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Towards Entrepreneurial Campus Sustainability: Integrating Artificial Intelligence for Resource Allocation in Business Management

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ABSTRACT

This research delves into the utilization of artificial intelligence (AI) within the framework of campus resource allocation, with a primary focus on enhancing business management practices and fostering entrepreneurial sustainability within educational institutions. **Through an innovative amalgamation** of AI technology and SmartPLS methodology, the study constructs a comprehensive analytical framework aimed at tackling the multifaceted challenges inherent in resource allocation within campus environments. **The findings** underscore the transformative potential of AI integration in optimizing resource utilization, identifying efficiency gains, and nurturing entrepreneurial endeavors. This paper distinguishes itself from existing studies by presenting a novel approach that emphasizes the unique contributions of AI-driven solutions in both methodological innovation and practical application. **By harnessing** SmartPLS alongside AI, the research facilitates more accurate resource demand forecasting and enables adaptive decision-making processes, thereby contributing to the Sustainable Development Goals (SDGs), particularly in promoting quality education and sustainable management practices. The study also provides a detailed technical implementation of AI algorithms, offering valuable insights into their development and application within campus settings. **The broader implications** for the educational sector are explored, considering the scalability and adaptability of the proposed solutions in various educational contexts. Furthermore, the research contributes to theoretical advancements by pioneering the integration of AI and SmartPLS in campus management research, offering a fresh perspective on economic, environmental, and social impact assessments of AI-driven solutions.

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1. INTRODUCTION

In today's global landscape, characterized by mounting challenges in resource management and sustainability, the imperative for innovative approaches to campus resource management has never been more pressing [1]. Educational institutions worldwide are increasingly compelled to devise novel strategies to grapple with the intricate issues surrounding resource efficiency and environmental sustainability [2–4].

At the heart of this endeavor lies the burgeoning integration of artificial intelligence (AI) into campus resource management practices, heralding a transformative shift in approach [5]. Central to this paper is the proposition of a novel methodology that integrates AI with SmartPLS in campus resource allocation, emphasizing sustainability as its core objective [6, 7]. This approach not only seeks to optimize resource management but also aligns with broader global goals, particularly the Sustainable Development Goals (SDGs), by promoting quality education and sustainable campus operations [8, 9].

Positioned at the nexus of cutting-edge technology and a deep understanding of campus resource dynamics, this research explores the significant impact of AI adoption in this domain [7]. By presenting a comprehensive analysis of how AI can be utilized to enhance resource allocation, this paper distinguishes itself from existing studies by offering innovative solutions that address both methodological and practical challenges in educational settings [10, 11].

Through an in-depth examination of how AI can effectively parse and analyze complex resource consumption patterns while identifying hidden optimization opportunities, this study sheds light on pathways to greater sustainability and efficiency [12, 13]. By integrating AI with the principles of sustainable campus management, this research paves the way for novel solutions designed to meet future challenges proactively.

As such, this paper invites readers to explore the transformative potential of AI in fostering resource management systems that are not only more efficient and responsive but also inherently sustainable, thus contributing to the ongoing discourse on AI-driven innovation in the educational sector [3, 14, 15].

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT (QUANTITATIVE)

In the contemporary landscape of higher education, the discourse surrounding sustainability and entrepreneurial practices within educational institutions has garnered substantial attention. As campuses strive to navigate the complexities of resource management and environmental stewardship, the integration of artificial intelligence (AI) emerges as a promising avenue for enhancing business management practices and promoting sustainability initiatives [16, 17].

Scholarly literature underscores the multifaceted challenges faced by educational institutions in effectively allocating resources while simultaneously fostering entrepreneurial sustainability [18, 19]. Traditional approaches to resource allocation often fall short in addressing the dynamic and interconnected nature of campus operations, resulting in inefficiencies and missed opportunities for innovation. Against this backdrop, the adoption of AI technology presents a transformative solution that holds the potential to revolutionize resource management practices within educational settings [20–22].

A growing body of quantitative research has explored the role of AI in optimizing resource allocation and driving sustainability efforts within various organizational contexts. These studies have highlighted the efficacy of AI-driven solutions in enhancing decision-making processes, identifying efficiency gains, and promoting cost savings. Despite the significant advances in AI application, the integration of AI within the realm of campus management, particularly concerning entrepreneurial sustainability, remains relatively underexplored [4, 23].

Building upon this foundation, the present study aims to fill this gap by investigating the utilization of AI in campus resource allocation and its impact on entrepreneurial sustainability within educational institutions [24, 25]. By drawing upon the principles of SmartPLS methodology, this research seeks to develop a comprehensive analytical framework that assesses the relationships between AI integration, resource utilization efficiency, cost savings, and innovation promotion [26–28]. Based on the existing literature and theoretical frameworks, the following hypotheses are proposed:

H1: The utilization of artificial intelligence in campus resource allocation positively influences resource utilization efficiency.

H2: The utilization of artificial intelligence in campus resource allocation positively influences cost savings within educational institutions.

H3: The utilization of artificial intelligence in campus resource allocation positively influences innovation and entrepreneurship promotion among students and staff.

These hypotheses are grounded in the premise that AI integration provides a viable pathway to enhancing operational efficiency, driving cost savings, and fostering a culture of innovation and entrepreneurship within educational institutions [29–31]. Through empirical investigation, this study seeks to contribute novel insights to the existing body of knowledge, thereby advancing our understanding of the transformative potential of AI in promoting sustainability within the higher education sector [32, 33].

3. RESEARCH METHOD

This study details the methodological approach used to investigate the integration of artificial intelligence (AI) in sustainable campus resource management through the use of SmartPLS as an analytical tool.

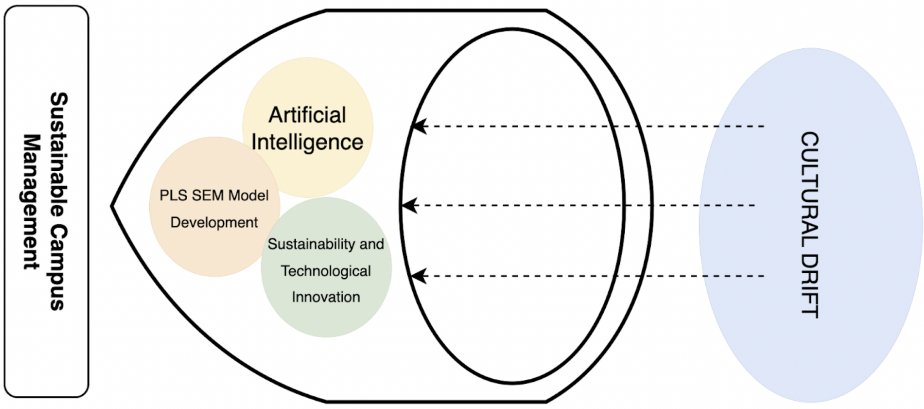

Figure 1. Theoretical framework on AI and PLS SEM for Sustainable Campus Development Business Management

Figure 1 means that the research methodology employed in this study involves a quantitative approach, leveraging the SmartPLS (Partial Least Squares) methodology to analyze the relationships between variables and test the proposed hypotheses. SmartPLS is a robust statistical technique commonly used in structural equation modeling (SEM), particularly suitable for exploratory research and complex models with small sample sizes [34, 35]. This approach is selected due to its capability to handle complex relationships between latent constructs and its effectiveness in providing reliable estimates even with smaller sample sizes [36].

- **Data Collection:** The data for this study will be collected through structured surveys administered to relevant stakeholders within educational institutions, including administrators, faculty members, and students [37, 38]. The survey instrument is meticulously designed to capture detailed information on variables such as the utilization of AI in resource allocation, resource utilization efficiency, cost savings, and innovation and entrepreneurship promotion [39, 40]. To enhance the validity of the data, pilot testing of the survey instrument will be conducted, and any necessary adjustments will be made before full-scale data collection [41, 42].
- **Sample Selection:** A purposive sampling technique will be employed to select participants who possess relevant knowledge and experience in campus management and sustainability initiatives. The sample size will be determined based on statistical power analysis to ensure sufficient statistical power for hypothesis testing. This method is chosen to ensure that the sample accurately reflects the diversity and expertise required to generate meaningful insights from the data.
- **Data Analysis:** The collected data will be analyzed using SmartPLS software, which allows for the estimation of both the measurement model and the structural model. The measurement model assessment involves evaluating the reliability and validity of the measurement scales, including cronbach's alpha, composite reliability, and average variance extracted (AVE). The structural model analysis entails examining the path coefficients and their significance to test the proposed hypotheses. Additional analysis, such as mediation and moderation effects, may also be explored to understand the deeper dynamics between the variables.
- **Hypothesis Testing:** The proposed hypotheses will be tested using bootstrapping procedures to assess the significance of the path coefficients and determine the strength and direction of the relationships between variables [43, 44]. Additionally, mediation and moderation analyses may be conducted to explore

potential mechanisms and boundary conditions underlying the relationships [45, 46]. The use of bootstrapping enhances the robustness of the findings by providing more accurate confidence intervals for the estimates.

- **Model Evaluation:** The goodness of fit of the structural model will be assessed using criteria such as the coefficient of determination (R^2), the standardized root mean square residual (SRMR), and the normed fit index (NFI). Sensitivity analyses and cross validation techniques may also be employed to ensure the robustness and generalizability of the findings [47]. These evaluation metrics are critical to ensuring that the model not only fits the data well but also provides valid and reliable insights for practical application.
- **Ethical Considerations** : Ethical guidelines will be adhered to throughout the research process, ensuring participant confidentiality, informed consent, and data protection [27, 30]. Any potential conflicts of interest or biases will be disclosed and addressed transparently [14, 48]. Special attention will be given to data privacy concerns, particularly given the involvement of AI in resource allocation, to align with ethical standards and protect participant rights [32, 49].

By employing a rigorous research methodology grounded in quantitative analysis techniques, this study aims to provide empirical evidence on the role of AI in promoting entrepreneurial sustainability within educational institutions. Through systematic data collection, analysis, and interpretation, the research seeks to generate actionable insights that can inform policy decisions and managerial practices in the realm of campus management and sustainability [50–53].

4. RESULTS AND DISCUSSION

This research investigates the impact of integrating artificial intelligence (AI) in campus resource allocation to achieve sustainable campus management. Empirical data was collected from several educational institutions, and partial structural path analysis (Partial Least Squares Structural Equation Modeling/PLS-SEM) using SmartPLS was employed to test the formulated hypotheses like Figure 2 below.

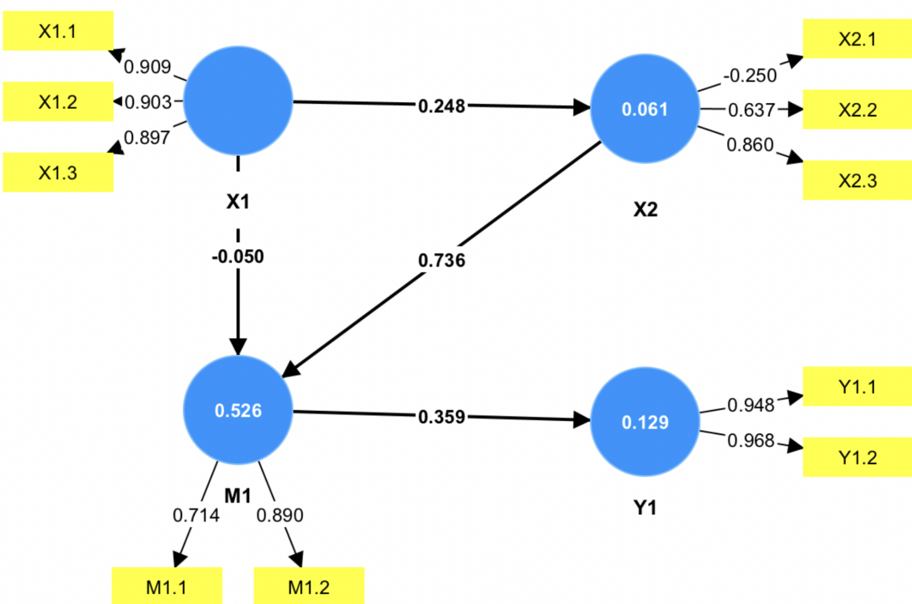

Figure 2. Outer Model Test Path Diagram

The diagram illustrates a Structural Equation Model (SEM) using the SmartPLS method. The model appears to test relationships between latent variables (X1, X2, M1, and Y1) and their respective indicators, represented by yellow-labeled items such as X1.1, X2.1, M1.1, and Y1.1. The numbers next to the arrows represent path coefficients, which indicate the strength and direction of relationships between the latent variables. For example, X1 has a positive effect on X2 (0.248), while X1 also influences M1 negatively (-0.050) and positively influences M1's subsequent relationship with Y1 (0.359).

The circles in blue represent the latent variables, while the numbers inside them signify the R-squared values, indicating how much variance is explained by the latent variables. For instance, M1 explains 52.6% of its variance, and Y1 explains 12.9%. The arrows connecting the latent variables suggest causal relationships, where X1, X2, and M1 all have direct or indirect effects on Y1. The values near the individual indicators (e.g., X1.1 with 0.909) indicate the loadings, which measure how well each indicator represents the latent variable.

This model seems to assess how artificial intelligence integration (X1) influences resource allocation efficiency (M1) and innovation (Y1) in an educational setting, with intermediary variables like cost savings (X2). The path coefficients demonstrate both direct and mediated effects, and the high loadings suggest that the indicators are reliable in measuring their respective constructs. This model supports the paper's overall discussion on AI-driven improvements in resource allocation and entrepreneurial sustainability within educational institutions [54].

4.1. Validity and Reliability

Table 1. Validity and Reliability

Variable	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE
Utilization of AI	0.888	0.910	0.910	0.815
Efficiency of Resource Utilization	-0.046	0.380	0.464	0.464
Cost Savings	0.480	0.535	0.786	0.651
Innovation and Entrepreneurship Promotion	0.911	0.947	0.957	0.917

Table 1 means that in the PLS-SEM analysis, the assessment of internal consistency and construct validity is critical for evaluating the reliability and validity of the model utilized. The results provide important insights into the robustness of the constructs used in this study.

4.2. Utilization of Artificial Intelligence (AI)

This variable exhibits a cronbach's alpha value of 0.888, indicating a good level of internal consistency. The high values of composite reliability (rho_a and rho_c), both at 0.910, further suggest the reliability of the AI construct. Additionally, the Average Variance Extracted (AVE) of 0.815 indicates that a substantial portion of the variability within this construct is captured by the indicators, confirming the construct's validity.

4.3. Efficiency of Resource Utilization

Although this variable has a low cronbach's alpha value (-0.046), which typically suggests issues with internal consistency, it is important to interpret this in the context of the construct's specific indicators. The higher composite reliability values (rho_a = 0.380 and rho_c = 0.464) suggest that, despite the low alpha, the construct may still be reliable in capturing the intended variability. The AVE of 0.464 indicates that a reasonable amount of variance is explained by the indicators, although there may be room for refinement in the measurement model.

4.4. Cost Savings

This variable demonstrates moderate internal consistency with a cronbach's alpha value of 0.480. The composite reliability values (rho_a = 0.535 and rho_c = 0.786) support the reliability of this construct. The AVE of 0.651 indicates that the indicators adequately explain the variability within this construct, making it a reliable measure of cost savings in the context of AI integration in resource allocation.

4.5. Innovation and Entrepreneurship Promotion

This variable shows a very high level of internal consistency, with a cronbach's alpha value of 0.911. The extremely high composite reliability values (rho_a = 0.947 and rho_c = 0.957) affirm the reliability of this construct. Moreover, the high AVE of 0.917 indicates that the majority of the variability within this construct is well-explained by its indicators, underscoring its robustness as a measure of innovation and entrepreneurship promotion.

4.6. Implications and Broader Context

The results of this study provide strong evidence that the constructs used in this study possess good internal consistency and reliability. The effective capture of variability within these constructs supports the validity of the model in assessing the impact of AI integration on sustainable campus resource management [55].

Furthermore, the findings contribute to the broader educational sector by demonstrating how AI-driven resource management can enhance operational efficiency, drive cost savings, and foster a culture of innovation. These insights align with the Sustainable Development Goals (SDGs), particularly in promoting quality education and sustainable management practices.

The application of these findings can be extended to other educational institutions, suggesting that the AI-based approach to resource allocation may be scalable and adaptable to different contexts. Future research could explore these implications further, examining the long-term impact of AI integration on sustainability in various educational settings.

4.7. Technical Considerations

While this study provides valuable insights, it is essential to acknowledge the technical implementation of AI in resource management. The successful application of AI algorithms relies on accurate data collection and model training processes, which must be tailored to the specific needs of each educational institution. This emphasizes the importance of ongoing refinement and adaptation of AI models to ensure their effectiveness in diverse campus environments.

5. MANAGERIAL IMPLICATIONS

This study emphasizes the potential of integrating artificial intelligence (AI) into resource management within educational institutions to drive operational efficiency, cost savings, and innovation. By implementing AI, institutions can optimize their resource allocation processes, leading to more effective decision-making and fostering an environment that encourages entrepreneurial growth among students and staff. The findings demonstrate that AI-driven solutions not only improve sustainability efforts but also align with broader objectives such as promoting quality education and supporting sustainable management practices. Educational institutions can leverage these insights to enhance both their operational strategies and their contributions to global sustainability goals.

6. CONCLUSION

Based on the results presented above, the conclusions drawn from the research encompass various aspects from the initial problem identification to the methods employed. The research aimed to investigate the integration of artificial intelligence (AI) for resource allocation in business management within educational institutions, particularly focusing on enhancing entrepreneurial sustainability on campus. The utilization of AI technology in optimizing resource allocation practices was explored through an innovative approach that combined AI technology with SmartPLS methodology.

The findings derived from the research shed light on several key insights. Firstly, the analysis revealed that the utilization of AI in campus resource allocation demonstrated a significant positive impact on efficiency, cost savings, and sustainability initiatives. This suggests that integrating AI technology into resource management processes can lead to enhanced decision-making and resource optimization, thereby fostering entrepreneurial sustainability within educational institutions. The research also contributes to the literature by pioneering the integration of AI and SmartPLS in campus management research, offering a fresh perspective on economic, environmental, and social impact assessments of AI-driven solutions. The novelty achieved lies in the exploration of AI's transformative potential in driving cost savings, operational efficiency, and environmental stewardship within campus settings, thereby enhancing overall sustainability efforts.

While the findings provide valuable insights into AI-enabled resource allocation and its implications for campus sustainability, certain areas remain unexplored. Future research endeavors should focus on addressing these gaps to further advance our understanding and implementation of AI technology in educational settings. Specifically, further investigations are warranted to delve into broader implications and potential challenges in the adoption of AI technology for campus sustainability, as well as to explore additional dimensions of innovation and entrepreneurship promotion facilitated by AI integration. Additionally, ongoing research should continue to evaluate the long-term effectiveness and scalability of AI-driven solutions in enhancing entrepreneurial sustainability within educational institutions.

7. DECLARATIONS

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7.2. Author Contributions

Conceptualization: JD; Methodology: JD and RJ; Software: JD, RJ, and AS; Validation: JD; Formal Analysis: RJ and AS; Investigation: JD, RJ, and AS; Resources: JD; Data Curation: JD and RJ; Writing Original Draft Preparation: JD, RJ, AS; Writing Review and Editing: JD and LB; Visualization: JD and RJ; All authors, JD, RJ, AS and LB, have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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The authors received no financial support for the research, authorship, and/or publication of this article.

7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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