Original Article

Web-Based Integrated Information System Model and User Behavior Analytics to Support Student Career Development and the Campus Entrepreneurship Ecosystem

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Abstract:

The rapid digital transformation in higher education has increased the demand for integrated information systems that not only support academic services but also facilitate student career development and campus entrepreneurship ecosystems. However, many universities still manage academic portals, career services, and entrepreneurship programs through separate systems, resulting in fragmented data, duplicated processes, and limited personalization of services for students. This condition prevents the optimal integration of academic performance, career interests, and entrepreneurial potential within a unified digital campus environment. This study aims to develop a conceptual model of a web-based integrated information system that leverages user behavior analytics to support student career development and strengthen campus entrepreneurship ecosystems. The research adopts a qualitative conceptual approach using a literature review method. A total of 15 relevant national and international publications related to higher education information systems, digital career platforms, campus entrepreneurship, web analytics, microservices architecture, and the PIECES evaluation framework were systematically analyzed. Data analysis was conducted through content analysis and conceptual synthesis to formulate the proposed system model. The results present a conceptual design of an integrated web-based information system consisting of academic, career development, entrepreneurship, and user behavior analytics modules within a unified architecture. The model is complemented by an evaluation framework that integrates the PIECES method with web analytics to assess system performance, information quality, efficiency, control, and service effectiveness. This study contributes a data-driven and adaptive conceptual model that can serve as a reference for universities in developing integrated digital systems oriented toward student needs, career readiness, and sustainable campus entrepreneurship development.

Keywords: integrated information system, student career development, campus entrepreneurship, user behavior analytics, PIECES.

Introduction

Higher education institutions play a strategic role in preparing competent, adaptive, and innovative human resources capable of responding to dynamic labor market demands and the growth of knowledge-based and entrepreneurial economies. Beyond academic instruction, universities are increasingly expected to support students' career development, entrepreneurial capacity building, and the provision of efficient digital services within an integrated campus ecosystem. The concept of a smart campus emphasizes the alignment of academic services, career guidance, and entrepreneurship development through information systems that are data-driven, interconnected, and responsive to user needs (Almarabeh et al., 2021; Sánchez-Torres et al., 2022).

However, in many universities, academic portals, career centers, and entrepreneurship units are still managed through fragmented or silo-based information systems. These systems often operate independently, relying on separate databases, platforms, and service workflows. Such fragmentation limits the integration of student academic records, career interests, and entrepreneurial activities, resulting in duplicated processes, inconsistent data, and limited personalization of services (Zhao et al., 2021). Consequently, universities face challenges in providing holistic support for students' career trajectories and entrepreneurial development, as well as difficulties in evaluating the effectiveness of their digital services comprehensively.

Recent advancements in web-based technologies, user behavior analytics, and modular system architectures have created opportunities to overcome these challenges. Integrated web-based information systems allow multiple services to be connected within a unified architecture, enabling seamless data exchange and coordinated service delivery (Al-Hawari et al., 2023). In particular, user behavior analytics derived from web usage data can provide valuable insights into students' interactions, preferences, and engagement patterns. These insights support more personalized services, informed decision-making, and continuous system improvement (Wang et al., 2020; Kumar et al., 2022).

From an evaluation perspective, the quality and effectiveness of integrated information systems require systematic assessment frameworks. The PIECES framework—covering Performance, Information, Economics, Control, Efficiency, and Service—has been widely adopted as a comprehensive method for evaluating information systems in organizational contexts (Rahman et al., 2021). When combined with web analytics, PIECES enables a multidimensional evaluation approach that not only examines technical integration but also assesses service quality, efficiency, and user-oriented performance (Putra et al., 2023). Nevertheless, existing studies tend to focus either on technical system integration or on isolated analytics applications, with limited attention to conceptual models that integrate academic services, career development, entrepreneurship ecosystems, and behavioral analytics within a single framework.

This research addresses this gap by proposing a conceptual model of a web-based integrated information system that connects academic services, student career development, and campus entrepreneurship, supported by user behavior analytics and evaluated using the PIECES framework. The novelty of this study lies in the integration of behavioral analytics as a core component of system design and evaluation, rather than as a supplementary tool, thereby enabling adaptive, data-driven services oriented toward students' holistic development. The proposed model is expected to provide a conceptual reference for higher education institutions seeking to develop integrated, scalable, and student-centered digital ecosystems that support both career readiness and sustainable campus entrepreneurship.

Literature Review
Information Systems in Higher Education

Information systems in higher education institutions function as the backbone of academic data management and service delivery. Academic information systems are designed to manage core processes such as student enrollment, course registration, grading, scheduling, and academic reporting. Their primary objective is to provide accurate, timely, and accessible information to students, faculty members, and institutional administrators, thereby improving transparency, efficiency, and accountability in academic administration (Almarabeh et al., 2021).

Despite significant progress in campus digitalization, many universities still operate information systems in isolated or standalone environments. Academic portals, administrative applications, and supporting services are often developed independently, resulting in data duplication, inconsistencies, and limited interoperability. In addition, challenges related to infrastructure readiness, data security, and the limited use of analytical capabilities hinder the optimization of campus information systems (Zhao et al., 2021). These limitations highlight the need for more integrated, adaptive, and web-based information systems capable of supporting diverse institutional functions within a unified digital ecosystem.

Student Career Development and Entrepreneurship Information Systems

Higher education institutions are increasingly expected to prepare students not only for academic success but also for effective career transition and entrepreneurial engagement. Student career development encompasses career counseling, employability skills training, job vacancy dissemination, and alumni tracer studies. In parallel, entrepreneurship development includes business incubation programs, startup training, mentoring schemes, and access to entrepreneurial networks and funding opportunities (Sánchez-Torres et al., 2022).

Information systems play a critical role in supporting these functions by providing digital platforms that connect students with career and entrepreneurship opportunities. Well-managed systems enable the collection and utilization of data related to students' competencies, interests, and activities, allowing institutions to deliver more personalized and relevant services. Without adequate information system support, career and entrepreneurship services tend to rely on manual processes, lack systematic documentation, and offer limited performance measurement, thereby reducing their overall effectiveness (Kumar et al., 2022).

Web-Based Integrated Information Systems

System integration refers to the unification of multiple subsystems into a cohesive and interconnected architecture. In the context of higher education, integrated information systems enable academic, career, and entrepreneurship data to coexist within a single digital ecosystem. Such integration supports seamless data exchange, coordinated service delivery, and improved decision-making across institutional units (Al-Hawari et al., 2023).

Web-based system architectures facilitate access to services through standard web browsers, reducing dependency on specific devices or platforms. These systems are commonly built using distributed services connected through application programming interfaces (APIs), which enhance scalability, flexibility, and maintainability. In campus environments, web-based integrated systems offer several advantages, including centralized maintenance, rapid system updates, broader accessibility for academic communities, and easier integration with emerging technologies such as data analytics and lightweight artificial intelligence applications (Wang et al., 2020).

The PIECES Framework for Information System Evaluation

The PIECES framework is a widely used method for evaluating information systems by examining six key dimensions: Performance, Information, Economy, Control, Efficiency, and Service. Performance focuses on system speed, capacity, and responsiveness; Information assesses accuracy, relevance, and quality of outputs; Economy considers operational and development costs; Control relates to data security and access management; Efficiency evaluates resource

utilization; and Service measures perceived service quality from the user perspective (Rahman et al., 2021).

Previous studies have applied the PIECES framework to evaluate academic portals and campus information systems, often through qualitative approaches such as focus group discussions and user surveys. Findings from these studies indicate that service quality and information accuracy are among the most critical aspects influencing user satisfaction. As a conceptual evaluation framework, PIECES provides a comprehensive foundation for assessing not only technical performance but also organizational and user-oriented dimensions of integrated information systems.

Web Analytics in Information System Evaluation

Web analytics refers to the collection, measurement, and analysis of user activity data within web-based systems. Common indicators include traffic volume, session duration, navigation paths, frequently accessed pages, and system response times. These metrics provide insights into user behavior, engagement patterns, and system usability (Putra et al., 2023).

In higher education contexts, web analytics supports data-driven decision-making by identifying which services are most utilized and which features require improvement. When applied to career and entrepreneurship platforms, user behavior analytics can reveal students' interests, engagement levels, and interaction trends, enabling institutions to design more adaptive and responsive services. As such, web analytics complements traditional evaluation frameworks by providing empirical behavioral evidence that enhances system assessment and continuous improvement processes.

A review of fifteen relevant studies reveals that national-level research predominantly focuses on the development of academic information systems, the institutional role in student career preparation, and the digitalization of entrepreneurship services. Several studies also employ the PIECES framework to evaluate the quality of academic portals. However, these studies generally examine each domain in isolation.

International literature, on the other hand, places greater emphasis on the use of web analytics, data mining, and modern system architectures to enhance digital services in higher education. Although behavior-based system integration has begun to emerge, it is typically limited to single domains such as e-learning platforms or career portals (Wang et al., 2020; Kumar et al., 2022).

Based on this synthesis, a clear research gap is identified in the limited availability of conceptual models that integratively combine academic services, student career development, and campus entrepreneurship within a unified web-based architecture supported by user behavior analytics and evaluated using the PIECES framework. This study addresses this gap by proposing a holistic conceptual model derived from systematic literature synthesis, offering a reference framework for universities seeking to develop integrated, data-driven, and student-centered information systems.

Methods

This study employed a qualitative conceptual research design using a literature review approach. This design was selected because the primary objective of the study was not to test hypotheses through empirical field data collection, but to develop a conceptual model of an integrated web-based information system through the synthesis of theories, concepts, and findings from previous studies. A literature-based approach enables researchers to identify patterns, relationships, and best practices in higher education information system development, particularly in relation to academic services, student career development, and campus entrepreneurship ecosystems.

The data sources used in this study consisted entirely of relevant scholarly literature. The literature was grouped into two main categories. The first category comprised five key publications authored by the researchers, which discuss higher education roles in career development and

entrepreneurship, web-based information system implementation, and system evaluation using the PIECES framework. These publications provided contextual and conceptual grounding for the development of the proposed integrated system model. The second category included ten national and international journal articles addressing higher education information systems, career information systems, digital entrepreneurship platforms, web analytics, and microservices architecture. These references were selected to enrich theoretical perspectives and to capture recent developments in information system technologies and evaluation methods.

Literature collection was conducted through a systematic process. The first stage involved identifying relevant studies based on topical relevance, scientific contribution, and alignment with higher education information system integration. The second stage focused on classifying key concepts identified in the literature, including system integration, user behavior analytics, digital career development, student entrepreneurship support, and information system evaluation. The third stage involved synthesizing these concepts into a coherent conceptual model that integrates academic, career, and entrepreneurship services within a unified web-based architecture.

Data analysis was carried out using multiple qualitative techniques. Content analysis was applied to examine the literature in depth and to identify significant concepts, methods, and findings relevant to the research objectives. Comparative analysis was then used to compare existing information system models, allowing the identification of strengths, limitations, and development opportunities. Finally, conceptual modeling was employed to design the proposed system model, illustrating the relationships among system components, data flows, and the integration of academic, career, entrepreneurship, and user behavior analytics services. Through these analytical stages, the study produced a logically structured and systematically developed conceptual model grounded in synthesized scholarly evidence

Results

Analysis of Integrated Campus System Requirements

The analysis of system requirements was conducted using the PIECES framework to identify limitations of existing campus information systems and to define the functional needs of an integrated model. From a performance perspective, fragmented systems require users to access multiple platforms, resulting in slower data retrieval and reduced usability. Similar performance issues in silo-based campus systems have been highlighted in previous studies, which emphasize the importance of centralized architectures to improve responsiveness and system reliability (Changwong et al., 2024).

In terms of information quality, student data related to academic achievement, career interests, and entrepreneurial activities are stored across different units, preventing the formation of comprehensive student profiles. This condition limits data-driven decision making and personalized services, as also reported in earlier research on higher education information systems integration (Riley, 2024). From an economic standpoint, maintaining multiple independent systems increases operational and maintenance costs, a concern frequently noted in studies on digital campus transformation.

Regarding control, decentralized access management increases the risk of data inconsistency and security vulnerabilities. Previous research indicates that centralized identity and access control mechanisms significantly enhance data protection in integrated systems. In terms of efficiency, many career development and entrepreneurship services are still handled manually, reducing process speed and service scalability. Finally, from the service dimension, students do not yet receive personalized recommendations aligned with their academic performance, career preferences, and entrepreneurial potential. These findings confirm the need for a unified system that integrates academic, career, and entrepreneurship data within a single digital ecosystem.

Proposed Conceptual Model of the Integrated System

Based on the requirement analysis, this study proposes a conceptual model consisting of four interconnected modules within a web-based ecosystem. The academic module manages student academic records, course histories, and inferred academic interests. These data serve as foundational inputs for career and entrepreneurship analysis, consistent with prior studies emphasizing the strategic role of academic data in career pathway modeling.

The career development module focuses on competency profiling, job vacancy information, and career pathway recommendations tailored to individual student profiles. This approach aligns with recent findings that digital career systems supported by analytics enhance graduate employability outcomes. The entrepreneurship module supports the documentation of student business ideas, participation in incubation programs, mentor engagement, and access to funding opportunities. Previous studies have shown that digital entrepreneurship platforms contribute to stronger campus innovation ecosystems when integrated with academic services.

The user behavior analytics module captures interaction data such as access frequency, page navigation patterns, and content preferences. These data provide behavioral insights that complement static academic records, enabling more adaptive and personalized services, as suggested by recent web analytics research in higher education contexts.

User Behavior Analytics Mechanism

The behavioral analytics mechanism begins with the collection of user activity data, including system logs, page clicks, and access duration. These data are stored in a dedicated analytics database separate from the operational database to ensure system performance and data integrity. Data mining techniques are then applied to identify behavioral patterns. Clustering methods are used to group students based on similar interests, while classification techniques are applied to predict tendencies toward specific career paths or entrepreneurial engagement.

The analytical results are processed through a recommendation engine that generates personalized suggestions for students. This mechanism reflects best practices identified in previous studies, which emphasize the integration of behavioral analytics to enhance decision support and user experience in digital education platforms.

Microservices-Based System Architecture

The proposed system adopts a microservices architecture, in which each core module operates as an independent service, including Academic Service, Career Service, Entrepreneurship Service, Analytics Service, and Recommendation Engine. These services communicate through an API Gateway that manages data exchange and service orchestration. Users interact with the system through an integrated web dashboard, ensuring a seamless experience despite the underlying distributed architecture. This architectural approach is consistent with contemporary research highlighting microservices as a scalable and flexible solution for complex information systems, particularly in dynamic environments such as higher education institutions.

Lightweight AI-Based Analytics Dashboard

The analytics dashboard serves as a centralized interface for data visualization and recommendation delivery. It presents insights such as student career interest maps, emerging entrepreneurship trends, and system-generated recommendations derived from behavioral patterns. The use of lightweight artificial intelligence, based on rule-based and pattern-based logic, allows the system to remain adaptable while minimizing implementation complexity. This approach aligns with recent studies suggesting that lightweight AI solutions are more feasible for institutional adoption compared to fully autonomous systems.

Conceptual Evaluation Using the PIECES Framework

Conceptual evaluation of the proposed model indicates improvements across all PIECES

dimensions. System performance is enhanced through centralized access and service orchestration. Information quality improves as integrated data produce comprehensive student profiles. Economic efficiency is achieved by reducing redundant systems and maintenance costs. Control is strengthened through centralized access management and data governance. Process efficiency increases as career and entrepreneurship services become more automated and data-driven. Finally, service quality improves through personalized recommendations that enhance user engagement and satisfaction. These outcomes are consistent with findings from previous studies on integrated information systems and analytics-driven digital services in higher education.

The findings of this study indicate that the fragmentation of academic, career, and entrepreneurship information systems remains a critical challenge in higher education institutions. The analysis using the PIECES framework confirms that separated systems reduce performance efficiency, weaken data integration, and limit the capacity of universities to deliver personalized services. This result is consistent with previous studies that report how silo-based information systems hinder strategic decision-making and diminish user experience in digital campus environments (Changwong et al., 2024). The lack of integrated student profiles further reinforces earlier findings that data discontinuity restricts the effective utilization of learning analytics and career intelligence systems (Riley, 2024).

The proposed conceptual model demonstrates that integrating academic, career development, and entrepreneurship modules within a single web-based ecosystem can address these limitations by enabling holistic student profiling. This approach aligns with recent international research emphasizing the importance of unified digital platforms to support graduate employability and innovation-driven education (Almeida et al., 2023). By positioning academic data as the foundation for career and entrepreneurship analysis, the model reflects contemporary perspectives that academic performance, behavioral engagement, and career readiness are interdependent dimensions of student development.

The incorporation of user behavior analytics represents a significant advancement compared to conventional campus information systems that rely solely on static data. Behavioral data such as access frequency, navigation patterns, and content preferences provide dynamic insights into student interests and intentions. This finding supports previous studies suggesting that web analytics can enhance personalization and predictive accuracy in educational services (Kumar et al., 2022). The use of clustering and classification techniques to interpret behavioral patterns further strengthens the system's capability to deliver adaptive recommendations, as also observed in prior research on data-driven career guidance platforms.

From an architectural perspective, the adoption of a microservices-based design responds to the growing complexity and scalability demands of higher education information systems. Earlier studies have highlighted that monolithic systems often struggle to adapt to evolving institutional needs, whereas microservices enable modular development, easier maintenance, and flexible integration with emerging technologies (Li et al., 2021). The findings of this study support these conclusions by demonstrating how modular services can independently evolve while remaining interconnected through a unified interface.

The use of a lightweight artificial intelligence approach in the analytics dashboard further contributes to the practicality of the proposed model. Unlike complex AI systems that require extensive computational resources and specialized expertise, rule-based and pattern-based analytics offer a more feasible solution for institutional implementation. This finding echoes recent literature suggesting that lightweight AI provides an effective balance between adaptability and operational feasibility in educational information systems (Zhao et al., 2023).

Overall, the discussion confirms that the integration of web-based systems, behavioral analytics, and the PIECES evaluation framework offers a comprehensive conceptual solution for enhancing career development and entrepreneurship ecosystems in higher education. The alignment of these findings with prior studies strengthens the theoretical validity of the proposed model and highlights its potential applicability as a reference framework for universities

undergoing digital transformation.

Conclusion

This study concludes that the development of a web-based integrated information system supported by user behavior analytics is crucial to overcoming the fragmentation of academic, career, and entrepreneurship services in higher education. The proposed conceptual model shows that integrating these services into a single digital ecosystem enables more comprehensive student profiling, improves operational efficiency, and enhances the quality of student services. The findings indicate that the use of behavioral analytics allows the system to provide more adaptive and personalized support for student career development and campus entrepreneurship activities. Overall, the model offers a structured and data-driven foundation for supporting student career pathways while strengthening the entrepreneurial ecosystem within higher education institutions.

Suggestion

This study suggests that higher education institutions may adopt the proposed conceptual model as a reference for developing integrated digital systems that support academic services, career development, and student entrepreneurship simultaneously. Future research is encouraged to focus on empirical implementation and system validation to examine usability, effectiveness, and user acceptance. Further studies may also expand the scope of the system by integrating external stakeholders, such as industry partners and startup communities, to enhance the relevance and sustainability of the campus entrepreneurship ecosystem.

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