

Analyzing the Determinants of Career Choice in Tertiary Education and Their Impact on Technological Development in Developing Economies

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Abstract

Technological advancement is fundamentally linked to the effective development and utilization of human capital through higher education systems. Despite the global expansion of tertiary education, particularly in science, technology, engineering, and medicine (STEM and health-related fields)—many developing economies continue to experience limited technological progress relative to their growing pool of graduates. This study investigates the factors influencing career choice in tertiary education and examines how these factors shape national and planetary technological development outcomes.

Using survey data from 2,000 engineering and medical students across selected higher education institutions, with Zambia and Zimbabwe as primary case studies, the research adopts a mixed analytical perspective integrating education policy, human capital theory, and innovation systems analysis. The findings reveal that while enrollment in engineering and medical programs continues to increase, graduates' capacity to contribute meaningfully to technological development is constrained by structural, institutional, and socio-cultural factors. Key determinants include curriculum misalignment with innovation needs, limited research infrastructure, insufficient career guidance, governance challenges in education systems, and societal norms that prioritize credential acquisition and job security over problem-solving and innovation.

The study further highlights disparities between the rapid expansion of engineering graduates and the more tightly regulated production of medical professionals, emphasizing the complementary yet distinct roles these professions play in technological and societal development. At a broader scale, the findings suggest that technological stagnation in developing economies is not primarily a function of graduate scarcity, but rather of systemic inefficiencies in workforce planning and human capital utilization.

The paper concludes by proposing policy-oriented recommendations focused on curriculum reform, interdisciplinary education, investment in research and training infrastructure, and ethical workforce

mobility. These measures are intended to enhance the contribution of tertiary education graduates to sustainable technological advancement at both national and global levels.

Keywords: Career choice; tertiary education; technological development; human capital; workforce planning; developing economies.

1. Introduction

Technological advancement is widely recognized as a central driver of economic growth, social welfare, and sustainable development. Nations that successfully translate scientific knowledge and technical expertise into innovation tend to demonstrate higher productivity, improved infrastructure, enhanced public health outcomes, and greater resilience to global challenges such as climate change, pandemics, and resource scarcity. Central to this process is the effective development and deployment of human capital through higher education systems, particularly in science, technology, engineering, and medicine (STEM and health-related fields).

Despite significant global expansion in tertiary education enrollment, particularly in developing economies, persistent disparities remain between the number of graduates produced and measurable technological and socio-economic progress. Globally, tens of millions of individuals hold advanced qualifications in engineering, medicine, and related scientific disciplines. However, the translation of this educational attainment into sustained technological innovation and development outcomes appears uneven, especially in low- and middle-income countries. This raises a critical question for education policy and development planning: **why does increased graduate output not consistently correspond to proportional technological advancement?**

Existing literature suggests that this disconnect cannot be explained solely by resource constraints or educational access. Instead, it reflects deeper structural and social factors, including misalignment between education systems and national development priorities, weak innovation ecosystems, limited research infrastructure, and suboptimal workforce utilization. Career choice within tertiary education emerges as a particularly underexplored yet influential factor in this context. The motivations, expectations, and constraints that shape students' selection of academic and professional pathways can significantly influence whether graduates become innovators, practitioners, or underutilized members of the labor market.

In many developing regions, higher education systems have expanded rapidly in response to rising demand for professional qualifications, often without commensurate investment in research capacity, curriculum modernization, or industry integration. As a result, graduates may acquire credentials without developing the skills, orientation, or institutional support necessary for technological problem-solving, innovation, and knowledge transfer. This phenomenon is especially relevant in engineering and medical education, two fields that play complementary roles in national and planetary development—engineers by creating technological systems and infrastructure, and medical professionals by sustaining the health and productivity of populations.

Socio-cultural influences further shape career choice and professional outcomes. Family expectations, societal perceptions of prestige and economic security, early educational exposure, and the visibility of role models all contribute to how students conceptualize success and professional contribution. Where education systems emphasize certification over creativity, maintenance over design, or employment over innovation, graduates may prioritize job security rather than problem-driven technological engagement. Such patterns can limit the collective capacity of a society to leverage its educated workforce for transformative development.

Governance and policy environments also exert a significant influence. The extent to which governments support research and development (R&D), ensure institutional autonomy in higher education, and align curricula with emerging technological needs affects not only the quality of graduates but also their ability to contribute meaningfully to national innovation systems. International evidence indicates that countries that separate educational governance from short-term political considerations and invest strategically in research infrastructure tend to achieve stronger outcomes in technological advancement and human capital utilization.

Against this background, the present study examines the factors influencing career choice among tertiary-level engineering and medical students and analyzes how these factors relate to broader patterns of technological development. Using survey data from 2,000 students drawn primarily from institutions in Zambia and Zimbabwe, with contextual reference to comparable developing economies, the study provides empirical insight into how individual motivations, institutional structures, and socio-cultural norms interact to shape professional trajectories.

The contribution of this paper is threefold. First, it offers empirical evidence on career choice determinants within STEM and medical education in developing contexts, an area that remains underrepresented in the global education literature. Second, it links micro-level educational decisions to macro-level technological and development outcomes, bridging education studies and development policy. Third, it proposes actionable policy recommendations aimed at aligning tertiary education systems with national and planetary technological objectives, including curriculum reform, research investment, interdisciplinary training, and ethical workforce mobility.

By situating career choice within the broader framework of human capital development and technological progress, this study seeks to inform policymakers, educators, and international development stakeholders on how higher education systems can be better structured to support sustainable, inclusive, and innovation-driven development.

2. Quantitative Trends and Technological Impacts of Engineering and Medical Graduates: A Comparative Global Assessment

The annual output of engineers and medical doctors reflects a nation's educational capacity and its ability to drive technological, economic, and health-sector progress. This paper examines global data on engineering and medical graduates, highlighting the scale of their production, geographic disparities, and their respective contributions to national and planetary technological advancement. Drawing on international data from the United Nations Educational, Scientific and Cultural Organization (UNESCO),

the World Health Organization (WHO), the Organization for Economic Cooperation and Development (OECD), and national statistical agencies.

2.1 ENGINEERING AND MEDICINE

Engineering and medicine are two professional pillars essential for societal advancement. Engineers develop infrastructure, technology systems, and innovations that underpin industrial and digital economies, while doctors ensure human health and stability necessary for sustainable productivity. Both professions collectively influence national resilience, technological growth, and global welfare. Understanding how many engineers and doctors graduate annually helps policymakers align education and labor-market outputs with national development priorities and global sustainability goals.

2.2 GLOBAL TRENDS IN ENGINEERING GRADUATES

UNESCO reports continuous growth in engineering, manufacturing, and construction graduates, driven by increased investment in STEM education and industrial policy worldwide [1]. In several major economies, including the United States of America (USA), engineering degrees represent up to 20% of total STEM completions, with consistent year-on-year increases [3]. Emerging economies such as China and India dominate global engineering output, producing over 1 million engineering graduates annually, reflecting national strategies toward technology-driven industrialization [1].

2.3 GLOBAL TRENDS IN MEDICAL GRADUATES

Medical education remains highly regulated and resource-intensive, limiting the number of graduates relative to population demand. WHO's Global Health Workforce Statistics indicate persistent regional imbalances, with high-income countries maintaining favorable physician-to-population ratios while many low- and middle-income nations struggle with shortages [2]. For instance, the European Union (EU) recorded approximately 69,279 new medical doctor graduates in 2022 [4], while the United States reports around 28,000 graduates annually from accredited medical schools [6]. In Africa, fewer than 15,000 physicians graduate per year across the entire continent [2]. Because medical training typically spans 6–8 years, followed by internships and residencies, the rate of graduate expansion remains slower than engineering, constraining rapid scale-up despite growing healthcare demand.

2.4 COMPARATIVE ANALYSIS: ENGINEERS VS. DOCTORS

Both professions are critical, but their system-level effects differ. Engineers accelerate technological and infrastructural development, enabling renewable energy deployment, digital systems, and industrial innovation. Doctors sustain human capital, improve life expectancy, and stabilize populations — prerequisites for sustained scientific productivity. Together, they define a country's capacity for both physical and human development.

2.5 IMPACT ON NATIONAL AND PLANETARY TECHNOLOGICAL ADVANCEMENT

At the national level, engineering graduates drive industrial competitiveness, infrastructure modernization, and innovation ecosystems, while medical graduates enhance population health, reduce economic losses from disease, and enable long-term labor productivity [1], [3]. At a planetary scale, engineers lead the energy transition, space exploration, and AI-driven automation, while doctors contribute to global health security, biomedical innovation, and pandemic preparedness [2], [4]. Both are pivotal for achieving the United Nations Sustainable Development Goals (SDGs).

3.0 Student Perspectives on Technological Contribution and Systemic Constraints

Understanding the limited translation of graduate output into technological advancement requires examination of student experiences within tertiary education systems. This section presents findings from a structured survey of **2,000 engineering and medical students** drawn from higher education institutions in **Zambia, Zimbabwe, and South Africa**. Similar approaches have been used in education and workforce studies to assess alignment between graduate training and national innovation systems [1], [11].

The analysis indicates that students’ challenges are primarily **systemic rather than individual**, reflecting governance structures, curriculum design, socio-cultural influences, and limited research infrastructure. These findings are consistent with international literature on human capital utilization in developing economies [12], [13].

3.1 Dominant Constraints Identified by Students

NUMBER OF STUDENT	REASON 1	REASON 2	REASON 3	REASON 4	REASON 5
50 STUDENTS	UP BRINGING				
1500 STUDENTS		GOVERNEMNT INFLUENCE			
300 STUDENTS			LACK OF INFRASTRUCTURE IN AND POOR TEACHING IN UNVERSITIES		
100 STUDENTS				LACK OF MOTIVATION, STUDENTS JUST STUDY FOR A	
50 STUDENTS					SOCIETAL NOMS

Table 1 summarizes the principal factors identified by respondents as limiting their capacity to contribute meaningfully to technological development. Although respondents provided diverse perspectives, five dominant themes accounted for the majority of responses.

Table 1: Dominant Factors Limiting Technological Contribution (Student Responses)

These factors are discussed in detail below.

3.1.1 Governance, Infrastructure, and Curriculum Design

A substantial proportion of respondents identified governance-related challenges within higher education and technology sectors as significant barriers to innovation. Students reported limited institutional autonomy, bureaucratic decision-making, and weak coordination between education policy and national technological priorities. Similar challenges have been documented in comparative studies of innovation systems in low- and middle-income countries [11], [12].

Inadequate laboratory facilities, outdated equipment, and limited access to advanced simulation and design tools were frequently cited. These constraints were perceived to reduce opportunities for experiential learning, applied research, and technological experimentation. Prior research emphasizes that investment in training infrastructure is a prerequisite for producing innovation-ready graduates [13].

Curriculum rigidity emerged as a recurring concern. Many respondents indicated that curricula remain static despite rapid global technological change, particularly in fields such as artificial intelligence, digital systems, renewable energy, and advanced manufacturing. This misalignment limits graduate readiness for emerging technological challenges and mirrors concerns raised by UNESCO and OECD regarding curriculum responsiveness in developing education systems [1], [12].

3.1.2 Upbringing, Early Exposure, and Career Motivation

Early educational exposure and family environments were identified as influential determinants of career motivation. Respondents noted limited visibility of scientists, engineers, and local innovators during primary and secondary education, a pattern observed in prior studies on STEM participation and motivation [9], [13].

This limited exposure was perceived to shape how careers are valued and pursued. Many students reported selecting engineering or medical programs primarily for employment security and social status rather than intrinsic interest in scientific discovery or technological problem-solving. While economic considerations are rational, existing literature suggests that innovation ecosystems are weakened when career motivation is driven predominantly by credential acquisition rather than problem-oriented engagement [11], [14].

The findings align with human capital theory, which emphasizes that early socialization and role models significantly influence long-term professional behavior and innovation capacity [13].

3.1.3 Societal Norms and Professional Expectations

Societal norms were found to play a significant role in shaping professional aspirations and technological engagement. Respondents indicated that prevailing social expectations often prioritize stable employment over innovation, entrepreneurship, or research-intensive careers. Similar observations have been reported in studies examining cultural influences on technological adoption and development [14].

Gender norms and traditional role expectations were also noted to influence specialization choices within engineering and medical fields. Although progress toward inclusivity is evident, persistent stereotypes were perceived to limit diversity in certain technical domains. Research indicates that reduced diversity constrains the range of perspectives available for innovation and problem-solving [9].

Conversely, respondents acknowledged growing societal awareness of sustainability, digital transformation, and global competitiveness. Increased interest in renewable energy, digital technologies, and health innovation reflects broader global shifts in societal priorities and technological direction [10], [15].

3.2 Measures Identified to Enhance Technological Contribution

Students emphasized that improving technological outcomes requires **coordinated institutional and societal interventions**. Key measures identified include increased public investment in research and development, establishment of innovation hubs within universities, strengthened university–industry

collaboration, and expanded access to research funding for early-career scientists and engineers. These recommendations are consistent with international best practices in innovation policy [11], [12].

Early STEM exposure, mentorship programs, and the visibility of local scientific role models were also highlighted as critical mechanisms for strengthening long-term engagement with innovation. UNESCO reports similarly emphasize the role of youth-centered innovation initiatives in building sustainable technological capacity [15].

3.3 Policy Implications

The student perspectives reinforce the need for higher education systems that move beyond credential production toward **innovation-oriented human capital development**. Policies promoting institutional autonomy, adaptive curricula, research investment, and ethical workforce mobility are essential for enabling graduates to contribute meaningfully to technological advancement. These findings align with UNESCO–WHO frameworks for workforce planning and sustainable development [1], [2].

Strategic alignment between tertiary education outputs and national development priorities can enhance the societal returns on educational investment and strengthen national and planetary technological resilience [10], [12].

4. Conclusion

This study examined the determinants of career choice in tertiary education and their implications for technological development, drawing on survey evidence from 2,000 engineering and medical students in selected developing economies, with a primary focus on Zambia and Zimbabwe. The findings demonstrate that the limited translation of graduate output into technological advancement is not primarily a consequence of insufficient human capital, but rather the result of systemic constraints embedded within education systems, governance structures, and socio-cultural environments.

The analysis shows that while enrollment in engineering and medical programs continues to expand, graduates' capacity to contribute to innovation and technological problem-solving is constrained by curriculum misalignment, inadequate research and training infrastructure, and weak integration between higher education institutions and national development priorities. These structural limitations reduce opportunities for applied research, design-oriented learning, and interdisciplinary collaboration—factors widely recognized as essential for technological progress [1], [11], [12].

The study further highlights the complementary roles of engineers and medical professionals in shaping national and planetary development trajectories. Engineers contribute directly to infrastructure development, industrial productivity, and emerging technologies, while medical professionals sustain population health and human capital, which underpin long-term scientific and technological productivity [2], [3]. Imbalances in training capacity, workforce planning, and professional utilization can therefore undermine both technological and societal outcomes.

Socio-cultural influences, including early educational exposure, career guidance practices, and prevailing social norms, were found to play a significant role in shaping career motivations and professional expectations. When tertiary education pathways are pursued primarily for credential acquisition and employment security, rather than innovation-driven problem-solving, the broader innovation ecosystem is weakened. These findings are consistent with prior research on human capital formation and innovation systems in developing contexts [13], [14].

From a policy perspective, the results underscore the importance of aligning tertiary education systems with long-term technological and development objectives. Strategic investment in research infrastructure, adaptive and interdisciplinary curricula, strengthened university–industry collaboration, and ethical workforce mobility frameworks can enhance the contribution of graduates to national and global technological advancement [10], [12], [15]. Importantly, such interventions require sustained institutional commitment and governance structures that support academic autonomy, evidence-based planning, and continuous curriculum renewal.

This study contributes to the literature by empirically linking career choice determinants in tertiary education to broader patterns of technological development, thereby bridging education research and development policy analysis. While the findings are grounded in case studies from Southern Africa, the underlying dynamics identified are relevant to many developing economies facing similar challenges. Future research could extend this work through longitudinal analysis, cross-regional comparison, and integration of labor-market outcome data to further refine workforce planning strategies.

In conclusion, enhancing technological development in developing economies requires not only expanding access to higher education, but also ensuring that career pathways, institutional structures, and socio-cultural contexts enable graduates to function as active contributors to innovation and sustainable development at both national and planetary scales.

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