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Business Modeling of Advanced Engineering Schools in Universities: Implications for Economic Education and School Business Management

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ABSTRACT

This article analyzes business processes and business models in Advanced Engineering Schools (AES) as hybrid academic–economic units within universities. The study aims to enhance the economic efficiency and financial sustainability of AES, while strengthening its role in economic education and school business management. Business modeling (systemic and comparative analysis, and expert judgment) reflects AES activities in three domains: research, innovation, and education. The proposed model clarifies revenue streams, cost structures, key partners, and value propositions for different stakeholder groups. The results showed that explicit business modeling supports better resource allocation, risk management, and diversification of income sources because it links academic decisions to financial outcomes. The study contributes a practical framework that universities and business schools can use to design and implement sustainable business models for engineering schools and inform policies for funding innovative academic units in diverse national higher education contexts.

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1. INTRODUCTION

The development of Advanced Engineering Schools (AES) in Russian universities under the national "Project 2030" reflects a strategic effort to strengthen technological sovereignty by preparing a new generation of engineers capable of driving industrial innovation (Neretin & Ilyina, 2024). Within the broader context of economic education, AES represents not only academic and research structures but also organizational units that must operate with financial discipline, cost efficiency, and sustainable business practices. As institutions increasingly integrate entrepreneurial and market-oriented approaches, business modeling becomes essential for improving the managerial and economic performance of academic units such as AES (Chikherev, 2023; Zhaxylykova & Baymankulov, 2022).

In the era of the Fourth Industrial Revolution, educational institutions face the challenge of adapting organizational structures, business processes, and leadership models to dynamic technological and economic environments (Adekunle & Fernandes, 2020; Cannikova & Pestova, 2019). AES, with its combined missions of research, innovation, and advanced engineering education, requires business models capable of capturing complex value creation mechanisms while ensuring financial sustainability. Scholars emphasize that innovation-oriented educational units must employ analytical and modeling tools to improve the efficiency of business processes and support strategic decision-making (Nazilin & Silakova, 2022).

The existing literature on business modeling identifies the importance of aligning organizational activities with clear value propositions, customer segments, cost structures, and revenue streams (Shulus, 2019; Kolyada, 2024). However, current business models such as that of Osterwalder and Pigneur often require adaptation to reflect the specific logic, resource constraints, and multi-level activities of university-based engineering schools (Glushchenko, 2025). Recent studies highlight that AES function as innovation hubs within post-industrial higher education and can benefit from tailored business models that integrate elements of educational, research, and technological processes (Glushchenko, 2025; Aetdinova, 2024).

Given these considerations, this study examines how business process analysis and business modeling can be used to enhance the economic efficiency and organizational sustainability of AES. The introduction of integrated business models for AES is expected to strengthen financial planning, resource management, and performance indicators across educational, research, and innovation domains. Thus, the study contributes to economic education by providing a framework that enables engineering schools to operate as financially viable and strategically managed academic enterprises.

2. METHODS

The methodological foundation of this study is based on the conceptualization of AES as a hybrid organizational structures that integrate academic, research, and economic functions within a university environment. Unlike traditional educational units, AES operates under principles of financial sustainability, commercial calculation, and resource optimization, which are central concepts in economic education and institutional management. In this regard, AES can be analyzed not only as pedagogical units but also as school business entities that must strategically manage costs, revenue generation, and value creation.

This study adopts an analytical approach that distinguishes between two major categories of processes within AES: technological processes and business processes. Technological processes include the production of scientific, technological, and educational outputs,

whereas business processes are oriented toward generating income, improving financial performance, and ensuring long-term sustainability. This distinction is consistent with contemporary models of organizational analysis, which emphasize the need to separate operational workflows from economic decision-making mechanisms (Nazilin & Silakova, 2022).

A key methodological element in this research is the restructuring of the Osterwalder–Pigneur business model to reflect the multi-level, multi-activity nature of AES. While the original model is widely recognized for its heuristic value, previous studies have noted its limitations in capturing the internal logic, activity differentiation, and specific resource constraints of university-based engineering schools (Glushchenko, 2025). Therefore, this study proposes modifying the model by beginning with the cost-side analysis of AES operations, followed by mapping key activities, resources, and partnerships across three principal domains: research, innovation, and education. This restructuring allows a clearer representation of AES activity flows and enhances its applicability for financial planning and school business management.

The methodological innovation of this study also includes the development of separate business models for each major activity area within AES. Scholars underline the appropriateness of adopting both process models and project models in analyzing university innovation structures, depending on the nature of funding, project duration, and institutional objectives (Glushchenko, 2022; Glushchenko, 2025). Accordingly, research activities may follow either continuous process-based modeling or time-limited project modeling, while innovation activities generally align with project-oriented frameworks. Educational activities, by contrast, predominantly follow process models characterized by stable patterns of inputs, outputs, and performance indicators.

In addition, the study employs qualitative analysis to establish causal relationships between AES business processes, managerial decisions, and economic outcomes. Special attention is given to financial indicators such as profitability, payback periods, and value creation metrics, which are widely used in assessing the performance of educational enterprises and innovation-driven university units (Zhaxylykova & Baymankulov, 2022). This analytical perspective allows the development of a comprehensive framework that integrates engineering education with economic education principles, thereby enabling AES to be examined as financially responsible and strategically managed institutions.

Overall, the methodology combines business modeling, structural-functional analysis, expert evaluation, and comparative assessment to create a robust foundation for evaluating and improving the economic efficiency of Advanced Engineering Schools.

3. RESULTS AND DISCUSSION

The results of the analysis indicate that the restructuring of the business model for AES provides a clearer depiction of how university-based engineering units function as both academic and economic systems. Based on the examination of key processes—research, innovation, and education—the proposed analytical model captures the internal logic and financial flows within AES more effectively than the traditional Osterwalder–Pigneur structure. This is particularly relevant because AES operates under hybrid conditions that combine public funding, competitive project grants, industry partnerships, and tuition-based revenue, all of which require coordinated management and economic decision-making (Glushchenko, 2025). The modified model, therefore, enhances the school's capacity to

identify inefficiencies, allocate resources strategically, and develop sustainable income structures.

The restructured model begins from the cost side, allowing AES to assess resource constraints before formulating value propositions and revenue strategies. This decision is significant for university economic planning because costs—particularly in research infrastructure, personnel, and technological facilities—tend to be rigid and long-term, while revenues from projects, training programs, and innovation activities are more variable. By foregrounding expenditures, the model shifts AES from a traditional academic mindset to a more business-oriented analytical approach. This is aligned with arguments that modern educational institutions must incorporate economic efficiency principles to maintain competitiveness and ensure long-term sustainability (Nazilin & Silakova, 2022). The cost-first logic also allows better identification of financial bottlenecks, enabling administrators to highlight areas where improved operational efficiency could yield substantial economic benefits.

Figure 1 illustrates the reconstructed business model for AES, showing the realignment of components based on activity types and highlighting the logical connection between resource inputs, key activities, partnerships, and revenue outcomes.

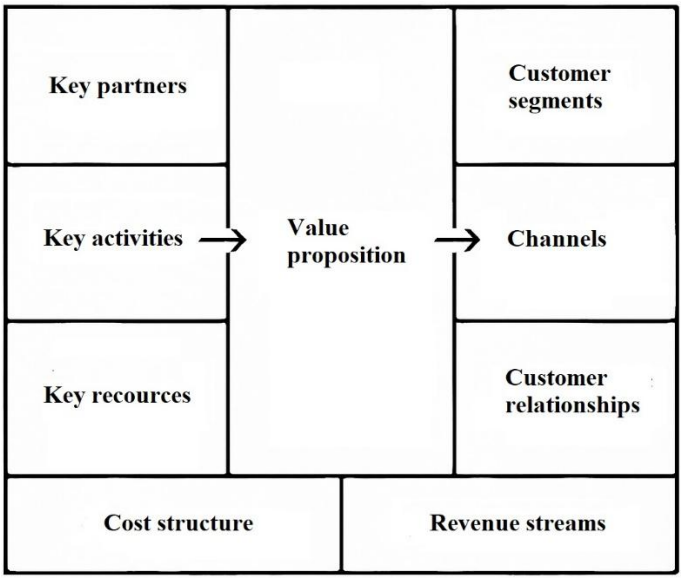

Figure 1. Reconstructed osterwalder–pigneur business model for advanced engineering schools.

The results further demonstrate that analyzing AES business processes through separate activity domains helps clarify their contribution to overall financial performance. Research activities, for instance, generate value primarily through competitive grants, contractual research with industry partners, and publication outputs that strengthen institutional ranking and visibility. However, these activities also incur high fixed costs, including laboratory maintenance, equipment depreciation, and personnel expenses (Aetdinova, 2024). When analyzed using a project model, research activities reveal distinct financial characteristics such as upfront investment requirements, uncertain revenue timing, and high dependence on external funding cycles (Glushchenko, 2022). These findings highlight the need for AES to maintain a diversified portfolio of research engagements to mitigate risks associated with inconsistent project funding.

Innovation activities reveal a different financial structure. These projects, especially those involving prototype creation, technology transfer, and industry collaboration, carry significant

development costs but also offer opportunities for high returns through commercialization, licensing, and long-term industrial partnerships. The analysis shows that innovation functions align most strongly with the logic of project-based business modeling, where success indicators rely on profitability index, net present value, and risk-adjusted revenue estimates. Because innovation activities carry more uncertainty, AES must implement robust risk management mechanisms, particularly in evaluating project feasibility and industry demand. The business model allows systematic identification of risk clusters—technical, financial, market-related, and regulatory—which supports the development of mitigation strategies consistent with organizational sustainability principles (Glushchenko, 2025).

Educational activities, unlike research and innovation, follow a process-based operational structure characterized by predictable revenue streams and relatively stable demand. Tuition fees, targeted training programs, and continuing education courses create reliable financial inflows that help stabilize the overall financial health of AES (Neretin & Ilyina, 2024). The analysis indicates that educational processes contribute significantly to maintaining operational liquidity because they provide a consistent income basis that is not affected by research funding cycles. Additionally, educational activities generate indirect financial value through strengthening the institutional reputation, attracting high-performing students, and building long-term industry relationships that later translate into sponsored projects or innovation collaborations (Popova, 2024). Applying business process analysis to educational activities uncovers opportunities to optimize curriculum offerings, expand market reach, and enhance customer (student) relationships.

To present these findings more concretely, a comparative analysis of activity domains reveals substantial differences in cost structures, income flows, and risk patterns. Educational activities are characterized by low variability and high sustainability; research activities by medium variability and medium sustainability; and innovation activities by high variability and uncertain sustainability. This categorization supports the hypothesis that financial planning for AES must consider the portfolio balance of these activities to achieve both stability and growth. It also suggests that investments in innovation should be supported by stable revenues from educational programs and selectively from research grants, forming a cross-subsidization mechanism that strengthens long-term institutional resilience (Shulus, 2019).

In addition to clarifying financial flows, the analysis reveals that partnerships play a crucial role in the economic functionality of AES. Research collaborations with academic institutions, innovation consortia with industry enterprises, and educational partnerships with targeted training departments collectively create a network that supports both resource acquisition and revenue generation. Partner contributions may include funding, equipment access, co-supervision of research, joint intellectual property, or co-development of educational programs. The business model thus highlights partnerships as economic assets that reduce operating costs, enhance value propositions, and expand market access (Canninkova & Pestova, 2019). This confirms the argument that modern engineering schools thrive not in isolation but within inter-organizational ecosystems that integrate government, academia, and industry.

A further result of the analysis is the identification of financial inefficiencies related to overlapping administrative procedures, insufficient integration of digital monitoring tools, and limited alignment between academic planning and financial planning. These inefficiencies reflect broader challenges observed in educational institutions during the digital transformation era, where organizational processes often lag behind technological advancements (Adekunle & Fernandes, 2020). The use of business modeling supports the

detection of these gaps by mapping activities, resources, and outputs in ways that expose redundancies and missing links. For example, linking the activities of innovation teams with financial accounting units allows AES to monitor development costs more accurately and adjust project strategies in real time.

The analysis also reveals that the financial structure of AES benefits from integrating systematic monitoring tools that allow continuous assessment of performance indicators across research, innovation, and educational domains. This aligns with the argument that multifactor evaluation systems improve managerial decision-making in complex educational environments (Zhaxylykova & Baymankulov, 2022). When economic indicators are tracked in parallel with academic outputs, AES administrators can derive a more realistic understanding of resource utilization and return on investment. Such integration supports evidence-based budgeting, enabling the allocation of funds to high-performing activities while minimizing expenditures on processes that do not contribute significantly to institutional goals.

To further illustrate the internal economic dynamics, a comparative overview of the three major activity domains is presented in **Table 1**. The table summarizes cost structures, revenue potential, risk levels, and sustainability characteristics based on the analytical findings derived from the restructured business model. The comparison highlights that while educational activities maintain the highest stability, innovation activities promise the highest long-term economic gains despite elevated risks. Research activities occupy an intermediate position, balancing intellectual value creation with economic uncertainty linked to external funding opportunities (Glushchenko, 2025). This distribution suggests that AES must adopt a portfolio strategy rather than prioritizing one domain exclusively, as each contributes differently to short-term survival and long-term development.

Table 1. Comparative characteristics of AES activity domains.

Activity Domain	Cost Structure	Revenue Potential	Risk Level	Sustainability	Notes
Research	High fixed costs (labs, equipment, personnel)	Medium, dependent on grants/contracts	Medium	Medium	Requires continuous competitive funding
Innovation	High development and prototype costs	High, through commercialization and licensing	High	Low–Medium	Strongly linked to industry partnerships
Education	Moderate and stable costs	High and stable (tuition, training programs)	Low	High	Main contributor to liquidity and stability

The table shows that AES's economic resilience depends on an effective combination of activities. Educational revenue stabilizes operations, research funding enhances academic prestige, and innovation generates strategic growth opportunities. This structure reflects the interdependence of academic and economic functions, supporting findings from broader studies on the hybrid nature of modern engineering schools (Aetdinova, 2024; Popova, 2024). The ability of AES to operate as financially conscious entities also enhances their role in national innovation ecosystems by enabling them to respond quickly to technological demands while maintaining academic integrity.

Another important result concerns the role of partnerships in mitigating financial risks and increasing the success rate of projects. Industry partnerships in innovation, academic

collaborations in research, and institutional alliances in educational programs provide diversified support networks that reduce operational uncertainties. These partnerships serve not only as economic buffers but also as value co-creation mechanisms, reinforcing the competitive positioning of AES in both academic and industrial landscapes (Canninkova & Pestova, 2019). Effective partnership management thus becomes a core component of AES's business strategy.

Finally, the results indicate that applying business modeling to AES activities allows a deeper understanding of institutional risks and creates opportunities for developing tailored risk management systems. This addresses concerns raised by scholars who argue that innovation-driven educational units must adopt specialized risk assessment frameworks due to their exposure to technological, financial, and market uncertainties (Glushchenko, 2022). The restructured business model contributes to this requirement by explicitly identifying risk factors within each activity domain, supporting the formation of preventive measures and strategic contingencies.

The discussion as a whole demonstrates that AES requires an integrated business perspective to operate effectively within contemporary higher education systems. Through business process analysis, financial modeling, and systematic evaluation, AES can enhance economic efficiency, improve sustainability, and strengthen its contribution to national technological development. The findings emphasize that modern engineering education must be tightly interconnected with economic education principles, enabling institutions to function not only as academic centers but also as strategically managed economic actors.

4. CONCLUSION

The study demonstrates that restructuring the business model of AES provides a more accurate representation of its economic and organizational dynamics. By beginning with the cost structure and then mapping activities, resources, partnerships, and revenue streams, the proposed model captures the complex interaction between academic functions and financial realities. The analysis confirms that AES operates as a hybrid entity (simultaneously educational, research-oriented, and innovation-driven) and therefore requires management approaches grounded in economic education principles to ensure sustainability and competitiveness.

The results show that research, innovation, and educational activities each possess distinct economic profiles, risk levels, and contributions to institutional stability. Educational processes supply steady revenue and liquidity, research activities enhance academic reputation and attract external funding, while innovation projects create high-value opportunities through commercialization and industry collaboration. Managing these domains as a balanced portfolio strengthens financial resilience and supports long-term institutional development.

Furthermore, the findings highlight the importance of partnerships as economic assets that reduce operational risks and expand value creation potential. Business modeling also proves effective in identifying inefficiencies, aligning academic and financial planning, and supporting the development of tailored risk management systems. Overall, the study reinforces that AES must integrate structured business analysis, financial monitoring, and strategic planning to function effectively in modern higher education systems.

The proposed framework offers practical implications for policymakers, university administrators, and business schools by demonstrating how engineering education can be successfully linked with economic efficiency, sustainable resource management, and

innovation-driven growth. It also establishes a foundation for future research on institutional economics, organizational design, and strategic financial management in advanced engineering education.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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