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Engineering Education in Zimbabwe: Challenges, Progress, and Future Prospects

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Abstract

Despite Zimbabwe's efforts to modernize its infrastructure and enhance its economic growth, the mismatch between its industry needs and the skillset possessed by its graduates continues to hinder its progress. This is due to the weak collaboration between industry and academia. Therefore, there is a need for significant transformation in the engineering education. This paper provides a comprehensive analysis of the engineering education landscape in Zimbabwe, aimed at promoting industry-academia partnerships and evaluation of the progress made by initiatives such as Education 5.0 since their inception. The findings shows that 59% of the respondents are not satisfied with the lecturing methodologies being used in engineering universities and 63% believe that weak policy frameworks are being used to promote collaboration between universities and the industry. One of the main challenges that impede engineering education is inadequate sponsorship towards research and development by the government and industry. This leads to lack of resources such as inadequate laboratory equipment, therefore inadequate practical implementation of theoretical concepts, limited learning capabilities, poor quality engineering education, and mismatch between the curriculum and industry relevance. Moreover, 57% have not yet observed any significant change in engineering education in Zimbabwe in the recent years. This implies that Education 5.0 has not yet made significant progress since its introduction. The study recommends that the industry must provide structured internship and graduate development programs, on top of contributing towards curriculum development of engineering programs.

Keywords
Engineering, Curriculum development, Engineering education, Education 5.0, Industry-academia partnership

1. Introduction
Engineering education is crucial for Zimbabwe's Vision 2030 Economic Agenda, which aims to drive innovation, industrialization, and sustainable development. Engineering education is fundamental to national development, providing the country with the technical skills needed to innovate, industrialize, and address the significant challenges in the country for sustainable development (Kumba et al., 2024). Engineers play a vital part in Zimbabwe, fostering sustainable development of the nation. Zimbabwe is a country with abundant natural resources, and it is striving to modernize its infrastructure, energy systems, and agricultural productivity. Goal 4 of the Sustainable Development Goals (SDGs) aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities (Saini et al., 2023). However, the country's engineering education is at a critical juncture (Mamina & Maganga, 2019). Engineering education in Zimbabwe is impacted by legacy of the past, limited resources, and there is no immediate urgency to match academic institutions with other fast-changing global trends. Therefore, there is a need for engineering education in Zimbabwe to undergo significant transformation to meet the demands of industrialization and technological advancement. This involves addressing various problems, implementing new sustainable educational models, and leveraging on technology to enhance the learning outcomes.

A recent study by (Hagreaves et al., 2024) depicts that engineering education is crucial for driving innovation and industrial growth, which are essential for sustainable economic development in the country. Nevertheless, in the country, the lack of adequate engineering skills is a significant challenge that hampers the country's industrial and economic growth. Since gaining sovereignty in 1980, Zimbabwe has expanded its higher education system, establishing institutions such as the National University of Science and Technology, Chinhoyi University of Technology, Midlands State University and Harare Institute of Technology to enhance and expand the core programs which were being offered at the University of Zimbabwe. These new introduced institutions have produced generations of seasoned engineers who have contributed to critical sectors like mining, water management, health, and telecommunications. Despite that, challenges persist including outdated curricula, limited industry collaboration, and a debilitating brain drain that sees skilled graduates seeking opportunities abroad.

In line with this, another research argued that the nation's engineering programs struggle to produce graduates equipped with the technical, practical, and innovative skills required to address contemporary challenges(Nyemba et al., 2019) . Globally, engineering education is facing growing pressure to evolve. It is essential to examine the role of engineers in the twenty-first century and explore how universities and skill development centers can better equip future engineers.
Consequently, this misalignment between academic graduates and industry demands has led to unemployment of engineering graduates, over reliance on foreign expertise for pivotal infrastructure projects, and this has constrained innovation in key sectors like energy, agriculture, health and sanitation. Moreover, despite some progress through

partnerships and policy initiatives, Zimbabwe's engineering education system remains inadequately positioned to leverage emerging technologies, therefore aligning with the sustainable development goals of the nation like the developmental frameworks of a middle economy by 2030 (Chasokela & Moyo, 2024).

Table 1. Summary of engineering problems in Zimbabwe

FACTORS	DESCRIPTION
Colonial legacy problems and the structural imbalances	Early focus on low-skilled labor, neglecting advanced engineering fields.
Persistent underfunding	Outdated research, ancient equipment, and insufficient research funding
Brain drain of lecturers and engineering professionals	Loss of expertise due to emigration of skilled engineers and lecturers
Outdated engineering curriculum	Theory heavy programs misaligned with modern global industry needs
Weak industry-academia collaborations	Limited internships, apprenticeships, and research partnerships
Political interference and policy instability	Hindered long-term planning due to shifting policies
Gender Disparities in STEM	Cultural biases limiting female enrolment in engineering
Reliance on Foreign Expertise	Dependency on external consultants for major projects
Lack of Continuing Professional Development	Limited opportunities for skill upgrades among lecturers

In a nutshell there is also a notable skills gap between what educational institutions provide and what the industry requires, aggravated by outdated teaching methods and limited access to modern equipment and technology. Table 1 summarizes some of the problems associated with engineering education in Zimbabwe.

The objectives of this paper are to provide a comprehensive analysis of the current state of engineering education in Zimbabwe, identifying key challenges such as economic instability, outdated curricula, and brain drain. They will also critically examine the state of engineering education in Zimbabwe, focusing on its historical challenges, recent progress, and future opportunities. This research is aimed at assessing the progress made with initiatives like the Education 5.0 model and explore prospects for enhancing engineering education through industry-academia collaboration, technological advancements, and sustainable development practices. Additionally, the paper seeks to recommend actionable solutions and policy developments to address these challenges and encourage stakeholder engagement to foster a supportive environment for engineering education in Zimbabwe.

2. Review and Analysis

2.1 Challenges

Skill deficiency is hindering the growth of the engineering and innovation sector in Zimbabwe. The engineering graduates from the universities often lack essential 21st-century skills such as innovation, creativity, problem-solving, and decision-making, which are central for solving complex engineering problems and meeting skills labour market demands in the country and the globe at large.

A closer analysis of the literature and background of engineering education in Zimbabwe reveals that economic and political instability are one of the major setbacks. The initial high standards of Zimbabwe's education system have been eroded by socio-economic and political instability, affecting the quality of education, including engineering therefore impacting sustainable developmental goals of the nation.

Further examination of the literature highlights that there is a mismatch between the Zimbabwean industrial sector needs and the engineering qualifications, this affects engineering graduates' employability (Chasokela & Moyo, 2024). There is a notable skills deficit in the engineering and technology sectors, with a significant 62% gap identified in a recent audit. This mismatch is to some extent due to the lack of access to modern equipment and technology by engineering institutions.

Despite findings from the previous research, infrastructure and resources are also paramount in engineering education for the country's Vision 2030 Agenda. The effectiveness of the introduced Education 5.0 in Zimbabwe is constrained by inadequate physical and technological infrastructure, irregular power supply, and insufficient financial resources. Engineering education at the University of Zimbabwe needs adjustments to align with the education 5.0 model and align with competency-based learning to address the growing need for competent engineers and industrialization. Seminal contributions have been made by (Mamina & Maganga, 2019), the authors reviewed engineering education at the University of Zimbabwe and recommends that adjustments must be made to address the need for highly skilled engineers. It was reported that The Royal Academy of Engineering endorsed an initiative to refine the quality and relevance of engineering education in Zimbabwe and other Sub-Saharan African countries (Nyemba et al., 2020) . The Ministry of Higher and Tertiary Education in Zimbabwe responded by launching an Education 5.0 philosophy. However, a recent study by (Hagreaves et al., 2024) concluded that implementation of Education 5.0 in tertiary educations in Zimbabwe meet obstacles head on, such as limited technological resources, resistance to change, inadequate budget support, and inadequate faculty training.

2.2 Progress

Enriching Engineering Education Program: To fill this literature gap from 2013 to 2015, the University of Zimbabwe, in collaboration with other institutions, successfully managed a program aimed at enhancing the quality and relevance of engineering graduates (Nyemba et al., 2021a). This included secondments of engineering academics to industry, knowledge-sharing workshops, and continuous professional development training. Moreover, the program received positive evaluations from students and local industries, leading to the generation of industrial design projects and innovations, some of which have been patented and commercialized (Table 2).

In conclusion, while Zimbabwe faces significant challenges in engineering education, there have been notable efforts and progress.

Table 2. Summary of the challenges, progress, and prospects of engineering education in Zimbabwe

Aspect	Details	References
Challenges	Skill deficiency, economic instability, mismatch with industry needs, inadequate infrastructure	(Kayyali, 2024) (Chitiyo, 2014) (Nyemba et al., 2021b)
Progress	Enriching Engineering Education Program, student and industry engagement	(Hagreaves et al., 2024) (Nyemba et al., 2021a)
Prospects	Holistic approach for Education 5.0, focus on sustainability and digitalization, global and regional collaboration	(Chasokela & Moyo, 2024)

3. Methodology

In this study, a quantitative methodology is employed to gather data about the status of the relationship between industry and the engineering universities in Zimbabwe. A questionnaire, created using Microsoft Forms, targeted 56 students, industry professionals, lecturers, and policymakers to share their insights based on their experiences. The aim was to determine the extent of the bond between these two parties, and their contribution towards fostering sustainable development in the country. The research questions addressed were:

i. What are the main hindrances to firm correlation between the industry and engineering education in Zimbabwean universities?
ii. To what extent has the adoption of Education 5.0 impacted engineering education in Zimbabwe?
iii. What role should the government play in shaping engineering education?

The framework of the questionnaire traces the progress made by Education 5.0 in enhancing the universities-industry partnership and evaluates the extent to which it has addressed its objectives so far. Table 3. summarizes the questionnaire.

3.1 Research Design

This research employs a quantitative research approach, utilizing semi-structured questionnaires as the primary data collection method. The quantitative approach is very suitable for capturing rich, in-depth insights into the challenges,

progress, and prospects of engineering education in Zimbabwe. A phenomenological research design is adopted to explore the first-hand information and experience of key stakeholders, including students, lecturers, policymakers, and industry professionals. This approach grasps an overview of how participants perceive and experience engineering education, providing a comprehensive analysis of the sector's current state and future directions.
A purposive targeted sampling technique is utilized to select participants who have direct experience with engineering education in Zimbabwe. The sample include:

1. Engineering students across different academic levels
2. Lecturers and faculty members from engineering institutions
3. Government policymakers involved in higher education
4. Industry professionals and employers in the engineering sector

The participants were invited based on their expertise, experience, and involvement in engineering education reforms. These participants were invited via a link on the emails, ensuring diverse perspectives while allowing for data saturation.

3.2 Data Collection Method: Questionnaire Design

This research used structured open-ended questionnaire to collect data. The questionnaire was designed to elicit detailed responses on participants' experiences, perspectives, and recommendations regarding engineering education in Zimbabwe. The questionnaire contains open-ended questions to allow participants to provide in-depth responses. Questions covered key themes such as curriculum relevance, funding challenges, policy reforms, industry collaboration, and Education 5.0 implementation.

The questionnaire was piloted with a small group of mentors to ensure clarity and relevance before full distribution. Email invitations were sent to targeted participants from academic institutions, government agencies, and industry. Responses were collected over a period of three to four weeks to allow for adequate participation.

Table 3. Structure of the questionnaire

S/N	Question
1	What is your current role in engineering education?
2	How many years of experience do you have in this field?
3	What is your highest level of education?
4	How would you characterize the current state of engineering education in Zimbabwe?
5	In your opinion, what are the biggest challenges facing engineering education in Zimbabwe today?
6	How do financial constraints (e.g., funding, tuition fees, infrastructure) impact engineering education in Zimbabwe?
7	Do you think the current curriculum aligns with the needs of industry and the job market?
8	How does the lack of modern technology and laboratory equipment affect the quality of engineering education in Zimbabwe? Rate below
9	What are the barriers to effective collaboration between universities and industry in Zimbabwe?
10	Have you observed any significant improvements or reforms in engineering education in Zimbabwe in recent years?
11	What impact has the adoption of Education 5.0 had on engineering education in Zimbabwe? (e.g., innovation, industrialization, entrepreneurship)
12	Are engineering institutions adequately preparing students for the Fourth Industrial Revolution (4IR)?
13	What role do government policies and initiatives play in shaping engineering education in Zimbabwe?
14	What role should industry play in shaping engineering curricula and training programs?
15	How do socio-economic factors, like access to education in rural areas, affect the pipeline of engineering students?
16	How can the global engineering community collaborate with Zimbabwe to support its goals?
17	What changes would you recommend to improve the quality of engineering education in Zimbabwe?
18	Do you have any additional insights, experiences, or recommendations regarding engineering education in Zimbabwe?
19	Based on your experience, are you happy with the engineering education in Zimbabwe?

4. Data analysis and discussion

Since engineering is one of the key fields that drives industrialization, hence the country's economic growth, each candidate in the target audience possesses an engineering qualification to extract key information. Therefore, out of the 56 respondents, 54 holds at least a bachelor's degree as shown in Figure 1.

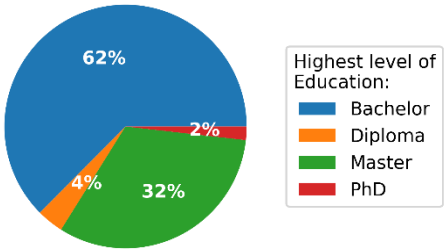

Figure 1. The level of education for the respondents

Aimed at understanding the current state of engineering education in Zimbabwe, the respondents were to characterize this initially, and 59% characterized it as negative shown by Figure 2. This implies that many people are not satisfied with the current lecturing methodologies being employed in engineering universities. Moreover, this shows a negative correlation between universities and industry since, in this case, satisfaction translates to expected outcomes. Therefore, academia is not meeting industry needs. About 63% of respondents believe that there are weak policy frameworks to support collaboration initiatives. This is illustrated by Figure 3 which shows the respondents' perceptions towards barriers to effective collaboration between universities and the Zimbabwean industry.

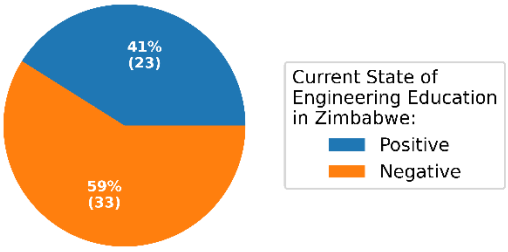

Figure 2. Status of engineering education in Zimbabwe

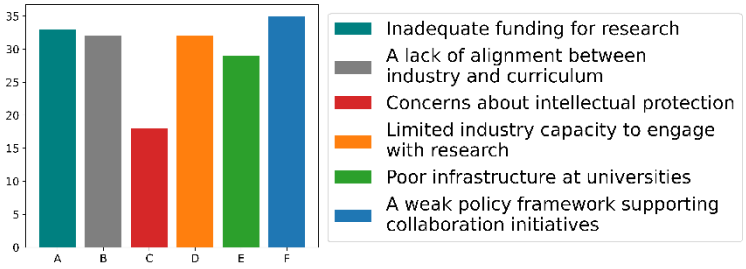

Figure 3. Common barriers to industry-academia partnerships

Therefore, the next question was aimed at addressing why this is so. Forty (40) respondents pointed out the lack of motivation by lecturers due to poor salaries, lack of resources such as inadequate laboratory equipment, and inadequate practical implementation of theoretical concepts. This shows inadequate sponsorship or investment in research and development by the government, industry, and universities themselves. In an ideal industry-universities partnership, the industry funds universities to solve industrial problems through research projects and/or provision of laboratory

equipment. Besides technological advancements, this ensures that the skillset possessed by graduate students is at par with industry needs.

Question 6, shown in Table 3, goes deeper to understand the extent to which financial constraints affect engineering education. Responses by most respondents such as lack of modern technology like relevant Computer Aided Design (CAD) software translate to limited learning capabilities, resulting in poor quality engineering education (supported by Figure 4) and mismatch between the curriculum and industry relevance. Supported by question 7, illustrated in Figure 5, 57% of respondents believe that the current engineering curriculum is not aligned with industry needs and the job market.

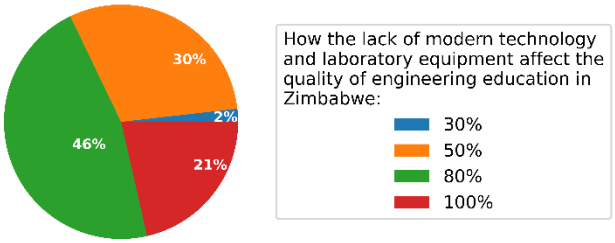

Figure 4. Impact of laboratory equipment on engineering education

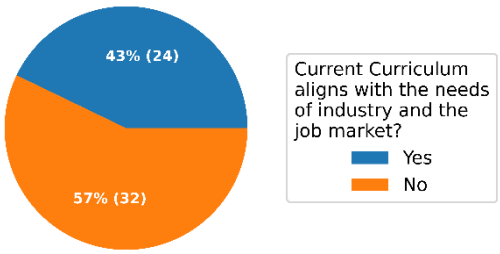

Figure 5. Alignment of curriculum with industry expectations

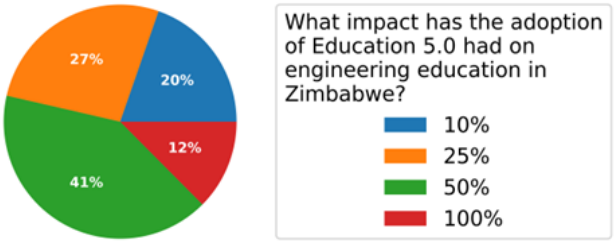

Figure 6. Impact of Education 5.0 on engineering education in Zimbabwe

Education 5.0 focuses on innovation, industrialization, and entrepreneurship. These pillars help accelerate the adoption of the fourth industrial revolution (4IR) technologies. However, as shown in Figure 6, only 54% of the respondents highlighted that Education 5.0 had at least 50% impact on engineering education in Zimbabwe, and 73% believe that engineering institutions are not adequately equipping the students with 4IR technologies as illustrated by Figure 7. Additionally, in Figure 8, 57% have not yet observed any significant change in engineering education in Zimbabwe in the recent years.

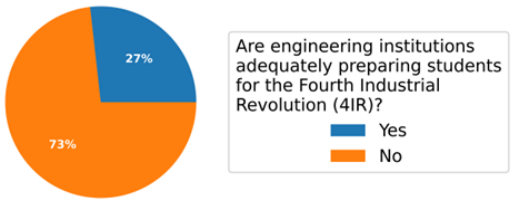

Figure 7. Engineering graduates' skillset vs adoption of 4IR technologies

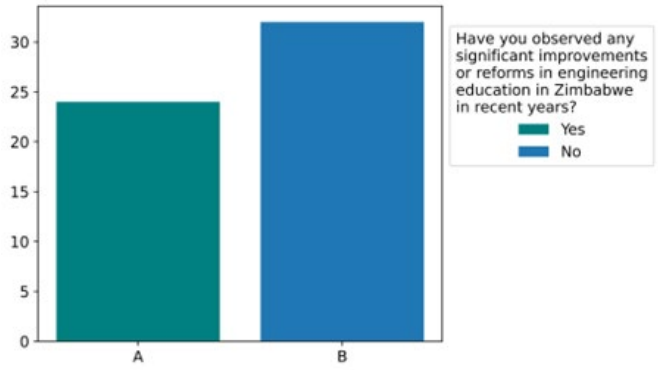

Figure 8. Perceptions towards improvement in engineering education

Key recommendations are input from industry during curriculum development and funding the students' postgraduate studies. Additionally, the industry is recommended to provide structured internship and graduate development programs. Moreover, enhancement of project-based learning ensures the students acquire the necessary hands-on experience.

5. Conclusion

This study critically examined the state of engineering education in Zimbabwe, highlighting persistent structural, institutional, and policy-related challenges that constrain its contribution to national industrialization and Vision 2030 objectives. The findings reveal a significant misalignment between university training and industry expectations, reflected in widespread dissatisfaction with teaching methodologies (59%), weak collaboration frameworks (63%), and limited observable impact of recent reforms such as Education 5.0 (57% reporting no significant change). Inadequate funding for research and development, obsolete laboratory infrastructure, limited exposure to 4IR technologies, and constrained industry participation in curriculum design remain central barriers to quality and relevance.

While initiatives such as the Enriching Engineering Education Program demonstrate progress toward strengthening academic-industry linkages, implementation gaps continue to undermine systemic transformation. The study underscores that Education 5.0's pillars of innovation, industrialization, and entrepreneurship have yet to translate into measurable structural change within engineering institutions. Sustainable reform will require strengthened policy coherence, increased investment in infrastructure and research, curriculum modernization aligned with industry needs, and institutionalized industry participation through structured internships and graduate development programs. A coordinated, multi-stakeholder approach is essential to reposition engineering education as a catalyst for technological advancement and sustainable economic development in Zimbabwe.

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