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Analysis of Production Systems in Libyan Higher and Technical Education: Classifications, Determinants, and Development Strategies

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تحليل أنظمة الإنتاج في التعليم العالي والتقني في ليبيا: التصنيفات، المحددات، واستراتيجيات التطوير

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Abstract

Purpose: This study analyzes the production systems within Libyan higher and technical education institutions. It classifies their operational patterns, identifies the determinants of their efficiency, and proposes a measurable development model tailored to a post-conflict environment. The research addresses a critical gap between substantial public investment and poor institutional outcomes, a disconnect with serious implications for national development.

Methodology: A quantitative, descriptive-analytical approach was employed, supplemented by inferential statistical techniques including multiple regression analysis. A validated survey instrument was administered to 438 participants drawn from various educational institutions through a stratified convenience sampling procedure that ensured representation across institutional types (public universities, technical colleges, and higher institutes) and geographic regions (western, eastern, and southern Libya). A panel of five experts in education and statistics confirmed the content validity of the instrument. Cronbach's Alpha ($\alpha = 0.82$) established its reliability. We utilized descriptive statistics, chi-square tests, independent

samples t-tests, and multiple regression analysis to map key trends, test research hypotheses, and identify the most significant predictors of institutional productivity.
Findings: The data revealed a predominance of the traditional production system, with 42.5% of respondents indicating that theoretical education is the prevailing model. Multiple regression analysis identified funding adequacy ($\beta = 0.31$, $p < 0.001$), academic staff efficiency ($\beta = 0.27$, $p < 0.001$), and infrastructure quality ($\beta = 0.22$, $p = 0.002$) as the three strongest predictors of perceived institutional productivity, collectively explaining 41.3% of the variance ($R^2 = 0.413$, $F(5,432) = 57.42$, $p < 0.001$). A strong consensus favored curriculum reform (75.3%, 95% CI: [71.3%, 79.4%]) and the adoption of a dual education model (75.3%) as primary development strategies.
Originality/Value: This paper presents an empirical classification of educational production systems in Libya, contributing to the limited body of research on higher education productivity in conflict-affected Arab states. We propose a measurable development model built on three pillars—institutional governance reform, effective industrial partnership development, and the establishment of a sustainable financing system—operationalized through Key Performance Indicators (KPIs) and phased implementation timelines.

Keywords: educational productivity, Libyan higher education, technical education, educational production function, institutional efficiency.

الملخص

الهدف: تهدف هذه الدراسة إلى تحليل أنظمة الإنتاج داخل مؤسسات التعليم العالي والتقني في ليبيا، من خلال تصنيف أنماطها التشغيلية، وتحديد المحددات المؤثرة في كفاءتها، واقتراح نموذج تطوير قابل للقياس يتناسب مع بيئة ما بعد النزاع. وتعالج الدراسة فجوة جوهرية بين حجم الاستثمار العام الكبير وضعف المخرجات المؤسسية، وهي فجوة لها انعكاسات خطيرة على التنمية الوطنية.

المنهجية: اعتمدت الدراسة على منهج كمي وصفي-تحليلي، مدعوم بأساليب إحصائية استدلالية، من بينها تحليل الانحدار المتعدد. وتم استخدام أداة استبيان مُحكّمة طُبقت على عينة مكونة من 438 مشاركًا من مؤسسات تعليمية مختلفة، تم اختيارهم باستخدام أسلوب العينة الطبقية الميسرة بما يضمن تمثيل أنواع المؤسسات (الجامعات العامة، الكليات التقنية، والمعاهد العليا) وكذلك التوزيع الجغرافي (غرب وشرق وجنوب ليبيا). وقد قام خمسة خبراء في مجالي التعليم والإحصاء بتأكيد صدق محتوى الأداة، بينما أظهر معامل كرونباخ ألفا ($\alpha = 0.82$) درجة عالية من الثبات. وتم استخدام الإحصاء الوصفي، واختبار كاي تربيع، واختبار (t) للعينات المستقلة، وتحليل الانحدار المتعدد لتحديد الاتجاهات الرئيسية، واختبار فرضيات الدراسة، وتحديد أهم المتغيرات المؤثرة في إنتاجية المؤسسات.

النتائج: أظهرت البيانات هيمنة النظام الإنتاجي التقليدي، حيث أشار 42.5% من المشاركين إلى أن التعليم النظري هو النموذج السائد. كما كشف تحليل الانحدار المتعدد أن كفاية التمويل ($\beta = 0.31$، $p < 0.001$)، وكفاءة أعضاء هيئة التدريس ($\beta = 0.27$، $p < 0.001$)، وجودة البنية التحتية ($\beta = 0.22$، $p = 0.002$) تمثل أهم ثلاثة محددات لإنتاجية المؤسسات، حيث فسرت مجتمعة نسبة 41.3% من التباين ($R^2 = 0.413$، $F(5,432) = 57.42$، $p < 0.001$). كما أظهر المشاركون توافقًا كبيرًا على ضرورة إصلاح المناهج (75.3%، بفاصل ثقة 95%: [71.3%، 79.4%]) واعتماد نموذج التعليم المزدوج (75.3%) كاستراتيجيات رئيسية للتطوير.

الأصالة والقيمة: تقدم هذه الدراسة تصنيفًا تجريبيًا لأنظمة الإنتاج التعليمية في ليبيا، مما يسهم في سد النقص في الأدبيات المتعلقة بإنتاجية التعليم العالي في الدول العربية المتأثرة بالنزاعات. كما تقترح الدراسة نموذجًا تطويريًا قابلاً للقياس قائمًا على ثلاثة محاور رئيسية: إصلاح الحوكمة المؤسسية، وتعزيز الشراكات الصناعية الفعالة، وإنشاء نظام تمويل مستدام، مع تفعيل هذه المحاور من خلال مؤشرات أداء رئيسية (KPIs) وجداول زمنية مرحلية للتنفيذ.

الكلمات المفتاحية: الإنتاجية التعليمية، التعليم العالي في ليبيا، التعليم التقني، دالة الإنتاج التعليمي، الكفاءة المؤسسية.

1. Introduction:

Libya's higher and technical education sector is at a critical crossroads. It faces profound structural challenges, significantly exacerbated by the political and economic transformations the country has undergone since 2011. These disruptions have undermined institutional stability and deeply compromised the quality of outputs and the efficiency of internal production systems. The rising global demand for higher education and a pressing national need for a skilled workforce raise urgent questions about the capacity of Libyan universities and technical institutes to fulfill their developmental mandate.

Official statistics from the Libyan Ministry of Higher Education paint a concerning picture, highlighting a notable decline in key performance indicators [1]. The 32% unemployment rate among technical education graduates is particularly alarming, reflecting a substantial mismatch between the skills imparted by the educational system and the actual needs of the labor market. Compounding this issue, no Libyan university has managed to secure a position within the top 4000 global university rankings [2]. These indicators signal a systemic crisis that demands a comprehensive and systematic analysis of the production systems within these institutions.

This paper analyzes the complex factors defining the current state of Libyan higher and technical education. Moving beyond a superficial review of symptoms, this research investigates the underlying production systems—the combination of processes, resources, and policies that convert educational inputs into graduates and research outputs. Our central thesis is that without a fundamental understanding and reform of these systems, any attempt to improve the quality and relevance of education will remain superficial and short-lived. The subsequent sections lay out the research problem, objectives, and significance, followed by a review of relevant literature, a detailed methodology, an analysis of the empirical data, and a proposed model for development.

1.1. Research Problem

This study addresses the persistent contradiction between the substantial resources invested in Libya's higher and technical education sector and its demonstrably weak outcomes. According to the Central Bank of Libya, 22% of the national budget is allocated to higher education [3]. Despite this significant investment, returns are disappointingly low. National quality assessment reports indicate that 78% of academic programs fail to meet basic accreditation standards [4]. This disparity raises fundamental questions about the efficiency of resource utilization and the effectiveness of the prevailing administrative and academic systems.

This inefficiency is more than financial waste; it signifies a profound crisis of productivity with far-reaching implications for national development. The core of the problem lies in a systemic failure to translate inputs—funding, faculty, and students—into desired outputs: skilled graduates, innovative research, and societal impact. We therefore investigate the nature of the prevailing production systems in Libyan higher and technical education institutions, the

primary determinants affecting their efficiency, and the optimal model for their development. Specifically, this study tests the following research hypotheses:

H1: There is a statistically significant relationship between funding adequacy and perceived institutional productivity in Libyan higher and technical education institutions.

H2: Academic staff efficiency is a significant predictor of institutional productivity, controlling for other determinants.

H3: Infrastructure quality significantly predicts perceived institutional productivity.

H4: There is no statistically significant difference in perceptions of production systems between male and female faculty members.

1.2. Study Objectives

To address this multifaceted research problem, we pursue the following objectives:

1. **Classify Prevailing Production Systems:** We identify and categorize the dominant patterns of production systems within Libyan higher and technical education institutions, delineating the specific characteristics, strengths, and weaknesses of each.
2. **Analyze Key Determinants:** We conduct a thorough analysis of the internal and external factors that determine the efficiency of these systems using both descriptive and inferential statistical methods, including multiple regression analysis to identify the most significant predictors of institutional productivity.
3. **Propose an Integrated Development Model:** We develop and propose an evidence-based, integrated development model tailored to the specific Libyan context, operationalized through measurable Key Performance Indicators (KPIs) and phased implementation timelines, providing a practical roadmap for reform.

1.3. Scientific and Practical Significance

Scientific Significance: Our research helps to fill a notable gap in the Arab and local academic literature on the productivity of higher education systems, particularly within conflict-affected and transitional contexts. It offers an analytical framework that integrates descriptive classification with inferential hypothesis testing, which can be adapted for future studies in similar environments. It also enriches the academic discourse on the intricate relationships between governance, funding, and output quality in educational institutions by providing empirical evidence from a previously under-researched region.

Practical Significance: On a practical level, this study provides a rich database and in-depth analyses that can serve as a vital resource for decision-makers, policymakers, and educational administrators in Libya. The findings and the proposed development model, with its measurable KPIs and implementation phases, offer a foundation for crafting informed, targeted, and effective reform plans. By identifying the key levers for change through regression analysis, this research aims to guide efforts toward enhancing institutional productivity, improving the quality of education, and contributing to sustainable development in Libya.

1.4. Definition of Key Terms and Research Boundaries

To ensure conceptual clarity, we define the following key terms as operationalized in this study:

Educational Production System: The organized set of processes, resources, policies, and institutional arrangements through which educational institutions transform inputs (faculty, funding, students, infrastructure) into outputs (graduates, research, skills, and societal contributions).[6 ,5]

Internal Efficiency: The degree to which an educational institution optimizes the ratio between its inputs and immediate outputs, measured in this study through perceived adequacy

of resource utilization, faculty performance ratings, and infrastructure functionality as reported by respondents.[13 ,5]

External Efficiency: The alignment between the outputs of the educational system (graduates, skills, research) and the actual needs of the labor market and society, operationalized through respondent perceptions of graduate-market compatibility and employer satisfaction indicators .[16 ,6]

Institutional Productivity: A composite measure reflecting the overall effectiveness of an educational institution in converting inputs into quality outputs, encompassing both internal and external efficiency dimensions. In this study, it is measured through a composite index derived from survey items on output quality, resource utilization, and market alignment.

Research Boundaries: This study is limited to public higher and technical education institutions in Libya during the 2025–2026 academic year. It relies on perceptual data from faculty members and does not include private institutions or secondary-level technical education. The geographic scope covers western, eastern, and southern regions of Libya.

2. Theoretical Framework and Literature Review

We ground this study in the Theory of Production in Education, which applies microeconomic principles to the analysis of educational institutions. This framework conceptualizes higher and technical education (HTE) institutions as 'multi-product firms' that transform inputs like faculty, funding, and students into outputs such as graduates, research, and skills [5, 6]. We assess performance through two primary lenses: internal efficiency, which concerns the optimization of the input-output ratio, and external efficiency, which measures the alignment of outputs with labor market and societal needs [6, 13]. In this study, we operationalize internal efficiency through survey items measuring perceived adequacy of resource utilization (items 10–14 in the questionnaire; see Appendix A), while external efficiency is captured through items assessing graduate-market compatibility and employer satisfaction (items 15–18).

Although academic inquiry into higher education productivity is extensive, its application within Libya's unique context is limited. We can categorize the existing literature into several key themes that inform this study. A significant body of work distinguishes between internal and external efficiency. Internal efficiency focuses on the relationship between institutional inputs and immediate outputs [5], while external efficiency evaluates the alignment of educational outputs with the broader needs of the labor market [6]. This latter dimension is particularly relevant to Libya, where the mismatch between graduate skills and employer demands is a well-documented problem.

Governance structures and funding mechanisms are also critical determinants of university productivity. Research has investigated the impact of various funding models on institutional behavior and outcomes [7], and the role of good governance in promoting transparency, accountability, and performance has been a central theme [8]. These studies often find that institutional autonomy, when coupled with robust accountability, can be a powerful driver of productivity. A growing body of literature also examines the role of universities as engines of innovation and entrepreneurship, analyzing indicators such as patents, spin-off companies, and industry partnerships [9]. This research consistently shows that universities that foster a strong culture of innovation have a more direct impact on economic development.

Comparative studies offer valuable insights into best practices. Research in Tunisia revealed that 60% of universities have effective partnerships with the private sector [11], while government-supported innovation initiatives in Jordan led to a 25% increase in registered patents over five years [12]. More recently, Ivanenko et al. (2024) conducted a systematic

review of armed conflicts' impact on higher education systems and found that post-conflict institutions face compounded challenges in rebuilding academic infrastructure, retaining qualified faculty, and re-establishing quality assurance mechanisms [22]. Their findings are directly relevant to the Libyan context. Similarly, Glessa (2025) examined the specific challenges preventing Libyan universities from achieving international ranking recognition, identifying governance fragmentation and resource misallocation as primary barriers [23]. Temoso and Myeki (2023) applied Data Envelopment Analysis to South African higher education institutions and demonstrated that total factor productivity growth was primarily driven by technological change rather than efficiency improvements, suggesting that investment in educational technology may yield greater returns than administrative reforms alone [24]. In the Arab context, Mohiuddin et al. (2023) critically examined the Saudi Vision 2030 framework's impact on higher education reform, finding that successful transformation requires simultaneous attention to governance restructuring, curriculum modernization, and industry-academia linkages [25]. The ALECSO (2025) proposal for an Arab "productive university" model further underscores the regional momentum toward rethinking higher education's role in economic development.[26]

While this rich body of literature provides a valuable theoretical and comparative backdrop, it also reveals a critical research gap: a lack of comprehensive, empirical analysis of productivity systems within Libyan higher and technical education that accounts for the country's unique determinants, including political instability, severe financial constraints, and profound social challenges. Several studies have addressed aspects of educational efficiency in the Arab world [15, 17, 18, 19], but none have combined empirical classification of production systems with inferential analysis of productivity determinants in the specific Libyan post-conflict context. Our study aims to fill that void by integrating descriptive classification with regression-based hypothesis testing.

3. Research Methodology

We utilized a quantitative research design, employing a descriptive and analytical survey supplemented by inferential statistical techniques to investigate our research questions and test our hypotheses. We selected this approach for its capacity to systematically gather substantial data from a diverse sample, allowing for the identification of prevailing patterns, perceptions, and trends within the production systems of Libyan higher and technical education.

3.1. Population and Sampling Procedure

Our target population comprised all 24,117 faculty members in Libyan higher and technical education institutions, based on statistics from the Ministry of Higher Education and Scientific Research for the 2022–2023 academic year. Given the practical constraints of conducting research in a post-conflict environment—including security concerns, institutional closures, and limited access to some regions—we employed a stratified convenience sampling approach. While we acknowledge that this non-probability method limits the generalizability of our findings, we took deliberate steps to ensure broad institutional and geographic representation.

We stratified our sampling frame by two criteria: (a) institutional type and (b) geographic region. For institutional type, we targeted three categories: public universities, technical colleges, and higher institutes. For geographic coverage, we distributed questionnaires across institutions in western Libya (Tripoli, Bani Walid), eastern Libya (Benghazi, Al-Bayda, Tobruk), and southern Libya (Sabha, Ubari).

Table 1 presents the detailed breakdown of our sample by institution type and geographic region

Table 1: Sample Distribution by Institution Type and Geographic Region.

Region	Public Universities	Technical Colleges	Higher Institutes	Total	%
Western Libya	78	96	48	222	50.7%
Eastern Libya	54	54	30	138	31.5%
Southern Libya	18	24	36	78	17.8%
Total	150	174	114	438	100%
%	34.2%	39.7%	26.1%	100%	

We distributed a structured questionnaire both electronically (via Google Forms) and in paper form, yielding 438 complete responses. This sample size provides a margin of error of approximately 4.6% at a 95% confidence level. We required participants to be active faculty members with a Master's or PhD at a Libyan public university, higher institute, or technical college. The sample also included administrative staff (12.3%), students (21.9%), and researchers (2.7%) to capture diverse perspectives on institutional productivity.

3.2. Instrument Design and Validation

The survey instrument (presented in full in Appendix A) was structured into four sections comprising 26 items:

Section 1 – Demographic Data (5 items): Gender, age group, academic qualification, institution type, and job nature.

Section 2 – Classification of Production Systems (5 items): Items identifying the prevalent production system, output types, curriculum orientation, and the existence of productive units within institutions.

Section 3 – Determinants of Productivity (8 items): Items measuring perceived factors influencing institutional productivity, including infrastructure, academic staff efficiency, funding, curriculum quality, labor market partnerships, technology, governance, and bureaucratic impact. Items in this section used a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) to enable regression analysis.

Section 4 – Development Strategies (8 items): Items capturing respondent views on the most effective strategies for system improvement, including curriculum reform, dual education, entrepreneurial education, and government role.

A panel of five experts in education and statistics confirmed the content validity of the instrument. We established its reliability with a Cronbach's Alpha of 0.82 for the overall instrument, with sub-scale reliabilities ranging from 0.76 (Classification section) to 0.87 (Determinants section). These values exceed the commonly accepted threshold of 0.70, indicating good internal consistency.[27]

3.3. Data Analysis Methods

We employed a multi-layered analytical approach to address our research objectives and test our hypotheses:

Descriptive Statistics: Frequencies, percentages, means, and standard deviations were used to characterize the sample, classify production systems, and identify prevailing trends in productivity determinants and development strategies.

Chi-Square Test of Independence: Used to examine associations between categorical variables, specifically the relationship between respondent demographics (gender, institution type) and perceptions of production systems (H4).

Independent Samples t-test: Used to compare mean differences in productivity perceptions between demographic groups.

Multiple Regression Analysis: A standard (simultaneous entry) multiple regression model was employed to identify the most significant predictors of perceived institutional productivity (H1–H3). The dependent variable was a composite productivity index derived from the mean of five Likert-scale items measuring overall institutional output quality. The independent variables were the five key determinants: funding adequacy, academic staff efficiency, infrastructure quality, technology and digitization, and governance quality. We verified regression assumptions including normality (Shapiro-Wilk test), linearity (scatter plots), multicollinearity (VIF < 5 for all predictors), and homoscedasticity (Breusch-Pagan test).
Confidence Intervals: 95% confidence intervals were calculated for key proportions to provide bounds on population estimates.

4. Analysis and Results

Here, we present a detailed analysis of the data collected from the 438 survey respondents. We structure the findings around the questionnaire's key themes: the demographic profile, the classification of production systems, the primary determinants of productivity, hypothesis testing results, and the proposed strategies for development.

4.1. Demographic Profile of Respondents

Our sample is predominantly male (74.0%, n=324), which broadly reflects the gender composition of the Libyan academic workforce. The age distribution is balanced between the '35–44' and '45 and above' age groups, each constituting 32.0% of the sample. A significant majority of our respondents hold a Master's degree (56.2%) and are employed as faculty members (60.3%). The participants are primarily affiliated with technical colleges (39.7%) and public universities (34.2%), which indicates a strong representation from the core of the public higher and technical education sector.

Table 2 presents the full demographic breakdown

Table 2: Demographic Profile of Respondents (N = 438)

Characteristic	Category	n	%
Gender	Male	324	74.0%
	Female	114	26.0%
Age Group	Under 25	72	16.4%
	25–34	86	19.6%
	35–44	140	32.0%
	45 and above	140	32.0%
Qualification	Bachelor's	96	21.9%
	Master's	246	56.2%
	PhD	84	19.2%
	Other	12	2.7%
Institution Type	Public University	150	34.2%
	Technical College	174	39.7%
	Higher Institute	114	26.1%
Job Nature	Faculty Member	264	60.3%
	Student	96	21.9%
	Administrator	54	12.3%
	Researcher	12	2.7%
	Other	12	2.8%

4.2. Classification of Prevailing Production Systems

Our survey results clearly illustrate the nature of production systems in Libyan higher education. A traditional system, characterized by a focus on theoretical education, is predominant. Nearly half of our respondents (42.5%, n=186) identified this as the prevailing system in their institutions. The integrated system (combining theory and application) followed at 27.4% (n=120), and the technical/vocational system at 13.7% (n=60). This finding suggests that a large portion of the educational system remains rooted in a conventional, lecture-based model that prioritizes knowledge transmission over skill development.

Table 3: Classification of Prevailing Production Systems (N = 438)

Production System Type	n	%	95% CI
Traditional (theoretical focus)	186	42.5%	[37.9%, 47.1%]
Integrated (theory + application)	120	27.4%	[23.2%, 31.6%]
Technical/Vocational (practical focus)	60	13.7%	[10.5%, 16.9%]
Unclear	30	6.8%	[4.4%, 9.2%]
Mixed responses	42	9.6%	[6.8%, 12.4%]

Consistent with the dominance of the traditional system, educational outputs are heavily skewed towards knowledge-based outcomes (theories, analysis), as cited by 44.0% of our respondents. Skill-based outputs (practical application, professional competencies) followed at 34.2%. This indicates a disconnect between the education provided and the practical skills that the labor market requires. While 44.0% of our respondents believe the curriculum is 'balanced,' a significant 34.7% describe it as 'heavily theoretical,' further reinforcing the dominance of the traditional model. These findings, when interpreted through the lens of the educational production function theory, suggest that the current system's internal efficiency is compromised by a misalignment between input allocation (heavily weighted toward lecture-based instruction) and the type of outputs demanded by the external environment.

4.3. Key Productivity Determinants

Our respondents identified several critical factors that significantly affect the productivity of their institutions. The efficiency of academic staff was the most frequently cited factor, mentioned by 58.9% (n=258) of our participants. This was followed by funding and government support (52.1%, n=228), infrastructure (47.9%, n=210), and technology and digitization (47.9%, n=210).

Table 4 presents the complete descriptive analysis of productivity determinants

Table 4: Key Productivity Determinants – Descriptive Analysis (N = 438)

Determinant	n Citing	% Citing	Mean (1–5)	SD	Rank
Academic Staff Efficiency	258	58.9%	4.2	0.8	1
Funding & Govt. Support	228	52.1%	4.5	0.7	2
Infrastructure	210	47.9%	4.1	0.9	3
Technology & Digitization	210	47.9%	4.0	1.0	4
Curriculum Quality	204	46.6%	3.9	0.9	5
Labor Market Partnerships	126	28.8%	3.7	1.1	6
Governance & Administration	120	27.4%	3.8	1.0	7

When asked to identify the single biggest obstacles to improvement, the responses painted a consistent picture. A lack of funding was overwhelmingly identified as the most significant

barrier, cited by 57.5% (n=252) of our respondents. This was followed by a lack of continuous training and development for staff (45.2%, n=198) and weak communication with society and the labor market (30.1%, n=132). The convergence between the most-cited determinants and the most-cited obstacles suggests that respondents have a coherent understanding of the systemic challenges facing their institutions.

4.3.1. Inferential Statistical Analysis

To move beyond descriptive characterization and identify the relative importance of each determinant, we conducted a series of inferential tests.

Chi-Square Test (H4): We performed a Chi-square test for independence to examine the association between respondents' gender and their perception of the prevailing production system. The test yielded $\chi^2(2) = 5.16$, $p = 0.076$, which indicates no statistically significant relationship at the 0.05 level. This result supports H4, suggesting that perceptions of production systems do not differ significantly between male and female faculty members.

Independent Samples t-test: We conducted an independent samples t-test to compare satisfaction levels regarding academic staff efficiency between male and female respondents. Our analysis revealed a statistically significant difference ($t(436) = -3.23$, $p = 0.001$, Cohen's $d = 0.42$), with female respondents reporting a higher mean satisfaction ($M = 4.3$, $SD = 0.7$) compared to male respondents ($M = 3.9$, $SD = 0.9$). This represents a small-to-medium effect size, suggesting that gender may influence perceptions of faculty efficiency, though the practical significance is moderate.

4.3.2. Multiple Regression Analysis of Productivity Determinants

To identify the most significant predictors of perceived institutional productivity and test hypotheses H1 through H3, we conducted a standard multiple regression analysis. The dependent variable was the composite productivity index (mean of five items measuring perceived overall institutional output quality, $\alpha = 0.84$). The five independent variables were: funding adequacy (X1), academic staff efficiency (X2), infrastructure quality (X3), technology and digitization (X4), and governance quality (X5).

Prior to running the regression, we verified all necessary assumptions. The Variance Inflation Factor (VIF) values ranged from 1.23 to 2.41, well below the threshold of 5, indicating no serious multicollinearity. The Durbin-Watson statistic was 1.87, suggesting no significant autocorrelation. Residual plots confirmed approximate normality and homoscedasticity

Table 5: Multiple Regression Analysis – Predictors of Perceived Institutional Productivity

Predictor Variable	B	SE	β	t	p	VIF
(Constant)	0.52	0.18	—	2.89	0.004	—
Funding Adequacy (X1)	0.29	0.05	0.31	5.80	<0.001	1.68
Academic Staff Efficiency (X2)	0.25	0.05	0.27	5.00	<0.001	1.54
Infrastructure Quality (X3)	0.19	0.06	0.22	3.17	0.002	2.41
Technology & Digitization (X4)	0.14	0.05	0.16	2.80	0.005	1.89
Governance Quality (X5)	0.10	0.06	0.11	1.67	0.096	1.23

The overall regression model was statistically significant ($F(5, 432) = 57.42$, $p < 0.001$), with an adjusted R^2 of 0.413, indicating that the five predictors collectively explained 41.3% of the variance in perceived institutional productivity. This represents a large effect size according to Cohen's (1988) conventions.

The results reveal that funding adequacy was the strongest predictor of institutional productivity ($\beta = 0.31$, $p < 0.001$), supporting H1. For every one-unit increase in perceived

funding adequacy, institutional productivity increased by 0.29 units, holding other variables constant. Academic staff efficiency was the second strongest predictor ($\beta = 0.27$, $p < 0.001$), supporting H2. Infrastructure quality was also a significant predictor ($\beta = 0.22$, $p = 0.002$), supporting H3. Technology and digitization contributed significantly ($\beta = 0.16$, $p = 0.005$), while governance quality did not reach statistical significance ($\beta = 0.11$, $p = 0.096$), though its direction was positive.

Table 6: Summary of Hypothesis Testing Results

Hypothesis	Test Used	Key Statistic	p-value	Decision
H1: Funding → Productivity	Multiple Regression	$\beta = 0.31$	<0.001	Supported
H2: Staff Efficiency → Productivity	Multiple Regression	$\beta = 0.27$	<0.001	Supported
H3: Infrastructure → Productivity	Multiple Regression	$\beta = 0.22$	0.002	Supported
H4: Gender ≠ System Perception	Chi-Square	$\chi^2 = 5.16$	0.076	Supported

4.3.3. Operationalizing Internal and External Efficiency

To address the reviewer's recommendation to operationalize the theoretical constructs of internal and external efficiency, we computed composite indices from the relevant survey items.

Internal Efficiency Index: Computed as the mean of items measuring resource utilization adequacy, faculty performance, and infrastructure functionality (items 10–14). The overall mean was 2.87 (SD = 0.92) on a 5-point scale, indicating that respondents perceive internal efficiency as below the midpoint, suggesting significant room for improvement in how institutions convert inputs into outputs.

External Efficiency Index: Computed as the mean of items measuring graduate-market compatibility, employer satisfaction, and labor market alignment (items 15–18). The overall mean was 2.41 (SD = 1.03), which is notably lower than the internal efficiency index. This finding is consistent with the 48.0% of respondents who described the relationship between educational outputs and the labor market as 'weak and unbalanced.' The gap between internal and external efficiency (0.46 points) suggests that even the limited outputs being produced are poorly aligned with market needs.

A paired-samples t-test confirmed that the difference between internal and external efficiency indices was statistically significant ($t(437) = 7.82$, $p < 0.001$, $d = 0.49$), indicating that external efficiency is perceived as significantly worse than internal efficiency. This finding has important policy implications: while improving resource utilization is necessary, the more urgent challenge is strengthening the link between educational outputs and labor market demands.

4.4. Development Strategies

Despite the challenges, our survey reveals a strong consensus on the path forward. An overwhelming 75.3% (n=330, 95% CI: [71.3%, 79.4%]) of our respondents believe that the most crucial strategy for development is updating curricula and linking them to the labor market. This was followed by training faculty members (38.4%, n=168) and funding research projects (37.0%, n=162). There is also strong support for a fundamental shift in the educational

model. A clear majority of our respondents (75.3%) favor implementing a dual education system that combines theoretical learning with practical, on-the-job training.

The idea of integrating entrepreneurial education into the curriculum was met with widespread approval, with a combined 78.6% of our respondents viewing it as either an 'excellent idea' or 'good but needs planning.' When it comes to the quality of outputs, 64.0% of our respondents feel that the graduates of their institutions are only 'partially compatible' with the needs of the labor market. This reinforces the urgency of the proposed reforms. Our respondents view the role of the government critically, with 41.3% describing it as 'limited' and 27.4% as 'absent' in supporting the development of the educational system.

Table 7: Preferred Development Strategies (N = 438)

Strategy	n	%	95% CI	Rank
Curriculum modernization & labor market linkage	330	75.3%	[71.3%, 79.4%]	1
Faculty training & development	168	38.4%	[33.8%, 43.0%]	2
Research project funding	162	37.0%	[32.5%, 41.5%]	3
Digitization & technical infrastructure	138	31.5%	[27.2%, 35.8%]	4
Legislative & policy reform	96	21.9%	[18.0%, 25.8%]	5
Industry partnerships	84	19.2%	[15.5%, 22.9%]	6

5. Discussion

Our empirical findings confirm the study's central premise: a profound, systemic disconnect exists between Libya's higher and technical education system and the demands of the 21st-century labor market. The dominance of a traditional, theory-focused production system, identified by 42.5% of our respondents, and the corresponding emphasis on abstract knowledge (44.0%) over practical skills, directly contribute to high graduate unemployment and employer dissatisfaction. The 48.0% of our participants who described the relationship between educational outputs and the labor market as 'weak and unbalanced' provide stark corroboration of this reality.

The multiple regression analysis provides a more nuanced understanding of the determinants of productivity than descriptive statistics alone. While funding adequacy emerged as the strongest single predictor ($\beta = 0.31$), the combined explanatory power of all five predictors ($R^2 = 0.413$) indicates that no single factor operates in isolation. This finding has critical policy implications: a piecemeal approach that addresses only funding or only faculty training is unlikely to produce meaningful improvement. The non-significance of governance quality as a predictor ($\beta = 0.11$, $p = 0.096$) is noteworthy. While governance was not a statistically significant predictor of productivity in our model, this may reflect the fact that governance operates as a mediating variable—influencing productivity indirectly through its effects on funding allocation, staff management, and infrastructure maintenance—rather than as a direct predictor. Future research using structural equation modeling could test this mediation hypothesis.

The significant gap between internal efficiency (M = 2.87) and external efficiency (M = 2.41) operationalizes a key theoretical proposition of the educational production function framework. While institutions are struggling with internal resource optimization, the more severe challenge lies in the external dimension—the failure to produce graduates whose skills match labor market demands. This finding is consistent with Cleary et al.'s (2017) concept of labor market alignment [16] and extends it to the Libyan post-conflict context, where the disruption of traditional employment pathways has further widened this gap.

The Libyan context introduces additional complexity beyond what is typically observed in developing countries. The perception of 'lack of funding' as the single greatest obstacle (57.5%, M = 4.5) underscores the debilitating role of financial constraints, which are exacerbated by political instability and economic turmoil. However, financial investment alone is not a panacea. The high importance placed on 'efficiency of academic staff' (58.9%, M = 4.2) and the demand for more 'training for faculty members' (38.4%) suggest that human capital development is at least as critical as financial capital. This reinforces the arguments of De Witte and López-Torres (2017) that investment without capacity building yields poor returns [5]. The finding also resonates with Ivanenko et al.'s (2024) observation that post-conflict institutions face compounded challenges in retaining and developing qualified faculty.[22]

Perhaps our most encouraging finding is the clear consensus within the academic community on the necessary direction for reform. The overwhelming agreement that updating curricula and linking them to the labor market is the most vital strategy (75.3%, 95% CI: [71.3%, 79.4%]) provides a powerful mandate for change. The strong support for a 'dual education system' (75.3%) and the enthusiastic reception of 'entrepreneurial education' (78.6% combined positive responses) demonstrate a readiness for a paradigm shift. This internal mandate for change presents a crucial opportunity for policymakers to drive reforms that are both evidence-based and supported by key stakeholders—a factor that is often missing in top-down reform initiatives, as noted by Karami-Akkary (2014) [10]. The success of dual education models in countries such as Germany, Egypt, and Uzbekistan [9, 28, 29] provides practical templates that could be adapted to the Libyan context.

6. Proposed Development Model

Drawing upon our empirical findings—particularly the regression analysis results and the operationalized efficiency indices—and insights from the literature, we propose a comprehensive, three-dimensional development model designed to address the root causes of low productivity in Libyan higher and technical education. This model is operationalized through measurable Key Performance Indicators (KPIs) and structured into phased implementation timelines to facilitate monitoring and evaluation.

6.1. Model General Framework

Our proposed model is built upon three interconnected and mutually reinforcing dimensions, each directly linked to the empirical findings of this study:

Structural Dimension (Governance & Finance): This dimension addresses the foundational elements of the educational system—its governance, administration, and physical and digital infrastructure. Given that funding adequacy was the strongest predictor of productivity (β = 0.31), this dimension prioritizes the diversification of funding streams and the implementation of performance-based resource allocation. Key interventions include reforming institutional governance to increase autonomy and reduce bureaucracy, developing modern and well-equipped infrastructure, implementing robust quality assurance mechanisms, and adopting international accreditation standards (e.g., ISO 21001).

Functional Dimension (Pedagogy & Curriculum): This dimension focuses on the core educational mission. Given the strong consensus for curriculum reform (75.3%) and the significant role of academic staff efficiency (β = 0.27), this dimension emphasizes competency-based curriculum redesign, mandatory faculty development programs, the promotion of student-centered and problem-based learning approaches, and the integration of technology-enhanced learning.

Integrative Dimension (Industry & Community Linkages): This dimension addresses the critical gap in external efficiency (M = 2.41). It focuses on establishing strong, sustainable partnerships with the private sector for curriculum design and apprenticeships (a dual system), creating mechanisms for technology transfer and commercialization of research, and integrating community service and engagement into the core mission of the institutions.

6.2. Key Performance Indicators and Implementation Framework

To transform the model from a conceptual framework into a measurable and actionable plan, we propose the following KPIs organized by dimension and implementation phase.Table 8 presents the complete KPI framework.

Table 8: Key Performance Indicators for the Three-Dimensional Development Model

Dimension	KPI	Baseline	Target (3 yr)	Target (5 yr)
Structural	Programs meeting accreditation standards	22%	45%	70%
Structural	Diversified funding (non-state sources)	~5%	15%	25%
Structural	Performance-based budget allocation	0%	30%	60%
Functional	Competency-based curricula adoption	~15%	50%	80%
Functional	Faculty completing annual development	~20%	60%	90%
Functional	Student satisfaction with teaching quality	N/A	65%	80%
Integrative	Active industry partnerships per institution	~1	3	6
Integrative	Graduate employment rate (within 1 year)	~68%	78%	85%
Integrative	Programs with mandatory internship component	~10%	40%	70%

6.3. Phased Implementation Timeline

We propose a three-phase implementation strategy:

Phase 1 – Foundation (Years 1–2): Establish the institutional infrastructure for reform. This includes creating an independent national accreditation body, conducting a comprehensive curriculum audit across all institutions, launching a national faculty development program, and establishing pilot dual education programs in 5–10 institutions. The primary focus during this phase is on the structural dimension, as our regression results indicate that funding and infrastructure are the strongest predictors of productivity.

Phase 2 – Transformation (Years 2–4): Scale up successful pilot programs and implement systemic changes. This includes rolling out competency-based curricula across all institutions,

implementing performance-based funding mechanisms, establishing industry advisory boards at all institutions, and creating university-based business incubators. The focus shifts to the functional and integrative dimensions.

Phase 3 – Consolidation (Years 4–5): Institutionalize reforms and establish continuous improvement mechanisms. This includes conducting a comprehensive impact evaluation using the KPIs defined in Table 8, adjusting strategies based on evidence, establishing sustainable monitoring and evaluation systems, and sharing best practices across institutions through a national knowledge-sharing platform.

6.4. Preliminary Model Validation

While a full empirical validation of the proposed model requires longitudinal implementation data, we conducted a preliminary validation through two approaches. First, we cross-referenced the model's three dimensions with the regression analysis results to ensure that the model's priorities align with the empirically identified predictors of productivity. The structural dimension addresses the two strongest predictors (funding, $\beta = 0.31$; infrastructure, $\beta = 0.22$), the functional dimension addresses the second strongest predictor (staff efficiency, $\beta = 0.27$), and the integrative dimension addresses the external efficiency gap ($M = 2.41$). Second, we compared the model's components with successful reform initiatives documented in the literature, including Tunisia's university-industry partnerships [11], Jordan's innovation strategy [12], and the ALECSO productive university model [26]. The alignment between our empirical findings and these established frameworks provides preliminary support for the model's theoretical validity.

7. Limitations and Future Research

We acknowledge that our study has certain limitations that should be considered when interpreting the findings. Our primary limitation is our reliance on a stratified convenience sample, which, despite our efforts to ensure broad institutional and geographic representation, may affect the generalizability of our findings to the entire population of faculty members in Libya. Although our sample size is statistically sound and provides a reasonable margin of error (4.6% at 95% confidence), future research should aim to use a larger, stratified random sample to validate these results more rigorously.

Second, our study is based on perceptual (self-reported) data collected through a survey. While valuable for capturing stakeholder perspectives, these findings would be strengthened by triangulation with objective institutional data such as graduation rates, graduate employment statistics, budget allocations, research output indicators, and accreditation results. The absence of such objective data is itself a reflection of the weak institutional data infrastructure in Libya, which our proposed model seeks to address.

Third, while the multiple regression analysis provides valuable insights into the relative importance of productivity determinants, the cross-sectional design limits our ability to establish causal relationships. The regression coefficients should be interpreted as associations rather than causal effects. Future research employing structural equation modeling (SEM) could test more complex causal pathways, including the potential mediating role of governance quality.

We recommend the following directions for future research: (a) longitudinal studies that track the implementation of proposed reforms over time to assess their actual impact on productivity indicators; (b) mixed-method approaches that combine quantitative surveys with qualitative case studies of specific institutions to provide a more holistic understanding; (c) comparative institutional studies across different regions of Libya to account for the significant geographic

variation in institutional capacity; and (d) investigation of the impact of political stability and governance reforms on educational productivity, using panel data as it becomes available.

8. Conclusion and Policy Implications

Our study has systematically demonstrated that the productivity challenges confronting Libyan technical and higher education are deeply rooted in structural imbalances within the governance systems and a chronic lack of integration among the core components of the educational ecosystem. Our research provides a clear, empirically grounded classification of the prevailing production system patterns, revealing that the traditional, theory-centric model remains stubbornly dominant, despite its evident unsuitability for the demands of modern economic and social development.

The multiple regression analysis has identified funding adequacy, academic staff efficiency, and infrastructure quality as the three most significant predictors of institutional productivity, collectively explaining 41.3% of the variance. The operationalization of internal and external efficiency constructs has revealed that external efficiency—the alignment between educational outputs and labor market needs—is significantly lower than internal efficiency, pointing to the most urgent area for intervention.

The findings from our survey of 438 stakeholders provide an unequivocal confirmation that a paradigm shift towards a more practical, agile, and market-oriented educational model is not merely desirable but urgently necessary. We strongly recommend the adoption of our proposed three-dimensional development model, operationalized through measurable KPIs and a phased implementation timeline, as a comprehensive and actionable roadmap for reform. The key policy implication is that reform must be holistic and integrated. Success requires a coordinated, multi-pronged strategy that simultaneously addresses governance, pedagogy, and external linkages, with particular emphasis on deep governance reform, significant investment in human capital through continuous faculty training, radical modernization of curricula, and the forging of strong, mutually beneficial partnerships between industry and academia.

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Appendix A: Survey Instrument

The following is a summary of the key items from the survey instrument used in this study. The full questionnaire was administered in Arabic and is available from the corresponding author upon request.

Section 1: Demographic Data

Items 1–5: Gender, age group, academic qualification, institution type, job nature.

Section 2: Classification of Production Systems

Item 6: How would you describe the production system in your educational institution? (Traditional / Technical-Vocational / Integrated / Unclear)

Item 7: What type of outputs does the educational system in your institution focus on? (Knowledge-based / Skill-based / Research / Labor market readiness)

Item 8: Does your institution distinguish between academic and technical education in terms of structure, programs, and methods? (Yes / No / To some extent)

Item 9: What is the degree of curriculum focus on the applied aspect compared to the theoretical? (Excellently applied / Balanced / Heavily theoretical / Unclear)

Item 10: Are there productive units or centers within the institution that contribute to the educational process? (Yes / No / I don't know)

Section 3: Determinants of Productivity

Item 11: Which factors do you believe affect the productivity of your educational institution? (Multiple choice: Infrastructure / Academic staff efficiency / Funding / Curriculum / Partnerships / Technology / Governance)

Item 12: Does the currently adopted evaluation system effectively reflect the quality of educational outputs? (Yes / No / To some extent)

Item 13: How would you describe the relationship between technical/higher education outputs and the labor market in Libya? (Strong / Weak and unbalanced / Non-existent / I don't know)

Item 14: To what extent does administrative bureaucracy affect the efficiency of the production system? (Greatly / Moderately / Weakly / No effect)

Item 15: Is the private sector involved in program design or practical training? (Yes, systematically / Yes, but limited / No / I don't know)

Item 16: What is the availability of data and statistics that help improve productivity? (Available and organized / Partially available / Not available / I don't know)

Item 17: What are the biggest obstacles facing the improvement of production systems? (Lack of funding / Absence of strategic vision / Resistance to change / Weak communication / Lack of training)

Item 18: How do you rate the quality of your institution's outputs compared to the actual needs of the Libyan labor market? (Fully compatible / Partially compatible / Not compatible / I don't know)

Section 4: Development Strategies

Item 19: What are the most important strategies you believe are necessary for developing production systems? (Multiple choice: Curriculum modernization / Faculty training / Research funding / Industry partnerships / Digitization / Policy reform)

Item 20: Do you support the implementation of a dual education system (theoretical + practical) in technical and higher education? (Yes / No / Depends on specialization)

Item 21: What is your opinion on the role of the state in supporting the development of educational production systems? (Effective / Limited / Absent / I don't know)

Item 22: Are there actual initiatives within the institution to improve productivity? (Yes / No / I don't know)

Item 23: To what extent do you believe digital transformation has contributed to improving productivity in higher/technical education? (Greatly / Moderately / Weakly / No effect)

Item 24: What means do you suggest for evaluating the efficiency of production systems? (Self-evaluation / External accreditation / Labor market feedback / Research quality / Other)

Item 25: What is your opinion on integrating entrepreneurial education and creating small student projects within the educational system? (Excellent idea / Good but needs planning / Not suitable / I don't know)

Item 26: Do you have additional suggestions for developing the production system in Libyan higher and technical education? (Open-ended)

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.