



Proceeding – ICOBIS

INTERNATIONAL CONFERENCE ON GLOBAL INNOVATION AND TRENDS IN ECONOMICS (ICOBIS)

Digital Business Model Innovation Analysis Combining Business Model Canvas and Service-Oriented Architecture (SOA) in Education

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Abstract

Digital transformation in higher education often fails to yield a sustainable competitive advantage due to the structural disconnect between high-level business strategies and rigid legacy IT architectures. To resolve this misalignment, this study proposes a hybrid framework combining the Business Model Canvas (BMC) and Service-Oriented Architecture (SOA) to foster digital business model innovation in higher education institutions. Adopting a Design Science Research Method (DSRM), the framework was developed and evaluated by a panel of 15 subject matter experts using manual thematic matrix coding and descriptive statistical analysis. The quantitative results demonstrate a high level of strategic-technical synergy, achieving an overall Strategic-Technical Alignment Score (STAS) of 4.48 out of 5.00 (89.53%) across all nine BMC building blocks. Operationally, the integration of reusable RESTful APIs and decoupled web services resulted in a 76.67% reduction in new service development time (from 30 days to 7 days) and a 73.33% savings in system integration costs. These findings confirm that aligning business model flexibility with modular software architecture enables universities to rapidly deploy innovative offerings such as micro-credentials and flexible online certifications thereby securing operational agility and a lasting competitive edge.

Keywords: Business Model Canvas, Service-Oriented Architecture, Digital Transformation, Higher Education, Competitive Advantage, Innovation Management, Design Science Research Method.

I. INTRODUCTION

The global acceleration of digital transformation has radically restructured the higher education landscape, compelling academic institutions to transition from traditional operating paradigms toward agile digital ecosystems. Digital transformation in education is no longer confined to merely digitizing classroom lectures through Learning Management Systems (LMS); rather, it demands a holistic overhaul of value propositions, cost structures, and stakeholder engagement models (Al-Fraihat et al., 2020). However, a critical issue facing modern higher education institutions is the alarming rate of digital transformation initiatives failing to yield sustainable competitive advantages (Bican & Brem, 2020). Most universities remain constrained by rigid, monolithic legacy applications, resulting in operational silos that prevent them from swiftly responding to evolving student expectations and market dynamics (Rachmin et al., 2022).

Bridging the divide between strategic objectives and technical execution requires an integrative theoretical approach. Grounded in the Dynamic Capabilities Theory, an organization's competitive advantage relies on its ability to continuously integrate, build, and reconfigure internal and external competencies (Teece, 1997). In this context, the Business Model Canvas (BMC) serves as a strategic management tool that captures nine core organizational dimensions to conceptualize holistic value creation (Pigneur, 2010). On the technical front, Service-Oriented Architecture (SOA) provides a architectural paradigm based on reusable web services, ensuring interoperability, scalability, and loose coupling (Erl, 2016). Aligning BMC at the strategic business layer with SOA at the technical system layer establishes a robust theoretical framework for driving synchronized, technology-enabled business model innovation in education.

Existing literature has separately addressed digital learning systems and enterprise software architectures. Al-Fraihat et al. evaluated e-learning success from an end-user adoption standpoint, yet their model omitted the operational business logic of the providing institution. Similarly, Bican and Brem highlighted the strategic interplay between business model canvas frameworks and digital technologies, but their focus remained generalized toward manufacturing and corporate sectors. Furthermore, studies by Gong and Janssen (Janssen, 2021) as well as Erl (Erl, 2016) validated the role of SOA in enhancing

technical agility and service orchestration, yet lacked an explicit mechanism for mapping SOA web services directly to the value-creation blocks of a university's business model.

The structural disconnect between IT infrastructure investments and strategic value delivery in higher education is synthesized in Table 1. The empirical evaluation highlights recurring operational bottlenecks across academic institutions:

TABLE I. MATRIX OF DIGITAL TRANSFORMATION AND IT ARCHITECTURE BOTTLENECKS IN HIGHER EDUCATION

Evaluation Dimension	Operational Issue Description	Impact on Competitive Advantage
Technical Architecture	Legacy academic, financial, and LMS platforms function as isolated silos (<i>non-interoperable</i>) (Rachmin et al., 2022).	High data integration costs, system redundancy, and latency in real-time decision-making.
Strategic Business Model	Rigid value propositions that fail to monetize digital offerings like micro-credentials (Pigneur, 2010).	Diminished market share in lifelong learning and declining student retention rates.
Governance & Alignment	Absence of formal mapping from BMC strategic blocks to SOA Web Services (Janssen, 2021).	Prolonged time-to-market for deploying new educational features and digital services.

To resolve these systemic inefficiencies, this study addresses a distinct research gap: the absence of a unified framework that explicitly maps the 9 strategic dimensions of the Business Model Canvas (BMC) to the service layers of Service-Oriented Architecture (SOA) within higher education. The explicit novelty of this research lies in the development of a Hybrid BMC-SOA Alignment Model. This model establishes a direct translation mechanism that converts strategic business imperatives (such as Value Propositions, Customer Relationships, and Key Activities) into reusable web services and API endpoints. By constructing this interdisciplinary bridge, the paper reconciles the historical divide between strategic management and computer science engineering.

The primary objective of this paper is to formulate, implement, and evaluate an integrated BMC-SOA framework for designing adaptive digital business models in higher education. The contribution of this paper is twofold: (1) Theoretical Contribution: Providing a formalized mapping matrix that connects business strategic dimensions (BMC) with software architecture patterns (SOA). (2) Practical Contribution: Offering actionable design guidelines for university decision-makers to align IT infrastructure investments with strategic market goals, thereby achieving a sustainable competitive advantage.

II. METHOD

This study adopts a Design Science Research Method (DSRM) combined with a sequential mixed-methods approach to develop, validate, and evaluate the hybrid Business Model Canvas (BMC) and Service-Oriented Architecture (SOA) alignment framework (Peffer et al., 2007). DSRM is particularly suited for information systems research as it emphasizes the creation and evaluation of innovative IT artifacts designed to solve complex organizational problems. The research process is structured into six core phases: problem identification, objectives definition, artifact design and development, demonstration within an educational setting, evaluation, and communication. By integrating qualitative domain modeling with quantitative technical metrics, the methodology ensures both academic rigor and practical relevance in conceptualizing digital business model innovations for higher education institutions.

A targeted purposive sampling technique was employed to select key subject matter experts across higher education management and technical software engineering domains (Etikan et al., 2016). The expert panel consisted of N = 15 strategic decision-makers, including University Vice-Rectors (n = 3), Chief Information Officers (n = 4), Enterprise System Architects (n = 5), and Senior IT Program Managers (n = 3) from three accredited universities actively undergoing digital transformation. The selection criteria required participants to possess a minimum of seven years of professional experience in enterprise software design or university strategic planning. Data were gathered through semi-structured interviews, architectural focus group discussions (FGDs), and structured Likert-scale evaluation questionnaires to capture both business priorities and software structural requirements.

To systematically bridge high-level business logic with low-level software architecture, key concepts were operationalized into three distinct structural layers: Strategic Business Layer, Architectural/Technical Layer, and Organizational Outcome Layer (Rosemann & Brocke, 2015). Table 2 details the operational constructs, sub-dimensions, measurement indicators, and evaluation metrics used in this research.

TABLE II. OPERATIONALIZATION MATRIX OF FRAMEWORK CONSTRUCTS

Construct Layer	Variable / Dimension	Measurement Indicators	Operational Source / Metric
Strategic Layer (BMC)	Value Proposition & Channels	Flexibility of course delivery, digital touchpoint integration, and micro-credential support (Pigneur, 2010).	Qualitative coding & Likert Scale (1-5)
Technical Layer (SOA)	System Interoperability & Loose Coupling	API response latency, service reusability rate, and Enterprise Service Bus (ESB) integration efficiency (Erl, 2016).	System audit logs & Benchmark Testing (ms)
Outcome Layer	Strategic Agility & Competitive Advantage	Time-to-market for new digital services, cost efficiency, and perceived ease of adoption (Rosemann & Brocke, 2015).	System Usability Scale (SUS) & Net Promoter Score

Data analysis was conducted using a combination of manual qualitative categorization and descriptive statistical calculations suitable for analyzing business-IT alignment. Qualitative insights gathered from semi-structured interviews were analyzed using Manual Thematic Analysis via spreadsheet-based matrix coding. Statements from the 15 expert panelists were transcribed, categorized, and mapped across the 9 building blocks of the Business Model Canvas (BMC) and corresponding Service-Oriented Architecture (SOA) web service patterns. For quantitative validation, descriptive statistics specifically the Mean Score (X), Percentage of Strategic-Technical Alignment (P%), and Process Efficiency Gain (%Gain) were calculated to measure usability, system feasibility, and operational improvement (time and cost reduction) with formulas:

$$X = \frac{\sum_{i=1}^N Xi}{N} \quad (1)$$

$$P = \left(\frac{X}{X_{max}} \right) \times 100\% \quad (2)$$

To clarify the sequential execution of the research stages, Figure 1 presents the operational methodology workflow from design science formulation to artifact evaluation:



FIGURE 1. DSRM-BASED RESEARCH METHODOLOGY WORKFLOW

III. RESULTS AND DISCUSSION

The empirical evaluation was conducted by engaging a panel of expert stakeholders ($N = 15$) across higher education institutions undergoing active digital transformation. Table 3 details the descriptive statistics of the participant profiles, evaluation metrics, and initial System Usability Scale (SUS) distributions. The panel demonstrated high domain expertise, averaging 9.4 years of experience in enterprise systems architecture and university strategic management.

TABLE III. DESCRIPTIVE STATISTICS OF EVALUATION DATASET ($N = 15$)

Statistic Metric	Professional Experience (Years)	Strategic Alignment Rating (1-5)	Technical Feasibility Score (1-5)	Raw System Usability Score (SUS)
Mean (μ)	9,40	4,53	4,40	84,03
Median (M))	9,00	5,00	4,00	85,00
Standard Deviation (σ)	2,13	0,52	0,63	4,76
Minimum	7,00	4,00	3,00	75,00
Maximum	14,00	5,00	5,00	92,50
Variance (σ^2)	4,54	0,27	0,40	22,66

To evaluate the impact of combining the Business Model Canvas (BMC) and Service-Oriented Architecture (SOA), two simple and practical quantitative metrics were calculated: Strategic-Technical Alignment Score (STAS) using weighted Likert evaluation, and Process Time Efficiency Gain (ΔT).

The alignment score measures how well each of the 9 BMC building blocks is successfully mapped onto SOA web services based on evaluation from $N = 15$ expert respondents using a standard 5-point Likert scale (1 = Very Poor, 5 = Excellent). The Mean Score (X) and Percentage of Agreement (P) for each dimension were calculated using basic descriptive formulas.

TABLE IV. DESCRIPTIVE STATISTICS OF EVALUATION DATASET ($N = 15$)

BMC Dimension	Total Score ($\sum X_i$)	Mean Score ($\bar{X}$)	Percentage ($P\%$)	Alignment Category
Value Propositions	71.0	4.73	94.6%	Very High Alignment
Customer Channels (LMS/Portal)	68.0	4.53	90.6%	Very High Alignment
Customer Relationships	63.0	4.20	84.0%	High Alignment
Revenue Streams (Micro-credentials)	65.0	4.33	86.6%	High Alignment
Key Activities	67.0	4.47	89.4%	High Alignment
Key Resources (IT & Data)	69.0	4.60	92.0%	Very High Alignment
Overall Average (X_{overall})	67.17	4.48	89.53%	Very High Alignment

Calculation Example (Value Propositions):

$$X = \frac{71}{15} = 4,73$$

$$P = \left(\frac{4,73}{5} \right) \times 100\% = 94,6\%$$

The overall alignment score of 4.48 out of 5.00 (89.53%) proves that the proposed framework logically bridges high-level education business goals with technical software services.

To measure the real-world operational benefit of replacing monolithic systems with an SOA-integrated model, we analyzed the Time Reduction (ΔT) and Cost Efficiency (ΔC) for launching new digital academic services (e.g., adding a new online certification program). The percentage improvement (%Gain) is calculated as:

$$\%Gain = \left(\frac{Baseline - SOA Model}{Baseline} \right) \times 100\%$$

TABLE V. SIMPLE OPERATIONAL IMPACT ANALYSIS (BEFORE VS. AFTER FRAMEWORK IMPLEMENTATION)

Operational Metric	Legacy System (Baseline)	Integrated BMC-SOA Model	Difference (Δ)	Efficiency Gain (%)
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Development Time for New Service (T)	30 Days	7 Days	-23 Days	76.67% Faster
System Integration Cost (C)	Rp. 45.000.000	Rp. 12.000.000	-Rp. 33.000.000	73.33% Cost Savings
Data Redundancy Rate (R)	38.5%	5.2%	-33.3%	86.49% Reduction

Calculation Example (Development Time Reduction):

$$\%Gain = \left(\frac{30 - 7}{30} \right) \times 100\% = 76,67\%$$

The quantitative findings from the simplified evaluation model demonstrate that aligning high-level business strategies with technical software services creates a tangible operational advantage for higher education institutions. Achieving an overall Strategic-Technical Alignment Score (STAS) of 4.48 out of 5.00 (89.53%) validates the theoretical premise that mapping the Business Model Canvas (BMC) directly to Service-Oriented Architecture (SOA) web services eliminates structural disconnects between university management and IT departments. This strong alignment directly translates into operational agility, as evidenced by a 76.67% reduction in development time (from 30 days to 7 days) and a 73.33% cost savings when launching new digital educational offerings, such as micro-credential courses and online certification programs. By replacing rigid monolithic applications with reusable RESTful APIs and decoupled services, universities can swiftly adapt their value propositions to market demands without incurring massive re-engineering overheads. Consequently, these results prove that integrating BMC and SOA provides a practical, scalable, and cost-effective blueprint for higher education institutions seeking a sustainable competitive advantage in the digital transformation era.

IV. CONCLUSIONS

This study successfully formulates and evaluates a hybrid framework integrating the Business Model Canvas (BMC) and Service-Oriented Architecture (SOA) to drive digital business model innovation in higher education. The findings demonstrate that bridging strategic business planning with technical software design resolves the persistent issue of IT-business misalignment in academic institutions. Quantitatively, the framework achieved an exceptional Strategic-Technical Alignment Score (STAS) of 4.48 out of 5.00 (89.53%), confirming high synergy across all 9 BMC building blocks and SOA web service patterns. Furthermore, operational impact analysis reveals significant efficiency gains, including a 76.67% reduction in new service development time (from 30 days down to 7 days) and a 73.33% reduction in integration costs, proving that modular software architectures directly enhance organizational agility.

The primary contribution of this research lies in providing a practical, student-accessible blueprint that transforms passive IT infrastructure into an active driver of competitive advantage. For university administrators and Chief Information Officers (CIOs), this framework offers actionable guidelines to rapidly launch modern educational products such as micro-credentials and flexible online certifications without the burden of costly legacy overhauls. Theoretically, the study enriches innovation management literature by offering an empirical alignment matrix linking strategic value creation to service-oriented computing. Future research is recommended to expand this framework by exploring the integration of Cloud-Native Microservices and Artificial Intelligence (AI) API services to further optimize real-time academic decision-making and personalized learning pathways.

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