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Basic proposal for the elaboration of public policies in the context of smart university cities

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ABSTRACT
University cities are hubs of knowledge, innovation, and development, where students, professors, and researchers collaborate to drive academic and technological advancement. With the rise of information and communication technologies comes the opportunity to transform these cities into smart environments where connectivity and efficiency are maximized. It is proposed an adjustment in the Institutional Evaluation System of UFMS, which will serve as a basis for the direction of public policies within the scope of the University City.

Keywords: Public policies, Elaboration, Institutional evaluation, Smart university cities.

INTRODUCTION

Society is witnessing an unprecedented urban transformation, where smart cities emerge as catalysts for a socioeconomic and environmental revolution, in which an innovation ecosystem, driven by technologies to increase the efficiency of its system, provides an improvement in the quality of life of citizens (Depiné; Teixeira, 2021). The intersection between urbanization and technological advances has given rise to an innovative concept, considered as the 4th Industrial Revolution, in which efficiency, connectivity, and sustainability converge to shape the future of our urban centers (Rampazzo; Corrêa; Vasconcelos, 2019).

Smart cities, by incorporating technologies such as the Internet of Things (IoT), Big Data, and Artificial Intelligence, seek not only to optimize operations, but also to embrace environmental responsibility, promoting sustainable urban practices (Abrusio, 2020). In this context, universities emerge as crucial spaces for reflection, research and dissemination of sustainable practices, with the role of performing the transition to sustainability as a process of multiple dimensions (Gonçalves-Dias; Herrera; Cruz, 2013). They are centers of knowledge that shape the minds of the future, not only preparing competent professionals, but also conscious citizens.

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The inclusion of sustainability in academic curricula creates a solid foundation for understanding contemporary challenges, encouraging innovation and preparing students to lead with the necessary changes, given that, for a long time, management practices have predominantly prioritized financial objectives, leaving aside crucial issues about the impact of business operations on the environment and society. lacking in the training of future managers in the face of environmental awareness (Teixeira Franco *et al*., 2015).

The importance of sustainability indicators in building a smart space is evident when considering the complexity of university operations. These indicators represent a tool to aid decision-making in the public sphere, as well as a means of informing and sensitizing the community about the university's environmental performance (Brandão; Malheiros; Leme, 2014). The use of indicators is the compass that will guide these institutions on the journey to development that invests in long-term resilience and prosperity, contributing to a more equitable and environmentally sound global scenario.

In this sense, the general objective of this study is to propose the use of the Institutional Evaluation System (SIAI) as a tool of opportunity to improve the understanding and measurement of sustainability within the scope of UFMS, in order to identify new specific indicators, incorporating questions related to smart cities, smart campuses and sustainable practices, as well as an adequacy of this management tool aligned with the 17 Sustainable Development Goals (SDGs) and UN global targets, in order to propose questions that identify and evaluate aspects of *Smart Cities.*

By seeking innovative strategies to improve the infrastructure and management of the academic environment, the study both fosters educational excellence and promotes environmental efficiency, through the interaction between students, teachers and employees. In this way, by concentrating efforts on the creation of a smart campus, the research raises the educational standard and converts it into a valuable investment for social progress, reflecting the commitment to innovation and collective well-being, since projects debated with the local population are fundamental for environmental transformation, as well as for material and human losses to be avoided (Ferraresi; Stangherlin, 2022).

MANAGEMENT OF UNIVERSITIES AS SMART CITIES

The concept of smart cities and sustainable environments has stood out as an innovative approach to urban and territorial development (Dallabrida, 2020), aiming at the integration of innovation education between organizations and governments, promoting efficiency and quality of life (Schaffers *et al.*, 2011). This movement has grown significantly around the world, with governments, businesses, and communities recognizing the importance of adopting technological solutions to improve infrastructure, transportation, safety, and sustainability in cities.

In the organizational environment, the implementation of smart city tools has been gaining greater prominence, such as internet sensors and artificial intelligence, forcing companies to rethink business models in order to face challenges by training workers to operate new technologies for Industry 4.0 (Santos; Ferreira; Ferreira, 2023).

In universities, this approach extends to the academic context, with institutions playing a crucial role in promoting smart and sustainable cities and campuses. However, although there are several organizations that address the subject, most of them are concentrated in large urban centers, due to the existence of incentive projects for the development of research in smart cities (Lazaretti *et al.*, 2019)

To evaluate and measure the effectiveness of these smart environments, organizations use various tools, such as questionnaires, satisfaction surveys, data analysis and performance indicators, which are methods used to obtain a comprehensive understanding of the impact, such as *Sustainable Cities and Communities - Indicators for City Services and Quality of Life*, which is a system of sustainability indicators in cities and communities in general (Abreu; Marchiori, 2020).

In addition, Information Technology (IT) and Internet of Things (IoT) departments represent an unprecedented technological revolution, playing a vital role in the implementation and maintenance of smart technological infrastructures, proving to be able to reconcile technology ideals with efficiency (Santiago; Payão, 2018).

The synergy between technology and sustainability in universities is reflected in the search for innovative solutions, transcending the technological sphere and demanding a comprehensive approach that takes into account several interdependent aspects, such as the well-being of individuals, the preservation of the environment, as well as effective public management (Brito *et al.*, 2023). As a result, the operational management of universities has been gaining greater importance in this scenario, adopting measures to meet quality-of-life, economic, environmental and sustainable dimensions (Oliveira, 2009).

Collaboration between diverse departments and institutions is essential for the success of smart city initiatives in universities, requiring advanced levels of sharing and integration of information and knowledge (Rodrigues *et al.*, 2019). Departments come together to create holistic approaches, connecting the physical environment to the digital environment, allowing a comprehensive approach to each other, with suppliers, products and people (Almeida; Andrade, 2023). However, the implementation of these smart environments faces challenges, such as issues related to cybersecurity, privacy, and financial services, given the lack of professionals specialized in this area (Ferreira, 2023).

The active involvement of the academic community is a key part of the success of smart city initiatives. Smart campuses incorporate innovations such as interactive classrooms and the creation of learning environments with attention to personalized education (Ferreira; Araújo, 2018).

Universities have played a significant role in the adoption of tools and indicators to assess smart cities and sustainability. For example, UFMS has the Institutional Evaluation System (SIAI), which, although not specifically intended for the evaluation of smart cities, offers a framework to measure the overall performance of the institution, including aspects related to sustainability.

The SIAI allows the collection of data on environmental management, social and economic practices, providing a comprehensive overview of the university's contribution to sustainable development, as it identifies strengths, potentialities and weaknesses of the Institution. Through the evaluation, it is possible to better understand the processes and identify opportunities for improvement (UFMS, 2023).

In the context of environmental sustainability, indicators such as the carbon footprint have become essential tools in order to combat climate change, since the emission of greenhouse gases are the main drivers of global warming (Sanfins, 2023). Universities often carry out carbon footprint assessments to measure their greenhouse gas emissions and implement strategies to reduce them, allowing them to influence the importance of pro-environmental behavior, reinforcing the existing database and encouraging research and teaching at the university (Borges, 2017).

In this scenario, it can be seen that this context is intrinsically related to the Sustainable Development Goals (SDGs), global goals of the United Nations (UN) initiative for the 2030 agenda, comprising 17 interconnected goals aimed at addressing global challenges and promoting sustainable development that covers economic, social and environmental aspects (UN, 2023), so that Goal 4 is aligned with Quality Education, which aims to ensure access to inclusive, quality and equitable education, and to promote lifelong learning opportunities for all, such as Goal 11 in accordance with the demands and targets of sustainable cities and communities, aiming to make cities and communities more inclusive, safe, resilient and sustainable.

Figure 1 – Sustainable Development Goals (targets 4 and 11)

Fonte: ONU (2023)

In the context of the transformation to smart cities, education has explored indicators related to connectivity and technological innovation, with the implementation of Internet of Things (*IoT*) systems, providing new ways to facilitate learning by building an intelligent ecosystem, where everyone at any place or time can learn and teach (Silva; Szesz Junior, 2018). Indicators such as the efficiency of the use of technological resources, accessibility to connectivity, and the development of smart infrastructures are key to assessing the progress of universities towards smart cities.

The implementation of smart environments in universities not only contributes to improving the quality of life in the academic community, but also generates positive economic impacts. The development of technological skills and the promotion of innovation can boost economic growth and political management that can have a significant impact on addressing global challenges (Abdala *et al.*, 2014).

METHODOLOGY

The research will adopt the qualitative approach with the documentary technique, aiming to deepen the understanding of the dynamics related to the implementation of sustainable practices in academic environments. The choice of the qualitative approach is justified by the need to explore the complexity and interactions underlying the sustainable development process, allowing a detailed analysis of the perspectives, values and experiences of the actors involved.

The documentary technique effectively complements the qualitative approach, allowing for the collection and analysis of a variety of institutional documents, reports, policies, and other relevant records. With this, the information will be analyzed through the existing institutional data of the tool itself, in order to identify and analyze the questionnaire applied in order to align it with the objectives of the global sustainability goals.

DIAGNOSIS OF THE PROBLEM AND/OR OPPORTUNITY

The Federal University of Mato Grosso do Sul (UFMS) adopts the Institutional Evaluation System (SIAI) as an essential tool to strengthen its commitment to academic and administrative excellence, starting its pre-test phase in 2017 and implemented, in fact, in 2018 (UFMS, 2023). The SIAI at UFMS plays a central role in the continuous evaluation of institutional practices, providing a comprehensive view of performance in crucial areas such as teaching, research, extension and administrative management.

By analyzing strengths and areas for improvement, UFMS uses the tool strategically to constantly improve its educational quality, reinforcing the university's transparency and accountability to its students, faculty, technicians, and the community in general.

Thus, the evaluation is structured through 5 major axes, namely: Axis 1 – Institutional Planning and Evaluation; Axis 2 – Planning and Institutional Development; Axis 3 – Academic Policies; Axis 4 –

Management Policies; Axis 5 – Infrastructure, in accordance with the provisions of Law No. 10,861, of April 14, 2004, which establishes the National System of Evaluation of Higher Education – SINAES and provides other measures (Brasil, 2004). It should be noted that the questions of the Axes adopt the Likert Scale, structured in 5 answers ranging from 1 to 5, where 1 represents unsatisfactory and 5 very good.

Table 1 - SIAI Evaluative Scale Point

AVERAGE	CATEGORIES
< 4 and/or most answers in 1 and 2	Fragility
< 4 and/or most responses in 3	Opportunity for Improvement
≥ 4 most answers in 4 and 5	Well Rated

Source: UFMS (2023)

Chart 2 - Axes of the UFMS Institutional Evaluation

AXIS 1 – INSTITUTIONAL PLANNING AND EVALUATION	**The actions carried out in the previous year, and the results of the university community's perception of the evaluation process. The results of external evaluations are also presented.**
AXIS 2 – PLANNING AND INSTITUTIONAL DEVELOPMENT	It aims to ensure that the strategic objectives are achieved, according to what was foreseen in its planning process, always seeking to improve its tools and modernize its institutional procedures.
AXIS 3 – ACADEMIC POLICIES	Results of the evaluation about the coordination of the course, disciplines and performance of teachers and students; teaching, internationalization, research, technological innovation and extension policies; assistance to students and graduates; Communication between UFMS and the community.
AXIS 4 – MANAGEMENT POLICIES	Evaluation of the Policies for training, qualification and performance of servers; General image of UFMS and its environment.
AXIS 5 – INFRASTRUCTURE	Evaluation of the physical infrastructure by students and staff

Source: UFMS (2023)

Infrastructure stands out as the main axis of the object of study, as it is where the evaluations related to facilities, accessibility, parking lots, laboratories and technology, communication and information environments are included, directly related to the central theme of the research, with the objective of identifying the evaluations in relation to the intelligent and sustainable environment.

Table 3 – SIAI Issues Axis 5 – Infrastructure

Classrooms	Physical and/or virtual collection
Teachers' Rooms	Safety
Administrative Rooms	Lighting
Auditoriums	Accessibility in buildings
Sanitary Facilities	Cleaning
Computer Labs	Bus stop and friendly ride
On-campus Internet access	Parking lot
Virtual Learning Environment (VLE/UFMS)	Bike rack
Communication Resources (email)	Internal track conditions

Laboratories, sectors and environments for practical activities (classes, activities, services)	Transport
Living Spaces	Telephony
Sports Venues	SISCAD – Academic and Faculty Control System
Eating spaces (Pantry, RUs, Canteens)	SIGPOS – Graduate Management System
Library	Attendance of the Academic Secretariat at the unit (face-to-face) and online.

Source: UFMS (2023)

It was observed that in the questionnaire applied, the areas of interest do not include the evaluation of smart and sustainable infrastructures, making it impossible to establish indicators that measure aspects related to the promotion of a smart campus in the institution, in accordance with the Sustainable Development Goals (SDGs), in view of the global goals established by the United Nations (UN).

It is noteworthy that in Axis 2, management, governance, *compliance* and sustainability practices are presented as evaluation guidelines, however still in an elementary way, and it was identified in the 2022 evaluation that students attributed low perception in relation to the 17 goals of the SDGs, concluding the need for greater disclosure about the link between institutional actions and global goals.

With this, there is an opportunity to explore in Axis 5, in a more in-depth way, the evaluation with themes related to *IoT* (Internet of Things), smart parking, traffic management, environmental education, waste management and energy efficiency, in order to align UFMS infrastructure with the SDGs, which can contribute to institutional development and planning, considering that the institution already has several resources in this regard, such as: Ecopoints, Photovoltaic Energy, Bike Racks, Electric Scooters, applications for Relationship Management and collaborative demands, solid waste collection, among other actions.

PROPOSED CHANGE, INTERVENTION OR RECOMMENDATION

Considering the SIAI tool as an instrument for collecting data at UFMS, there is an opportunity to use it as a mechanism to obtain information about the university community in order to subsidize institutional public policies that allow the development of an intelligent and sustainable university environment.

With this, changes are proposed in the current questionnaire, including questions related to the theme Smart Cities, with the objective of promoting the culture of innovation for a connected Campus that uses its resources in a rational and sustainable way and generates references and/or subsidies for the formulation of public policies.

Table 4 – Proposal for changes to the SIAI - Infrastructure Axis

Axis 5 – INFRASTRUCTURE **Theme: Smart and Sustainable University Campus**
1. Do you believe that the university's technological infrastructure contributes to the creation of a smart and connected university environment?
2. What technological services offered by the university do you consider essential for the construction of a smart city within the campus?
3. In your opinion, does the university provide adequate resources to promote sustainability and energy efficiency in its physical environment?
4. How do you evaluate living and interaction spaces within the university in relation to the integration of smart technologies such as monitoring systems, smart lighting, and waste management?
5. Do you believe the university promotes the use of smart and sustainable transportation, such as shared bikes, smart public transportation, or smart parking lots?
6. In your perception, does the university use data and analytics to make strategic decisions in the development of a university smart city?
7. What steps could the university take to improve the safety of students and staff through the use of smart technologies such as surveillance cameras and access control systems?
8. Do you consider that the university provides adequate opportunities for student participation in the design and implementation of smart technology solutions on campus?
9. How do you assess the availability and quality of digital services offered by the university, such as academic management systems, online teaching platforms, and mobile applications?
10. In your opinion, does the university offer awareness and training programs to promote the adoption of smart technologies by students, faculty, and staff?
11. Does the university have an adequate communication network infrastructure to support the demands of a university smart city?
12. Is there an efficient and sustainable energy management system in place at the university, aiming to reduce consumption and promote sustainability?
13. Does the university have an intelligent transportation system that facilitates the mobility of students, faculty, and staff within the campus and its surrounding area?
14. How does the university use technology to improve security in the university city, for example, through monitoring systems, security cameras and access control?
15. Does the university promote digital connectivity by providing free, high-speed Wi-Fi throughout the campus?
16. Is there an efficient waste management system implemented in the university city, involving the selective collection, recycling, and proper treatment of waste?
17. Does the university's infrastructure include living spaces and green areas, providing a pleasant environment conducive to the well-being of students and the academic community?
18. Does the university adopt smart lighting solutions, such as LED lamps and presence sensors, to promote energy savings and safety at night?
19. Is there a smart water management system implemented in the university city, aiming at the conservation and efficient use of this natural resource?
20. How does the university use technology to promote interaction and engagement in the academic community, for example, through mobile applications, online platforms and social networks?
21. Are you aware of the Sustainable Development Goals (SDGs) set by the United Nations as part of the 2030 Agenda?
22. In your opinion, what is the importance of the SDGs in the global context? Do you believe these goals are relevant to addressing the social, economic, and environmental challenges we face today?
23. In your perception, as an integral part of the university community, what role do you believe you play in promoting and achieving the Sustainable Development Goals? Do you think there is a shared responsibility in this global effort?

Source: Prepared by the author

Regarding the SDGs, questions 21, 22 and 23 are highlighted, elaborated in a generic way to the theme, considering that there are 17 global goals among the various areas presented by the UN, however, the proposal is initially envisioned with comprehensive questions about the sustainable and smart goals, in order to identify the discussion by the university community about the 2030 agenda.

CONCLUSIONS

The advent of smart cities in universities triggers a significant transformation in the academic environment, and their importance is particularly highlighted when considering institutions such as the Federal University of Mato Grosso do Sul (UFMS). The integration of innovative technologies and state-of-the-art tools not only modernizes the Campus infrastructure but also promotes a more sustainable and efficient approach to academic and operational management.

In the context of UFMS, the implementation of technology tools plays a vital mechanism in promoting a smart campus. The use of sensors, *IoT* networks, and intelligent management systems creates a dynamic environment that responds to the specific needs of the university community. Not only does this enhance the student and staff experience, but it also contributes to operational efficiency and reduced environmental impact.

The Institutional Evaluation System (SIAI) provides this process as a fundamental tool in the search for an intelligent and sustainable Campus in the institution, allowing to provide institutional evaluation indicators. In addition to its traditional role in the evaluation of academic and administrative processes, the SIAI, when adapted to encompass indicators related to smart cities and campuses, in accordance with the Institutional Axes, becomes a valuable instrument, offering a robust framework to measure progress in the implementation of sustainable practices, indicating areas of success and opportunities for improvement. serving as a basis to guide institutional public policies, so necessary to discipline the implementation and implementation of smart university cities.

The relevance of SIAI goes beyond simple data collection, as it becomes a catalyst for the creation of more effective strategies aligned with the goals of a smarter and more sustainable institution. By adopting this holistic approach, and considering the global goals in accordance with the 17 Sustainable Development Goals (SDGs) in the area of Infrastructure, UFMS positions itself not only as a higher education institution, but as an agent of change, positively influencing its community and contributing to the advancement of the concept of smart cities within the academic context.

Ultimately, the implementation of the smart and sustainable Campus is not only a response to the demands of the present, but an investment in the future of higher education and the environment, but which can only take place through adequate public policies, based on basic institutional measurement, now proposed through the Institutional Evaluation System – SIAI/UFMS.

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