Knowledge Management Framework for Evaluating Biomedical Information Systems: A Tool for Open Scholarship

Lisa Kruesi[1], Frada Burstein[1], Kerry Tanner[1] and Octavia Madge[2]
[1]Monash University, Faculty of Information Technology, Melbourne, Australia
[2]University of Bucharest, Romania

Lisa.Kruesi@monash.edu
Frada.Burstein@monash.edu
kjtanner@bigpond.com
octavia.madge@litere.unibuc.ro

Abstract: A socio-technical Knowledge Management System (KMS) Framework for evaluating biomedical information systems that support open scholarship is proposed. The Framework spans nine knowledge-lifecycle processes—discovery, creation, representation, classification, storage, retrieval, dissemination, transfer, and translation—and aligns them with people, process, technology, and content elements. Using an action research approach that combined expert interviews and literature reviews, the Framework is applied to three systems: Europe PMC, Epistemonikos, and ResearchGate. The evaluation identified exemplary components as well as recurring gaps, particularly in downstream knowledge transfer and translation, which are often overlooked by repository checklists. Findings show the Framework's value as a comprehensive, transparent lens for comparing systems, diagnosing weaknesses, and prioritizing enhancements across the full knowledge lifecycle. By making strengths and omissions explicit at the socio-technical level, the KMS Framework guides improvements to biomedical information systems in service of more effective open scholarship.

Keywords: Knowledge management framework, Open scholarship, Information repositories, biomedicine, Action research

1. Introduction

Thousands of open scholarship repositories exist to support research. The global index, Registry of Open Access Repositories (ROAR) and the Directory of Open Access Repositories OpenDOAR detail 6,000 repositories (University of Southampton, 1999-, University of Nottingham (UK), 2005-). The motivation behind the development of a Knowledge Management System (KMS) Framework was to identify and map the situation beyond organisational boundaries, along with representing the perspectives of all users, such as the clinical practitioner, the biomedical researcher, and the health sciences librarian.

A KMS Framework is a conceptual representation of combined KM practices, such as a set of methods to support learning and organizational processes of KM development, and KM tools, including IT-based systems supporting the practices (Centobelli et al., 2019). There are other frameworks and evaluation tools for repositories, although in most cases they are not designed to evaluate information systems. A few of the main examples and their focus are the COAR Community Framework for Good Practices in Repositories, which is written for library and information practitioners, in particular those who have specialized in managing content repositories (Confederation of Open Access Repositories, 2022); the COAR Next Generation Repositories which has a focus on generic technologies (Confederation of Open Access Repositories, 2022); PLOS Criteria for Recommended Data Repositories, which has a focus on data (PLOS, 2018); Plan S which has strict open access criteria (European Science Foundation, 2021); and the FAIR Principle, which also focuses on data (GO FAIR, 2019). Unlike the proposed KMS Framework, these frameworks do not take a holistic socio-technical approach in order to identify the strengths and weaknesses of an information system to serve the objective of open scholarship to all of the stakeholders, especially those in biomedicine, given that it is a complex and dynamic field.

The KMS Framework is a way to improve the poor coordination of people, process, technology and content elements in biomedical KM that results in a costly disconnect through to the pipeline that delivers the point-of-care evidence for patient care (Australian Living Evidence Consortium, 2018).

'Pain points' that researchers experience when navigating the wide array of information systems to support research and practice have been reported (Laera et al., 2021). Application of the KMS Framework is a means to identify the key strengths and weaknesses (Kruesi et al., 2020b). In particular, the 'pain points' include access, awareness, paywalls, uniformity of systems and the resource scope, which is the difficulty determining what resource to use and when to use it (Laera et al., 2021). Identification of 'pain points' from use of the Framework presents an opportunity to address them.

2. Theoretical Background

A system is a collection of processes, elements and/or components that are organized for a common purpose (Tech Target Network, 2023). The systems chosen for evaluation were not limited to open access biomedical repositories. The process that distinguishes a repository and an information platform is that a repository usually ingests and stores digital objects (content), and information platforms, such as aggregator platforms, do not always host digital objects.

Whilst it is not possible at present to have a one-stop information system, given the wide array of information systems, achieving confidence to navigate and search across multiple repository systems in the future will be essential and Artificial Intelligence (AI) is a likely means to achieve this. Even though the advent of library discovery systems has brought together disparate information databases and platforms, present efforts are focused on optimising open scholarship systems, to work in parallel with commercial library database systems. Navigating the vast amount of biomedical knowledge has improved significantly, although it is still not possible to synthesise knowledge without human involvement (Clark et al., 2025). Translation of biomedical findings into practice takes many years to occur (Morris et al., 2011). With technology moving fast to accelerate some of these processes, it is important to have a way of assessing the trade-offs of removing "humans from the loop," for example, relying upon technology for continuous monitoring of bibliographic and other databases, to underpin living evidence (Elliott et al., 2021).

The KMS Framework is a means to guide KM processes throughout their biomedical open-scholarship life cycle (Kruesi et al., 2020b). The main objective of this paper is to demonstrate the KMS Framework's utility in evaluating the strengths and weaknesses of biomedical systems in supporting open scholarship. Unlike existing tools that focus on functionality, the Framework assesses systems against biomedical KM processes. To illustrate the power of the conceptual KMS Framework for analysing an open repository (Kruesi et al., 2020b), it was tested on three existing systems, including Europe PMC, Epistemonikos and ResearchGate (Table 1. Systems evaluated).

Table 1: Systems evaluated

System	Description
Europe PMC (repository)	Openly accessible repository, focus on biomedical research, links to research data, includes other research data sets and resources
Epistemonikos (database)	Openly accessible, provides a summary of research evidence, includes biomedical research
ResearchGate (RG) (repository)	Openly accessible, based on scientific social networking services and also serves as a repository as it has a specific feature that allows members to upload full-texts of their publications.

3. Methodology

3.1 Research Design

Action research was adopted, employing a cyclical approach that links theory with practice. The steps followed included diagnosing the problem, planning actions, and implementing and evaluating outcomes (Lewin, 1946). Identifying the relationships and linkages between elements in the framework helped eliminate redundant legacy organizational boundaries. Within the collaborative, distributed open science network, the repository is an integral cog, although its effectiveness depends on achieving a fine balance as part of the discovery, creation, representation, classification, storage, retrieval, dissemination, transfer, and translation processes that underpin biomedical knowledge. This network must be aligned to achieve quality and reproducibility throughout the complex system as the means to advance open science (Kruesi et al., 2020b).

For the final action research cycle, systems were selected on being established for more than five years; being open or partially open (such as ResearchGate); containing biomedical content; having millions of users; and demonstrating distinct differences.

Governance and quality were identified as critical overarching principles of an open biomedical repository (Kruesi et al., 2020b). Governance includes operational controls such as compliance with funder and institutional policies, administration and ethics (Governance Institute of Australia, 2023). The NHMRC's six quality principles—respect, rigor, transparency, accountability, innovation and efficiency— also apply (National Health and Medical Research Council (Australia), 2019). These principles operate across the broader environment rather than within each individual process or element of a repository (Kruesi et al., 2020b).

A KMS Framework evaluation template was created in Excel to assess each system. Following collection of the data by application of the procedure that follows, the findings were synthesised into a combined evaluation document, with a sample shown in Table 3: Example from an Excel template of processes that align with content. The complete comparative summary table of the systems evaluated is available as an appendix (Kruesi et al., 2020a).

The first repository that was evaluated was Europe PMC. Data came from two interviews with the Europe PMC, Head of Open Research, who was introduced to the authors by an Australian leader in open access. Following ethics approval, a semi-structured videoconference interview was conducted, supported by a literature review and analysis of the Europe PMC website. Certain element components change regularly, for example the Europe PMC content element reported in the discovery process increases daily when the system is updated.

Epistemonikos was evaluated using an interview with a Foundation board member, a literature review and examination of the Epistemonikos website. The ResearchGate (RG) evaluation was based on a literature review and personal use of the information system. As there were numerous primary published studies on ResearchGate to use for the assessment and based on the experience with the system by the authors, an interview with the system owner was not undertaken.

3.2 Procedure

A four-step procedure was applied with each of the four systems evaluated. The first repository to be evaluated was Europe PMC, followed by Epistemonikos and ResearchGate.

Step 1. Plan

A literature search for research papers on the systems was undertaken.

An Excel template was used to tabulate the data for the evaluation. The template comprises a worksheet with a column for each of the nine KM processes: discovery, creation, representation, classification, storage, retrieval, dissemination, transfer and translation, listed as column headings, and aligned with the elements: people, process, technology and content that are listed in the first column as row headings. Each of the processes and the elements have been defined to achieve a consistent approach. An example of a definition for the KM process, discovery, associated with the people element is “knowledge discovery is the development of new tacit or explicit knowledge from data and information or from the synthesis of prior knowledge.” The processes identified underpin biomedical knowledge. The definitions are a permanent feature of the template.

Step 2. Collect data

Step 2 comprised the following activities:

- Analysis of journal articles found in the Step 1 literature search and populating the Excel template with a summary of the relevant findings which are referenced;
- Reviewing the system’s website and populating relevant details into the Excel template; and
- Conducting an interview with the staff responsible for the system (where possible) to discuss the draft system analysis and get feedback on the suitability of the analysis.

Step 3. Document

Step 3 involved the mapping of data into the Excel worksheet template. Table 3 provides an example from an Excel template of processes aligning with the content element, taken from the ResearchGate evaluation.

Step 4. Reflect

Step 4 involved reflection on the process of grading the data in each cell, and then evaluating and reporting on the results. A ‘high’ indicates the component(s) in the element that make the system an exemplar in the field; a ‘medium’ grading indicates the components within the element either have scope for improvement and/or may rely on external influences; and a ‘low’ grading indicates that the components in the element may be external to the system and may detract from the system. The grading is represented here with grey shading (although it was originally developed using traffic light colours: with green for ‘high,’ yellow for ‘medium’ and red for a ‘low’ grading). The definitions of the shadings are provided in Table 2.

Table 2: Definitions of the shadings

High	**includes components that make the system an exemplar in the field**
Medium	components with scope for improvement and/or may rely on external sources
Low	components may be external to the system and detract from the system

Table 3: Example from an Excel template of processes that align with content

System	Representation	Classification	Storage
ResearchGate = RG ***Content is the 'what' such as research data, metadata, database records, classification schemes, articles, videos, graphs, maps, visualizations, reports and other digital objects***	*Representation comprises explicit knowledge in the form of digital scholarly objects or the metadata for the objects.* Every publication registered also has its own page giving metadata and, in some cases, a preview and a link to a full text version, if the author has uploaded one to the site and the publisher has not requested that it be removed for copyright reasons (Clarke, 2013). Users can also become actively engaged by participating in the questions discussion threads, both by posing research questions and by sharing expertise.	*Classification schemes and ontologies are used by repositories to allow users to navigate content* RG has indexed many citations for a single website and has become a major source for academic papers, perhaps even starting to challenge Google Scholar in this regard. Combined with the apparent citation advantage of uploading to academic social network sites (Niyazov et al., 2016), RG citations can potentially be manipulated by uploading non-peer reviewed or fake documents and hence should be used cautiously for research evaluation (Thelwall and Kousha, 2017B).	*Content, including metadata, needs to be stored in a standard way, that can be efficiently migrated to future systems.* Migration of metadata and articles out of RG does not appear to be an option for users.

3.3 Summary of Data Collection

Extensive work was undertaken to collect data on each of the information systems, including Europe PMC, Epistemonikos and ResearchGate. The evaluation first took place in 2020 and was updated in 2026. As the study was during the COVID-19 pandemic the only major change to Europe PMC was the establishment of the COVID-19 initiative, whereby additional publishers were providing coronavirus content openly available from PMC as soon as possible (SPARC, 2020). The first repository that was analysed and evaluated was Europe PMC. In Cycle Two of the action research, the KMS approach was applied to develop the first version of the conceptual framework for an open biomedical repository (Kruesi et al., 2020b). Consolidation of the learning gained, some of which was derived from interviews with key staff at Europe PMC and at Epistemonikos, and a literature review and exploration of the Europe PMC, the Epistemonikos and the ResearchGate websites, was undertaken to complete the evaluation.

4. Findings

4.1 Europe PMC

Europe PMC is an open repository for research publications (Ferguson et al., 2021), established in 2007 (US National Library of Medicine, 2021a). It is part of PMC International (PMCI) (US National Library of Medicine, 2021a), a collaborative arrangement between NIH/NLM, publishers and American funders that submit content to the PMC archive, and other funders across the globe who support open and permanent access to journal content by the researchers they fund (US National Library of Medicine, 2021a). PMCI achieves high levels of compliance, as publishers typically submit author content to the repository (Lariviere and Sugimoto, 2018). A key benefit is that national or regional repositories of grant-funded research output can add other content to the repository. Systems such as Europe PMC discourage authors from signing away their copyright to the publishers, who resell it to agencies that have funded it in the first place.

Dr Johanna McEntyre led a Wellcome Trust grant, supported by the Europe PMC's 35 funding bodies, to maintain and develop Europe PMC. Governance is an overarching principle of the KMS Framework, and for Europe PMC, governance is undertaken by a Scientific Advisory Board and a Funder Committee (Europe PMC, 2026).

Research on PMC and Europe PMC informed the development of the conceptual Framework for an open biomedical repository previously reported (Kruesi et al., 2020b). The elements and processes of Europe PMC were aligned and graded (Kruesi et al., 2020a), based on the definitions of the elements and the processes (the definitions of the elements are available in Table 4). The findings indicated that the repository comprises

components that distinguish this system from others in the field, with only a few of the elements being dependent on external influences to exist and no components that detract from the system (Kruesi et al., 2020a).

Table 4: Definitions of the elements

Element	Definition
People	The 'who' such as digital engineers, asset managers, project sponsors, data custodians, architects, consultants, internal and external stakeholders.
Process	The 'how' and includes standards, regulations, technical guides, plans, checklists, codes, taxonomies, policies, procedures and other explicit sources.
Technology	The 'tools' such as software, hardware, storage, digital systems, platforms, databases and other expert systems.
Content	The 'what' such as research data, metadata, database records, graphics, maps, visualizations, reports and other digital objects.

An analysis of the dissemination process, as reported in (Kruesi et al., 2020a), KMS Framework evaluation subset, for Europe PMC, is exemplary. This is based on the comprehensive forums and outlets, such as social media (including X, blogs, YouTube), conferences and journal publications, which are used to promote this open repository and its content by people. The element process within dissemination is of a high standard based on each of the funders making their open access publishing policies available from the Europe PMC website. Whilst the dissemination technology is able to indicate the number of free full text articles available, and if they are free to read and use, some of the research articles remain behind paywalls. The grading for Europe PMC's dissemination technology is therefore medium with scope for improvement, which appears likely with the ongoing increase in open full text articles, whereas the dissemination of Europe PMC's content is graded as exemplary based on the successful dissemination of billions of articles and the privacy the repository assures its users, as no individual usage patterns are reported.

Europe PMC achieves an ideal mix of KM processes and elements as identified from applying the KMS Framework. The system meets the requirement of external authorities, such as adhering to legislative requirements, standards and codes determined by governments, funders and publishing bodies and has numerous elements that distinguish this system in the open biomedical repository field. Europe PMC is a set of open systems and services that ingest, store, manage, display, retrieve and allow reuse of digital objects with the balance required of the four elements, resulting in an exemplary open biomedical repository.

4.2 Epistemonikos

Epistemonikos, established in 2009 at Pontificia Universidad Católica de Chile, is a search platform that provides a multilingual database of human health evidence (El-Khayat, 2017, Rada et al., 2020). The platform searches ten bibliographic databases either daily or weekly to find systematic reviews related to health-decision-making (Rada et al., 2013), combining human and automated systems with the aim of providing a comprehensive platform to access systematic reviews to support clinical practice. In regard to the KMS Framework's overarching quality principle, Epistemonikos' criteria for selection of systematic reviews and methods followed are in adherence with international practice, such as the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021) and the Cochrane Handbook (Higgins et al., 2019). In 2016, Epistemonikos became a partner of The Cochrane Collaboration and the Cochrane Library now offers the option to search the Epistemonikos database from its website (Epistemonikos Foundation, n.d.). The platform aims to bring evidence closer to health decision makers for rapid and reliable solutions (Epistemonikos Foundation, n.d.).

The target audience for Epistemonikos (people element) is researchers, health decision makers and policymakers (Rada et al., 2020). The system is not intended for the general public, although it is used successfully by lay people and journalists. Epistemonikos generates output to enable explicit knowledge from the synthesis of prior knowledge. The platform has some components that make the resource an exemplar in comparison with other repositories and platforms, such as the ability to generate an evidence matrix with a pivot table that shows systematic reviews that each share one of the same studies that meet the criteria to be included in those reviews. Another exemplar feature is the wide array of sources that are searched, such as ten health sciences literature databases that are searched daily or weekly. The content is added to the platform and underpins the discovery process, although there is a dependency upon clinical experts (people) to create the metadata and this may be an area with scope for improvement. Efforts to automate processes in classification, retrieval and translation are impressive and each of these has some human (people) intervention (Rada et al., 2020).

For example, as detailed in the KMS Framework evaluation subset (Kruesi et al., 2020a), the people element of the transfer process, involves clarification of the terms and conditions between relevant parties in relation to the use of the content. There are no licensing requirements put forward by Epistemonikos, as the platform links to the full text of openly accessible or proprietary articles. The process element of transfer takes place through patenting, licensing, contracts, trade secrets, joint ventures with inventors and commercial deals in relation to the content. The transfer of Epistemonikos content can occur within the copyright limitations of the content. The technology supports Application Programming Interfaces (APIs) for querying the Epistemonikos database. The content is standards based and bibliographic details can be transferred to reference software.

Epistemonikos has a number of processes (Kruesi et al., 2020a) that are dependent upon external sources, such as creation, dissemination and transfer.

4.3 ResearchGate

Research Gate (RG) is both a social networking site and repository. It hosts over 80 million publications, including 19 million full text articles (Jamali, 2017) and has more than 25 million members globally (ResearchGate, 2026). Based in Berlin, RG is a for-profit company funded by over US$80 million in start-up investments from sources including the Wellcome Trust and Bill Gates (Van Noorden, 2017). Its model combines free services with paid offerings, such as recruitment and brand building (ResearchGate, 2026). Membership requires institutional affiliation or evidence of research activity (ResearchGate, 2024).

RG has faced criticism and legal action due to copyright breaches from author uploads and crawler-added full text articles (Van Noorden, 2014, Van Noorden, 2017). However, agreements with publishers, such as Springer Nature, Cambridge University Press and Thieme have mitigated some concerns. Whilst RG has been controversial, it has KM processes that have attracted millions of research members and its success warrants greater understanding as it may help to advance the open scholarship system. The people element in regard to discovery found that RG is used by academics, who upload their articles to make them freely available (Jamali, 2017).

The people element in the translation process involves the “synthesis, exchange, and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people’s health”(Pablos-Mendez and Shademani, 2006). An analysis of the translation process, as detailed in (Kruesi et al., 2020a) of the KMS Framework evaluation subset for ResearchGate, the people element comprises the suggesting of similar articles, the provision of job and grant advertisements and the proprietary quantitative altmetric called RG research interest score, which are means to assist people with the research translation process. The RG research interest score, along with the potential misuse of the accumulated user data, have been raised as areas of concern (O'Brien, 2019), therefore the grading is medium in the evaluation Framework, indicating scope for improvement. The process and technology elements in the Framework evaluation are graded as low given RG’s lack of transparency in its operations and platform (Martín-Martín et al., 2016). The translation of the content promulgated using RG is graded as medium as it is dependent upon external sources and only a few noteworthy cross-country collaborations have been reported based on use of the platform (Hamm, 2009).

There are major concerns with RG. Whilst RG technology allows the import of publications from other applications, there is no method for the transfer of the same content out of the RG system. There is no long-term preservation strategy (the storage process), unlike most institutional and disciplinary repositories. The limitations identified detract from the RG system and, based on these, it is not regarded as an open access repository (Fortney and Gonder, 2015).

Even so, RG does include elements that make the system exemplary when compared with other platforms. For the people element in the representation process, each member has a profile page that includes brief biographical information and a publication list. Every publication (content) registered also has its own page giving metadata and, in some cases, a preview and a link to a full text version, if the author has uploaded one to the site and the publisher has not requested that it be removed for copyright reasons (Clarke, 2013). Users (the people element) can also become actively engaged by participating in the discussion threads, both by posing research questions and by sharing expertise. The RG collaboration options, which is in the dissemination process, allows for researcher commenting and file sharing; collaborators must be invited to see these areas. In relation to information retrieval, it is one of the top sources of full-text articles found through Google Scholar (Jamali, 2017).

4.4 Importance of the Overarching Principles

Identification of the varying degrees of governance and quality implementation as overarching principles was undertaken during the system evaluations. Europe PMC and Epistemonikos provide explicit details in relation to their governance, which is openly accessible from their websites (Epistemonikos Foundation, n.d., Europe PMC, 2026). Governance details for ResearchGate could only be located in the terms and conditions on their website.

5. Discussion, Future Research and Limitations

Whilst the COAR Next Generation Repositories initiative puts forward a vision that rests upon the resource rather than the repository being the focus of the services and infrastructure (Confederation of Open Access Repositories, 2022), the KMS Framework addresses the entire biomedical knowledge life-cycle (Kruesi et al., 2020b). In biomedicine, focusing on the 'information resource' can be limiting when the final goal of research output is to influence the route from basic research to healthcare solutions. The transfer and translation processes are critical to the transformation of fundamental knowledge into practice and these do not appear to be addressed in the expert evaluation tools and frameworks. The KMS Framework is a means to design and evaluate the entire spectrum of biomedical knowledge processes and it provides a systematic approach to dissect each of the elements to identify gaps and omissions. The KMS Framework can be applied by repository experts, managers, librarians and others who design, use or evaluate such systems.

Applied appropriately, the KMS Framework integrates relevant elements of people, process, technology and content to achieve best practice as specified by authoritative bodies. The use of the KMS Framework is a means to achieve a systematic, whole-of-system evaluation and a tool for comparing open systems with platforms that may be commercial systems or other types of platforms.

Not all content can be made open access; however, applying the KMS Framework surfaces many of the pain-points that can then be addressed. Examples include fewer password barriers and removing paywalls where possible to improve access to journal articles and research data. KMS Framework analyses and assessment of information systems are a means to determine the benefits and pitfalls that can be communicated to users. It is also a means for librarians to identify key components and advocate for consistency across information systems to improve the user experience.

Quality should be assessed based on factors such as adherence by people to process as defined by standards, codes, handbooks and statements that specify required practice and procedures. PMC International publishes explicit, stringent journal acceptance criteria (US National Library of Medicine, 2021b). Epistemonikos aggregates content from databases with human oversight to flag quality and enrich metadata to incoming system records. In addition, Epistemonikos states that it has designed its system to follow high standards of international codes and processes, for example PRISMA and the Cochrane Handbook (Higgins et al., 2019, Page et al., 2021).

The governance of RG is opaque due to limited public information on this entity. RG has argued that the lack of quality with its system is because of breaches of copyright that reflect researchers' non-compliance with copyright requirements (Jamali, 2017). Based on the KMS Framework, it is possible to account for RG's lack of content quality because of failing processes within their system.

As these findings are based on empirical research, it is possible that interpretative bias has occurred which is a limitation of this research.

Future research is recommended to test and extend the KMS Framework to support broader analytic approaches to repositories and platforms.

The people, process and quality content elements are core to the success of a repository, in addition to the underlying criticality of the technology; although technology largely serves as the vehicle for moving research content through its life cycle. The inclusion of the entire biomedical KM processes in the design of an information system for open scholarship is potentially a way to speed up the transfer and translation of primary knowledge in the research pipeline. Use of the KMS Framework is a means to identify roadblocks in getting evidence through to the pipeline that delivers the point-of-care evidence for patient care. The adoption of the Framework is a powerful means to identify the extent to which open scholarship processes and elements already exist and what remains to fill the gaps to achieve a sustainable open scholarship system.

6. Conclusion

The extensive work undertaken to document and analyse the information systems, including the definitions of each KM process based on the associated people, process, technology, and content elements forms the basis of the findings synthesised in the three case evaluations reported.

The evaluations support the proposition that the KMS Framework is an effective theoretical framework for analysing and evaluating repository and platform designs that advance open scholarship. Unlike existing assessment frameworks, the KMS Framework addresses the entire biomedical knowledge life cycle, in particular, the often-overlooked transfer and translation processes. Although repositories typically ingest, store, manage, display, retrieve and allow reuse of digital objects (Pinfield et al., 2014), they can also incorporate elements that provide data on the transfer and translation of knowledge. It is recommended that the entire range of KM processes be included in future open biomedical repository designs. Further research should apply and refine the KMS Framework through use by information specialists and comparative analysis with information systems, including those incorporating AI.

Ethics declaration: In particular, this research entailed potentially sensitive content from interview, focus group and workshop transcripts. Approval was obtained from the Monash University Human Research Ethics Committee (MUHREC) for this research.

AI declaration: Copilot was used to help with reducing the word count in the introduction and the discussion sections of this paper.

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