ASEAN Journal of Educational Research and Technology

Journal homepage: https://ejournal.bumipublikasinusantara.id/index.php/ajert

Advanced Engineering Schools as Innovation Hubs in Post-Industrial Higher Education: Institutional, Pedagogical, and Business Model Perspectives

Valery Vladimirovich Glushchenko[1,2*]

[1]Moscow Polytechnic University, Rusia
[2]Russian University of Social Technologies, Rusia
Correspondence: E-mail: valery.v.glushchenko@gmail.com

ABSTRACT

This paper examines the role of Advanced Engineering Schools (AES) as key innovation subsystems within post-industrial higher education. Drawing on institutional theory, systems analysis, and creative pedagogy, the study explores how AES integrates scientific research, technological innovation, and educational practices to enhance university competitiveness and national technological sovereignty. The research presents the organizational structure of AES, its business models, customization strategies, and the incorporation of neuro-innovation and personnel development systems. The study also highlights how AES fosters creative pedagogy to prepare graduates for future-oriented professions and contribute to the formation of a national creative class. By integrating research, innovation, and education, AES serves as a dynamic platform for interdisciplinary learning, offering valuable insights for higher education reform globally. The findings contribute to the development of educational models that balance innovation, institutional transformation, and pedagogical creativity in the rapidly evolving landscape of higher education.

ARTICLE INFO

Article History:
Submitted/Received 25 Feb 2025
First Revised 25 Mar 2025
Accepted 03 Jun 2025
First Available online 04 Jun 2025
Publication Date 01 Sep 2025

Keyword:
Advanced engineering school,
Business model,
Creative pedagogy,
Higher education,
Innovation subsystem.

1. INTRODUCTION

In the 21st century, higher education faces profound transformations driven by technological, economic, and societal changes. The global demand for highly qualified engineering personnel, combined with rapid scientific advancements, has prompted universities to adopt new structural and pedagogical models to remain competitive and relevant in the post-industrial knowledge economy. In Russia, these developments have led to the emergence of innovation subsystems within leading universities, incorporating competence centers, technology transfer centers, departments of additional education, and advanced engineering schools (Bidzhiev, 2023; Mikryukova, 2024).

Among these components, Advanced Engineering Schools (AES) have become central innovation-oriented divisions tasked with integrating scientific research, technological development, and educational practice (Barbashina *et al*., 2023). The establishment of AES reflects a shift toward interdisciplinary, project-based, and creative educational environments that prepare students for emerging professions and contribute to national technological sovereignty.

Based on our previous studies (Glushchenko, 2022; Glushchenko, 2023; Glushchenko, 2024; Glushchenko, 2025), the purpose of this study is to analyze the institutional role, business models, pedagogical approaches, and personnel development systems of AES as key elements of post-industrial higher education innovation subsystems. The novelty of this work lies in its integration of institutional theory, business modeling, neuro-innovation, and creative pedagogy to examine how AES transform both educational practice and university structures. This interdisciplinary framework contributes to the development of adaptive educational models that foster innovation, creativity, and economic competitiveness. By investigating AES through these multiple lenses, this research offers valuable insights for educators, policymakers, and university administrators seeking to modernize higher education systems in response to global innovation challenges.

2. METHODS

This study employed a multidisciplinary qualitative approach combining institutional analysis, systems theory, and creative pedagogy to examine the role of Advanced Engineering Schools (AES) within post-industrial higher education. The institutional approach was used to analyze the organizational structure and stakeholder relationships that define AES within the broader innovation subsystem of universities (Belomestnov, 2019). The systems approach allowed for the investigation of the interrelationships among research, innovation, and educational functions within AES.

The business modeling framework of Johnson, Christensen, and Kagermann provided a structural tool to analyze the operational and financial aspects of AES. Additionally, elements of creative pedagogy were integrated to explore innovative teaching practices aimed at preparing students for future-oriented professions in a rapidly evolving technological landscape. Neuro-innovation and personnel development systems were also examined to assess emerging approaches to managing staff creativity and self-actualization within AES.

By combining these analytical frameworks, the study offers a comprehensive examination of AES as integrated innovation hubs that simultaneously advance scientific research, technological development, and educational transformation.

3. RESULTS AND DISCUSSION

3.1. The Innovation Subsystem in Post-Industrial Higher Education

Post-industrial higher education systems are experiencing structural transformations characterized by the integration of innovation subsystems within traditional university frameworks (Jafarov, 2023; Ziembla *et al*., 2024). These innovation subsystems aim to enhance university competitiveness, foster national technological sovereignty, and respond to the demands of rapidly evolving global industries (Bidzhiev, 2023; Al-Sulaiti *et al*., 2024; Wong *et al*., 2024). In the Russian context, the innovation subsystem consists of competence centers, technology transfer centers, departments of additional education, and Advanced Engineering Schools (AES) (Mikryukova, 2024).

Competence centers focus on identifying and developing the knowledge and skills necessary for innovation across multiple industries, serving as bridges between universities and the national economy. Technology transfer centers facilitate the commercialization of scientific research, enabling the practical application of new technologies in industrial settings (Mikryukova, 2024). Departments of additional education provide flexible, lifelong learning opportunities that align educational offerings with evolving labor market needs (Khoperskov, 2024).

The integration of these innovation-oriented divisions reflects a broader trend in higher education toward interdisciplinary collaboration, industry partnerships, and applied research. Within this structure, AES has emerged as the central institutional element responsible for coordinating research, innovation, and education, preparing highly qualified professionals capable of supporting national innovation agendas (Barbashina *et al*., 2023). This innovation subsystem represents a strategic response to global competitiveness pressures and the increasing importance of knowledge-driven economic growth.

3.2. The Role of Advanced Engineering Schools (AES)

AES's function is as the core of the innovation subsystem within post-industrial universities by integrating research, innovation, and education into a unified structure. Established under national educational reform initiatives, AES are tasked with preparing engineering personnel capable of driving technological sovereignty and addressing complex challenges in science and industry (Barbashina *et al*., 2023). Unlike traditional university departments, AES is innovation-oriented faculty that combines scientific inquiry, industrial partnerships, and advanced educational methodologies.

A defining feature of AES is its interdisciplinary nature, which allows it to create project-based teams that collaborate across fields of engineering, technology, and management. This approach fosters an environment where students, faculty, and industrial partners jointly develop innovative solutions aligned with national priorities. The educational process within AES emphasizes rapid knowledge transfer, where the results of scientific research are immediately integrated into instructional practices, ensuring that students are exposed to cutting-edge technological developments.

Furthermore, AES serves as a platform for cultivating creative pedagogy, encouraging students to actively engage in problem-solving, design thinking, and collaborative innovation projects. These pedagogical practices not only enhance technical competence but also foster the personal development of graduates as future leaders in the national innovation system. As such, AES plays a strategic role in shaping the next generation of highly skilled professionals capable of contributing to the development of knowledge-based economies.

3.3. Institutional Structure of AES

The institutional structure of AES reflects a complex network of professional, administrative, and social relationships that position AES as both an academic unit and an innovative institution within modern universities (Belomestnov, 2019). Unlike conventional faculties, AESs are organized as independent organizational units with dedicated leadership, specialized faculty, and close integration with industrial and governmental stakeholders.

At the institutional level, AES operates within a framework of partnerships involving multiple stakeholders, including the Ministry of Education and Science, university administrations, industry partners, faculty members, students, and their families. These partnerships ensure that AES activities are aligned with national technological priorities, industrial demands, and educational objectives. The Ministry defines strategic goals for AES, including technological sovereignty, while university leadership oversees the operational efficiency and integration of AES into the broader academic system.

Industrial partners play a critical role in defining research agendas, providing practical training environments, and collaborating on innovation projects that ensure the market relevance of AES outcomes (Mikryukova, 2024). Faculty and staff are responsible for conducting research, delivering education, and contributing to innovation projects, while also participating in ongoing professional development to remain at the forefront of technological advancements. Students engage in interdisciplinary project-based learning, benefitting from industry collaborations that enhance their employability and career prospects.

The institutional design of AES promotes close integration of research, innovation, and education while fostering stakeholder collaboration, ultimately contributing to the efficiency and adaptability of the university's innovation subsystem.

3.4. Business Model of AES

The complex operations of AES require a structured business model that integrates educational, scientific, and financial activities to ensure both academic quality and economic sustainability. AES business models reflect the specific institutional mission of supporting national innovation agendas while maintaining self-sufficiency and financial stability. The AES business model can be conceptualized using the framework proposed by Johnson, Christensen, and Kagermann, which includes four key components: value proposition, profit formula, key resources, and key processes. The value proposition focuses on delivering highly qualified engineering graduates, advanced research outputs, innovative technologies, and patents that directly contribute to national technological sovereignty and industrial competitiveness (Barbashina *et al*., 2023).

The profit formula includes diverse revenue streams such as government funding, industry-sponsored research, intellectual property licensing, targeted student enrollment, and continuing education programs. This diversified financial structure enables AES to maintain operational independence while supporting large-scale innovation projects in partnership with government agencies and industrial enterprises.

Key resources include faculty expertise, advanced laboratory facilities, intellectual property portfolios, technological equipment, information systems, strategic partnerships, and highly qualified students. These resources ensure the capacity of AES to conduct cutting-edge research, deliver high-quality education, and support innovation-oriented project work.

Key processes involve integrated research, innovation management, project-based education, administrative operations, and technology transfer mechanisms. The systematic

coordination of these processes enables AES to respond flexibly to dynamic market demands while maintaining educational excellence (Mikryukova, 2024).

Through this business model, AES functions as a self-regulating innovation ecosystem, bridging academia, industry, and government to advance national technological priorities.

3.5. Creative Pedagogy in AES

Creative pedagogy plays a central role in the educational philosophy of Advanced Engineering Schools (AES), distinguishing them from traditional academic departments. Unlike conventional teaching models that emphasize passive knowledge transfer, creative pedagogy encourages students to actively engage in problem-solving, interdisciplinary collaboration, and innovative thinking, preparing them for the demands of rapidly changing industries.

Within AES, creative pedagogy transforms students from passive recipients into active participants in the learning process. Educational content is structured around real-world projects, enabling students to apply theoretical knowledge in practical contexts while developing critical thinking, leadership, and entrepreneurial skills. Through project-based learning, students work in interdisciplinary teams, often in collaboration with industrial partners, to address authentic engineering and technological challenges.

An important feature of creative pedagogy is its emphasis on customization and adaptability, allowing teaching methods to be tailored to individual student needs, career goals, and rapidly evolving industry standards. Instructors serve not only as content experts but also as mentors who guide students through complex design processes, foster creativity, and encourage intellectual risk-taking.

Creative pedagogy also integrates elements such as heuristic learning, emotional intelligence development, participatory decision-making, and the cultivation of organizational culture within innovation ecosystems. This approach prepares graduates to become self-directed professionals capable of contributing to scientific progress, technological innovation, and the creative economy.

By embedding creative pedagogy at the core of AES programs, these schools ensure that students acquire not only technical expertise but also the creative competencies essential for success in emerging professions and knowledge-based industries.

3.6. Neuro-Innovatics and Personnel Development in AES

The development of human resources within Advanced Engineering Schools (AES) is closely linked to the implementation of neuro-innovatics, an emerging approach that applies neurotechnologies to enhance staff creativity, self-actualization, and innovation management. As innovation-oriented institutions, AES must continuously support the professional and personal development of both faculty and students to sustain high levels of scientific and technological productivity.

Neuro-innovatics integrates methods such as emotional intelligence training, collective idea generation, organizational-activity games, intuition development, and artificial intelligence support into personnel management systems. These techniques allow AES leadership to foster an environment that maximizes individual creative potential while promoting collaborative problem-solving within multidisciplinary teams.

The social development management system in AES extends beyond conventional personnel policies by incorporating career trajectory planning, participatory decision-making, motivation systems, and conflict resolution strategies. This human-centered management

approach ensures that faculty and staff remain engaged, innovative, and aligned with the institution's long-term objectives.

Students also benefit from these approaches through personalized learning pathways, interdisciplinary project opportunities, and the development of metacognitive and emotional competencies that enhance their creative capacity and adaptability in complex professional environments.

The integration of neuro-innovatics into AES operations reflects a broader institutional philosophy that views human creativity as the primary resource for sustaining innovation and maintaining competitiveness in post-industrial economies. By systematically developing the intellectual, emotional, and creative capabilities of its personnel, AES strengthens its capacity to function as a dynamic innovation hub within national education systems.

3.7. Educational Implications and Future Prospects

The educational model of AES provides valuable insights for the transformation of higher education in the post-industrial era. By integrating innovation, research, and creative pedagogy into a unified system, AES addresses the growing need for educational institutions to prepare graduates who can contribute directly to national innovation ecosystems and technological sovereignty.

The AES model demonstrates the importance of interdisciplinary, project-based learning that closely aligns educational content with the rapidly evolving needs of the labor market (Barbashina et al., 2023). Through partnerships with industry and government, AES ensures that students develop practical skills alongside theoretical knowledge, fostering graduates who are both highly specialized and adaptable to technological change.

The incorporation of creative pedagogy, neuro-innovatics, and personalized career development models reflects a broader shift toward student-centered learning and lifelong professional growth. These approaches enable students to develop critical competencies such as emotional intelligence, creative problem-solving, and leadership skills essential for navigating increasingly complex social and economic environments.

Looking ahead, the AES experience offers a scalable model for global higher education reform. The integration of institutional flexibility, stakeholder collaboration, and innovation-oriented pedagogy presents a pathway for universities worldwide to adapt to the demands of the Fourth Industrial Revolution and knowledge-based economies. As the complexity of global innovation systems grows, the AES framework may serve as a foundation for designing the next generation of higher education institutions.

4. CONCLUSION

This study has explored the role of AES as an innovative subsystem within post-industrial higher education. Positioned at the intersection of research, innovation, and education, AES represents a transformative approach to university organization, responding to the evolving demands of national economies and global industries. By integrating scientific research, industrial collaboration, and creative pedagogy, AES creates an environment that fosters both technological advancement and the development of highly skilled professionals.

The institutional structure of AES enables close coordination between universities, government agencies, and industry partners, ensuring that educational programs remain aligned with national priorities and labor market needs. The implementation of business models supports financial sustainability while advancing research, commercialization, and knowledge transfer. Additionally, creative pedagogy and neuro-innovatics provide innovative

frameworks for personalizing learning, enhancing emotional intelligence, and supporting the creative development of students and staff.

As higher education continues to evolve, AES offers a model for institutions seeking to integrate innovation into every dimension of academic life. The experience of AES demonstrates the potential for universities to serve as dynamic innovation hubs, balancing educational excellence with national economic development. Continued development of this model may contribute to global higher education reform and the formation of creative, future-ready graduates.

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.

6. REFERENCES

Al-Sulaiti, A., Hamouda, A. M., Al-Yafei, H., and Abdella, G. M. (2024). Innovation-based strategic roadmap for economic sustainability and diversity in hydrocarbon-driven economies: the Qatar perspective. *Sustainability*, *16*(9), 3770.

Barbashina, N. S., Tikhomirov, G. V., and Shevchenko, V. I. (2023). Best practices of advanced engineering schools. *Professor's Journal. Series: Technical Sciences*, *1*(6), 4–21.

Belomestnov, V. G. (2019). Innovative economy of Russia: The institutional approach. *Problems of the Modern Economy*, *4*(72), 30–34.

Belomestnov, V. G. (2019). Innovative economy of Russia: The institutional approach. *Problems of the Modern Economy*, *4*(72), 30–34.

Bidzhiev, A. O. (2023). Expediency of forming competence development centers at higher educational institutions. *The Flagship of Science*, *4*(4), 330–338.

Glushchenko, V.V. (2022). Ergo design of mentoring in the national ecosystem of vocational education in the period of the 10th technological order. *Indonesian Journal of Educational Research and Technology*, *2*(3), 223-236.

Glushchenko, V.V. (2023). Ergo design in project management based on the general theory of transport systems in the conditions of the 10th technological order. *ASEAN Journal of Science and Engineering*, *3*(3), 289-300.

Glushchenko, V.V. (2024). Formation of pedagogy of higher project education in the period of the new 18th-century technological order. *Indonesian Journal of Teaching in Science*, *4*(2), 205-258.

Glushchenko, V.V. (2025). Formation of the methodology of the project-activity game in inclusive higher education. *Indonesian Journal of Multidiciplinary Research*, *5*(1), 53-58.

Jafarov, S. (2023). Synergetic and innovative approaches to education. *Revista De Investigaciones Universidad Del Quindío*, *35*(1), 415-430.

Khoperskov, K. T. (2024). The experience of the Krasnodar multidisciplinary institute of additional education in distance learning of specialists in the field of additional professional education. *A Young Scientist*, *23*(522), 301–306.

Mikryukova, O. S. (2024). Technology transfer centers: Key players in the field of scientific competencies. *The Matrix of Scientific Knowledge*, *10*(1), 423–429.

Wong, C. Y., Yeung, H. W. C., Huang, S., Song, J., and Lee, K. (2024). Geopolitics and the changing landscape of global value chains and competition in the global semiconductor industry: Rivalry and catch-up in chip manufacturing in East Asia. *Technological Forecasting and Social Change*, *209*, 123749.

Ziembla, M., Uyarra, E., and Pinkse, J. (2024). The uphill battle for reinventing post-industrial regions: The case of Greater Manchester's 'clean growth'mission. *Environmental Innovation and Societal Transitions*, *53*, 100915.