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The Role of Higher Education in Developing Green Skills in Kazakhstan

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Abstract

Kazakhstan is advancing toward sustainable economic growth by transitioning to a green economy that aligns with global Green Deal principles. This research investigates the readiness of Kazakhstan's higher education system to prepare a workforce equipped with the skills required for the green economy. The study employs content analysis and indexation to examine university policy documents, curricula, research outputs, and community outreach initiatives, assessing their alignment with green competencies. Data were collected from 19 state universities across various regions of Kazakhstan, focusing on integrating sustainability principles into academic and operational practices for 2022-2024. The "Greenness Index" results reveal a generally low level of sustainability integration across Kazakhstan's higher education institutions. While technical and engineering disciplines show moderate progress in incorporating green skills, non-technical disciplines demonstrate limited alignment with sustainability principles. Institutional practices such as waste management and energy-saving initiatives are partially reflected in strategic documents but lack widespread implementation. The overall analysis highlights significant disparities in sustainability efforts across universities, with a generally low level of "greenness". This research underscores the need for strategic reforms in higher education to align curricula, research, and community initiatives with the demands of the green economy. By fostering a skilled workforce, Kazakhstan's universities can play a pivotal role in advancing sustainable development.

1. Introduction

In the context of global ecological challenges, Kazakhstan committed to decreasing carbon dioxide emissions by 2050, which aligns with the sustainable development agenda. However, the It is a long process and demands technological change and human capital with green skills. Thus, green skills, including knowledge and competencies focused on solving ecological issues using renewable resources, will become a key element of human capital accumulation in the future years.

ILO (2018) states that 24 million jobs will be created by 2030 due to the transition towards a green economy. Moreover, the number of green job vacancies is doubled compared with the number of employees with green skills. The demand for green skills is increasing fast (Willige, 2024). These new green jobs are not only key to protecting the environment, but they play a crucial role in the transition towards a more sustainable and low-carbon economy.

Universities have to adapt their courses, curricula, and methods of forming the workforce to fit the current fast-changing environment. The gap between labour market needs and the current system requires more deep research into mechanisms of integrating green competencies into higher education.

Despite the growing literature on green practices and sustainability worldwide, there is a lack of research focusing on these topics within the context of Kazakhstan. This gap highlights the need for localized studies that explore how sustainability principles are implemented in the country's higher education institutions.

This research aims to investigate the readiness of Kazakhstan's higher education system to prepare a workforce with the skills required for the green economy. The research has theoretical and applied significance in offering solutions for universities, employers, and state bodies.

The research questions arise:

(RQ1) How effectively are green skills integrated into the curricula of higher education institutions in Kazakhstan?

(RQ2) To what extent do university policy documents align with the goals of the green economy?

The research paper addresses the identified gap by focusing on the implementation of sustainability principles within higher education institutions in Kazakhstan. By analyzing 19 universities located in various cities across Kazakhstan, the research evaluates the integration of green practices, curricula, social inclusion, and institutional policies. The selected universities provide a comprehensive basis for conducting a content analysis of sustainability practices and educational approaches across diverse academic environments. The findings aim to provide evidence-based tool for strategies and recommendations to enhance sustainability efforts in Kazakhstan's higher education sector, contributing to the broader understanding of green education in emerging economies.

2. Theoretical framework

Environmental challenges such as climate change, biodiversity loss, and resource reduction require green skills and behaviour to overcome the changes (Consoli et al., 2016). Moreover, Climate change will change the order of things, i.e., individuals and organizations will need to adapt to new technologies, manufacturing processes, and market demands (Foo, 2013). Addressing environmental challenges and adapting to the impacts of climate change requires a collective shift toward green skills, sustainable practices, and innovative solutions to ensure sustainability in a rapidly changing world.

United Nations Sustainable Development Goals are aimed at increasing environmental awareness. As a result, they promote sustainable consumption and production, create green jobs (Strietska-Ilina et al., 2011), adopt eco-friendly practices, and innovate green technologies. UNESCO (2014) emphasized the need to equip students with skills and abilities that promote sustainability. Thus, green skills and competencies are crucial for businesses and governments to foster a sustainable and prosperous future (Adecco Group, 2021). Aleksejeva (2016) states that qualified human capital with green skills leads to economic growth.

Universities can help the labour market with smooth shifts and foster sustainability by incorporating eco-friendly tools, techniques, policies, and strategies (Aithal & Rao, 2016; Yar et al., 2024). Moreover, integrating sustainability at MBA, postgraduate, and executive training levels prepares students for the green economy and promotes green business practices (Beuron et al., 2017). Green skills are developed through learning, professional training, and practical application. According to Aver et al. (2021), universities are centers of research and innovation that educate and train future generations.

Climate change and rapid digital innovation call for green education to play a pivotal role in shaping a sustainable future (Abd Hamid et al., 2019). Yar et al. (2024) suppose that green skills could be acquired through green buildings, green curriculum, green training, and green communities. Cortese (2003) also mentioned research and innovations and generalized green building as an institutional practice.

1. *Green curricula and education.* The incorporation of green competencies and sustainable practices into curricula fosters the development of innovative solutions that address societal needs to tackle contemporary environmental challenges (Yar et al., 2024). Also, Pavlova (2016) emphasizes that green education, combined with skill-building programs, empowers individuals to contribute meaningfully to the green economy. According to Baumgarten and Kunz (2016), educational reform is a key driver for shaping a sustainable and environmentally conscious future. These insights underline the necessity of systematic updates in education to support the transition to sustainable practices.

Zhong et al. (2022) highlight the success of sustainability courses that leverage academic expertise, strategic planning, and external partnerships to facilitate hands-on learning. These courses connect theoretical knowledge with practical applications through problem-solving, project-based initiatives, and action-oriented tasks. Students develop essential skills such as critical thinking, creativity, and systems analysis while contributing to achieving Sustainable Development Goals (Fisher & McAdams, 2015). Enhancing educational attainment can be key in facilitating the green transition (Li et al., 2023).

In addition, green education advocates for integrating "green digital skills" through an inclusive and multidisciplinary approach. These skills promote sustainable habits and principles, nurturing a generation of environmentally conscious individuals (Abd Hamid et al., 2019). Strategies that minimize ecological harm ensure that learners are well-prepared to address environmental crises and foster sustainable ways of living and working.

2. *Research* develops innovative solutions, advances green technologies, and informs evidence-based policies to address environmental challenges. According to Sianes et al.(2022), scientific research on sustainability fosters collaboration between researchers and higher education institutions (HEIs) and is a valuable tool for decision-making at both governmental and corporate levels.

3. *Green communities* illustrate sustainable living, foster collaboration, reduce environmental impact, and inspire broader adoption of eco-friendly practices (Fissi et al., 2021).

4. *Institutional practice.* Higher education is critical in promoting sustainability through principles of responsible consumption across campuses, academic programs, and community initiatives (Beuron et al., 2017). Universities are tasked with incorporating sustainability into their physical infrastructure and embedding these principles within their curricula to raise awareness and inspire action among students (Amaral et al., 2015). A sustainable university aligns its organizational framework, campus operations, and community engagement with real-world opportunities that can be proactively developed or adapted to achieve sustainability objectives (Zhong et al., 2022).

In conclusion, green education, research, community collaboration, and institutional practices play a crucial role in addressing climate change and fostering a sustainable future necessitates. Green curricula and education empower individuals with the skills and knowledge needed to contribute meaningfully to the green economy, fostering innovation and sustainable practices. Research is vital in advancing green technologies, driving evidence-based policies, and encouraging collaboration between academic and corporate sectors. Green communities highlight sustainable living and inspire broader adoption of eco-friendly practices, while institutional practices in higher education act as catalysts for change by embedding sustainability principles in operations, infrastructure, and curricula. Together, these elements highlight the critical role of education and innovation in equipping societies to meet contemporary environmental challenges and transition toward a greener future.

The theoretical implication of the research is new knowledge about the role of higher education and institutional practice in forming green competencies. The practical implication is using findings for development strategies and recommendations for incorporating green competencies within universities, evidence-based policies, and public awareness about the importance of an environmentally conscious approach.

3. Research methodology

Research design

The choice of an index to assess the role of Higher Education Institutions (HEIs) in green skills development is based on its ability to provide a comprehensive and standardized measure of complex, multidimensional phenomena. Green skills development involves diverse aspects such as curriculum design, research initiatives, community engagement, and institutional sustainability practices.

The index of "Greenness" is developed to assess the role of HEIs in developing green skills.

This index serves as a comprehensive framework to measure and evaluate the integration of sustainability and green practices within HEIs. By incorporating multiple dimensions, such as course offerings, research initiatives, community engagement, and institutional practices, the index provides a holistic understanding of how HEIs contribute to fostering green skills among students and faculty. The methods outlined in this section describe the conceptualization, indicators, data collection processes, and analytical approaches used to construct and apply the "Greenness Index."

The index is based on four main criteria: the presence of courses, research, social projects, and institutional practices. Each criterion is assigned a weighting coefficient, and a set of indicators is evaluated in points. The overall index is calculated as a weighted sum of all criteria (Table 1).

Table 1: Criteria of greenness index

Criterion	Weight	Indicators	Max Points
1. Availability of Courses	0.25	- Programs/courses with elements of sustainable development. - Number of interdisciplinary courses related to ecology.	25
2. Availability of Research	0.25	- Number of publications on sustainable development topics over the past 3 years. - Amount of grant funding for ecological research.	25
3. Community Projects	0.25	- Number of implemented projects (e.g., eco-education, urban ecological initiatives).	25
4. Institutional Practices	0.25	- Use of renewable energy. - Waste sorting systems are available on campus. - Existence of a sustainability policy.	25

The following formula is proposed (1):

$$GREEN \ of \ University \ index = \sum_{i=1}^{4} W_i \left(\frac{Sum \ of \ score}{B_i} \right) \qquad (1)$$

where:
W_i - weigh of criteria i;
B_i - maxinal score for criteria i;
Sum of all $W_i = 1$.

Result Interpretation
- 0–0.3 (30%): Low level of "greenness". Significant improvement is needed.
- 0.3–0.6 (30–60%): Medium level. Some foundational elements are present, but considerable development is required.
- 0.6–0.8 (60–80%): Good level. Green initiatives are well-integrated, but there are areas for further growth.
- 0.8–1.0 (80–100%): High level. Serves as a leading example for others in sustainability practices.

Selection

State universities were selected from each region of Kazakhstan to ensure comprehensive coverage, except for the Almaty region, where no state higher education institutions are present (Table 2). State universities, excluding national universities, were also selected from Almaty and Astana to ensure balanced representation in these cities.

Table 2: State Regional Universities

№	City	Name of University	Main Directions
1	Semey	Shakarim University	Humanities, Natural Sciences, Engineering
2	Kokshetau	Kokshetau University named after Sh. Ualikhanov	Teacher Training, Natural Sciences, Engineering
3	Aktobe	Aktobe Regional University named after K. Zhubanov	Teacher Training, Social Sciences, Natural Sciences
4	Atyrau	Atyrau Oil and Gas University	Oil and Gas Studies
5	Ust-Kamenogorsk	East Kazakhstan Technical University named after D. Serikbayev	Engineering, IT, Mining
6	Karaganda	Karaganda University named after E.A. Buketov	Social Sciences, Humanities, Natural Sciences
7	Kostanay	Kostanay University named after A. Baitursynov	Agriculture, Natural Sciences, Teacher Training
8	Kyzylorda	Kyzylorda University named after Korkyt Ata	Teacher Training, Humanities, Agriculture
9	Aktau	Caspian University of Technology and Engineering named after Sh. Yessenov	Engineering, IT, Oil and Gas Studies
10	Petropavolsk	North Kazakhstan University named after M. Kozybayev	Teacher Training, Agriculture, Social Sciences
11	Pavlodar	Pavlodar University named after S. Toraigyrov	Technical Sciences, IT, Humanities
12	Turkistan	International Kazakh-Turkish University named after H.A. Yassawi	Humanities, Medicine, Technical Sciences
13	Zhezkazgan	Zhezkazgan University named after O.A. Baykonurov	Engineering, Natural Resources, Technical Sciences
14	Uralsk	West Kazakhstan Agrarian-Technical University named after Zhangir Khan	Agriculture, Technical Sciences, Ecology
15	Taraz	Taraz University named after M.H. Dulati	Humanities, Engineering, Agriculture
16	Taldykorgan	Zhetysu University named after I. Zhansugurov	Humanities, Teacher Training
17	Almaty	Academy of logistics and transport	Logistics, transport
18	Astana	Kazakh Agrotechnical University named after S. Seifullin	Agriculture, Technical Sciences, Natural Resources
19	Shymkent	South Kazakhstan State University named after M. Auezov	Teacher Training, Social Sciences, Engineering

Data collection

The data for content analysis and greenness index components were sourced from the official websites of universities in December 2024 for the period 2022-2024. Research publications were retrieved from the Web of Science and Scopus platforms, focusing on the period from 2022 to 2024. The search was conducted using targeted keywords such as *"ecolog," "sustainab*," "energy saving," "renewable energy," "solar energy," "wind energy," "waste management," "climate change," "environmental aspect,"** and similar terms to ensure comprehensive coverage of topics related to green and sustainable research.

4. Results and analysis

The results of the analysis for the greenness index provide valuable insights into the extent to which sustainability principles are incorporated in higher education. By evaluating key indicators such as the integration of courses with greenness elements, the scope of research on ecological topics, community-driven environmental projects, and institutional practices like renewable energy use and waste management, the findings reveal a low overall level of "greenness" in current offerings (Figure 1). These findings highlight critical areas for improvement, emphasizing the need to enhance

educational frameworks to align with global sustainability goals and address pressing environmental challenges.

These results underscore significant gaps in sustainability-focused education and operations, highlighting the urgent need to strengthen curricula, research initiatives, and institutional policies to align with global sustainability goals and address critical environmental challenges.

Figure 1 illustrates the results of the greenness index analysis across various universities, showcasing the extent to which sustainability principles are integrated into their educational programs, research efforts, community projects, and institutional practices.
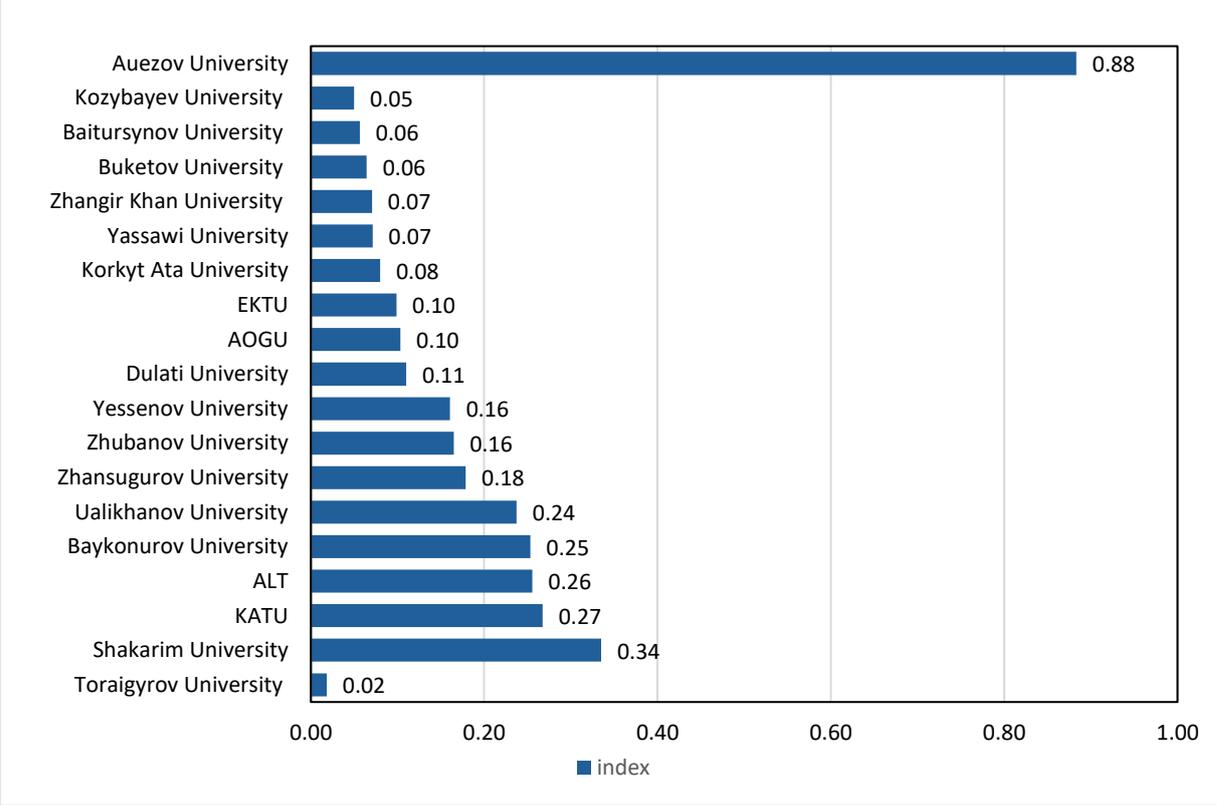
Figure 1. Index of greenness for 2022-2024

Auezov University stands out as the top performer, achieving the highest index score, while other universities demonstrate varying levels of "greenness," with many scoring significantly lower. These results highlight substantial disparities in implementing sustainability initiatives within higher education institutions, emphasizing the need for targeted improvements to bridge the gap and promote sustainable practices across the sector.

The wide range in index values suggests significant disparities in these universities' efforts or outputs. Institutions with lower scores may benefit from strategic focus and resource allocation to improve their standing, while top performers could act as benchmarks for best practices in the evaluated domain.

According to PAGE's Report (2020), Kazakhstan defined majors in power engineering, heat, and power industry, the energy supply of agriculture, agronomy, water resources, and water use, forest resources and forestry, and fruit and vegetable farming as the high capacity the green transition. Similarly to Wals & Blewitt (2010), the adoption of green competencies within curricula has been limited despite the clear potential to be integrated into various academic disciplines. However, the curricula analysis discovers a small incorporation of green into agriculture, forestry, and farming-related majors, which creates a risk to food safety. At the same time, technical and engineering majors have elements of sustainability in their educational programs.

The slow progress of incorporating "green" into curricula could be because of overloaded curricula, some educators thinking that Education for Sustainability doesn't relate to their courses (Christie et al., 2015), and the lack of qualified faculty (PAGE, 2020).

Green skills are mostly incorporated into technical engineering majors as elements of energy saving, renewable energy, and waste management. The inclusion of green skills and competencies into curricula is a positive step toward meeting the needs of the green economy's human capital.

Some universities have specific policies regarding sustainability and eco-development, while others do not entirely comprehend the scope of sustainability. The same situation exists with smart campuses and campus practices. Contrary to Leihy and Salazar (2011), Kazakhstani universities try to incorporate sustainability practices into curricula rather than introduce institutional practice. One reason could be a lack of investment in infrastructure to make smart buildings. Integrating sustainability principles into university activities enhances education and influences students' daily behavior, encouraging the application of sustainability principles in their lives.

Most universities do not reflect their social projects, which means they lack social engagement in ecological issues. Mostly they limit with participation in Taza Kazakhstan eco initiative. This highlights the limited role of HEIs in fostering sustainability and raising awareness regarding ecological issues. In conclusion, based on the results, strategic reforms in higher education are essential to align with green economy demands and foster skilled human capital to advance sustainable development.

5. Conclusion

Regarding to RQ 1, the presented index reveals that the incorporation of green skills into courses is limited, indicating insufficient integration of sustainability principles into academic curricula, research and society inclusion.

Regarding to RQ 2, universities reflect sustainability policies and practices, such as waste management and energy saving; however, these are often limited to being outlined in policies or strategic and development plans without significant implementation in practice.

The limitations of this research include its focus exclusively on state universities, excluding private and national institutions, which may provide additional insights into sustainability practices. Another significant limitation is the lack of available data; some official university websites do not provide information on campus sustainability practices or social inclusion initiatives. Additionally, curricula content is often not publicly presented, limiting a comprehensive analysis of green education integration.

Based on the finding the following recommendation for universities is offered:

- Integrate green education into existing courses rather than creating separate modules to reduce curriculum overload;

- Prioritize interdisciplinary approaches that include green concepts across diverse disciplines such as economics, engineering, and social sciences;

- Collaborate with external organizations, NGOs, and government bodies to secure funding and expertise for ecological education programs;

- Offer professional development opportunities for faculty, including workshops, certifications, and exchange programs focused on sustainability education;

- Establish partnerships with international universities to share teaching materials, research, and resources related to ecological education;

- Foster partnerships between universities and local communities to implement practical ecological initiatives;

- Encourage student clubs and societies to actively participate in sustainability projects, with university recognition or credits as incentives;

- Promote ecological awareness campaigns on and off campus, leveraging social media and other platforms to increase community participation and visibility.

These recommendations aim to address structural and systemic challenges while fostering a collaborative, resource-efficient approach to enhancing green education.

This study provides a foundation for understanding the current state of green skills integration in Kazakhstan's higher education. It highlights actionable steps to enhance its role in the country's sustainable development journey. Future research should explore specific institutional practices and student outcomes to build a more comprehensive picture of progress in this critical area.

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