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Article

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Design Science Research in practice: Ideation of an Institutional Repository based on a journal

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ABSTRACT

Introduction: Institutional repositories were consolidated as important tools for the Open Access movement due to the possibility of making scientific production available, however, there are still challenges related to the implementation and maintenance of repositories, especially with regard to underutilization and copyright issues /intellectual property. Thus, considering this context and with the objective of teaching practical use of the Design Science Research method applied to Information Science, during the Design Science Research discipline of the Graduate Program in Knowledge Management and Organization, from the School of Information Science and the Graduate Program in Built Environment and Sustainable Heritage, from the School of Architecture, both from the Federal University of Minas Gerais, the students were challenged to develop an institutional repository as an artifact. Objective: Present the experience of applying the Design Science Research method to design a digital repository. Methodology: Design Science Research. Results: It presents the journey through the stages of identification and awareness of the problem, systematic review of the literature and ideation of an institutional repository based on a scientific journal. The Design Science Research method proved to be a driver of all research and, through the association of rigor and relevance, promoted the approximation between theory and practice. Conclusion: It contributes not only to the presentation of the method in a theoretical and practical way, but also exemplifies its use in the field of Information Science.

KEYWORDS

Design Science Research. Institutional repository. Information Science. Organizational memory.

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Design Science Research na prática: Ideação de um Repositório Institucional baseado em periódico científico

RESUMO

Introdução: Os repositórios institucionais consolidaram-se como ferramentas importantes para o movimento Acesso Aberto em razão da possibilidade de disponibilização da produção científica, contudo, ainda há desafios relacionados à implementação e manutenção dos repositórios, especialmente no que tange à subutilização e às questões de direito autoral/propriedade intelectual. Assim, considerando esse contexto e, tendo por objetivo o ensino prático do método Design Science

Research aplicado à Ciência da Informação, durante a disciplina Design Science Research do Programa de Pós-Graduação em Gestão e Organização do Conhecimento, da Escola de Ciência da Informação e do Programa de Pós-Graduação em Ambiente Construído e Patrimônio Sustentável, da Escola de Arquitetura, ambos da Universidade Federal de Minas Gerais, os alunos foram desafiados a desenvolverem como artefato um repositório institucional. Objetivo: Apresentar a experiência de aplicação do método Design Science Research para projetar um repositório digital. Metodologia: Design Science Research. Resultados: Apresenta o percurso pelas etapas de identificação e conscientização do problema, revisão sistemática da literatura e ideação de um repositório institucional baseado em periódico científico. O método Design Science Research revelou-se como um condutor de toda a pesquisa e, por meio da associação do rigor e relevância, promoveu a aproximação entre teoria e prática. Conclusão: Contribui não apenas na apresentação do método de forma teórica e prática, como exemplifica o seu uso na área da Ciência da Informação.

PALAVRAS-CHAVE

Design Science Research. Repositório institucional. Ciência da Informação. Memória organizacional.

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1 INTRODUCTION

An Institutional Repository (IR) can be understood as "a digital library designed to store, preserve and ensure free access via the Internet to the scholarly production of a given institution" (Marcondes; Sayão, 2009a, p. 9). This type of information system has gained notoriety due to its importance for the Open Access movement, which seeks to promote initiatives for the free distribution of scientific literature, especially those resulting from publicly funded research, a reality almost exclusive to research developed in Latin America (Costa; Leite, 2019).

In Brazil, the Open Access movement was marked by the Brazilian Manifesto in Support of Free Access to Scientific Information, launched by the Brazilian Institute of Information in Science and Technology (BIIST) on September 13, 2005. "Thus, each scientific or academic institution [...] should keep copies of the scientific production of its community in its institutional open access repository" (Marcondes; Sayão, 2009a). The authors outline a historical overview of the Open Access movement in Brazil and worldwide, emphasizing that

> Institutional repositories now bring universities and research institutions the opportunity to strengthen themselves institutionally from the visibility of their organized and available academic production, as a faithful portrait of their institution, from their institutional repository (Marcondes; Sayão, 2009a, p. 19).

To learn about the successes and challenges experienced by IR initiatives in university libraries that have committed to developing and maintaining an IR, Palmer, Teffeau, and Newton (2008) conducted a comparative case study of three institutions and found that the benefits of implementing an IR outweigh the basic ideal related to collection, but one of the main concerns or barriers faced, which consumes a significant amount of time and resources, is the issue of intellectual property, as much of the content collected requires copyright clearance before deposit in the IR. One of the institutions made significant progress in this regard by acquiring high-value academic publications directly from publishers. Still, this approach did not prove feasible and an alternative was to collect materials without copyright restrictions by providing a base of local technical reports, grey literature, theses, and dissertations.

In addition to copyright/intellectual property issues, the results of the survey conducted by Rafiq (2022) identified other barriers to the development of IR in universities, such as lack of staff with the necessary skills and knowledge; lack of funding; lack of necessary equipment and/or software; lack of an established IR plan, policies, and procedures; priority given to other projects; low commitment from university management; and lack of knowledge about IR. These are challenges that also appeared in the systematic literature review conducted by Asadi *et al*. (2019), who, considering studies published from 2007 to 2018 and retrieved from ScienceDirect, IEEE Explorer, Springer, ACM, Taylor, and Francis, and Emerald insight databases, identified problems related to awareness of IR, inadequate or outdated infrastructure, copyright issues, and scarce incentives.

In this context of challenges, Holter (2020) highlights the under-utilization of IRs due to what he calls a lack of enthusiasm for self-archiving by researchers. Such a situation would be intriguing, given that the search for visibility and reputation is important in academia, and, in this sense, it should be extremely valuable for researchers to make the results of their research available on open-access platforms. However, the results of interviews conducted by the author with nine IR managers in the UK indicate that researchers see little value in IR for several reasons, including: not understanding the functions and purposes of an IR; seeing self-archiving as a complicated, unpleasant, boring and time-consuming task because IRs do not provide

feedback to the researcher; practical difficulties in depositing articles; the need to enter many different types of metadata; and the poor interface of IRs compared to other interfaces.

For Holter (2020), however, depositing an article in an IR is not very different from the process of submitting an article to a journal, and the process of entering metadata is practically the same, and therefore the main difference between depositing an article in an IR and submitting an article to a journal would be that researchers are much more willing to do the second task because they perceive a direct and immediate benefit, which is the publication of an article.

It seems that, although IR is undoubtedly an important component for the expansion of Open Access, it has not yet reached its full potential, and new research is needed to investigate and present alternatives for simplifying the process, improving visibility, infrastructure, and services, and, in particular, providing solutions to the problem of under-utilization of IRs.

The aim of this article is therefore to present an experience of applying the Design Science Research (DSR) method to the design of a digital repository for the Postgraduate Program in Built Environment and Sustainable Heritage (PBESH), of the School of Architecture (SA/UFMG). The artifact was developed in an interdisciplinary way by students of the PBESH and the Postgraduate Program in Knowledge Management and Organization (PPKMO), of the School of Information Science (SIS/UFMG), as a way of practical learning of the Design Science Research (DSR) method.

The general objective of the project, called "Memor", was to propose a context that would favor the strengthening of PBESH and give greater visibility to its academic productions. Thus, "Memor" presented two aspects:

> a) Repository: the creation of a digital repository of the program to maintain a memory of its productions;
> b) Event: holding a periodic event to present the results and progress of the Program's research, as a way to encourage and promote the sharing of knowledge.

Here, the experience report is focused on the repository aspect and aims to exemplify the application of the DSR method in Information Science (IS). According to Bax (2013), IS itself is already, to a large extent, a design science, since it is part of the Applied Social Sciences area of knowledge. The author considers DSR " one of the most appropriate methodologies" in guiding research in the area of IS because it is "an approach that combines the relevance of practical application with scientific rigor" (Bax, 2013, p. 298).

The article is divided into five sections. The first, this introduction, with the identification and awareness of the problem to be addressed and an explanation of the intended objective; the second section, focusing on IRs, presents the Systematic Literature Review (SLR) conducted to obtain more information on the subject and survey of artifacts already developed in other studies; the third section, focusing on the DSR method, provides a general explanation of the method, its steps, and main characteristics; the fourth section, the practical part of the study, presents the report of the experience of using DSR, for the idealization of an IR based on a scientific journal and, finally, in section five, final considerations are presented with reports of learning, research limitations and suggestions for future work.

2 INSTITUTIONAL REPOSITORY (IR)

An IR is responsible for gathering, storing, organizing, preserving, retrieving, and disseminating scientific information and this increases the visibility of the results of the research that takes place in the institutions and, thus, allows other scientific communities to have access

to the research carried out, enabling the meeting of diverse scientific fields (Marcondes; Sayão, 2009a). As highlighted by the authors:

> One of the most important motivations for the creation of institutional repositories is to ensure that digital research materials remain available and accessible for the long term, contributing to the construction and preservation of the academic memory of research and teaching institutions (Marcondes; Sayão, 2009a, p. 39).

Murakami and Fausto (2013) provide an overview of the IRs of higher education institutions in Brazil. Using the Registry of Open Access Repositories (ROAR), the Directory of Open Access Repositories (OpenDOAR), the Luso-Brazilian Directory of Open Access Journals and Repositories, and the addresses shared in the "L_repositorios" list of BIIST as sources for data collection, the authors identified 49 IRs of higher education institutions in Brazil in August 2013, making available 396,881 articles.

Considering the number of works made available, the five largest repositories were:

a) 18.8%: LUME, IR of the Federal University of Rio Grande do Sul (UFRGS);
b) 13.6%: Digital Library of the State University of Campinas (UNICAMP);
c) 10.4%: Digital Library of Theses and Dissertations of the University of São Paulo (USP);
d) 9.4%: Digital Collection of the State University of São Paulo (UNESP);
e) 8.3%: IR of the Federal University of Santa Catarina (UFSC).

Consequently, even knowing that an institution can maintain more than one repository, the five largest maintaining institutions were: UFGRS (18.8%), USP (17.5%), UNICAMP (13.6%), UNESP (9.4%), and UFSC (8.3%). Regarding the type of institution, most of the repositories identified were federal (65.3%).

To review, systematically integrate and examine the results of previous research on the current state of studies on IR in higher education institutions, Asadi *et al*. (2019) conducted a collection of studies published from 2007 to 2018 from six major databases (ScienceDirect, IEEE Explorer, Springer, ACM, Taylor, and Francis, and Emerald insight), selecting a total of 115 studies based on inclusion and exclusion criteria.

The findings of Asadi *et al*. (2019) reinforce that the dissemination of research and knowledge through IRs is considered the most important factor for scholars to choose IRs. They highlight IRs as the basis for the development of research communication among scholars from different institutions, and their collaboration from academic perspectives in teaching and learning. The research questions in the authors' survey were related to identifying the potential benefits and main challenges of an IR, the purposes for which university IRs are used by their scholars, and whether the IR can contribute to improving learning, teaching, and research activities in universities.

In terms of potential benefits, the studies highlighted that IRs make the institution's research output visible, thereby enhancing its reputation, and that scholars can benefit from the increased impact of their research through easy access and increased views and citations. They, therefore, suggest that IRs can increase the visibility of the academic institution, improve its local and global ranking, enhance its prestige and public value, improve teaching and learning, and develop the research of the institution's scholars.

Regarding the purposes for which IRs are used by academics in higher education institutions, studies point to seeking greater collaboration with other scholars, disseminating research, increasing the visibility of the institution, improving influence on research productivity, changing the paradigm of scholarly publications, improving internal relationships and collaboration within the academic institution. IRs enable a new environment for research collaboration by improving its reach, being a method to reduce the cost of scholarly publication, and increasing the visibility of academic research.

Asadi *et al*. (2019) point out as main challenges for the implementation and maintenance of IRs: (i) lack of awareness about open access IRs; (ii) insufficient communication and information technology infrastructure; (iii) copyright issues; (iv) insufficient incentive for open access and; (v) technological obsolescence. Among those pointed out, the lack of knowledge of open access IRs among academics and institutions and inadequate information and communication technology infrastructure would be the main challenges considering the studies analyzed. But here, considering the need to develop a repository for PBESH, what stood out was the low incentive for open access.

This contextualization of IRs provided an overview of the relevance and motivation for their implementation, the main challenges, and the existence of institutions that have more than one IR. However, there were still some questions that could only be answered with a broad theoretical survey. According to Morandi and Camargo (2015, p. 142):

> Systematic literature reviews are secondary studies used to map, find, critically appraise, consolidate and aggregate the results of relevant primary studies on a specific research question or topic, as well as identify gaps to be filled, resulting in a coherent report or synthesis. The term systematic means that the review should follow an explicit, planned, accountable and justifiable method, as in primary studies. This method should be designed to ensure that the review is free from bias (a tendency to present one partial perspective at the expense of other possibly valid ones), rigorous, auditable, replicable and updatable.

Therefore, to identify the most recent discussions related to the implementation and use of IRs in higher education institutions, a systematic literature review (SLR) was conducted to obtain an overview of recent studies (2019 - 2022). The main intention was to review the main thematic categories and topics addressed, highlighting studies that could provide insights for the proposal of an IR for PBESH. The StArt® tool, developed by researchers from the Federal University of São Carlos (UFSCar), was used in the systematic review process, whose protocol is described below.

Databases related to applied or interdisciplinary social sciences were selected, providing complete works and with a wide coverage and inclusion of scientific journals, selected to guarantee the quality and reliability of the scientific content. Therefore, the databases chosen were Scopus and Web of Science. The generic search string to cover the terms "institutional repository" and "higher education institutions" was defined as ("institutional repository" OR "institutional repositories" OR "digital repository" OR "digital repositories" OR "institutional repository" OR "digital repository" OR "digital repositories") AND ("higher education institution" OR "higher education institutions" OR "university" OR "universities" OR "higher education institution" OR "higher education institutions" OR "university" OR "universities").

The criteria for including studies in the SLR were: only documents of the article type, written in English, Portuguese, or Spanish, published between 2019 and 2022, and containing the search terms in the title, abstract, or keywords. In addition, only articles that specifically addressed the implementation or use of IR in higher education institutions, that were available in full text and that met the previously defined quality criteria were selected. The following dimensions were adopted as quality criteria, as indicated by Morandi and Camargo (2015, p. 157). The quality of each dimension was rated as high, medium, or low, and only studies that received a "high" rating were included in the SRL:

1. Quality of study execution: Does the proposed method meet the standards required for the topic under study, did the study strictly follow the proposed method, and are the results supported by facts and data?
2. Appropriateness to the review question (IRs): Does the study address the target

topic of the systematic review?

3. Appropriateness to the focus of the review (IRs in higher education institutions): Was the study conducted in the context defined for the review?

The search results were exported for analysis using the StArt® software. First of all, all duplicate articles not automatically recognized as such by StArt® were excluded, then, with the help of the software, the papers received a score based on the identification of the keywords in the title, abstract or keywords, adopting the criterion validated by StArt® itself: 5 points per occurrence in the title, 03 points per occurrence in the abstract and 02 points per occurrence in the keywords. All papers without a score were excluded.

The papers that were not rejected in this initial classification underwent a reading of titles and abstracts to verify relevance, taking into account the questions to be answered by the SRL. After reading the titles and abstracts, the papers were accepted or rejected according to the criteria of (I) inclusion and (E) exclusion.

The initially accepted studies were read in their entirety. At this stage, the quality of the studies was assessed according to the previously defined criteria. The studies that met the quality criteria were accepted for extraction of the following data: title, author and year. In addition, the reading allowed the delineation of general thematic categories for each article and the main topic addressed was also extracted. Thus, the summarization of the results adopted the technique of narrative textual synthesis, which, according to Barnett-Page and Tomas (2009), organizes studies into more homogeneous groups.

As summarized in Table 1, 167 articles were retrieved from the selected databases. After the study selection steps, 54 articles were considered for SLR.

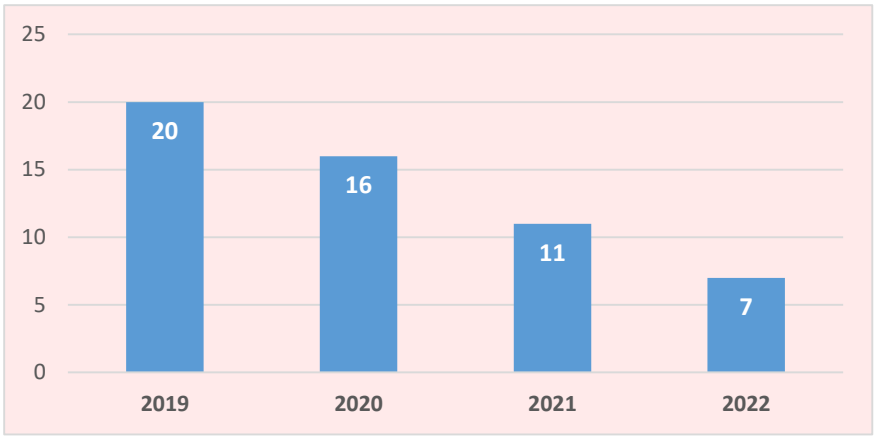
Table 1. Stages of selection of studies - quantitative.

Study selection stages	No. of documents analyzed	Excluded	Accepted
Step 1 (exclusion of duplicates and articles with score "0" - automatic StArt® classification based on the presence of the search terms in the title, abstract and keywords)	167	55	112
Step 2 (after reading the titles and abstracts)	112	45	67
Step 3 (after full reading and quality assessment of studies)	67	13	54

Source: elaborated by the authors

Considering the year of publication of the 54 selected articles, as shown in Graph 1, there is a trend towards a decrease in publications on IRs in higher education institutions. However, it is not possible, nor is it the intention of this study, to state that researchers are losing interest in the subject or that it is reaching a saturation point.

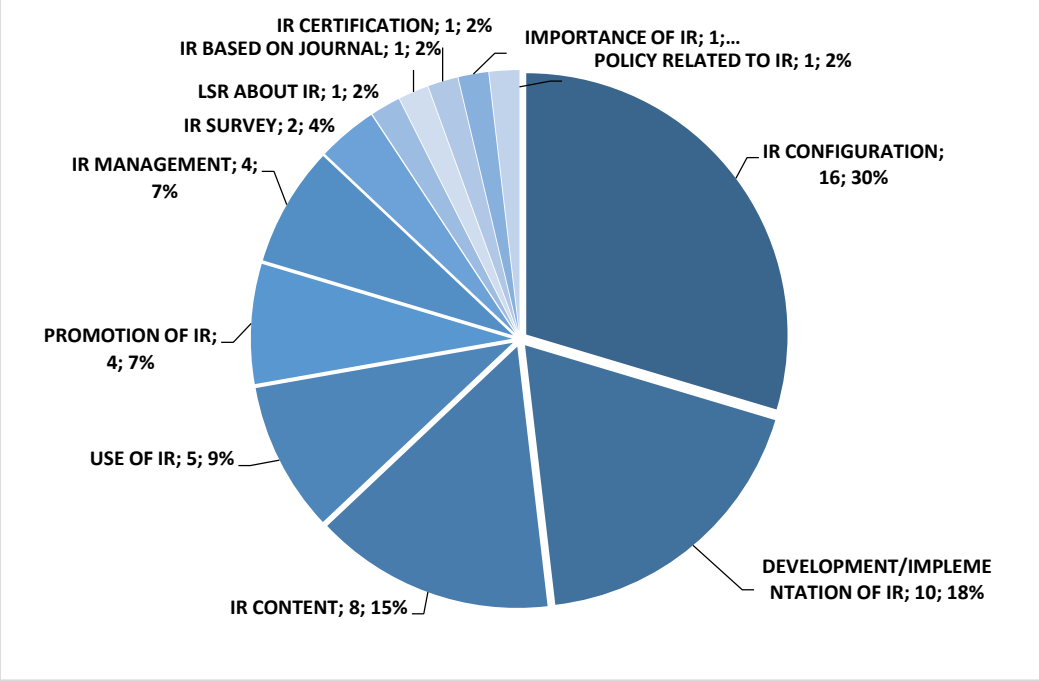
Graph 1. Publications by year



Source: elaborated by the authors

Considering the SLR's guiding question: "What are the most recent discussions related to the implementation and use of IRs in higher education institutions?", for each article selected for the SLR, a main subject was highlighted and, in the end, articles with similar subjects were grouped into similar categories. It was possible to extract 12 thematic categories from the 54 selected articles, according to Graph 2.

Graph 2. Thematic categories identified



Source: elaborated by the authors

Approximately 30% of the studies addressed the configuration of IRs, including issues such as:

a) metadata quality (Carson; OR, 2019; Mering, 2019; Phillips; Zavalina; Tarver, 2020; Thompson *et al.*, 2019);
b) Thematic representation in IRs (Tartarotti, 2020);
c) Analysis of IR metadata requirements (Nicholson; Bennett, 2021);
d) Software for data integration and automation in the article deposit process (Zhang,

2020);

e) Reliability of IRs (Nyitray; Reijerkerk, 2021);
f) Optimization of IRs (Macgregor, 2020);
g) Integration of the IR with the library collection (Makula, 2019);
h) Aggregated services in IRs (Fernandez-Ramos; Barrionuevo, 2021);
i) Architectural improvement of IRs (Fernandez-Luna; Perez-Montoro Gutierrez; Guallar, 2019);
j) Use of the Open Archival Information System (OAIS) model in IRs (Ochoa-Gutierrez; Saenz-Giraldo; Tirado-Tamayo, 2021);
k) Agile methodology and user experience design to improve usability in IRs (Gonzales *et al*., 2021) and,
l) Evaluation model of vocabulary control in IRs (Lopes Fujita, 2022).

The second theme, addressed by 18% of the articles, was specifically about the development or implementation of an IR:

a) Implementation of IR (Andrés *et al*., 2020; Fernandes; Cabral Nunes, 2020; Grasso; Pagola; Zanotti, 2019; Nurdin; Mukhlis, 2019; Somerville *et al*., 2020; Swain, 2020);
b) Development of a comprehensive IR (Evans *et al*., 2022; Scherer; Valen, 2019);
c) Framework for the development of IRs in universities (Rafiq, 2022);
d) National infrastructure for implementation and management of IRs (Posavec; Celjak; Musap, 2020).

The thematic category Content of IRs encompassed 15% of the selected articles that dealt with the inclusion of various materials in IRs:

a) Open Educational Resources (OER) in IRs (Santos-Hermosa *et al*., 2020);
b) Multimedia repository (Assunção *et al*., 2022);
c) Definition of metadata for inclusion of anatomical digital images in IR (Rezende; Ferreira; Manini, 2019);
d) IR of ancient coins (C. Klose; Goldstein; Levy, 2022);
e) Use of IR for archiving student symposia (Symulevich; Hamilton, 2022);
f) Performing arts content in IR (Shelley, 2020);
g) Audiovisual repository (De Freitas; Dos Santos, 2021).

The use of IRs was the subject of 9.3% of the articles, including:

a) Teachers' perceptions regarding IR (Msomphora, 2021; Shajitha; Majeed, 2019);
b) Use of IRs in public universities (Tapfuma; Hoskins, 2019a);
c) Analysis of user navigation in IRs (Phillips; Andrews; Krahmer, 2019);
d) Mandatory use of IR as a strategy against underutilization and analysis of the impact of this requirement on researchers and IR managers (Holter, 2020).

IR management was the subject of 7% of the articles that dealt with:

a) IR management practices (Marti-Lahera; Puerta-Diaz, 2019);
b) Vertical cooperation model to manage digital collections and institutional resources (MANESS *et al*., 2020);
c) Workflow for recruiting content to the IR (Smart, 2019);
d) Driving forces behind IR management (Adam; Kiran, 2021).

The same percentage of articles, 7%, were interested in the promotion of IRs:

a) IRs and social engagement (Boulton, 2020);
b) Promotion of IRs through visualizations (Jiang; Fitzgerald, 2019);

c) Analyzing the visibility of IR websites (Ghosh; Kumar, 2022);
d) The role of the academic librarian in promoting IR (Tapfuma; Hoskins, 2019b).

Two articles were also identified that conducted surveys of IRs: Kipnis, Palmer and Kubilius (2019), interested in IRs of medical schools and academic health centers, and Costa and Leite (2019), who surveyed open access IRs in Latin America.

The least addressed themes, for which only 01 article was identified, were:

a) Policy related to IRs, with Sondervan *et al*. (2021) dealing with the law on copyright to encourage open access through OER;
b) Certification of IRs, with the analysis of IR websites certified by TDR - Trustworthy Digital Repositories (Donaldson, 2020);
c) Importance of IRs, with Bradley (2021) addressing the importance of IRs in the dissemination and impact of research;
d) SLR on IRs in higher education institutions (Asadi *et al*., 2019);
e) journal-based IR, with the presentation of an IR on a digital, free and open access publishing platform for all academic production (Woutersen-Windhouwer *et al*., 2020).

Underserved topics can be an opportunity for innovation in DSR, and in this sense the work of Woutersen-Windhouwer *et al*. (2020) stands out. The authors developed a scholarly journal-based repository, "University Journals", as a solution to circumvent the fact that researchers do not find IRs very attractive and accessible as an open access publishing platform. A journal-based repository, on the other hand, might be more attractive to researchers who are more likely to publish and deposit their scholarly articles because it has the look, recognition, and dissemination of a scholarly journal.

The proposal of the "University Journals" repository involves a collective action of universities, based on their IRs, with the aim of sharing as many research results as possible, regardless of the type of production. The repository presented by Woutersen-Windhouwer *et al*. (2020) is based on journal technology, but is not structured like a traditional journal; it covers all disciplines and all types of research output. The goal is to provide a "home" for all scholarly outputs (reports, datasets, tests, protocols, methods, software, and other research products) that can be published quickly and thoroughly in "university journals". All publications will be assigned a Digital Object Identifier (DOI) for easy citation.

Another innovation is the replacement of traditional peer review as a quality assurance strategy. In University Journals, this can be replaced by quality assurance checks within the university itself, giving researchers and universities control over the rapid publication of all types of research products. The system is based on trust and gives universities control over their publications, deciding between internal and external review, or no review at all, depending on specific local and disciplinary policies. The final published article carries a badge or label indicating the type of quality control and/or blind/non-blind internal/external review the publication has undergone.

Woutersen-Windhouwer *et al*. (2020) point out that university journals publish all research on any topic, without selection of subjects, discipline, or impact of the study, to ensure that the review is done quickly and rejection rates are very low.

Considering the problem in question, the proposal of Woutersen-Windhouwer *et al*. (2020) emerged as the main reference to subsidize the development of the artifact.

3 *DESIGN SCIENCE RESEARCH* (DSR)

One of the aspirations of scientific research should be the juxtaposition of theoretical and methodological rigor in its conduct with the practical relevance of its results; however, as Dresch, Lacerda, and Antunes Júnior (2015) note, this is not the reality of much of the research developed in academia, which, although often based on solid theoretical review, critical reflection, and consistent methodologies, shows little concern for the use of the results by society. It is self-centered research, focused almost exclusively on dialogue with the academic community itself.

Thus, the need for research that is not only theoretically and methodologically rigorous, but also produces knowledge that is of practical use to society is emphasized. "It is not enough to understand a phenomenon in depth [...]. It is necessary to develop knowledge on how to intervene in a given situation [...] and generate the desired results" (Dresch; Lacerda; Antunes Júnior, 2015, p. 2).

These are the pillars on which the DSR research method is based: scientific validity and pragmatic validity, meeting both the necessary theoretical and methodological rigor and ensuring the usefulness of the proposed solution to the problem (Dresch; Lacerda; Antunes Júnior, 2015).

DSR is epistemologically based on design science, whose emphasis is precisely on the connection between knowledge and practice in order to produce scientific knowledge by designing useful things (Wieringa, 2009). However, it is important to clarify that the DSR method is not the only one that proposes to conduct research with rigor and relevance. For example, action research is one of the research methods that seeks to develop scientific knowledge while acting to solve real problems (COLLATTO *et al*., 2018).

Some studies even consider Action Research and RSD as similar (JÄRVINEN, 2007), while others distinguish them (Iivari; Venable, 2009; Dresch; Lacerda; Miguel, 2015; Collatto *et al*., 2018), highlighting differences in terms of objectives, the role of the researcher in conducting the research, the possibility of generalizing the results, the need for collaboration between researcher and researched, and the need for an empirical basis.

The choice of one or the other method depends very much on the type of study to be conducted. Studies that develop artifacts, use them in an organizational context (collaboratively or not) and evaluate them have adequate methodological support through DSR (Collatto *et al*., 2018). As highlighted by Dresch, Lacerda and Antunes Júnior (2015), "Design Science aims to conceive knowledge about how to design, not only to apply it. In other words, Design Science is a science that deals with projects" (DRESCH; Lacerda; Antunes Júnior, 2015, p. 57).

The concept of Design Science, translated as project science or science of the artificial, was introduced by Herbert Simon in his book "The Sciences of the Artificial" (Dresch; Lacerda; Antunes Júnior, 2015). By artificial, Simon means everything that is produced, invented or intervened by humans. In this sense, artifact, which denotes something built by man, is one of the most important concepts of design science and can refer to a construct, model, method, instantiation (operationalization of other artifacts in a real environment) or, more characteristic of the method, a design proposal or generalization of a solution for a certain class of problems (Dresch; Lacerda; Antunes Júnior, 2015).

For Weigand *et al*. (2021), the artifact designed by DSR presents well-described design specifications with instances that are used, directly or indirectly, for both practical and research purposes, with the aim of building knowledge about the domain in question. It is considered a "universal artifact" because it should be generalizable to multiple contexts of use, which does not mean that every universal artifact is a DSR artifact. To be a DSR artifact, it must have both

scientific rigor and practical relevance, i.e. it must have a measurable impact on use and be related to a scientific domain.

Generalization allows the proposed solution not only to be a specific response to a given problem, but also to contribute to increasing the knowledge base of a given domain and to be used by other researchers or organizations in the context of similar problems (Dresch; Lacerda; Antunes Júnior, 2015).

Thus, according to Dresch, Lacerda and Antunes Júnior (2015, p. 67), RSD "is the method that underlies and operationalizes the conduct of research when the objective to be achieved is an artifact or a prescription". Since it is oriented towards solving problems, it aims at understanding them and constructing artifacts that allow offering solutions, thus reducing the distance between theory and practice. It is important to emphasize that the method seeks to propose not necessarily an ideal or optimal solution, but a satisfactory solution to the situation.

Collatto *et al* (2018) summarize the main characteristics of DSR:

a) epistemological paradigm: Design Science;
b) Objective: to develop artifacts that offer satisfactory solutions to practical problems, while also contributing to the development of theories. It involves designing and prescribing;
c) Main activities: problem identification, problem awareness, systematic literature review, identification of artifacts and existing classes of problems, artifact design, artifact development, artifact evaluation, explicitness of learning, generalization of the artifact to a given class of problems, conclusion and reporting of results;
d) Main research results: development of the artifacts;
e) Knowledge generated: how things should be;
f) Evaluation of results: applications, simulations, experiments using the artifact;
g) Data collection/analysis: can be qualitative and/or quantitative;
h) Generalization: generalizable to a certain class of problems;
i) Non-mandatory aspects for the method: collaboration between researcher and participants, empirical basis, implementation.

On this last point, the authors clarify that DSR does not require a joint collaboration between researchers and participants in the environment in which the research is conducted. In some situations, interaction may be necessary; however, the researcher can work collaboratively or not when using Design Science Research (Collatto *et al*., 2018).

Regarding DSR enabling the dispensation of empirical basis and implementation, Sein *et al*. (2011) considers that, although support for abstraction and invention is strong, organizational intervention is secondary in DSR. Despite this, Weigand *et al*. (2021) reinforce the importance of instantiations (which refers to the operationalization of the artefact in a real context or environment) to be able to obtain knowledge in relation to the evaluation of the artefact.

The activities listed by Collatto *et al* (2018) are the same as those proposed and detailed by Dresch, Lacerda and Antunes Júnior (2015) as a method for conducting DSR, in 12 steps:

1. Identification of the problem;
2. Awareness of the problem;
3. SLR, occurring simultaneously with problem awareness;
4. Identification of existing artifacts and classes of problems;
5. Proposing artifacts to solve the specific problem;
6. Design of the selected artifact;
7. Development of the artifact;

8. Evaluation of the artifact;
9. Explanation of learning;
10. Conclusions;
11. Generalization of the artifact for a given class of problems;
12. Communication of the results.

The first two steps (problem identification and awareness) involve describing the identified problem, briefly justifying its relevance and gathering the main information regarding the problem and the context in which it is found and, when possible, its main causes (Dresch; Lacerda; Antunes Júnior, 2015).

> The problem to be investigated through Design Science Research arises mainly from the researcher's interest in studying new or interesting information, finding an answer to an important question, or the solution to a practical problem or a class of problems (Dresch; Lacerda; Antunes Júnior, 2015, p. 126).

Aware of the problem, the SLR follows, a fundamental step because it allows "the researcher to make use of existing knowledge and consult other studies focused on the same or similar problems". The SLR will support the researcher to identify existing artifacts, allowing greater assertiveness in the proposals for developing new ones. If the researcher comes across an existing solution in the literature, "his research can continue to the extent that the new artifact brings better solutions compared to existing ones" (Dresch; Lacerda; Antunes Júnior, 2015, p. 128).

Regarding the configuration of problem classes, Dresch, Lacerda and Antunes Júnior (2015, p. 106) clarify that "there are no problem classes already built. Thus, it is necessary an intellectual effort of the researcher to build them and identify the associated artifacts" (Dresch; Lacerda; Antunes Júnior, 2015, p. 106).

> It is also a way to ensure that the research being developed offers a relevant contribution to a given class of problems. In fact, the configuration of the class of problems will define the scope of the contributions of the artifact (Dresch; Lacerda; Antunes Júnior, 2015, p. 128).

These first four steps - "Problem Identification", "Problem Awareness", "SLR", and "Identification of Existing Artifacts and Problem Classes" - can be subsumed under the first phase proposed by Wieringa (2009), called Problem Investigation to Understand the Situation. Or it can be said that it corresponds to the "problem space" in the DK model (Design Knowledge) proposed by Brock *et al*. (2020), which presents two main components, (1) problem context, with a detailed description of the problem, and (2) quality criteria or design requirements to solve the raised problem.

The first study provides the researcher with subsidies to identify the possibilities of artifacts that would offer a solution to the situation studied and, from the study of the pros and cons of each alternative, also considering the context and feasibility, define the one that will present the most satisfactory solution (Dresch; Lacerda; Antunes Júnior, 2015). These are steps five and six ("proposing artifacts to solve the specific problem" and "designing the selected artifact"), fundamental for the next step, which correctly refers to the development of the selected artifact. "Artifact development" does not only refer to product development, but also to the generation of knowledge applicable to solving problems, improving existing systems or creating new solutions (Dresch; Lacerda; Antunes Júnior, 2015). As highlighted by Wieringa (2009), it is the development of a solution project, which may consist of a technique, notation, instrument, device, algorithm, process, new or improved business structure, and may be represented in different ways, such as diagrams, sketches, plans, mathematical models, models, prototypes, among others.

In the DK (Design Knownledge) model proposed by Brock *et al*. (2020), these design steps are encompassed by the so-called "solution space" and the results or artifacts generated by Design Science Research (DSR) can include everything from designed artifacts (constructs, solution models, methods and instantiations) to design principles or design theories.

The developed artifact is followed by the evaluation phase, which, according to Brock *et al*. (2020), links solutions ("solution space") to problems ("problem space"). The aim is to demonstrate the practical and academic validity of the artifact, and the definition of the evaluation method must be directly related to the type of artifact developed and its applicability. There are several ways to evaluate an artifact (Dresch; Lacerda; Antunes Júnior, 2015):

a) observational: checking how the artifact behaves, in a case study;
b) analytical: studying the artifact during use to evaluate it, measuring its performance;
c) experimental: studying the artifact in a controlled environment or running it with artificial data;
d) testing: running the artifact to check for faults and defects;
e) descriptive: using information from knowledge bases to argue about the usefulness of the artifact;
f) focus groups: for deeper and more participatory discussions about the artifact.

The final stages involve explaining the learnings and conclusions. It includes a description of successful aspects and those that should be improved for a next research. One of the considerations should refer to the generalization of the results to a class of problems, allowing "that the knowledge generated in a specific situation can later be applied to other similar situations that are faced by different organizations" (Dresch; Lacerda; Antunes Júnior, 2015, p. 132).

> Finally, it is essential to communicate the results, through publication in journals, sectoral magazines, seminars, congresses, etc., in order to reach as many people as possible interested in the theme, both in academia and in organizations. The dissemination of the knowledge generated contributes significantly to the advancement of general knowledge (Dresch; Lacerda; Antunes Júnior, 2015, p. 132).

It is important to highlight that, despite the identification of common steps in research using RSD, one differs from the other depending not only on the object of study, but also on the context and the strategy defined. Reining *et al*. (2022), through an RSL, selecting 64 articles published between 2004 and 2020, retrieved from the AIS Basket of Eight Journals, identified 07 main strategies:

1. Create and instantiate artifacts, with instantiation being a secondary contribution to demonstration and evaluation. Predominance of computational artifacts with experimental evaluation methods;
2. Create and instantiate artifacts, adding descriptive or defining knowledge (construct) that provides a higher level of generality. Instantiation as a secondary contribution to demonstration and evaluation. Predominance of representative artifacts with observational or participatory evaluation methods;
3. Create artifacts and generalize from instantiations rooted in practice and used to abstract design principles based on a specific client problem. Usually, RSD is associated with another research method, such as Action Research, including as an evaluation method, applying successive cycles of Action Research. It involves the need for a multidisciplinary team and client involvement;
4. Create artifacts and generalize from instantiations grounded in theory. Usually

associates RSD with another research method, such as Action Research. It is based on a specific problem of a client and the evaluation is done through the confrontation between theory and practice. Its main starting point is general knowledge (theory). It involves the need for a multidisciplinary team and client involvement;

5. Hypothesize and test propositions, for example by implementing a simple system. Articles are primarily quantitative with prescriptive knowledge. Does not necessarily require an extended period of research;
6. Create design theories, with computational type artifacts, prototype development and evaluation predominantly experimental. Theory development adds to the time required to build and evaluate the artifact;
7. Creating design theories by adding relevant explanatory/descriptive theory, with artifacts of various genres (constructs, testable propositions or causal explanations). Instantiation including prototyping. Theory development adds to the time needed to build and evaluate the artifact.

Strategy 1, signaled by Reining *et al*. (2022), was adopted in this work, as presented below.

4 DSR IN PRACTICE: IDEATION OF IR

The learning of the DSR method was not only theoretical, but also practical, given the very nature of DSR, which, like a two-sided coin, has theoretical rigor and practical relevance as its "heads" and "tails". Thus, also reflecting the composition of the class itself, with students from different fields, the "problem space", according to Brock *et al*. (2020), was related to the academic memory of PBESH, and the "solution space" would involve the ideation, prototyping and implementation of a digital repository and a periodic event, with the know-how of PPKMO students from the School of Information Science (SIS/UFMG).

The project was therefore developed by a multidisciplinary team, with participants immersed in both the "problem space" and the "solution space", focused on proposing two artifacts (repository and periodic event) that would favor the strengthening of PBESH, giving greater visibility to their academic productions. The team responsible for the "repository" artifact held weekly virtual meetings in September and October 2022 for planning, concept alignment, action plan definition, task distribution, knowledge sharing and discussions.

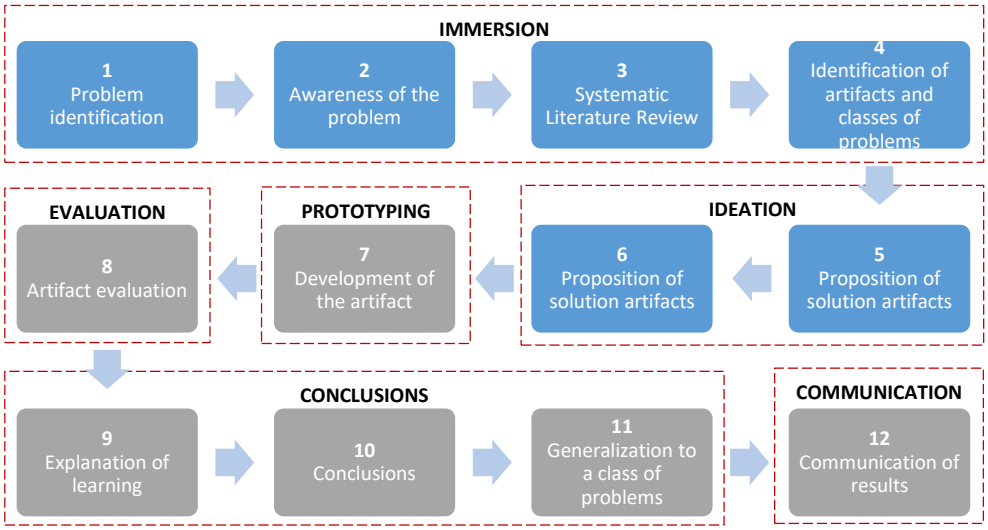
Based mainly on the method for conducting DSR proposed by Dresch, Lacerda and Antunes Júnior (2015), the following is a report of this experience, succinctly illustrating the application of DSR for the ideation of a repository based on scientific journals, and exposing the doubts and learnings of the process.

For simplicity, the 12 steps have been grouped into six action categories that summarize the process as a whole (Figure 1):

1. **Immersion**, to deepen both the existing theoretical content on the topic and the practical nature of the problem at hand;
2. **Ideation**, which involves the entire creative process of the researcher in proposing solutions based on theory and focused on practical relevance;
3. **Prototyping**, which is directly related to the construction of the artifact;
4. **Evaluation**, which involves putting the artifact into use and conducting tests to verify its practical validity;
5. **Conclusions**, learning, research paths, successes and failures, suggestions for future research and possibilities of generalizing the solution;

6. **Communication of results,** which includes sharing of results, publications, production of materials.

Figure 1. Summary of the steps for operationalizing the DSR



Source: prepared by the authors based on Dresch, Lacerda and Antunes Júnior (2015).

At the time of submission of this work, the prototyping stage (development of the artifact) was in progress, so the stages of immersion in the context of the problem and ideation of the IR based on scientific journal will be exemplified, as detailed below.

4.1 Immersion

The immersion stage involves the identification and awareness of the problem, the realization of an SLR to survey what has already been addressed on the issue, as well as the identification of existing artifacts. With this context it is possible to identify the class of problems for which the artifact to be developed can present a satisfactory solution. This identification is crucial for the proposition of generalization (step 11, Figure 1).

4.1.1 Identification and awareness of the problem

According to Dresch, Lacerda and Antunes Júnior (2015), the identification of a problem can arise "mainly from the researcher's interest in studying new or interesting information, finding an answer to an important question, or the solution to a practical problem or a class of problems" (Dresch; Lacerda; Antunes Júnior, 2015, p. 126).

As already presented in section 1 (Introduction), the problem is related to the need to circumvent the challenges and barriers to the success of an IR, especially its underutilization. A problem of practical relevance was posed: the proposal to develop an artifact, in this case, a digital repository for PBESH, whose field of competence is shared or specific research in the areas of Built Environment and Sustainable Heritage, structured by the discipline of Applied Social Sciences and transversally supported by the Interdisciplinary area. According to the Regulation (CEPE Supplementary Resolution No. 02/2017, of 04/07/2017), one of the central objectives of the program is the preparation of researchers who can develop qualified research in the area of Built Environment and Sustainable Heritage.

It was found that the program did not have its own digital repository that would provide for the storage, preservation, organization and availability of scientific production. Its website (https://sites.arq.ufmg.br/pos/ambienteconstruido/) only contained lists of theses and

dissertations defended, in alphabetical order, of students by year of entry. However, the Federal University of Minas Gerais (UFMG) has an IR (https://repositorio.ufmg.br/), and one of the team's discussions was whether it would not be the case to reformulate the PBESH website itself to structure, instead of a repository, a directory that would list the Program's productions and direct them to the UFMG IR.

This was the first point of 'crisis' for the team. A moment of reflection on the problem and the requirements that an alternative solution would need to present to be satisfactory. And it is in this phase of problem awareness that "the functionalities of the artifact, the expected performance, as well as its operating requirements must be considered" (Dresch; Lacerda; Antunes Júnior, 2015, p. 126).

This question accentuated the need for a theoretical review that would provide subsidies, especially on the relevance of a repository, to understand what has been treated on the subject and to verify whether, in fact, it would be appropriate to propose a repository of its own or a directory for the program.

4.1.2 Systematic Literature Review ("SLR")

This stage did not start directly with the SLR, but with a quick survey to get an overview of repositories and help identify search terms. The research helped in the elaboration of the protocol and the conduction of the SLR whose results were presented in section 2.

4.1.3 Identification of existing artifacts and classes of problems

The SLR pointed to the artifact proposed and developed by Woutersen-Windhouwer *et al*. (2020). This proposal emerged as promising to inspire the artifact by:

a) allowing the construction and preservation of the academic memory of PBESH;
b) for presenting a more attractive format for researchers, having the appearance, recognition and dissemination of a scientific journal;
c) for not having limitations regarding the type of production and research area, compatible with the interdisciplinary nature of PBESH.

The artifact to be developed, therefore, should present itself as a satisfactory solution to the class of problems related to the construction and preservation of Organizational Memory (OM) which, for Freire *et al*. (2012, p. 43) "is the creation of a collection with information, being also a kind of "tool" of the organization for knowledge management". Or, more specifically, it can be said that the artifact will be related to the class of problems called "repository memory", a concept proposed by Santos (2019, p. 66) for the OM segment specifically related to formal and explicit information and knowledge or materialized through a physical or digital support and that are "subject to registration, preservation, structuring and retrieval".

4.2 Ideation

The ideation stage corresponds to the creative part of the process. It involves the survey of possible solutions to the identified problem considering the entire context studied in the immersion stage, as well as the design of an artifact selected from those idealized.

4.2.1 Proposing artifacts to solve the specific problem

According to Dresch, Lacerda and Antunes Júnior (2015), the stage of proposing artifacts as satisfactory solutions to the identified problem is an essentially creative process, in which the researcher makes use of all this prior knowledge to propose solutions that consider aspects such as the context of action and feasibility.

Based on the findings and reflections already exposed, only one artifact proposal was made considering the context and nature of the problem. The artifact consists of an interdisciplinary repository, having as platform a software for management and publication of electronic journals, the Open Journal System (OJS), to house all types of PBESH production. The design of the artifact is detailed below.

4.2.2 Design of the selected artifact

At this stage it is important that "the researcher describes all the procedures for building and evaluating the artifact"; also "the expected performance must be informed, which will guarantee a satisfactory solution to the problem" (Dresch; Lacerda; Antunes Júnior, 2015, p. 131).

Considering the objective of building and preserving the academic memory of PBESH through the creation of a digital repository for the collection, preservation and dissemination of the intellectual production of the Program, the first definition of the project involved the choice of software to be adopted. In the survey carried out by Murakami and Fausto (2013) on IRs of higher education institutions in Brazil, the results pointed to DSpace as the predominant software (83.7%). DSpace is a cooperative project developed by the Massachusetts Institute of Technology (MIT) libraries and Hewlett-Packard (HP) laboratories. It is an "innovative digital repository system that captures, stores, indexes, preserves and redistributes research materials in digital format produced by academic communities within the context of research organizations and universities" (Marcondes; Sayão, 2009b, p. 44-45).

However, due to the proposal of a repository in journal format, OJS was chosen, which, according to Brito *et al*. (2018, p. 20):

> It is a web application for the complete management of the editorial process of periodicals, i.e. from the submission of articles to the publication of the issue. It manages the activities of the actors involved in the process, the complete editorial flow of the journals, from the creation of the journal to the maintenance of the issues already published. It includes the submission of the work by the authors, the registration of the recommendations of the referees in relation to this document and its approval or rejection by the scientific editor or also by the executive editor; the publication on the web of information about the publication, its history, and the issues and articles in full text. It also supports the publication of hypermedia resources. It also offers tools for searching its content and integration with other systems for sharing, dissemination, preservation and democratization of access to published content. It has pre-installed plugins for automatic Digital Object Identifier (DOI) assignment and indexing in several indexers, which are already integrated.

Another advantage of OJS is its flexibility, being able, in just one installation, to support the operation of one or more journals (Brito *et al*., 2018).

The configuration designed for the repository proposed here is detailed below:

a) **Portal title:** "Memor - PBESH repository". Name chosen because it refers to the institutional memory of the program;
b) **Description about the portal**: Digital repository of the Postgraduate Program in Built Environment and Sustainable Heritage (PBESH) of the School of Architecture (EA/UFMG) with the objective of collecting, preserving and disseminating

intellectual production preserving the academic memory of the program.

c) **Publisher**: Federal University of Minas Gerais. "In the case of university journals, it is suggested to put the name of the university in the Publisher field, as it is mandatory metadata for the DOI" (Brito *et al*., 2018, p. 57).

d) **Sections**: it is possible to insert several sections, such as editorial, interview, articles, essays, reviews, photo essays, etc. According to Brito *et al*. (2018, p. 113), "in most journals, the issues are divided into typological sections, such as editorials, original articles, review articles, reviews, interviews, credits, among others". Aiming to register all the academic production of the Program, it would be important to include a section, not peer-reviewed, to include a list of articles published in other journals highlighting metadata. In OJS, it is also possible to "attach images, audio and videos to the article page, in order to give the reader multimedia access" (Brito *et al*., 2018, p. 134).

e) **Evaluation**: OJS offers the option to define double-blind, blind and open evaluation modalities (Brito *et al*., 2018). As proposed by Woutersen-Windhouwer *et al*. (2020), the type of evaluation could be defined by the Program with identification of the evaluated material, with a seal referring to the type of evaluation adopted, to give transparency to the process. However, considering the objective of the proposal, the open modality is suggested, with submission by the student and evaluation by the teacher who taught the subject that originated the work developed or by the student's supervising teacher.

f) **Main roles of users in the Portal:**

- ***Portal administrator:*** information technology (IT) support of the Program (suggested). "The role of OJS administrator can be the responsibility of a technician or, preferably, a partnership of the institution's IT team" (Brito *et al*., 2018, p. 37);
- ***Journal Manager/Editor:*** administrative support of the Program (suggested). "Responsible for the configuration of the journal, implementing the policies defined by the Editorial Board" and can simultaneously perform the role of editor, who manages the evaluation and editing of submissions at all stages of the editorial workflow (Brito *et al*., 2018, p. 56).
- ***Evaluators***: professors of the Program (suggested). "Performs the content evaluation of the submission assigned to them by the editor. It then forwards the evaluation to the editor via the system, with its recommendations" (Brito *et al*., 2018, p. 21);
- ***Author***: students of the Program. "The most important user of the journal, as it is the one who provides content. In the general scope of the journal, it acts only in the editorial flow of its own submission" (Brito *et al*., 2018, p. 21);

g) **Periodicity**: Semiannual (suggested).

h) **Access options to the journal's content:** free access to its content is suggested, ensuring effective Open Access.

It is important to note that the proposal for a repository based on scientific journals does not aim to direct the publication of the program's unpublished production to the repository. The main objective is to preserve the academic memory of the program so that it is possible, including studies related to the state of the art by lines of research, emerging issues, concentration of discussions over time, among others.

Papers would be encouraged to follow the current flow of publications; however, the repository, like the one proposed by Woutersen-Windhouwer *et al*. (2020), would provide space for all production not published in other journals (reports, datasets, tests, protocols, methods,

software and other research products), as well as present a section, not peer-reviewed, to include a list of articles published in other journals with descriptive metadata.

The sequential steps to the ideation will involve setting up the repository in OJS, evaluating it with artificial data (experimental evaluation) and conducting tests or pilot projects with real data (instantiation). An interesting evaluation alternative will also be to conduct focus groups with teachers, collegiate members and students for deeper and more participatory discussions about the artifact.

5 CONCLUSION

Throughout the experience of learning and using the DSR method, it was inevitable not to recognize the classroom as a "ba", "a context in which knowledge is created, shared, and used" as proposed by Takeuchi and Nonaka (2008, p. 166); a physical, virtual, and mental space that promotes knowledge transformation. For those involved in designing and proposing the artifact, the greatest gain was the knowledge journey and the discoveries of the process. Knowledge was internalized through the sharing of doubts, discussions, and the back and forth between steps that characterize the iterative process.

Among the steps foreseen for the execution of the method, "Problem Awareness" and "SLR" emerged as crucial for the development of a research aiming at results with practical relevance and scientific rigor. From them it is possible to obtain sufficient information not only to assess the relevance of the research problem, but also to survey the existing theoretical framework on the subject and to identify other artifacts that may have already been proposed by other researchers.

The DSR method, due to its characteristics and steps, actually proved to be a driver of the entire research. Compared to other methods whose structure seems to support the research from the methodological procedures to the analysis of the results, the DSR method considers the study from the identification of the problem to be addressed and the subsequent design of the entire research to the communication of the results.

In the context of IS, methods that reduce the distance between theory and practice or between science and society are promising, and in this sense RSD is an appropriate method, as in the case of the IR proposal carried out here. The structure followed allowed the idealization of a solution that was not only based on the literature or met the rigor of the method, but was also satisfactory for a real practical situation.

However, even in these initial stages, the experiment was not without limitations. Since the problem had already been posed, there was no way to explain the process of identifying a problem. There was also no opportunity or time to conduct a more in-depth survey of the problem with the actors involved, be they program coordinators, collegiates, teachers, librarians, or administrative support staff, in order to assess the problem and identify possible ongoing solutions.

Although collaboration between researcher and researched, or those directly involved in the problem, is not mandatory in the DSR, in this context it would be an important action, not only in the evaluation stage, but also in the initial stages of problem identification and awareness, and even in the ideation phase of the satisfactory solution for raising implications and assessing feasibility related to the maintenance of a repository based on scientific journals for the program, with analyses related to the availability of personnel for operationalization and management, updates, agreement of teachers in acting as reviewers, among other aspects.

Another limitation is related to the impossibility of exemplifying the other stages of the DSR, with the configuration and evaluation of the repository, conclusions and communication (which are in the process of development, at the time of submission of this work).

Thus, as a suggestion for future work, it is the explanation of the sequential steps of this process of ideation of a repository based on a scientific journal for PBESH (UFMG), as well as new reports of experience of application of the method as a way to encourage its use by other researchers, especially in situations that demonstrate the use of multiple data collection instruments (observation, field diary, interviews, application of questionnaires, focus groups) to further deepen the problem awareness stage, as well as mixed data analysis techniques (qualitative and quantitative).

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