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SPECIAL ISSUE: 20 YEARS OF THE STRATEGIC MANAGEMENT CONFERENCE – 3Es FROM ANPAD

ARTIFACTS FOR RESOURCE MANAGEMENT IN HIGHER EDUCATION INSTITUTIONS

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Abstract

Objective of the study: To propose a set of artifacts designed to assist managers of Higher Education Institutions (HEIs) in minimizing challenges related to resource management associated to technological development.
Methodology / Approach: This qualitative study employs a single-case study approach at the Federal Institute of Mato Grosso (IFMT). Data were collected from documents, questionnaires, and interviews with staff and external participants. The creation of artifacts was financially supported by IFMT through two applied research projects conducted between 2019 and 2021.
Originality / Relevance: The research contributes to Resource Orchestration by elucidating how artifacts can mitigate challenges faced by HEI managers in directing resources associated to technological development.
Main results: Resources related to technological development, such as intellectual properties, development projects, and individual competencies of IFMT researchers, had not been cataloged, hindering the creation of partnerships to address the demands of external stakeholders.
Management Contributions: The proposed artifacts empower HEIs to enhance the fulfillment of their purposes, serving as scalable, replicable tools with potential economic impacts. These tools aid in alleviating the challenges faced by managers in directing resources associated with technological development.

Keywords: Resource Orchestration. Technological Showcase. Federal Institute of Education, Science, and Technology.

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ARTEFATOS PARA O GERENCIAMENTO DE RECURSOS EM INSTITUIÇÕES DE ENSINO SUPERIOR

Resumo

Objetivo do estudo: Propor um conjunto de artefatos que auxilie gestores de Instituições de Ensino Superior (IES) na minimização das dificuldades relacionadas ao gerenciamento de recursos ligados ao desenvolvimento tecnológico.
Metodologia/abordagem: Pesquisa qualitativa realizada a partir de estudo de caso único no Instituto Federal de Mato Grosso (IFMT). Os dados foram coletados a partir de documentos, questionários e entrevistas com servidores e participantes externos. O desenvolvimento dos artefatos recebeu financiamento do IFMT, em razão da execução de dois projetos de pesquisa aplicada realizados durante os anos de 2019 e 2021.
Originalidade/Relevância: A pesquisa contribui para a Orquestração de Recursos, ao oportunizar uma compreensão de como os artefatos podem minimizar as dificuldades enfrentadas por gestores de IES no gerenciamento de recursos relacionados ao desenvolvimento tecnológico.
Principais resultados: Os recursos relacionados ao desenvolvimento tecnológico, tais como propriedades intelectuais, projetos de desenvolvimento e competências individuais dos pesquisadores do IFMT não estavam catalogados, o que dificulta a formação de parcerias para atender as demandas de atores externos.
Contribuições para gestão: Os artefatos propostos possibilitam às IES o reforço no cumprimento de uma de suas finalidades, sendo ferramentas escaláveis, replicáveis e com potenciais efeitos econômicos, que servem para minimizar as dificuldades dos gestores no gerenciamento de recursos relacionados ao desenvolvimento tecnológico.

Palavras-chave: Orquestração de recursos. Vitrine tecnológica. Instituto Federal de Educação, Ciência e Tecnologia.

ARTEFACTOS PARA LA GESTIÓN DE RECURSOS EN INSTITUCIONES DE EDUCACIÓN SUPERIOR

Resumén

Objetivo del estudio: Proponer un conjunto de artefactos que ayuden a los gestores de Instituciones de Educación Superior (IES) a minimizar las dificultades relacionadas con la gestión de recursos vinculados al desarrollo tecnológico.
Metodología/enfoque: Investigación cualitativa basada en un estudio de caso único en el Instituto Federal de Mato Grosso (IFMT). Los datos fueron recopilados a partir de documentos, cuestionarios y entrevistas con personal y participantes externos. El desarrollo de los artefactos recibió financiamiento del IFMT debido a la ejecución de dos proyectos de investigación aplicada realizados durante los años 2019 y 2021.
Originalidad/Relevancia: La investigación contribuye a la Orquestación de Recursos, al ofrecer una comprensión de cómo los artefactos pueden minimizar las dificultades enfrentadas por los gestores de IES en la gestión de recursos relacionados con el desarrollo tecnológico.
Principales resultados: Los recursos relacionados con el desarrollo tecnológico, como propiedades intelectuales, proyectos de desarrollo y competencias individuales de los investigadores del IFMT, no estaban catalogados, lo que hace dificil la formación de asociaciones para satisfacer las demandas de actores externos.
Contribuciones para la gestión: Los artefactos propuestos permiten a las IES reforzar el cumplimiento de uno de sus propósitos, siendo herramientas escalables, replicables y con potenciales efectos económicos, que ayudan a minimizar las dificultades de los gestores en la gestión de recursos relacionados con el desarrollo tecnológico.

Palabras clave: Orquestación de recursos. Escaparate tecnológico. Instituto Federal de Educación, Ciencia y Tecnología.

1 INTRODUCTION

If the future of universities and other types of Higher Education Institutions (HEIs) aligns with current expectations, these institutions will increasingly require strategic resource management. A prevalent discourse, advocated by policymakers, assigns to HEIs the responsibility of fostering the socioeconomic development of their communities and regions, which is recognized as their Third Mission, in addition to Teaching and Research (Compagnucci & Spigarelli, 2020). Different regional, national, and international public policies have reinforced these aspirations; for instance, in 2022, the European Commission outlined a plan for universities to contribute to the recovery of the European continent after the COVID-19 pandemic by 2024. The proposal underscores the need for financial strengthening, incentives for academic career development, capacity building for universities to play roles in green and digital transitions, and internationalization based on global cooperation (European Commission, 2022).

In Brazil, the scenario is no different. In 2008, recognizing the imperative for technical and technological education in the country, the Federal Government restructured the provision of professional, scientific, and technological education by assigning this responsibility to Federal Institutes (FIs). Federal Institutes constitute a network of institutions committed to technological education, applied research, and scientific and technological development (Law No. 11,892, 2008). It is expected that FIs will play a pivotal role in fostering interaction between academia and the productive sector, offering training programs and technological solutions that address the demands of both industry and society.

It is essential to underscore that Higher Education Institutions (HEIs) can be categorized as public, private, and community-based in the country (Law No. 9,394, 1996). Historically, public HEIs have consistently held the best positions in terms of teaching and research quality. In 2023, among the top one hundred universities considered, seventy-one are public (Folha de São Paulo, 2023). Moreover, among the fifty largest patent holders in 2020, thirty-three were affiliated with HEIs, with only one being a non-public HEI (INPI, 2020).

Nevertheless, the commitment to new directives leaves HEIs, such as universities, in a "strategically burdened" position (Sánchez-Barrioluengo & Benneworth, 2019), facing a crossroads where they must navigate multiple internal and external interests (Compagnucci & Spigarelli, 2020). Scholars in the field of strategy, such as Leih and Teece (2016), have warned about the imperative for enhanced strategic management in universities worldwide. This is especially pertinent as, through the exchange of experiences and adoption of best practices,

connections are fortified, and the reservoir of scientific and technological competencies and skills is enriched, fostering collective knowledge generation within higher education institutions (Gómez Zermeño & Alemán de la Garza, 2021). In this context, organizational competence is understood as the set of skills and specific knowledge possessed by individuals within an organization (Mills, Platts & Bourne, 2003).

Previous studies (Heaton, Siegel & Teece, 2020; Leih & Teece, 2016; Thomas, Faccin & Asheim, 2021) indicate that universities leverage their resources to meet the expectations of external stakeholders. To achieve this alignment, managers must navigate the utilization of resources available and develop new ones that may be necessary for fulfilling the purposes of HEIs. However, this is a complex task, as these institutions typically concentrate a substantial amount and variety of tangible and intangible resources, contributing to the complexity of their management. Furthermore, the incorporation of additional objectives, such as the development of technological solutions through collaboration with industries, governments, and society, accentuates the complexity of resource management in HEIs.

In this context, the objective of this technological article is to propose a set of artifacts designed to aid managers of Higher Education Institutions in minimizing challenges associated to resource management related to technological development. To fulfill this purpose, a qualitative research approach employing a single case study method was conducted at the Federal Institute of Mato Grosso.

The research revealed challenges faced by managers and researchers at the institution in managing resources allocated to technological development. Although the HEI had established several actions to assist its researchers in developing solutions for social demands, which is one of its purposes (Law No. 11,892, 2008), both managers and researchers frequently encountered challenges in identifying resources conducive to fostering partnerships for technological development and other collaborations with external stakeholders. It should also be noted that intellectual properties (IP), such as patents, trademarks, and software programs, along with technological development projects and individual competencies of researchers - resources related to technological development - had not been cataloged by the HEI, thus limiting their accessibility to potential users.

To address these challenges, three artifacts referred to as "showcases" were developed through the implementation of two applied research projects funded by the HEI between 2019 and 2021. The Technological Showcase consolidates registered intellectual properties and the laboratory infrastructure for partnerships; the Innovation Projects Showcase presents technological development projects characterized by an advanced level of technological

maturity; lastly, the Competency Showcase includes profiles of researchers categorized by campus, area, and individual competencies for technological development. The process of developing these artifacts is detailed throughout the article.

Since their creation, interviewed managers have affirmed that the showcases serve as valuable tools for resource management, particularly in the context of technological development. The showcases ensure that resources remain accessible to managers, members of the academic community, and organizations seeking technological solutions. This, in turn, enables them to provide HEIs with resources aimed at broadening the scope of technological offerings.

In answering the appeal made by Leih & Teece (2016) for additional studies to assist university leaders in navigating the evolving landscape of Higher Education Institutions (HEIs), Resource Orchestration (RO) (Sirmon, Hitt, Ireland & Gilbert, 2011), a theoretical advancement of the Resource-Based View (Barney, 1991), is embraced to provide insights into the challenges encountered by HEIs.

The technological and social contributions of this study are limited to: (1) the creation of three scalable, replicable artifacts with potential economic effects; (2) the identification of an opportunity for practically-oriented researchers to utilize organizational incentives for implementing improvements to the benefit of the institution itself, as the proposition of the reported artifacts is linked to the execution of two applied research projects funded by the HEI; (3) reinforcing the fulfillment of one of the purposes of the analyzed institution.

The proposal is intended for a broader audience, including not only scholars but also practitioners, such as managers of Higher Education Institutions. The development of this study followed the guidelines suggested by Biancolino, Kniess, Maccari & Júnior (2012). Meanwhile, the instructions outlined by Motta (2017, 2022) guided the understanding of the characteristics and anticipated criteria for a production oriented towards the comprehension of knowledge that leads to technology generation. In alignment with instructions for preparing articles focused on practical contributions, Fisher (2022) emphasizes that the orientation of the work can be past, present, or future. Based on this classification, this study has a present orientation, as it stems from a current problem to be addressed through an intervention based on an existing theory.

2 CONCEPTUAL FRAMEWORK

Since the objective of this technological article is to provide a practical contribution, Resource Orchestration (RO) (Sirmon et al., 2011) has been adopted. Specifically, the processes

of resource management within RO have been employed to facilitate the comprehension of a problematic scenario encountered by a Higher Education Institution (HEI). RO stands out as one of the more recent theoretical approaches elucidating the orchestration of resources and capabilities (Rojo-Gallego-Burin, Llorens-Montes, Perez-Arostegui & Stevenson, 2020).

Resource Orchestration (RO) integrates two models: resource management (Sirmon, Hitt & Ireland, 2007), grounded in the Resource-Based View, and asset orchestration (Helfat et al., 2007), anchored in the Dynamic Capabilities approach. Sirmon et al. (2011) highlight that the Resource-Based View and the Dynamic Capabilities approach have underexplored the role and actions of managers in resource management within organizations. To address this gap, RO deepens the relationship between organizational resources, managerial actions, and organizational performance (Sirmon et al., 2011).

The Resource Orchestration perspective has been applied in research related to the development and deployment of technologies. For instance, Li, Chen, Yan, Xu, and Jiang (2023) contend that two subcomponents of technological opportunism, namely technological perception capability and technological response capability, have effects on business performance from the RO perspective. To validate their research, they utilized data from 350 Chinese companies across various industries and identified that three resource orchestration capabilities—structuring, bundling, and leveraging—play distinct roles in the association between technological opportunism and performance. Another example is the research conducted by Wang, Zhang, and Guo (2023), integrating Knowledge-Based Theory with Resource Orchestration to formulate a model that evaluates how advanced manufacturing technology in design, manufacturing, and administration influences product innovation performance. The study revealed that absorptive capacity served as a partial mediator in the relationship between advanced manufacturing technology and innovation. Furthermore, it was observed that the mediating effect was amplified by design, manufacturing, and innovation.

Within the framework of Resource Orchestration, resource management is defined as "the comprehensive process of structuring the firm's resource portfolio, bundling the resources to build capabilities, and leveraging those capabilities with the purpose of creating and maintaining value for customers and owners" (Sirmon, Hitt & Ireland, 2007, p. 273). Regarding the subject of this study, a conceptual alignment is assumed between the processes of bundling and leveraging resources at the organizational level, extending from the firm level to the level of the Higher Education Institution. It is acknowledged that these institutions can combine resources to develop capabilities and capitalize on opportunities.

Table 1 provides the breakdown of resource management processes into subprocesses.

Table 1

Processes and Subprocesses of Resource Management

Process	Subprocess	Description
Structuring: Refers to the management of the firm's resource portfolio.	Acquiring	The process of purchasing resources from strategic factor markets.
	Accumulating	The process of developing resources internally.
	Divesting	The process of shedding firm-controlled resources.
Bundling: Refers to the combining of firm resources to construct or alter capabilities.	Stabilizing	The process of making minor incremental improvements to existing capabilities.
	Enriching	The process of extending current capabilities; although the degree of enrichment can vary, it extends beyond keeping skills up to date.
	Pioneering	The process of creating new capabilities with which to address the firm's competitive context.
Leveraging: Refers to the application of a firm's capabilities to create value for customers and wealth for owners	Mobilizing	The process of identifying the capabilities needed to support capability configurations necessary to exploit opportunities in the market.
	Coordinating	The process of integrating identified capabilities into effective yet efficient capability configurations.
	Deploying	The process of physically using capability configurations to support a chosen leveraging strategy, which includes the resource advantage strategy, market opportunity strategy, or entrepreneurial strategy.

Source: Sirmon, Hitt Ireland (2007, p. 277).

While Resource Orchestration has found application in various empirical studies, there remains a gap in understanding how it can be beneficial for non-business organizations, particularly Higher Education Institutions. In a search conducted in November 2023 using the terms "Resource* orchestration" AND "universit*" OR "academia" OR "higher education*" in the titles, abstracts, and keywords of works indexed in Web of Science, 16 works were located. Of these, nine were published in peer-reviewed journals in the fields of Business and Management. Among these, only one study (Jatmiko, Sofyani & Putra, 2022) addressed how HEIs orchestrate their resources. The authors developed a model of information technology resource orchestration in HEIs amid periods of environmental changes, such as those induced by the COVID-19 pandemic. This inquiry reveals a dearth of studies, leaving room for new research to explore how RO can serve as a pertinent framework for HEIs to navigate the increasingly dynamic environment in which they operate.

Higher Education Institutions are organizations that typically concentrate a large array of tangible and intangible resources, including human resources represented by faculty

members, administrative staff, and students, as well as physical and organizational capital resources. These resources can vary based on the type, size, and orientation of the HEI. For instance, the University of São Paulo (USP), ranked number one in Brazil (QS World, 2022), features 5,996 professors and a total of 43,012 computer units (University of São Paulo [USP], 2022).

HEI managers may face challenges in resource management to fulfill their purposes, especially due to the dynamic and abstract nature of resources, such as individual academic competencies. To address these challenges, the creation of artifacts is proposed. Artifacts are "artificial things can be characterized in terms of functions, goals, adaptation" (Simon, 1996). In the realm of knowledge, artifacts refer to any object, tool, or document used to create, store, or share knowledge (Mentzas, 2004). In more specific contexts, such as HEIs, might be designated, depending on the context as, "knowledge document," "knowledge resource," or "knowledge instrument," contingent on the specific type of artifact under consideration. Hence, HEI managers can leverage knowledge-related artifacts to create or alter organizational resources and capabilities.

3 TECHNICAL PRODUCTION METHOD

This study seeks to propose a set of artifacts to assist managers of Higher Education Institutions in minimizing difficulties related to the management of resources associated to technological development. To achieve this objective, a qualitative research approach utilizing a single-case study method was chosen. Creswell (2014) observes that a case study is appropriate when a comprehensive understanding of a particular case or set of cases is sought.

Hence, the Federal Institute of Education, Science, and Technology of Mato Grosso was chosen as the study subject for the following reasons: (a) it represents an HEI whose managers grapple with difficulties in managing resources related to technological development; (b) it is part of an extensive network of institutions dedicated to applied research, offering the potential for replicating the proposed artifacts; and (c) the majority of the authors are affiliated with the institution, contributing to access and providing an "insider" perspective into the investigated context.

A comprehensive dataset spanning the years 2019 to 2021 was gathered through various sources, including documents, questionnaires, and interviews. Table 2 delineates the utilization of the collected data in investigating the problem and developing the artifacts.

Table 2

Description of Data Collection and Analysis Procedures

Procedures	Description	Development of Artifacts
Documentary Collection and Content Analysis.	Records of intellectual properties in the National Institute of Industrial Property.	The cataloging of intellectual properties supported the development of the Technological Showcase.
	Records and reports of technological development projects approved in calls for proposals at the institution between 2015 and 2019.	The cataloging of projects supported the subsequent collection of primary data from coordinators. Project information supported the development of the Innovation Projects Showcase.
	Research in technological showcases of other institutions, including the University of São Paulo, Federal University of Minas Gerais, University of Brasília, Federal University of Rio Grande do Sul, and Federal University of Mato Grosso.	The identification of constituent elements of analyzed technological showcases supported the development of the Technological Showcase.
Questionnaires and Descriptive Statistical Analysis.	The distribution of a questionnaire to 173 project coordinators resulted in 52 responses from projects approved in calls for technological development spanning the years 2015 to 2019. The data collection aimed to delineate the profiles of the projects and ascertain their levels of technological maturity. All coordinators were invited to participate, with the goal of incorporating the highest possible number of projects into the showcase.	The identification of projects with the highest level of technological maturity facilitated the development of the Innovation Projects Showcase. Additional information concerning the organizational context further contributed to understanding the problem situation.
	The distribution of a questionnaire to 446 faculty members in professionalizing areas resulted in 108 responses. The objectives were to: (a) identify individual competencies for technological development; (b) assess interest in partnerships for technological development; (c) evaluate satisfaction with incentives for technological development; and (d) identify facilitating and hindering factors for technological development. The invitation to participate was extended to all faculty members in the professionalizing core of the institution, aiming to include the largest number of competencies in the showcase.	The identification of individual competencies contributed to the development of the Competency Showcase. Faculty members provided consent to showcase their profiles. Additional information related to the organizational context further enriched the understanding of the problem situation.

Interviews. Notes taken were analyzed through content analysis.	Interviews were conducted with three executives and former executives at the strategic level of the institution, selected based on their C-level positions. The interviews were structured as dialogues, exploring the evolution of the institution's performance in external partnerships. Additionally, an evaluation was obtained regarding how the proposed artifacts mitigated challenges in managing resources related to technological development.	Validation of the problem situation and checking the results from the development of the three artifacts.
	Interviews were performed with two faculty members affiliated with the University of Brasília and the Federal Institute of São Paulo, actively engaged in research related to the cataloging of competencies within their respective institutions. The participants were identified through their published works on the cataloging of competencies for technological development. The interviews were structured as discussions, aiming to understand how the interviewees' institutions cataloged the competencies of academics. The interviewees were briefed on the objectives of the Competency Showcase, offering insights and recommendations for future decisions and actions.	Obtaining recommendations and validating the stages for the development of the Competency Showcase.
	Interviews were conducted with 12 faculty members affiliated with the institution, representing 10 distinct areas of expertise. The selection of interviewees was based on convenience, considering their position at the institution and professional experience in their respective fields. The interviews were structured as discussions, delving into the collection of competencies within each area of expertise. Interviewees were briefed on the objectives of the Skills Showcase, allowing for an assessment of the initiative and the provision of recommendations when applicable.	Validation of procedures, the data collection instrument, and the objectives of the proposal. The interviews supported the development of the Competency Showcase.

Source: The authors.

The affiliation of the initial two authors with the institution facilitated field access and offered a close insight into the problem situation. Furthermore, the second author held a managerial position within an organizational unit directly associated with technological development for approximately two years. As a result, the authors were able to build a preliminary understanding of the showcases' relevance to the challenges confronted by the institution.

The collected data not only contributed to the development of the proposal but also served to validate the problem situation. For this purpose, an iterative progressive process was conducted, enabling the iteration of data and confirming the nature of the problems through additional sources. As detailed in the section that delves into the case details, based on the characterization of the institution and the problem situation, the notes taken during the interviews supported decisions related to the development of the showcases.

As outlined in Table 2, the selection of interviewees followed defined criteria. The interviews served a dual purpose: with the managers, validation of the problem situation was obtained; with the HEI faculty and external faculty, the procedures for the development of the Competency Showcase were validated. These interviews were not intended to achieve evidence saturation but rather sought insights into the development of the aforementioned showcase. Additionally, questionnaire-based data collection was employed to identify technological development projects and individual competencies of researchers, providing content for the Innovation Projects Showcase and the Competency Showcase, respectively. These data also provided evidence regarding the institution's context.

Concerning the validation of the proposal, the information presented in the Technological Showcase and Innovation Projects Showcase was reviewed, respectively, by the inventors and project coordinators. In the case of the Competency Showcase, faculty members who consented to the disclosure of their profiles conducted a review of the provided information. The validation of the artifacts' efficacy occurred through a comparison of the context before the intervention, when the showcases were nonexistent, and after the intervention, with the showcases already established. To achieve this, interviews with managers confirmed the usefulness and suitability of the artifacts.

4 PROBLEM SITUATION

4.1 Institution Characterization

The institution under analysis is the Federal Institute of Education, Science, and Technology of Mato Grosso. It is part of the Federal Network of Professional, Scientific, and Technological Education (RFEPCT), a system established in 1909 as part of Federal Government public policies aimed at mitigating socio-economic disparities and integrating marginalized segments of the population into society (Kunze, 2015). Since its creation, the component institutions of the network have undergone several institutional changes, with the most significant occurring in 2008 when Federal Law No. 11,892 was enacted, leading to the creation of Federal Institutes.

The Federal Institutes (FIs) are established as institutions of higher, basic, and professional education specialized in providing professional and technological education across various teaching modalities (Law No. 11,892, 2008). The creation of FIs aimed to diminish the country's technological dependence, develop professional groups aligned with the demands of the productive sector, and provide technical and technological solutions conducive to socio-economic development (Law No. 11,892, 2008). Similar to Brazilian federal universities, the institutes benefit from administrative and financial autonomy, incorporating the inseparability of teaching, research, and extension. They also offer integrated technical courses at the high school level, as well as undergraduate and graduate courses (*Lato* and *Stricto sensu*) (National Council of the Institutions of the Federal Network of Professional, Scientific, and Technological Education [CONIF], 2020).

The career trajectories of public servants within the Federal Network of Professional, Scientific, and Technological Education (RFEPCT), including both educators and educational technicians, share similarities to the careers of public servants within federal universities. However, there exists a distinction in the scope of courses offered by FIs compared to federal universities, indicative of their specialization in Professional and Technological Education. In line with their mission, the courses offered by FIs are aligned with the economic vocations and aspirations of the communities they serve.

In 2022, each state in the nation accommodated at least one branch of the federal institutes, with several states, including Goiás, Bahia, and Rio Grande do Sul, housing multiple branches (CONIF, 2020). During the same year, the Federal Institutes network consolidated a budget of approximately BRL 19.2 billion, with over 1.5 million enrolled students (Ministry of

Education, 2023). The RFEPCT has more than 600 units (CONIF, 2020), underscoring its extensive presence across the national territory.

In Mato Grosso, which hosts a unit resulting from the integration of three autonomous entities predating the law that established the Federal Institutes (FIs), there are 19 campuses spread across 17 cities. In 2022, IFMT offered 209 courses, with 27,350 enrolled students, employing 1,227 teachers, 862 administrative technicians, and having a budget of approximately BRL 511 million (Ministry of Education, 2023). Like other federal institutes in the country, IFMT campuses provide courses aligned with local characteristics. Similarly, research and extension activities have been tailored to address regional demands, exemplified by the institution's active role in responding to external crises, such as the COVID-19 pandemic (Instituto Federal de Educação, Ciência e Tecnologia de Mato Grosso [IFMT], 2022a).

In the realm of education, the three campuses situated in the metropolitan region of the state capital of Mato Grosso, Cuiabá, provide technical courses spanning engineering, electronics, chemistry, and management. Additionally, they offer undergraduate and graduate programs, with a particular emphasis on STEM disciplines (science, technology, engineering, and mathematics), including Computer Engineering, Control and Automation Engineering, Electrical Engineering, Industrial Automation, Food Engineering, and Industrial Chemistry. In the interior cities of the state, the campuses align their course offerings with the prevailing economic activities, notably in agriculture and livestock. Mato Grosso contributes to 17% of the national agricultural production (State Department of Economic Development of Mato Grosso [SEDEC-MT], 2022) and harbors approximately 15% of the country's cattle herd (Brazilian Institute of Geography and Statistics [IBGE], 2021). In these cities, for instance, higher education courses are available in agriculture, agronomic engineering, and grain production.

The institutional emphasis on technology has played a significant role in advancing technology within historically less technology-intensive sectors. An illustrative example is the collaboration between IFMT, the municipal government of Primavera do Leste, and other entities, leading to the introduction of the state's inaugural technical course in aircraft maintenance in 2022. Primavera do Leste, contributing nearly 25% of the state's cotton production in 2020—a sector representing nearly 70% of national production (IFMT, 2022b)—embodies the profound impact of this initiative. Remarkably, Mato Grosso, the 25th most populous state in Brazil, stands at the 5th position in the country's aeronautical records (National Civil Aviation Agency [ANAC], 2023), a consequence of extensive agricultural aviation practices.

4.2 Characterization of the Problem Situation

Considering that one of the purposes of the Brazilian Federal Institutes network is to "develop professional and technological education as an educational and investigative process for the generation and adaptation of technical and technological solutions to social demands and regional peculiarities" (Law No. 11.892, 2008), our endeavor was to investigate how the institution explored its potential in developing technological solutions. To address this inquiry, the authors affiliated with IFMT established a research group with the explicit goal of conducting research on this topic.

To explore the context of the Higher Education Institution (HEI), it is crucial to highlight the significance of the Technological Innovation Center (NIT), an entity established in 2008 and placed under the authority of the Pro-Rectorate for Research, Postgraduate Studies, and Innovation. Within two years of its creation, the institution formulated its inaugural innovation policy. In accordance with this policy, the center underwent a name change to the Technological Innovation Agency (AIT), assuming the role of the department responsible for overseeing technological development at IFMT. AIT is entrusted with tasks such as intellectual property registrations, technology scouting, technology transfer, establishment of partnership agreements for Research, Development, and Innovation (R&D&I), licensing, and monitoring innovation indicators, in addition to providing support for technological extension, among other purposes (IFMT, 2020).

In 2020, the innovation policy underwent revision in response to the advancements in the Legal Framework for Science, Technology, and Innovation, sanctioned in 2016. The updated policy delineated a series of procedures centered on research, innovation, and technological extension. These procedures encompassed aspects such as partnership agreements, the provision of specialized services, resource sharing, including laboratories and their equipment, and mechanisms designed to incentivize applied research (IFMT, 2020).

In addition to the initiatives pertaining to the regulatory environment, the HEI has implemented various practices to foster the development of technological solutions. It actively engages with potential partners through representation at events and forums, raises awareness within the academic community regarding the potential for technology development, establishes a specialized *Stricto Sensu* graduate program (Graduate Program in Intellectual Property and Technology Transfer for Innovation) in collaboration with two local universities, and provides financial support for technological development projects, which the institution refers to as "innovation projects."

While these practices proved to be facilitating factors in fulfilling the analyzed purpose, it became imperative to identify hindering factors. Noteworthy evidence was gathered from interviews with managers who occupied C-level positions in the IFMT management between 2017 and 2022. The interviewees, denoted as A, B, and C, participated in interviews conducted in 2022, structured as conversations to encourage more spontaneous accounts. The notes taken during these interviews, along with other observed evidence, contributed to an understanding of the challenges associated with managing resources related to technological development.

Respondents A and C highlighted that the HEI became more intricate with a new focus on research and extension activities, following the enactment of the law that established the FIs. According to respondent A, *"[...] research was unveiled,"* favoring technological development. However, respondent B made an analogy in the opposite direction*: "[...] I still see us as ants that cover, at each stretch, half of what is left to arrive. What does this mean? We will never reach the end."* The respondent justified the statement by explaining that *"[...] companies want partnerships but do not comprehend the limitations of the institution in meeting them within the expected period."* Respondent A reported a backlog of demand for technological development partnerships arising from the COVID-19 pandemic, stating, *"[...] we have to be available (for partnerships) because the institution was closed in its time."* These narratives highlight disparities in responsiveness between the HEI and external entities seeking partnerships for technological development.

A recurrent constraint highlighted in the respondents' statements was the challenge of allocating resources for the development of technological solutions. Regarding this matter, respondent B expressed, *"[...] society still doesn't see us completely, what I've seen is that we need to present the institution, [...] (however) we can't find individuals to coordinate partnerships or take care of specific issues."* Respondent C categorically framed this limitation as a constraint, stating, *"[...] to make partnerships effective, the major bottleneck that arises is mobilizing competencies or determining if we have professionals to meet the demand."*

Supporting these findings are the outcomes derived from the questionnaires distributed to the coordinators of technological development projects carried out from 2015 to 2019. Table 3 delineates the main findings, emphasizing a dearth of internal and external collaboration in project execution. This outcome underscores the significance of artifacts designed to facilitate both internal and external promotion of projects.

Table 3

Characteristics of innovation projects approved in calls for proposals

Category	Results
Continuity	34.6% is a continuation/extension of a previous project, 63.5% is not a continuation/extension of a previous project.
Execution difficulties	Limited financial resources, bureaucracy for item acquisition, insufficient deadlines, lack of specialized technical workforce.
Internal collaborations	82.7% did not have collaboration from researchers from other campuses of the institution.
External collaborations	80.8% did not have collaboration from researchers from other institutions.
Demands from the productive sector	86.5% did not have any type of external partnership.

Source: The authors.

Two examples, elucidated by the managers, underscored the issue. After 2015, a non-profit organization associated to agriculture approached IFMT with the objective of establishing a collaboration in Research and Innovation. However, the intended project did not materialize, with one of the reasons being the challenge of identifying necessary resources, particularly human resources. Another challenge identified during the research was the researchers' difficulty in accessing physical resources due to a lack of awareness of their existence. As a multicampus HEI situated in a state of considerable geographical expanse, managers and researchers may lack awareness of the resources available in other units, beyond the ones in which they operate.

5 INTERVENTION PERFORMED

The analysis revealed challenges encountered by managers and researchers in the management of resources associated to technological development, primarily due to the absence of cataloging, which restricts accessibility for stakeholders. To address this issue, the proposed intervention introduces a set of artifacts designed to aid HEI managers in mitigating these challenges. Consequently, three knowledge-related artifacts were formulated: a Technological Showcase, an Innovation Projects Showcase, and a Competency Showcase.

The creation of these artifacts ensued from the implementation of two applied research projects conducted between 2019 and 2021. Since 2015, IFMT has been endorsing technological development initiatives, denominated as "innovation projects," through funding solicitations. Recognizing the significance of knowledge-related artifacts, two projects were submitted in response to calls in 2019 and 2020. Leveraging the institution's funding opportunities for artifact development not only secured financial support but also

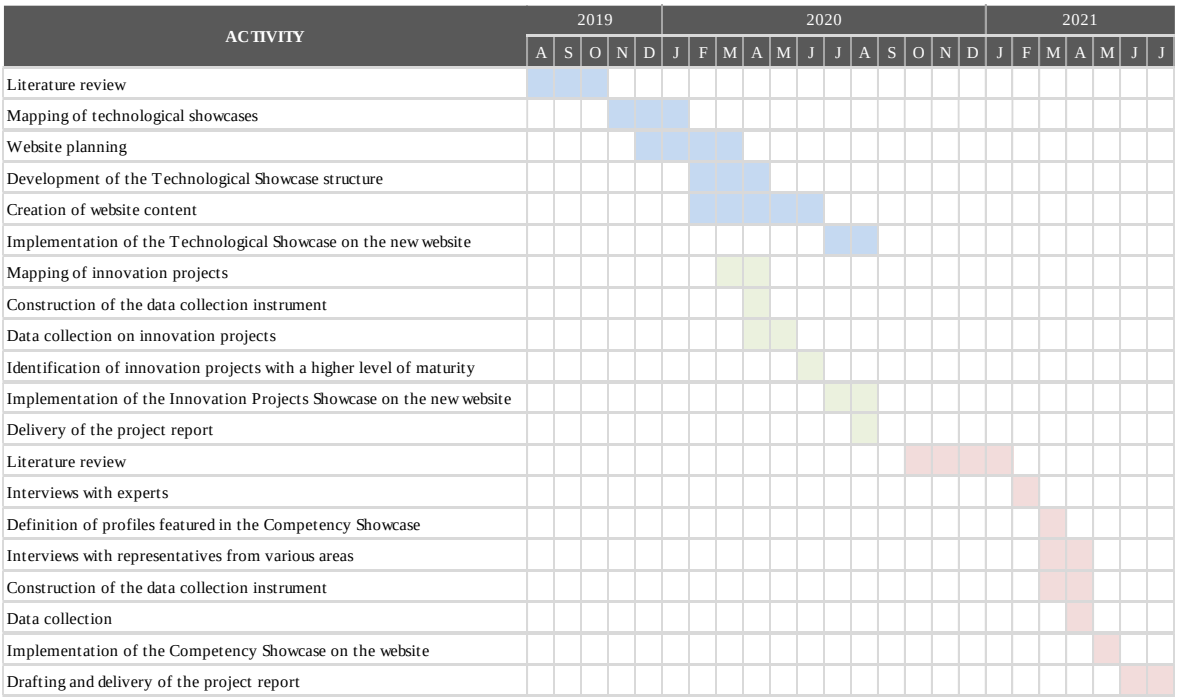
institutionalized the proposed initiatives. These calls have incentivized endeavors aligned with enhancing the management practices of the HEI, consistent with the outlined proposals.

In 2019, the inaugural project associated with the creation of the Technological Showcase and the Innovation Projects Showcase was submitted. The proposal was approved, reaching the third position among 42 competing projects. Subsequently, in the subsequent year, the project focused on creating the Competency Showcase was submitted and once again achieved third place, mirroring the number of projects from the previous year. Alongside the coordinator, a collective of six researchers and six student research fellows from diverse academic domains actively engaged in these projects, all serving as integral members of the initially established research group.

Figure 1 identifies the key activities performed, as well as their respective durations.

Figure 1

Intervention Timeline for the Problem Situation



Source: The authors.

Regarding financial resources, a sum of BRL 1,568.14 was allocated in non-adjusted values. This modest amount reflects a positive aspect of the proposal, illustrating a favorable cost-benefit ratio for public higher education institutions in Brazil. It is widely acknowledged that these institutions confront recurrent budget reductions. Notably, the investment budget for Brazilian federal universities in 2021 amounted to BRL 4.5 billion, marking a reduction of BRL 1.1 billion compared to the 2011 budget (Oliveira, 2021). According to the same source, if

adjusted for the accumulated inflation during the period, the 2021 value should have been at least BRL 7.1 billion, indicating a substantial decline in public investments in federal universities.

The showcases are accessible on the website of the Technological Innovation Agency of IFMT, at the address http://inovacao.ifmt.edu.br. Table 4 presents the categories and subcategories of menus available in the showcases.

Table 4

Organization of showcases on the website

Menu	Submenus	Description
Institutional	Innovation Policy Contact Our Website Our Team	Presents the functions of AIT, team, and contacts.
Technological Showcase	Our Patents Our Software Programs Our Trademarks Our Laboratories	Showcases registered intellectual properties and laboratories for partnership establishment.
Innovation Projects Showcase	30 projects divided into six development areas	Highlights projects with the highest level of technological maturity.
Competencies Showcase	92 profiles of faculty members from 19 campuses and the rectory	Profiles researchers, organized by campus, area, and individual competencies for technological development.
Inventor	Calls for Proposals Submit Your Invention Frequently Asked Questions Guides and Articles	Compiles announcements and information for inventors.

Source: Technological Innovation Agency [AIT] (2022).

The following subsections detail the activities carried out for the development of each showcase.

5.1 Development of the Technological Showcase

The Technological Showcase comprises the intellectual properties registered by IFMT. The initial phase of its development involved a literature review on the creation of showcases of this kind. The research yielded a restricted number of works.

Showcases or technological portfolios serve as platforms utilized by Higher Education Institutions (HEIs) and Institutes of Science and Technology (ISTs) to promote assets available for licensing agreements (Malvezzi, Zambalde & Rezende, 2014; Medeiros, Souto & Silva, 2019). Traditionally, the literature addressing these showcases has applied a marketing logic, drawing upon the theoretical-conceptual contributions of Marketing. By employing Resource

Orchestration, it was possible to comprehend how the artifacts can alleviate the challenges faced by HEI managers in the management of resources associated with technological development. This approach aligns with the principles advocated by Sirmon, Hitt, and Ireland (2007), emphasizing the leveraging process and the subprocess of coordination through the integration of effective and efficient capabilities.

Following the literature review, an analysis of technological showcases from various Higher Education Institutions (HEIs) was conducted. The institutions included in the analysis were: Inova from the University of Campinas; São Paulo Innovation University Agency (Auspin); Coordination of Technological Transfer and Innovation, Federal University of Minas Gerais (CTIT-UFMG); Center for Technological Development Support, University of Brasília (CDT-UnB); Technological Development Secretariat, Federal University of Rio Grande do Sul (SEDETEC-UFRGS); and Technological Innovation Office, Federal University of Mato Grosso (EIT-UFMT). This analysis contributed to structuring the showcase, identifying elements that could be developed. Table 5 provides a summary of the results of this stage, identifying 12 constituent elements found in the reviewed showcases.

Table 5

Elements of technological showcases

Element	INOVA-UNICAMP	AUSPIN-USP	CTIT-UFMG	CDT-UnB	SEDETEC-UFRGS	EIT-UFMT
Showcase website	https://patentes.inova.unicamp.br/ retrieved November 15, 2023	https://hubusp.inovacao.usp.br/patentes retrieved November 15, 2023	http://www.ctit.ufmg.br/vitrine-tecnologica/ retrieved November 15, 2023	https://cdt.unb.br/pt-br/tecnologias-protegidas/energia/199-vitrine-tencologica retrieved November 15, 2023	https://www.ufrgs.br/vitrinetecnologica/ retrieved November 15, 2023	https://www.ufmt.br/unidade/eit/pagina/portfolio-tecnologico/9753#top_page retrieved November 15, 2023
Organized by type of intellectual property (IP)	X					X
Basic description	X	X	X	X	X	X
Advantages	X		X	X	X	
Illustrative image	X		X	X	X	X
Inventor	X	X	X	X	X	
Development stage			X		X	X
Executive summary			X	X		
Registration number and filing data	X	X	X	X	X	X
Link to patent database		X				
Institution's objective			X			
Presentation video		X		X		
Potential partners						X

Source: The authors.

Only a portion of the showcases is organized by type of IP. It is possible to observe that some elements are commonly provided, such as basic description, inventors, registration number, filing data, and illustrative image. In light of this, the initial version of the IFMT Technological Showcase was designed to encompass these commonly adopted elements. Future updates are recommended to potentially include additional elements, such as the development stage, potential partners, and the institution's objectives related to the property. Executive summaries and the use of videos, as a more interactive presentation form, could also be considered. Given the complexity and volume of information, it is prudent to introduce

supplementary elements gradually as managers of technological showcases become more acquainted with the functionality of this type of knowledge artifact.

The subsequent phase involved an analysis of the visual structure employed by the IFMT NIT website. The determination was made that the existing website layout would be insufficient to accommodate the functionalities envisioned for the showcase. Consequently, the priority was redefined to develop a new website for the NIT. Following an exploration of various website templates, the Kallyas Theme WordPress© was chosen and acquired utilizing project resources.

Having established the visual structure, the phase of content creation began, incorporating diverse materials from the deactivated website, albeit subject to revision. Furthermore, texts containing pertinent information for inventors, frequently asked questions, institutional data, and relevant bibliographic materials—such as brochures and academic articles—were formulated and compiled.

The next stage involved a documentary investigation into the intellectual properties recorded by the institution at the National Institute of Industrial Property (INPI). A narrative was created using a "non-patent" language, deemed more accessible to potential stakeholders, and to articulate the inventions, with illustrations serving as supplementary components to textual information. In cases where the intellectual property descriptions proved complex for the team members, communication with inventors was pursued, coupled with an additional content review conducted before the official launch of the showcase.

An employee of the institution, who participated in the project leading to the creation of the Competency Showcase, conducted laboratory mapping as part of their master's research. The mapping offered a comprehensive overview of the institution's laboratories, including available resources, equipment, and contact information for the identified 109 laboratories (Lacerda, 2020). While this study was not initially included in the reported proposal, it has been integrated into the Technology Showcase as part of the "Our Labs" submenu.

5.2 Development of the Innovation Projects Showcase

The Innovation Projects Showcase consolidates projects in technological development that exhibit a higher level of technological maturity. These projects are geared towards creating "new products or processes or the addition of new features or characteristics to an existing product, service, or process, capable of generating improvements and/or effective gains in quality and/or performance" (Law No. 10.973, 2004, p. 2). As previously mentioned, IFMT has

actively promoted the advancement of technological solutions through project financing. From 2015 to 2021, a total of BRL 1,553,400.00 was allocated to bench fees and scholarships for researchers and students (IFMT, 2021).

A documentary research endeavor was undertaken to identify projects that secured funding between 2015 and 2019. The temporal restriction to this period aligns with the initiation of technological development project calls starting in 2015. Data collection persisted until 2019, coinciding with the commencement of the project culminating in the Innovation Projects Showcase. Project completion deadlines were extended due to the beginning of the pandemic. A total of 173 projects were quantified and categorized into 12 development areas. Notable areas of focus included food technology (55), agriculture (21), and educational technologies (20).

Our aim was to comprehensively understand the project profiles by employing a questionnaire structured with three blocks of inquiries. The initial block focused on the coordinator's profile, followed by a second block addressing project characteristics, and a final block requiring the completion of a Technology Readiness Level (TRL) scale. The TRL scale, a globally recognized method for gauging technology maturity (Gil, Andrade & Costa, 2014), was integrated into the questionnaire. Data collection occurred in April 2020, utilizing the Google Forms tool, an integral component of the Google Workspace for Education package, which was provided at no cost to IFMT members. Contact with the 173 coordinators was established via email, yielding 57 responses, with 52 deemed valid.

Even though the data collection included a subset of projects, the outcomes substantiated the limited level of collaboration among researchers, both within the institution and externally, throughout the execution of the research. In terms of maturity, the results exposed that 30 projects failed to reach the minimum development level and were consequently deemed eligible for inclusion in the Innovation Projects Showcase. These projects were systematically classified into six groups, offering a valuable organizational structure to emphasize areas with substantial opportunities. Information from project completion reports was collected to underpin the showcase descriptions.

In certain projects, coordinators were approached for clarification of issues requiring additional exploration. Ultimately, all coordinators validated the content before its inclusion in the showcase.

5.3 Development of the Competency Showcase

The Competency Showcase compiles the individual competencies of researchers for technological development. Among the three showcases, this one presented the highest level of complexity and was exclusively executed during the second applied research project conducted between 2020 and 2021. Similar to the previous showcases, the initiative began with a literature review, aiming to establish a theoretical foundation for the proposal. As observed in other cases, there was limited existing academic literature on the cataloging of individual competencies of researchers for technological development.

An exemplary contribution is the mapping of competences of faculty members at the University of Brasília, as developed by Viana et al. (2014). It is acknowledged that mapping of competences is intricately associated to the process of grouping, which has the potential to initiate a pioneering subprocess. This is noteworthy as new capabilities are formed (Sirmon et al., 2007) from elements that were previously available and scattered.

In order to gather recommendations and validate decisions for the development of the Competency Showcase, interviews were conducted with experienced academics involved in Research and Development (R&D) agreements. These academics had previously engaged in research aimed at cataloging the individual competencies of researchers for technological development. Two researchers, affiliated with the University of Brasília and the Federal Institute of São Paulo, were identified as suitable interviewees and were invited to participate. Both interviewees held managerial roles in technological development centers, accumulating a combined experience of over 10 years in the field. The exploratory interviews were conducted separately and lasted approximately 90 minutes each.

From the interviews, the method for collecting academics' competencies was defined, establishing that the utilization of secondary data, such the Lattes Platform, would not be considered relevant at the time. This decision was motivated by the absence of project team members equipped for manual or automatic data extraction, coupled with the potential for the data to be outdated. The authors' experience indicates that such a situation is commonly encountered within the institution.

It was further determined to limit the target audience of the data collection, acknowledging the presence of over 1,000 professors within the institution. Given the project's constrained execution period of up to 12 months, an all-encompassing data collection from the entire population was deemed impractical, particularly considering that neither the researchers nor the institution had previously undertaken such a proposal.

Decree No. 1,122 of 2020, issued by the Ministry of Science, Technology, Innovations, and Communications, establishing priorities for research, development, and innovations in Brazil, provided guidance for defining the target audience. The decree outlined various areas, some of which were not applicable to IFMT. Generally, these areas include technologies for industry, agribusiness, communications, infrastructure, and services. Consequently, the decision was made to catalog the competencies of faculty in the professionalizing education areas of the institution. It is recommended that future updates to the Competency Showcase include the competencies of faculty in the common core areas, educational technicians, and students in scientific initiation and graduate programs.

In the subsequent phase, it became imperative to comprehend the methods through which the individual competencies of researchers across different areas could be elicited. In this context, interviews were carried out with faculty members representing 10 distinct areas. Invitations were sent via email, with a deliberate selection of faculty members who had previously contributed to the understanding of the problem situation through informal discussions. The selection criteria for faculty members were based on the convenience of access, considering their longstanding tenure at the institution, along with their professional expertise in the respective fields. A total of twelve faculty members were interviewed, with one session involving a dual interview with two professors. The interviews occurred via Google Meet, totaling approximately 345 minutes in duration, between May and April 2021. The adoption of the virtual format was required by the prevailing circumstances of the COVID-19 pandemic.

The records taken during the interviews played a pivotal role in shaping decisions related to how competencies would be requested in the questionnaire. Additionally, these notes facilitated the elucidation of the showcase's objectives and allowed for the solicitation of feedback from each interviewee. The response was uniformly positive, with unanimous support for the proposed initiative.

Table 6 summarizes the information regarding the profile of the interviewees.

Table 6

Summary of Interviewees' Profile

Area	Gender	Academic Degree	Time with the Institution	Professional Experience in the Field	Duration
Business Administration	Male	Master's degree	7 years	14 years	32 min
Architecture	Female	Master's degree	3 years	9 years	20 min
Economics	Male	PhD	10 years	17 years	24 min
Civil Engineering	Female	PhD	11 years	29 years	35 min
Control and Automation Engineering	Male	Master's degree	5 years	5 years	52 min
	Female	Specialization	4 years	10 years	20 min
Electrical Engineering	Male	PhD	9 years	13 years	33 min
Forest Engineering	Male	PhD	9 years	15 years	30 min
Data Processing	Male	Master's degree	10 years	19 years	26 min
Chemistry	Male	PhD	6 years	13 years	25 min
	Male	PhD	12 years	16 years	39 min
Food Technology	Female	PhD	12 years	20 years	

Source: the authors.

The preliminary version of the data collection instrument was shared with two external interviewees and the 12 faculty members for their input and suggestions. Following the incorporation of the recommended adjustments, the questionnaire reached its final version in April 2021, marking the beginning of data collection. The formulation of questions was based on the literature and interviews, incorporating elements from the Strategic Diagnosis of the Innovation and Technology Transfer Agency of the Federal Institute of São Paulo (INOVA IFSP, 2020).

The survey consisted of three sections: the initial segment covered demographic inquiries, the second focused on evaluating the incentives offered by the institution to professors for technological development, and the concluding section centered on individual competencies. The questions included both open-ended and closed-ended formats, dichotomous choices, and a 5-point Likert scale.

The data collection process occurred through the Google Forms tool, contacting 446 faculty members across 16 areas via email. These areas encompass Administration, Architecture and Urbanism, Agricultural Sciences, Accounting, Economics, Law, Environmental and Sanitary Engineering, Cartographic Engineering, Civil Engineering, Control and Automation Engineering, Forest Engineering, Electrical Engineering, Mechanical Engineering, Production Engineering, Chemistry, Chemical Engineering, Education degrees in

the field, and Computing, covering Computer Science, Computer Networks, Information Systems, Informatics, Data Processing, and Software Engineering.

Upon the creation of a new website to host the initial two showcases, the decision to integrate the Competency Showcase into the same platform was intuitive. During this phase, a benchmarking analysis was undertaken, examining other showcases that aggregate competencies, such as the Integra Portal developed by the Federal Institute of Rio Grande do Sul. This platform features a menu named "Service Provision," offering a curriculum summary, areas of expertise, and types of services offered by registered faculty. In contrast to this framework, the proposed showcase was labeled the Skills Showcase, a more encompassing term designed to include various activities associated with technological development.

The data collection spanned approximately one month and yielded 108 responses. Among these, 92 researchers granted authorization for the public disclosure of their self-declared competencies. All 108 responses, deemed valid, indicated an interest in undertaking technological development projects involving external participants. In general, faculty members reported moderate satisfaction with the physical infrastructure of the campuses, including laboratories, equipment, and software, as well as with the institutional support required for initiating partnerships in applied research.

Among the factors cited to justify interest in these partnerships, six categories were identified, with particular emphasis on: (1) professional development, (2) attracting external resources, and (3) contributing to local socio-economic development. Facilitating factors for partnerships were grouped into seven categories, with notable emphasis on: (1) high qualification of the faculty, (2) institutional legitimacy, and (3) growing demand. Conversely, hindering factors were identified as: (1) campus infrastructure, (2) insufficient working conditions, (3) excessive bureaucracy, (4) overload with teaching activities at the expense of research and extension, and (5) the imbalance of expectations between academics and demanders.

Concerning competency mapping, the profiles of the interviewees were organized by campuses and structured into eight elements, namely: (1) name, (2) academic degree, (3) field of expertise, (4) campus, (5) research lines, (6) areas of interest tags, (7) clusters of technological activity, and (8) individual competencies for technological development, detailed as the operation of technologies, equipment, software, technological artifacts, processes, and techniques. All respondents were invited to validate the contents before the virtual launch of the showcase in May 2021, with the participation of project members, the academic community, managers, and guests.

It is essential to underscore that, as an attribute inherent to each professional, Competency Showcase managers must continually update the showcase. Given the inherently flexible nature of individual competencies, it is vital to establish mechanisms to monitor researchers whose profiles are accessible. The suggestion is that researchers can autonomously update their profiles. In situations where self-updating is not feasible, employing an electronic tool, such as a questionnaire, can prove useful for researchers to submit newly acquired competencies or indicate any changes to the competencies they previously made available.

6 RESULTS OBTAINED

The creation of the showcases constituted an intervention aimed at mitigating the challenges encountered by managers in directing resources associated with technological development. However, it is essential to note that the mere development of platforms should not be regarded as a conclusive resolution to the issue.

Throughout the approximately three-year duration of proposal development, it became possible to comprehend a multifaceted scenario intertwined with operational, strategic, and institutional challenges, encompassing regulations, and divergent perspectives among researchers, managers, and external stakeholders. Nevertheless, a substantial effort was exerted to formulate a proposal aimed at alleviating the identified issue.

The 2022 interviews with managers A, B, and C were instrumental in assessing the achieved outcomes. Interviewee A unequivocally asserted that the showcases represent a valuable asset for fostering connections between the educational institution and a technological park currently under construction in the region. The interviewee highlighted two ongoing opportunities, both involving collaborations with foreign educational institutions—one with a Portuguese university and the other with a Chinese university, aiming to establish a research and innovation laboratory in agriculture. The manager acknowledged that the showcases create a *"[...] window of opportunities to showcase the potential of the institution because partners constantly tell us: we need to know more about you. What is the potential of your institution?"*. This statement underscores the significance of the Competency Showcase, which identifies the strengths and areas of expertise among the institution's faculty in technological development.

Interviewee C suggested that showcases can aid in dispelling the perception that technological development is confined to faculty members in the institution's professionalizing core areas—an insight recommended for future updates to the showcase. The interviewee mentioned being involved in informal negotiations for two projects, one with a state

government agency and the other with a logistics sector concessionaire. In both cases, it was conveyed that the Competency Showcase would be utilized to identify the individual competencies of faculty members that could contribute to these partnerships.

In conclusion, interviewees A and B underscored the valuable role of the showcases in minimizing the time between identifying demands and fulfilling them, thereby enhancing responsiveness in locating essential resources. Interviewee C highlighted the institution's challenge to establish routines that not only maintain the showcases up-to-date but also expand their scope to address various types of demands and diverse audiences.

In this context, it is essential to acknowledge that the initial versions of the showcases were rooted in the members of the institution's academic community. As with any artifact, subject to refinement, it is advisable that future updates involve the exploration of external actors as potential stakeholders in technological solutions. This category encompasses technology-based company executives, public officials, managers of entities representing private interests, as well as managers from social organizations such as social enterprises, cooperatives, and community organizations.

It is noteworthy that situational factors might have influenced the outcomes of the initiative. In late 2020, the institution held elections for the positions of rector and campus directors, leading to the appointment of new administrators who initiated an extensive organizational restructuring. It is plausible that these alterations could have impacted the ongoing maintenance of the showcases. In light of this, Table 7 provides guidance to managers and researchers regarding the stages, activities, crucial considerations, and focal points for the development of the presented showcases.

Table 7

Guidelines for the Development of Showcases of Resources Related to Technological Development

Technological Showcase					
Stage	1) Identification of registered IPs.	2) Definition of the Constituent Elements of the Showcase.	3) Drafting of the constituent elements of the showcase.	4) Uploading of the contents developed on the showcase website.	5) Review of the contents uploaded on the showcase website.
Activities	Search for IP registration documents.	Organize the IP records.	Define the selected constituent elements for each IP. Contact IP inventors. Engage inventors in the development of the showcase.	Create, adapt, and define the presentation structure of the showcase (website template). Upload the developed content to the website.	Review the developed content. Request verification by inventors and other stakeholders.
Central questions	Does the quantity and variety of IP registered by the HEI justify the creation of the showcase?	Does the HEI have a defined strategy for IP management and technology transfer that allows prioritizing constituent elements?	Can inventors be accessed? Do HEI managers have clarity regarding expectations for each IP?	Does the HEI have a website to host the showcase with the expected functionalities? Does the showcase manager have a multidisciplinary team for website creation and management?	Will the inventors of the IP be engaged in the development of the showcase?
Attention points	Access to documents and IP registration databases is a necessary condition. The minimum quantity of IP justifying the development of the showcase will depend on the objectives of the HEI.	The selection of elements should consider the showcase manager's proficiency in translating elements from IP documents. It is prudent for the initial version of the showcase to contemplate the release of a subset of elements. As resources become available, including a multifunctional team	The creation of elements will necessitate a twofold interaction by the showcase manager. Firstly, with inventors to convert elements from IP documents into showcase components. The practice of "copy and paste" is discouraged due to the technical	It is advisable to use interactive templates that can offer diverse functionalities for user interaction. An illustration of this recommendation is the technological showcase of CTIT-UFMG.	Content review by inventors will be crucial for corrections and validation.

		and accrued experience, the consideration of all elements becomes possible. Organizing the showcase by IP type is recommended.	nature of the documents. Conversely, interaction with HEI managers is essential to identify expectations for each IP. It is recommended to assess the technological maturity of IPs.		
Innovation Projects Showcase					
Stage	1) Identification of technological development projects.	2) Selection of projects based on the level of technological maturity.	3) Drafting of basic information for the selected projects.	4) Uploading the developed content to the website.	5) Review of the content uploaded to the showcase website.
Activities	Search for documents, such as project reports.	Create the contact database (project coordinators and researchers). Collect primary and secondary data from the projects. Evaluate the technological maturity of the projects.	Organize documents and project reports. Structure the contents of each selected project, including basic description, involved researchers, and types of interests for partnerships. Contact project coordinators and researchers to provide/complement information for basic descriptions.	Create, adapt, and define the presentation structure of the showcase (website template). Upload the elaborated content to the website.	Review the elaborated content. Request confirmation from the inventors and other stakeholders.
Central questions	Is the creation of the showcase justified by the quantity and technological maturity level of technological development projects?	Do the coordinators and managers of the HEI possess clarity regarding the expectations for the projects?	Will the showcase manager have the capability to access the coordinators and researchers of the projects?	Does the HEI have a website equipped to host the showcase with the anticipated functionalities? Does the showcase manager have a multidisciplinary team	Will the coordinators and researchers of the projects actively participate in the development of the showcase?

				dedicated to the creation and management of websites?	
Attention points	Access to documents and information limited to project coordinators will be essential. The minimum number of projects warranting the development of the showcase will be contingent on the objectives of the HEI.	Fundamental content can be acquired through the collection of primary and secondary data. Coordinators can receive training on technological maturity to prevent distortions in the self-assessment of results.	The creation of basic information will require the manager's engagement with project coordinators and researchers for content development.	Interactive templates, capable of providing diverse functionalities for user interaction, are recommended.	The review of content by coordinators and researchers will be pivotal for corrections and validation.
Competency Showcase					
Stage	1) Definition of sources for collecting competencies	2) Definition of the target audience scope	3) Definition of elements for showcase profiles	4) Identification of competencies	5) Loading of elaborated content on the website	6) Review of content uploaded to the showcase website
Activities	Specify how individual researchers' competencies will be acquired, which may involve the use of primary data, secondary data, or a combination of both.	Determine the extent of the target audience for competency collection.	Define the components of the profiles showcased.	Administer questionnaires and/or conduct research in databases and archives.	Develop, modify, and establish the presentation structure of the showcase (website template). Upload the developed content onto the website.	Assess the content that has been developed. Seek validation from researchers.
Central questions	In the event of collecting data from primary sources, can the manager of the showcase readily access the researchers? Regarding secondary data, what potential sources can furnish	Does the HEI have a well-defined strategy for partnerships in technological development? Does the HEI prioritize specific areas for technological development?	How do the nature and specific characteristics of the HEI inform the definition of profile elements?	Do researchers express an interest in presenting their profiles in the showcase?	Does the HEI have a website for hosting the showcase with the anticipated functionalities? Does the showcase manager have a multidisciplinary team for both the creation and management of the website?	Will researchers actively participate in the development of the showcase?

	information on individual competencies (e.g., Lattes Curriculum or other institutional databases)? Does the HEI possess additional databases to acquire competencies of researchers? Is the provided information current and capable of addressing individual competencies? Does the manager of the HEI have tools for extracting secondary data?					
Attention points	The inclination of the HEI towards developing a showcase is not in itself a sufficient condition. Researchers need to demonstrate commitment to the objectives of the showcase. While collecting primary data offers more accurate information, it requires active engagement and participation of researchers in the	Initial iterations of the showcase may focus on a subset of researchers, particularly in instances of a large number. It is advisable for the development of the showcase to proceed gradually, acknowledging the common constraint of personnel for showcase management. The justification for the scope of the target audience is essential.	The definition of elements can be informed by the type of data and specificities of the HEI. Basic elements collected might include research lines, areas, and competencies for technological development.	Access to information restricted to researchers may be imperative. Researchers should consent to the availability of their profiles, considering the provisions of the General Data Protection Law.	Interactive templates, capable of providing various functionalities for user interaction, are recommended. Example: AUSPIN-USP.	Content review by researchers will be pivotal for corrections and validation.

	showcase development. The process of collecting secondary data streamlines the development of the showcase, although it may compromise the accuracy of the information. Data extraction will necessitate the creation of an Application Programming Interface (API). A high volume of researchers may render manual extraction impractical.

Source: The authors.

Managers may opt to create one or multiple showcases based on the goals of each HEI. Nevertheless, as previously noted, upkeep is an integral aspect of artifact development. Outdated showcases can yield results contrary to the initial expectations. As suggested, routines for updates should be implemented, considering the accessibility of multidisciplinary teams and other essential resources. This recommendation underscores the ongoing responsibilities associated with artifact development. Consistent updates and enhancements are advisable.

7 FINAL REMARKS AND TECHNO-SOCIAL CONTRIBUTION

This study introduced a series of artifacts designed to aid Higher Education Institution (HEI) managers in alleviating challenges associated with the administration of resources associated to technological development. The validation of these artifacts demonstrated a reduction in difficulties related to resource management. IFMT emerged as the second institution in the state of Mato Grosso to establish a Technological Showcase and one of the pioneers nationally in implementing an Innovation Projects Showcase and a Competency Showcase.

Hence, the study puts forth the following techno-social contributions: (1) the development of three scalable, replicable artifacts with potential economic implications; (2) the recognition of an opportunity for practically-oriented researchers to utilize organizational incentives effectively in implementing enhancements for the institution, as the conception of the artifacts was associated with the execution of two applied research projects financed by the institution; (3) the reinforcement of fulfilling one of the objectives of the analyzed institution.

The Resource Orchestration perspective is conceived as a counterbalance to the predominance of the Marketing field in studies concerning showcases and technological portfolios. It offers insights into how artifacts can alleviate the challenges encountered by HEI managers in directing resources associated with technological development. Consequently, these artifacts function as instruments for both managers and academics to conduct their activities and accomplish the objectives of HEIs.

The study meticulously outlines the process of creating showcases, providing a comprehensive guide for replication by other Higher Education Institutions . A noteworthy observation is that the proposal has been recognized as an exemplary model for other institutions. This was underscored by the involvement of a dean from a federal university who expressed interest in the proposal during the inauguration event of the Competency Showcase.

In addition to the limitations outlined in the development of the showcases, other constraints can be identified. Alternative types of interventions could be explored to address the presented problem. It is acknowledged that a selection bias may have constrained the evaluation of other alternatives, given that the applied research projects inherently focused on the development of the showcases.

It is advisable for future research endeavors to adopt Design Science Research (DSR) to establish a cohesive framework across the various stages of the methodology. While this study offers a practical solution, it is essential to note that the implementation of the proposed solutions did not adhere to the DSR recommendations, presenting a clear methodological limitation. Furthermore, forthcoming studies have the potential to assist managers in executing the essential activities for maintaining showcases. Such studies might propose systematic routines for the maintenance and periodic updates of the artifacts, along with control measures to assess the results derived from the showcases.

Finally, IFMT is an institution affiliated with the Federal Network of Professional, Scientific, and Technological Education, endowing it with unique characteristics when compared with other Higher Education Institutions including federal, state, private, denominational, and community universities. For future studies, it is recommended to consider these distinctions, fostering fresh insights into diverse solutions applicable to different contexts.

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