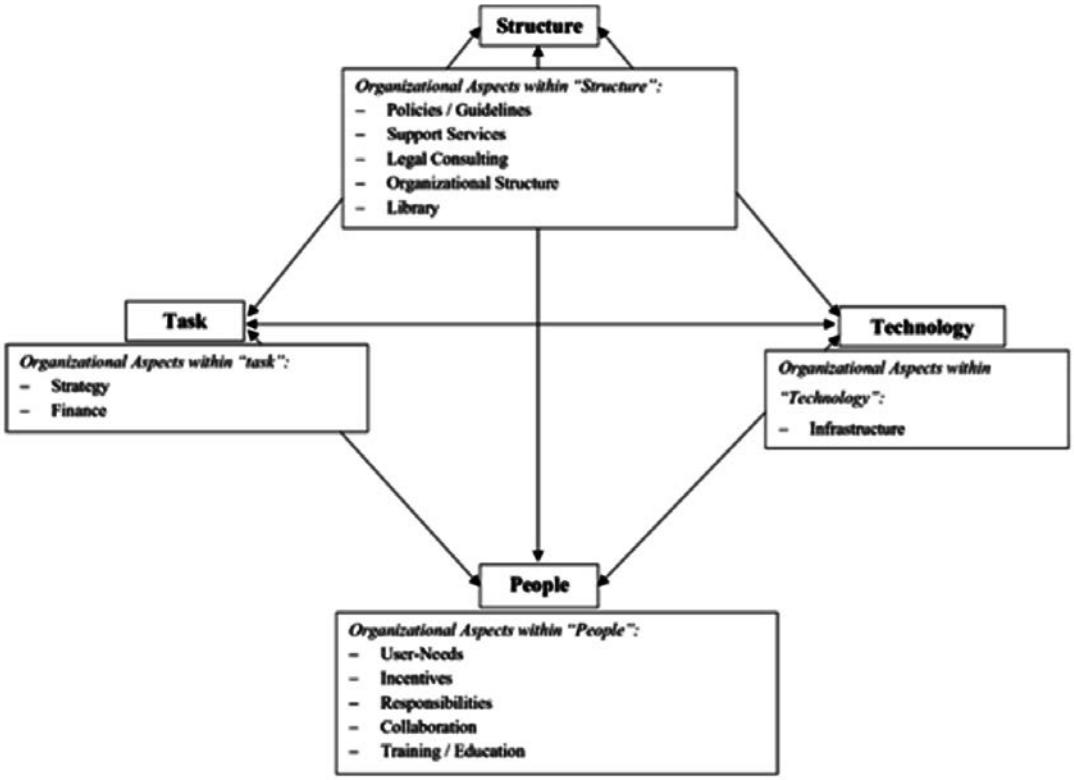

Fig. 2: Leavitt's classical model of organizational change and the assigned organizational factors.

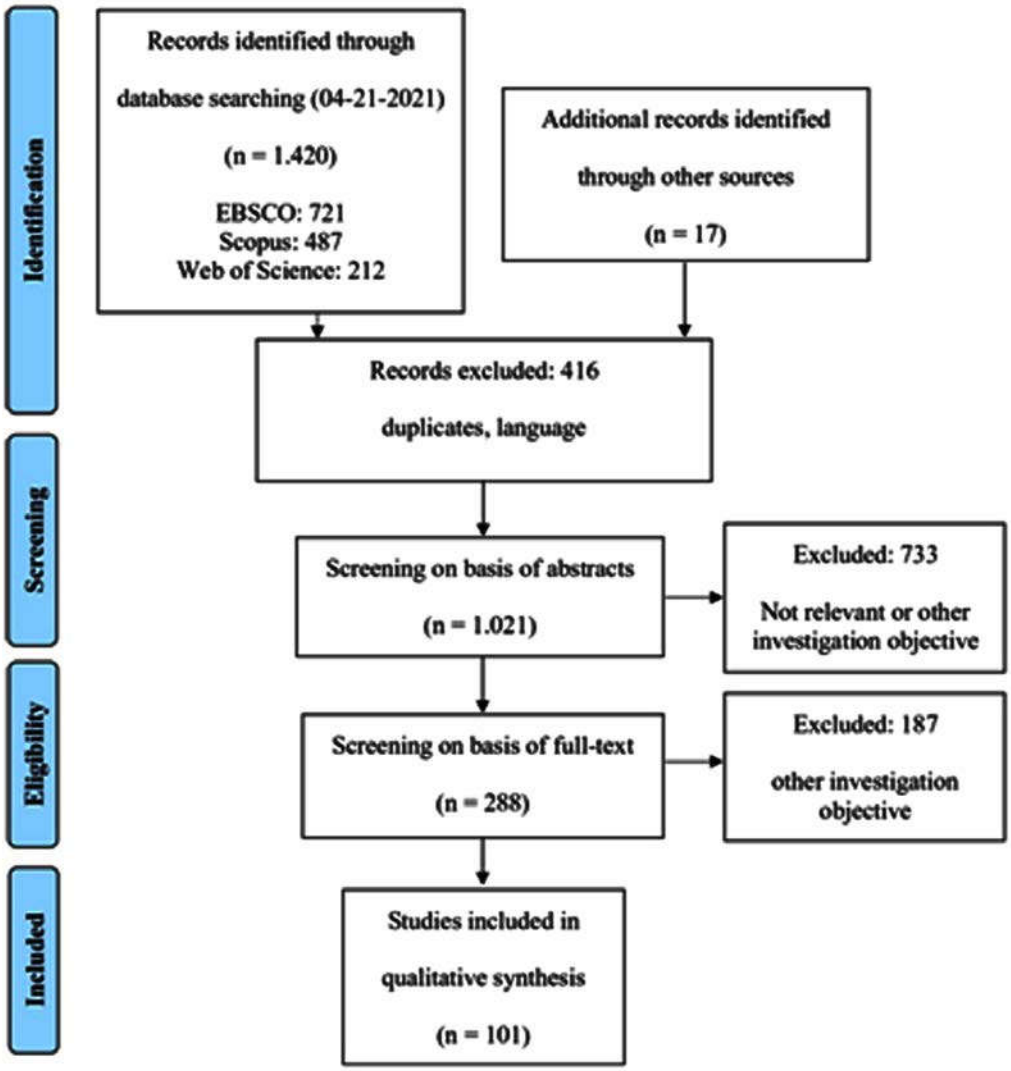

Fig. 3: PRISMA flow diagram.

Bibliographic Findings

Although the discussions about RDM are young and organizational issues seem not to be the focus, the earliest relevant study of this literature review was published in 1980 by van Hoose and Leaders (1980). Not until 2010, further studies relevant for the sample were identified. 70% of all identified studies were published from 2016 to 2020, which reflects the increasing relevance of RDM.

The studies of the literature review were published in 49 journals, four books, and eight conference volumes. Most studies (61%) were published in journals with the focus on "library" or "library and information science." The remaining studies were published in research fields like "information management," "business management," "medicine," or "multi research fields." Case studies were the most prominent research design (36%). The sample is completed by descriptive, quantitative, qualitative studies, as well as two literature reviews.

Most of the studies (69%) were published by lead authors from North America, UK, Australia, or Europe. This focus on the "global north" is complemented by lead authors from China, Singapore, and Japan (6%), from India, Pakistan, Saudi Arabian, Jordan, and Iraq (14%) as well as from Africa (11%).

To get an idea how the studies defer to the components of Leavitt's (1965) organizational change model (task, structure, infrastructure, people), every study was read and organizational factors were assigned to them. Based on the differences within the research design and origin, the studies discussed the identified organizational factors with varying depth. The necessity to

focus on user needs as well as the importance of collaborations for the implementation of an RDMS were the organizational factors with the most attention. The importance to develop policies/ guidelines as well as education courses were frequently highlighted, too. Although the scientific commissions emphasized the need to ensure a sustainable financial base for an RDMS as well as to consider incentives (Wissenschaftsrat, 2011, 2012), these two organizational factors were barely in the focus of the study sample. Furthermore, data handling is related to legal issues like data security, protection, or copy rights. Nevertheless, just 12 studies discussed this organizational factor. Especially the practice and conference papers highlighted the importance to deal with legal issues.

The focus was on four aspects: policy, technology, skills and knowledge of support staff and existing data services and support. The data was analysed by first transcribing all the seven interviews, individually analysing each transcript and institutional document to identify key terms and topics, grouping these topics into categories using colour codes and annotations, comparing the categories across the different transcripts and documents for patterns, and regrouping and condensing them to form themes which were then presented and discussed. The presentation and discussion were done by mixing data from both sources as well as corroborating data from the interviews with data from the institutional documents.

RESULTS

Institutional Policies framework on RDM

"UG Research Policy" (section 5.6). Four RDM issues are addressed in the Research Policy:

a. Recognition of RDM as a good research practice and integrity issue.

1 Data management is one of the essential areas of responsible conduct of research.

b. Institutional commitment to developing systems to support RDM.

2 The University will create a meta-database of research materials/data repositories.

c. Researchers' responsibility as the main steward of research data.

3 Under normal circumstances the original materials and data sets will be held by the PI who undertook the research.

d. Mandate of researchers to keep datasets for not less than ten years after the completion of a research project.

4 The PI is expected to maintain this data set for a minimum of ten years the final project close-out. In certain special circumstances, this minimum period may be extended.

Despite the lack of an explicit policy, there was a guideline for RDM "UG Research Policy Guideline on Good Practices: Record Keeping and Data Management". This was the most pronounced institutional document on RDM that spells out in greater details a number of best practices for guidance in the management of research data for the research community. Captures many important aspects of RDM such as data ownership, data collection and documentation, data storage and retention, data protection, data privacy, and data sharing and publication.

The study sample agreed about the importance to incorporate user needs (e.g. Clements, 2013; Knight, 2015; Schmidt and Dierkes, 2015; Syn and Kim, 2019). With the incorporation of researchers their willingness to comply as well as their sensitivity for the topic can be increased. This incorporation can take place through questionnaires, interviews, or workshops (e.g. Clements, 2013; Cruz *et al.*, 2019; Eifert *et al.*, 2016; Knight, 2015; Liu and Ding, 2016; Mohammed and Ibrahim, 2019; Plomp *et al.*, 2019; van Zeeland and Ringersma, 2017).

Incentives can be seen as an additional factor to support a cultural change in data handling as well as to increase the awareness of researchers for RDM (Burgi *et al.*, 2017; Chawinga and Zinn, 2019).[9] Whereas monetary incentives could be a successful way, in the most cases they are not realized due to budget restrictions (Grynoch, 2016). But the implementation of Data Steward and Data Champion programs that incorporate researchers and support their data management activities was described as quite successful incentive (e.g. Adika and Kwanya, 2020; Plomp *et al.*, 2019; Savage and Cadwallader, 2019).[9]

While researchers were seen as responsible for their data, the study sample emphasized that services will only come to life when the responsibilities and roles of all participants are defined, communicated, and a deep understanding for RDM exists (e.g. Chiware, 2020; Cox and Verbaan, 2016; Faniel and Connaway, 2018; Pinfield *et al.*, 2014)[9]; Verbaan and Cox, 2014). Pryor (2014b) concluded that the responsibilities for RDM are distributed between

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the management, administrative units, and researchers. The study sample named libraries, IT departments, and research offices as units with the main responsibilities (e.g. Faniel and Connaway, 2018;[19] Piracha and Ameen, 2019). This underlines that RDM depends on multi-contributors. It can be expected that the collaboration between institutional units which had not collaborated before will be challenging at the beginning. Another form of collaboration, already mentioned within the component "technology," can take place among HEI to use resources as efficient as possible (Grasse *et al.*, 2018; Henderson *et al.*, 2014; Pryor, 2014a; Sánchez-Solís and Budroni, 2015)21 and to learn from the experiences of other HEI (Hamad *et al.*, 2021).

Further education courses can contribute to increase the awareness for the importance of data management (Bunkar and Bhatt, 2020; Schmidt and Dierkes, 2015). Yu *et al.* (2017) concluded that these courses need to take discipline-specific differences into account to provide tailored workshops. The study sample agreed that they should be open to researchers of every career stage (e.g. Adika and Kwanya, 2020; Avuglah and Underwood, 2019; Krahe *et al.*, 2020).[28] Furthermore, education courses for support units were described as necessary to ensure efficient services (Avuglah and Underwood, 2019; Cole and Evans, 2014; Henderson and Knott, 2015).[18]

The presentation of the organizational factors already reveals the strong connection between them and underlines that a separate consideration of them will not fit the purpose to implement an RDMS. To emphasize the complexity of an RDMS, the consideration of all aspects within Leavitt's classical model of organizational change appears to be useful. The main findings to be considered for the implementation of an RDMS are summarized in Appendix Table 2.

DISCUSSION

This literature review set out to emphasize the importance of organizational factors for the implementation of an RDMS in HEI. It synthesized the existing literature under the focus of Leavitt's (1965)[30] classical model of organizational change. Based on the insights from the position papers toward RDM of various scientific commissions as well as on Leavitt's model, the search terms for this literature review were defined (cf. Fig. 1). The model was chosen because it underlines the strong interrelation between the identified organizational factors. The study sample highlighted that the implementation of an RDMS can take place under varying perspectives and with different priorities on the identified organizational factors. In average the studies discussed almost five organizational factors with varying depth and presented their interrelation.

With the increasing attention for data handling under the FAIR principles (Wilkinson *et al.*, 2016) as well as the aim of the European Commission to establish the European Open Science Cloud (European Commission, 2018), new requirements to ensure good scientific practice appear which can be interpreted as reason to implement an RDMS (Funamori *et al.*, 2018). The study sample underlined that RDM depends on the behavior of the researchers. Hence, HEI are required to increase the awareness for it as well as to support its researchers. The number of the identified organizational factors and how they interact with each other revealed the complexity of the implementation of an RDMS Thus, it is reasonable to interpret the implementation of an RDMS as an organizational change process.

RDMS combine technical with political, economic, and political issues (Cox *et al.*, 2016).[18] Technical developments in previous years opened new opportunities for researchers to collect, analyze, and store their data. These developments seem not to have reached the end point, yet. Cruz *et al.* (2019) described data management as a moving target. Therefore, an RDMS needs to be as flexible as possible. This can be realized through the frequently review of services and policies to ensure their relevance (Cox and Verbaan, 2018). Additionally, further education courses for researchers and support units are a main factor. They are important to raise the awareness and increase knowledge among the researchers. They also contribute to the understanding of support units regarding their own role in RDM as well as the complexity and importance of these activities (Ashiq *et al.*, 2020; Avuglah and Underwood, 2019; Bunkar and Bhatt, 2020). Besides further education, the Cruz *et al.* (2019) underlined that an institutional policy, infrastructure, and support services influence the day-to-day actions of the researchers, too. This presents the interrelation between the technical component, support services, education, and culture. But the implementation of them is also connected with financial challenges (Cox *et al.*, 2019; Hamad *et al.*, 2021; Zondergeld *et al.*, 2020). Under this perspective a strategy which takes the potential investments, long-term costs, options for

financing, and aims into account is important (Jones, 2014; Whyte, 2014).[23] This emphasizes the strong connection between all components of Leavitt's model (cf. Fig. 2). The task to ensure research under good scientific practice will be influenced by changes in data handling. HEI can support their researchers with an adequate infrastructure and support services. But the implementation of them is accompanied by new responsibilities of the support staff, the necessity to develop the culture toward sustainable data handling and costs.

Thirty seven studies discussed the necessity to enhance the service profile of libraries with the implementation of RDMS. The studies described the library as an ideal coordinator for RDM because they already manage and link research output (e.g. Cox and Pinfield, 2014; Guss, 2016; Joo and Peters, 2020).[11] The studies characterized RDM as a process with multi contributors. Various institutional units need to be incorporated to run an RDMS. Besides the libraries the IT departments were named as main contributors (e.g. Buys and Shaw, 2015; Faniel and Connaway, 2018; Jackson, 2018; Piracha and Ameen, 2019; Sesartic and Töwe, 2016; Steel *et al.*, 2019; Zondergeld *et al.*, 2020). But a potential competitive component between libraries, IT-departments, and others (Cox and Pinfield, 2014) as well as the requirement that the collaborators speak the same language will challenge the promotion of these collaborations. To ensure an efficient collaboration, it will be necessary that the contributors get a deeper understanding for RDM and their own role in it which underlines the need for further education (Bardyn *et al.*, 2018; Cox and Verbaan, 2016;[13] Hiom *et al.*, 2015; Verbaan and Cox, 2014).[14] Furthermore, before starting to design an RDM service portfolio, the coordinator needs to adapt technical skills. Especially when the libraries shall adopt this new responsibility (Cox and Pinfield, 2014).[13] The role of the library in RDMS was also highlighted with the description of potential tasks like consultancy and support for the development of data management plans (Bishoff and Johnston, 2015; Wittenberg and Elings, 2017), the definition of institutional data standards and policies (Briney *et al.*, 2017)[6], as well as the conceptualization of education and training offers for researchers (Castle, 2019; Gunjal and Gaitanou, 2017). The study sample draws a clear picture in which direction libraries could enhance their service profile in the future. It seems to be important that researchers see the library as counterpart for RDM, otherwise the demand for services will be low (Faniel and Connaway, 2018). Chawinga and Zinn (2020b) argued that libraries should be more proactive in promoting RDM services to influence this perception. In addition, libraries do not enjoy a good reputation in every country. In China, they have the role to evaluate research proposals for their novelty to ensure funding. Therefore, they are placed above researchers which seem to make them less service oriented and are seen suspiciously by researchers (Huang *et al.*, 2021).[23] Further influencing factors for the library service portfolio were identified as lack of technical and human resources, missing commitment by the management as well as communication, collaboration, and coordination (Faniel and Connaway, 2018). Furthermore, to what extent a library could provide services also depends on the organizational structure as well as the size of the HEI (Shelly and Jackson, 2018). Although RDM provides an interesting opportunity for libraries to enhance their service profile and to define their role in a new way, they will also face a variety of challenges. With strategy for the RDM and the support by the management, these challenges could be overcome more easily (Chawinga and Zinn, 2021; Eifert *et al.*, 2016; Jones, 2014).[8] The future role of the libraries presents once again how strong the organizational factors are interrelated.

In conclusion, the implementation of RDMS depends on a variety of organizational factors. HEI face a major challenge to provide user oriented services under the restriction of the existing budget. The study sample provide numerous examples for the implementation of an RDMS within HEI. Appendix Table 3 presents the contributions of the particular studies to the organizational factors.

CONCLUSION

Previous studies investigated particular components of an RDMS, like technical issues, policies, or user needs. This literature review not only identified organizational factors but also underlined the interrelation between them. The findings emphasized that the implementation of an RDMS will cause changes in the organizational structure of HEI. Furthermore, the interrelation between the different organizational factors increases the complexity. To get a comprehensive understanding of the interrelation between these organizational factors Leavitt's classical organizational change model was employed.

Based on the findings, several open research areas can be identified. First, future research should investigate the relationships and capacities between the identified organizational factors with more depth. Studies which discussed the need to

establish services for RDM often emphasized the interrelation with user-needs, to provide RDM infrastructure, as well as to develop policies or guidelines.

The only notable data related support revealed by the data are: guidance for best practices on RDM which the ORID has provided in the form of RDM guideline, which is available on its website, and support for data analysis (provision of and training on the use of data analysis software SPSS and NVivo) offered by the UGCS and the Library. There is also limited support for collaborative and computational research, through the provision of higher performance computing (HPC) and high storage capacity infrastructure. The issue is that these services are disjointed and not formally instituted as RDM services. This finding is consistent with the literature. The studies by Chiware and Becker (2018)[9], Chigwada, Chiparausha and Kasiroori (2017)[27] and Takeda *et al.*, (2010) all reported limited RDM support. This is in part because RDM is new and underdeveloped and there is a lack of appropriate skill and adequate knowledge about RDM.

Institutions sometimes articulate their RDM aspirations through non-mandatory guidelines rather than a binding policy. RDM is undeveloped, but there is potential for growth. There is a considerable RDM skills and knowledge gap and technological capabilities were generally found to be small scale, uncoordinated and not necessarily provisioned for RDM. Though there is no formal RDM infrastructure or programmes in place at UG, it is still considered an essential research integrity concern by the University's management. This also suggests that RDM issues in themselves are a natural part of research activities and even when they are not formally instituted as a service, HEIs and research institutions are conscious about proper handling of data, which is the basic ingredient for scientific inquiry, knowledge production and validating research findings (Jones, Pryor & Whyte, 2013: 1-2; Lynch & Carleton, 2009: 236)[24]

The outcomes of this study have practical implications for future RDM development at UG. It provides some pointers to the University management and stakeholders with regards to which RDM capabilities currently exist, which ones need to be developed and a snapshot of the general institutional preparedness. To the broader academic and research community, this study makes a significant contribution to the body of knowledge on institutional RDM development from the perspective of a developing country India by showing how institutions that are without any formal RDM programmes could respond to RDM as a critical part of an emerging research process.

While this study reveals that the state of RDM development at UG is similar to most institutions further research would be required to validate the findings in this study. More researchers and other critical RDM stakeholders (e.g. University management, legal department, archives, Government etc.) would have to be engaged to provide a stronger and more accurate picture.

RECOMMENDATIONS

On the basis of the findings of the study, the following recommendations are proposed for developing RDM:

1. The development of a clear and comprehensive institutional policy framework for RDM. This must be practicable, harnessing all the current capabilities identified and covering all essential aspects including an explicit retention policy, data management planning and a framework for monitoring compliance. This is a key requirement for developing a coherent RDM programme and must be done through coordinated and collaborated efforts of the Library, Research Office and the local academic community.
2. A conscious and gradual programme to embed data management planning (DMP) into the research practices. For instance, at UG this can be done by including DMPs as part of the current ethics approval process. This will help to identify potential uses and risks for research data very early in the research process, so that the institution can identify which data are worth retaining or discarding or what actions must be taken to address data risks.
3. The University management should set up a high-level working group comprising senior officials from the Research Office, Library, IT department, Legal department and any relevant stakeholders to champion RDM within the institution and also ensure a deeper cooperation between researchers and the RDM working group for broader consultations and assessment of institutional capabilities and RDM needs.
4. Invest in building capacity for research support staff. This is crucial for a competent and reliable professional expertise on RDM

within the institution. Research support staff should be supported to attend trainings, short courses, conferences and workshops about research data management. This will retool current staff to take up data management support roles and also build their capacity as trainers.

5. The skills and knowledge gap also have implication for curricula development. It is recommended that the School for Library studies update its graduate curricula to reflect the new and emerging roles of librarians in the emerging data driven research environment.
6. This study is also an awakening for Academic and Research libraries therefore, recommended that librarians should be proactive by innovatively developing specialized research support services for their researchers whether there is a mandate or not.

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