Synopsis

Introduction

India's skill development landscape is at a decisive juncture, shaped by one of the world's largest youth populations and a labour market undergoing rapid transformation. Short-term skill training (STT) programs have emerged as an important policy instrument for improving employability, particularly for youth from underserved communities. Flagship initiatives such as the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) at the national level and Utkarsh Bangla in West Bengal have sought to create large-scale skilling opportunities within compressed timeframes. However, despite substantial public investment, the performance of Training Providers (TPs) operating under these schemes remains uneven.

West Bengal, with its strong presence of both Center-Based and Industry-Integrated TPs, provides an ideal setting to examine the operational and contextual drivers of efficiency in state-sponsored training. The state's diverse socio-economic profile, mix of urban and rural training centres, and active industry participation create a rich environment for comparative efficiency analysis. Yet, systematic benchmarking of TP performance at the state level remains limited, with existing evaluations often focusing on output volumes rather than technical efficiency or qualitative outcomes.

Against this backdrop, the present study undertakes a comparative efficiency assessment of short-term skill training providers using an output-oriented Variable Returns to Scale (VRS) Data Envelopment Analysis (DEA) framework. The research not only benchmarks efficiency levels but also seeks to uncover the reasons why some providers achieve higher performance than others, integrating both quantitative and qualitative insights. This dual approach enables

a deeper understanding of operational practices, scale dynamics, and contextual factors—offering actionable guidance for policymakers, administrators, and training institutions.

By aligning DEA-based benchmarking with thematic interpretation from provider and trainee perspectives, the study bridges the gap between statistical evaluation and ground realities. It is designed to contribute both to academic literature on efficiency analysis in the skill development sector and to practical policymaking in state-level skilling missions.

Review of Literature

Skill Development Policy Framework

India's skill development ecosystem has evolved significantly, particularly after the establishment of the Ministry of Skill Development and Entrepreneurship (MSDE) in 2014. The National Skill Development Policy emphasises outcome-based training, industry-aligned curricula, and standardised certification under the National Council for Vocational Education and Training (NCVET). This policy orientation seeks to align training supply with labour market demand while ensuring consistent quality.

State governments complement national initiatives through locally designed schemes, adding another layer to the delivery system. In West Bengal, the flagship *Utkarsh Bangla* program operates under the Technical Education, Training & Skill Development Department, aiming to provide free, quality, short-term training linked to employment. This dual governance model creates a complex ecosystem, making efficiency evaluation both necessary and challenging.

Data Envelopment Analysis in Education and Training

Data Envelopment Data, first proposed by Charnes, Cooper, and Rhodes (1978), is a non-parametric frontier technique for evaluating the relative efficiency of decision-making units (DMUs) with multiple inputs and outputs. Banker, Charnes, and Cooper (1984) extended this

to Variable Returns to Scale (VRS), enabling analysis in contexts where units operate at different scales. DEA is particularly suited for public sector and educational settings, as it does not require a predefined production function and benchmarks each unit against an efficiency frontier of best performers (Emrouznejad & Yang, 2018).

In education and training, DEA has been widely applied to measure institutional efficiency. Studies have examined schools, universities, vocational institutions, and labour market training programs (Shi & Bangpan, 2022; Cho et al., 2013; Jespersen et al., 2007; Fuchs et al., 2021). For instance, Achi (2020) assessed technical efficiency of vocational institutions in Algeria, while Fatimah & Mahmudah Umi (2017) applied DEA to Indonesian elementary schools. More recently, Fazlollahtabar & Ebadi (2023) explored efficiency measurement in higher education contexts. However, Indian applications remain sparse. DEA has earlier not been applied to gauge the efficiency of short-term skill training providers.

Research Gap

In light of the gaps identified across both the global DEA literature and India-specific skill training studies, this research makes several distinct contributions—methodologically, contextually, and analytically -

1. **Adoption of an output-oriented VRS DEA model**: Most existing studies rely on input-oriented or CRS-based models, which are less suited to the performance-driven nature of short-term skill training schemes. This study adopts an output-oriented Variable Returns to Scale (VRS) approach, which better reflects the operational realities of government-funded programs where outcomes like trainee certification are emphasized, and input constraints are predefined.

2. **Comparative benchmarking of TP types**: Existing literature tends to treat the short-term training delivery models as

homogeneous groups. This study distinguishes between the two training delivery models - enabling more nuanced benchmarking and operational insights.

3. **Integration of qualitative data from trainees and training providers**: Unlike most studies conducted to evaluate the impact of short-term training schemes, this research combines quantitative benchmarking with qualitative feedback from certified trainees and institutional heads. This allows for a deeper understanding of not just how efficient providers are, but why they perform the way they do.

4. **Focus on India's under-researched STT ecosystem**: While DEA has been widely applied in global contexts, there is limited application in India's short-term skilling sector. This study focuses on Short-Term Skill Training Providers covering a diverse sample of providers—addressing a critical void in the empirical literature.

5. **Policy relevance and practice-level insights**: By combining efficiency scores with ground-level narratives, the study offers actionable insights for program administrators, policymakers, and training partners. These include best practices, inefficiency drivers, and potential levers for improving institutional performance in a decentralized skilling ecosystem.

Contribution of the Present Study

This study addresses these gaps by applying an output-oriented VRS DEA model to a large, state-level sample of short-term skill training providers in West Bengal, using K-means clustering to account for heterogeneity. It combines quantitative benchmarking with qualitative interviews and surveys and employs Tobit regression to link efficiency scores with contextual factors such as gender composition and social group representation. This integrated approach

not only measures efficiency but also explains it, providing a direct evidence base for targeted improvement strategies.

Research Objectives

The study aims to conduct a comprehensive efficiency assessment of short-term skill training providers in West Bengal, identifying operational and contextual factors that differentiate high-performing institutions from underperforming ones.

Research Objectives

- To identify the best practice benchmarks for different skill training providers using efficiency frontier
- Compare efficiency distributions between Center-based Training Providers vs. Industry-Integrated Training providers to determine which model delivers greater productivity and can be replicated nation-wide
- To understand how skill training programs can be scaled up by learning from the best in the market.
- Distil best practices from the most efficient TPs and propose actionable guidelines for government (Utkarsh Bangla) and training partners to elevate under-performing providers
- Policy and practice guidelines tailored to under-performing short-term training providers

Research Questions

RQ1: How efficient are training providers (TPs), relative to the DEA frontier, in converting inputs into certified training outcomes?

RQ2: What operational characteristics and institutional practices differentiate efficient TPs from their inefficient counterparts?

RQ3: How do certified trainees perceive their training experience, and do these perceptions vary based on the efficiency level of their training provider?

Hypotheses

Given the exploratory nature of mixed-methods research, this study is guided by open-ended research questions rather than formal hypotheses. However, the quantitative regression phase examines whether contextual characteristics such as gender composition, social group representation, or training model are statistically associated with variations in DEA-derived efficiency scores.

Methodology

Research Design

The study adopts an **explanatory sequential mixed-methods design (QUAN → QUAL)**. This design allows for an initial quantitative phase to measure and compare efficiency levels, followed by a qualitative phase to interpret the results in operational and contextual terms. This approach ensures that the efficiency scores are not only statistically valid but also practically meaningful.

Population and Sampling

The population comprises all short-term skill training providers (TPs) delivering government-sponsored programs in West Bengal during FY 23-25. According to the Technical Education, Training & Skill Development (TET&SD) Department, approximately 570 TPs were active during this period. The sampling frame included all such TPs with valid contact details. While a census approach was planned, complete data was obtained from **134 TPs** (63 Center-Based,

71 Industry-Integrated), with the coverage providing sufficient variability for efficiency analysis while maintaining statistical reliability and exceeding the minimum count of 12 DMUs.

DEA Model Specification

The Data Envelopment Analysis (DEA) is employed to measure **technical efficiency**, defined as the ability of a TP to maximise outputs from a given set of inputs. Given the policy focus on maximising certified trainees, an **output-oriented** approach was chosen. The **Variable Returns to Scale (VRS)** model, as per Banker, Charnes, and Cooper (1984), was selected because TPs operate at different scales and may not be functioning at optimal capacity.

The DEA model solves the following linear programming problem for each DMU

Maximize φ

Subject to:

- $\Sigma_j \lambda_j x_{ij} \leq x_{io}, \forall i = 1,...,m$
- $\Sigma_j \lambda_j y_{rj} \geq \varphi y_{ro}, \forall r = 1,...,s$
- $\Sigma_j \lambda_j = 1$
- $\lambda_j \geq 0, \forall j$

Where:

- φ represents the efficiency score ($\varphi \geq 1$; $\varphi = 1$ indicates efficiency)
- x_{ij} and y_{rj} are inputs and outputs for DMU j
- λ_j are intensity variables for peer DMUs
- The constraint $\Sigma_j \lambda_j = 1$ ensures VRS

An efficient DMU lies on the production frontier and scores 1. Inefficient units are ranked by the proportional increase in outputs they would need to match efficient peers under VRS assumptions.

Inputs:

- I1: Number of Trainees Enrolled
- I2: Average Experience of Trainers (years)
- I3: Average Course Duration (hours)

Output:

- O1: Number of Certified Trainees

These were finalised after correlation checks to remove redundancy, ensuring that no input or output was overly collinear with another. The output-oriented approach focuses on maximizing certification outcomes given standardized inputs across providers, aligning with public scheme objectives.

Clustering Analysis

To reduce bias from heterogeneity in operational scale and structure, **K-means clustering** was applied to the input–output data. This produced **three distinct clusters** of TPs with similar operational profiles. DEA was then run both globally and within each cluster to identify intra-group performance variations. The cluster approach enhances comparability by benchmarking TPs against peers with similar scale and resource profiles.

Tobit Regression

DEA scores are bounded between 0 and 1, which violates assumptions of ordinary least squares regression. A **Tobit model** is therefore used to account for the censored nature of the dependent variable (PTE score). The general model is:

$PTE_i^* = \beta_0 + \beta_1 Z_{1i} + \beta_2 Z_{2i} + ... + \beta_k Z_{ki} + \varepsilon_i$

Where:

- PTE_i^* is the latent efficiency score for training provider i
- Z_{ki} are environmental variables
- β_k are coefficients to be estimated
- $\varepsilon_i \sim N(0,\sigma^2)$ is the error term

Tobit regression model examines contextual drivers of efficiency, incorporating the below environmental variables -

- Percentage of female trainees
- Percentage of SC/ST/OBC trainees

Qualitative Data Collection

Qualitative insights are gathered through:

- **Training Provider Interviews**: 42 training providers participated in structured interviews covering operational practices, challenges, and strategies
- **Trainee Surveys**: 113 certified trainees provided feedback on training quality, trainer effectiveness, and job preparedness

Responses were thematically coded and integrated with quantitative findings to explain efficiency differences, identify best practices, and reveal operational bottlenecks.

Results and Expected Outcomes

Global DEA

The output-oriented VRS DEA model revealed substantial variability in the performance of the 134 TPs analysed. Only **18%** of providers were found to be fully efficient (PTE = 1.00), with the mean PTE score at **0.91**. This implies that, on average, TPs could increase their certified trainee output by approximately 9% without requiring additional inputs, if they adopted the practices of frontier units. Scale efficiency results indicated that a considerable portion of providers, particularly Center-Based TPs, operate below optimal scale, reflecting mismatches between capacity and utilisation.

Comparison by TP Type

Industry-Integrated providers demonstrated a clear advantage over Center-Based providers:

- 25.4% of Industry-Integrated TPs achieved full efficiency compared to 9.5% of Center-Based TPs.
- The difference in the incidence of full efficiency was statistically significant ($\chi^2 = 4.66$, $p = 0.0308$).

Operationally, Industry-Integrated providers tend to benefit by being direct employers or having direct employer partnerships, which streamline curriculum relevance, ensure better alignment between training and job requirements, and often facilitate smoother placements.

Tobit Regression Findings

The second-stage Tobit model revealed that the **percentage of female trainees** is positively and significantly associated with efficiency (coefficient = 0.00169, p = 0.018). Operationally, this may indicate that providers actively recruiting and supporting female trainees tend to adopt more structured, inclusive, and learner-focused operational practices, which in turn improve overall efficiency.

Representation of SC/ST/OBC trainees did not show a statistically significant effect (p = 0.404), suggesting that while social inclusion remains important for policy, it does not automatically translate into higher efficiency without corresponding operational adjustments.

Qualitative Insights

Efficient Provider Characteristics:

- Structured needs assessment using surveys and employer consultation
- Continuous market alignment and curriculum updates
- Proactive counselling and trainee support systems
- Sustained employer partnerships and placement focus

Inefficient Provider Patterns:

- Reliance on informal or ad-hoc planning methods
- Limited employer engagement and market research
- Reactive approach to challenges and constraints

Trainee Perspectives

Trainee satisfaction remains consistently high across all provider types (mean ratings ≈ 4.9/5.0), with minimal differentiation between efficient and inefficient providers. However, qualitative feedback reveals more detailed and confident responses from trainees of efficiently run training centers.

Integration of Findings

The combined quantitative and qualitative evidence underscores that efficiency in short-term skill training is not solely determined by scale or inputs but is heavily influenced by management practices, employer linkages, and the integration of inclusive training strategies.

Key Findings and Interpretation

1. **Efficiency Variation Across Providers:** The DEA results revealed significant variation in technical efficiency among training providers. Only a subset reached the efficiency frontier, while many operated below potential, indicating scope for better resource utilization.

2. **Industry-Integrated Superiority**: Industry-Integrated (II) providers consistently outperformed Centre-Based (CB) ones, being 1.8 times more likely to achieve full efficiency. This demonstrates that stronger industry linkages translate into better alignment with labour market needs.

3. **Cluster-Level Insights:** Clustering analysis showed efficiency differences across provider groups. Urban and industry-linked clusters reported higher performance, while rural and smaller providers often struggled due to infrastructure and resource constraints.

4. **Determinants of Efficiency:** Tobit regression indicated that contextual factors such as gender participation and social group representation had a significant association with efficiency outcomes. Providers with higher female enrolment tended to be more efficient.

5. **Qualitative Drivers of Performance:** Thematic analysis of provider and trainee perspectives highlighted that efficient providers were distinguished by practices such as structured mobilization, continuous trainer development, strong employer engagement, and outcome-linked counselling. These qualitative drivers complemented the quantitative DEA findings

Policy Recommendations

Drawing on both quantitative benchmarking and qualitative insights, the following policy recommendations aim to strengthen the effectiveness of short-term skill development programs. They reflect lessons from high-performing providers as well as challenges faced by those operating below efficiency potential.

1. **Align Training with Market Needs**
    - **Mandatory Needs Assessments:** Require providers to conduct labour market surveys and community consultations before finalizing training batches.
    - **Employer Involvement:** Institutionalize mechanisms for industry partners to co-design curricula, conduct guest sessions, and provide continuous feedback.
    - **Curriculum Responsiveness:** Introduce periodic course reviews led by Sector Skill Councils and industry experts to ensure alignment with evolving job roles.
2. **Strengthen Counselling and Trainee Support**
    - **Professionalize Counselling:** Define minimum qualifications and training standards for counsellors to ensure consistent quality.

- **Integrate Career Guidance:** Embed structured career counselling, motivation, and personal support into all programs, with monitoring for effectiveness.

3. **Promote Inclusion for Women and Marginalized Groups**
    - **Operational Inclusion Measures:** Require providers to implement flexible schedules, safe training environments, and community engagement strategies.
    - **Inclusion Monitoring:** Track enrolment and completion by gender and social group, linking incentives or recognition to demonstrated outreach and retention.
4. **Improve Placement and Post-Training Support**
    - **Localized Job Linkages:** Encourage partnerships with local industries to enhance placement sustainability while respecting trainees' mobility preferences.
    - **Relocation Support:** Provide structured guidance, stipends, or transition support for trainees willing to move, particularly from disadvantaged groups.
5. **Institutionalize Continuous Quality Improvement**
    - **Mandatory Feedback Loops:** Require training providers to collect and act upon feedback from trainees, employers, and alumni.
    - **Holistic Reviews:** Promote mixed-method evaluation frameworks that assess training quality beyond certification and placement statistics.
6. **Celebrate and Replicate Best Practices**
    - **Knowledge Sharing Platforms:** Publicize successful models of mobilization, counselling, and employer engagement.
    - **Peer Learning Networks:** Facilitate structured forums where weaker providers can learn directly from high-performing peers.

7. **Redefine Efficiency Beyond Numbers**
    - **Efficiency with Equity:** Ensure funding frameworks reward providers that serve high-barrier populations, not just those maximizing placement numbers.
    - **Expanded Success Metrics:** Include job quality, wage growth, career advancement, and empowerment indicators in monitoring frameworks.
    - **Recognize Diverse Aspirations:** Acknowledge that not all trainees seek immediate employment—many values certification, skill validation, or personal growth. Policy frameworks should reflect this diversity.

Implementation of these measures would not only improve efficiency scores but also enhance placement rates, reduce dropout rates, and ensure more equitable skill development outcomes across provider types.

Conclusions

Primary Contributions

This study is among the first to systematically assess the efficiency of short-term skill training providers (STSTPs) in India using an output-oriented, Variable Returns to Scale (VRS) DEA framework. By combining quantitative benchmarking with qualitative insights, the research highlights not only *how efficient providers are*, but also *why efficiency varies*. The integration of DEA, cluster analysis, Tobit regression, and thematic inquiry provides a holistic view of performance, positioning this study as a methodological contribution to the literature on skill development and efficiency evaluation.

1. **Methodological Innovation**: First comprehensive DEA-based efficiency assessment of India's short-term skill training providers with mixed-methods integration

2. **Empirical Insights**: Identification of specific operational practices that differentiate efficient providers, including structured needs assessment, continuous market alignment, and proactive counselling systems
3. **Policy Relevance**: Evidence-based framework for provider performance evaluation and improvement strategies

Practical Implications

The study provides actionable recommendations for multiple stakeholders:

For Policymakers:

- ✓ **Mandate labour market needs assessments** before course approvals to align training with real demand.
- ✓ **Strengthen employer linkages** by making industry participation in curriculum design and feedback compulsory.
- ✓ **Institutionalize counselling standards**, ensuring every training program has qualified career guidance staff.
- ✓ **Promote inclusion through incentives**, linking funding and recognition to gender and social group representation.
- ✓ **Redefine efficiency metrics** to go beyond placement counts, incorporating job quality, career progression, and long-term employability.
- ✓ **Facilitate peer learning platforms** for knowledge sharing between high- and low-performing providers.

For Training Providers:

- ✓ **Adopt structured mobilization strategies**, combining grassroots outreach with counselling to align trainee aspirations and job opportunities.

- ✓ **Invest in continuous trainer development**, ensuring trainers remain industry-relevant and pedagogically strong.
- ✓ **Build robust employer networks** to enhance placement opportunities and ensure smoother workplace transitions.
- ✓ **Implement practical inclusion measures** (flexible timings, safe environments, childcare support) to increase female and marginalized participation
- ✓ **Use feedback loops actively**, collecting insights from trainees, alumni, and employers to refine delivery.

Limitations and Future Scope

Limitations

While the study offers valuable insights, several limitations should be acknowledged:

- **Sample-Dependent Efficiency Scores**

  The Data Envelopment Analysis results are relative to the sample of training providers in West Bengal. Including providers from other regions or newer entrants could shift the efficiency frontier and alter comparative scores.

- **Cross-Sectional Design Constraints**

  The study relies on a single time-point analysis, limiting the ability to assess changes in efficiency or productivity over time.

- **Trainee Survey Ceiling Effects**

  The use of high Likert-scale ratings in trainee feedback may mask subtle differences in quality, making it harder to detect marginal improvements.

Scope for Future Research

To build on the current findings, future research could explore the following directions:

- **Longitudinal DEA Analysis:** Apply Malmquist indices to track changes in productivity and efficiency over time, capturing the impact of process improvements.
- **In-Depth Case Studies**: Conduct ethnographic research on high-performing training providers to uncover tacit operational routines and cultural factors driving success.
- **Cost-Efficiency Evaluation:** Extend the DEA framework to include financial inputs, enabling a more comprehensive assessment of cost-effectiveness.
- **Experimental Policy Pilots:** Design and test structured interventions—such as mandatory counselling services or employer advisory boards—through randomized controlled trials to evaluate their impact on provider efficiency.

References

Achi, A. (2020). The efficiency of public vocational institutions by DEA: Case of VTACs of Banta province, Algeria. International Journal of Management in Education, 14(4), 352–378. https://doi.org/10.1504/IJMIE.2020.107999

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. European Journal of Operational Research, 2(6), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Cho, Y., Kalomba, D., Mobarak, A. M., & Orozco, V. (2013). Gender Differences in the Effects of Vocational Training: Constraints on Women and Drop-Out Behavior.

Cooper, W. W., Seiford, L. M., & Tone, K. (2007). Data envelopment analysis: A comprehensive text with models, applications, references and DEA-solver software: Second edition. Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software: Second Edition, 1–490. https://doi.org/10.1007/978-0-387-45283-8

Deming, W. E. (1986). Out of the Crisis: Quality, Productivity and Competitive Position. Massachusetts Institute of Technology. Center for Advanced Engineering Study, 507. https://lib.ugent.be/en/catalog/rug01:000162160

Emrouznejad, A., Parker, B. R., & Tavares, G. (2008). Evaluation of research in efficiency and productivity: A survey and analysis of the first 30 years of scholarly literature in DEA. Socio-Economic Planning Sciences, 42(3), 151–157. https://doi.org/10.1016/j.seps.2007.07.002

Emrouznejad, A., & Yang, G. liang. (2018). A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016. Socio-Economic Planning Sciences, 61, 4–8. https://doi.org/10.1016/J.SEPS.2017.01.008

Fatimah, S., & Mahmudah Umi. (2017). Two-Stage Data Envelopment Analysis for Measuring the Efficiency of Elementary Schools in Indonesia. Article in International Journal of Environmental and Science Education, 17, 170. https://www.researchgate.net/publication/321033816

Fazlollahtabar, H., & Ebadi, S. (2023). Skill Training Supply Chain Performance Evaluation using Network Data Envelopment Analysis. International Journal of Industrial Engineering & Production Research, 34(1), 1–14. https://doi.org/10.22068/ijiepr.34.1.12

Fuchs, M., Röhrer, N., & Vogelsang, B. (2021). COMPANIES AS LOCAL SKILL-PROVIDERS? THE 'SKILLS ECOSYSTEM' IN MEXICO. Erdkunde, 75(4), 295–306. https://doi.org/10.3112/ERDKUNDE.2021.04.03

Jespersen, S. T., Munch, J. R., Skipper, L., Hansen, J. v, Holm, A., Lechner, M., Bo Nielsen, S., Rosholm, M., Sianesi, B., & Torp, H. (2007). Costs and benefits of Danish active labour market programmes. https://doi.org/10.1016/j.labeco.2007.07.005

R. D. Banker, A. Charnes, & Cooper W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis on JSTOR. Management Science. https://www.jstor.org/stable/2631725

Shi, Y., & Bangpan, M. (2022). Young people's participation experiences of technical and vocational education and training interventions in low- and middle-income countries: a systematic review of qualitative evidence. Empirical Research in Vocational Education and Training, 14(1), 1–42. https://doi.org/10.1186/S40461-022-00136-4/FIGURES/2

Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. Journal of Econometrics, 136(1), 31–64. https://doi.org/10.1016/j.jeconom.2005.07.009