The Impact of Government-Subsidized Training on Organizational Performance: An Efficiency Analysis Using DEA and the TTQS Evaluation System

Wen-Sheng Tan
Department of Industrial Management /
Department of Business Administration
I-Shou University /
Shu-Te University,
Kaohsiung City 84001, Taiwan /
Kaohsiung City 82445, Taiwan

Nai-Chieh Wei
Management College,
Guangdong Polytechnic
Normal University, China
ncwei@cloud.isu.edu.tw

Chung-Yuan Dye
Graduate School of Business and
Administration College of Management
Shu-Te University,
Kaohsiung City 82445, Taiwan

Abstract

This study investigates whether enterprise participation in Taiwan's government-subsidized "Enterprise Human Resources Enhancement Program" (EHREP) enhances organizational performance. Focusing on firms that participated in both 2023 and 2024, data were collected from the official system maintained by the Workforce Development Agency. A total of 66 enterprises were analyzed using Data Envelopment Analysis (DEA), with input variables including total training subsidy, hours, and sessions, and output variables comprising average annual profit per employee and the number of professional certifications obtained.

Findings reveal that the average technical efficiency was only 0.239, indicating a widespread inability to fully translate training investment into measurable outcomes. Enterprises with TTQS ratings of Bronze or above exhibited significantly higher efficiency, particularly within the service sector. Multiple regression analysis showed that while total training hours and subsidy amount had moderate predictive power for certification outcomes, they did not significantly influence profitability. The study concludes with recommendations for a streamlined version of the TTQS framework tailored to SMEs, and calls for enterprises to strategically align training initiatives with organizational goals to enhance human capital value and competitiveness.

Keywords: Employee Training, TTQS, Data Envelopment Analysis, Organizational Performance, Government Subsidy

The Strategic Importance of Human Capital Development and Taiwan's Enterprise Training Policy

In the era of globalization and the knowledge-based economy, human capital has become a decisive factor for maintaining competitive advantage. Talented employees not only drive organizational efficiency but also sustain long-term growth. As UNESCO highlights, enhancing workforce quality through education and training is fundamental to improving labor productivity (Barney & Hesterly, 2010). Organizations that invest in structured development programs benefit from improved retention, stronger knowledge-sharing cultures, and greater overall effectiveness (Collins & Smith, 2006).

Recent empirical research supports this view. Martins (2021) found that EU-funded training programs significantly enhanced firm performance in productivity and exports. Likewise, Brunello et al. (2012) confirmed that vocational training, especially in SMEs, yielded wage benefits and organizational gains. In Taiwan, Chen et al. (2024) stressed that the effectiveness of training subsidies depends on program quality, while Nguyen et al. (2022) emphasized that AI-enhanced training platforms further increase adaptability in dynamic industries.

From a strategic standpoint, investing in human capital yields greater economic returns than physical assets (Andrews, 2010). Scholars have long recognized the role of training in shaping competitive human capital and reinforcing intellectual assets essential for modern business sustainability (Crook et al., 2011). Moreover, Latorre et al. (2024) illustrated that training-related incentives can reduce turnover and enhance workforce stability.

Taiwan's government has institutionalized human capital development through programs such as the Enterprise Human Resources Enhancement Program (EHREP), initiated by the Workforce Development Agency in 2014. The program provides financial support (NT$950,000 to NT$2 million) across six training categories, from technological upgrading to internal trainer development. In 2023 alone, 1,217 enterprises participated, with 57.19% being SMEs, highlighting their strong reliance on government support.

Lastly, Arora et al. (2024) emphasized the importance of government-industry collaboration in large-scale upskilling efforts, reinforcing the need for coordinated national strategies to meet digital economy demands.

The Strategic Role of Training and Government Support in Enhancing Organizational Performance

Achieving superior organizational performance and strengthening competitive advantage are core goals for modern enterprises. In response, many governments—including Taiwan—have invested heavily in employee training initiatives to enhance workforce quality and organizational adaptability. These structured, scalable programs are most effective when aligned with firm-specific needs and strategic objectives (Ho & Yang, 1993).

Empirical studies have consistently demonstrated the positive impact of well-planned training on firm performance. Martins (2021) showed that government-subsidized training significantly improved company sales and productivity, while Brunello et al. (2012) found that training support yielded measurable wage returns, particularly in SMEs. In Taiwan, Chen et al. (2024) emphasized that training effectiveness hinges on quality, with high-standard programs leading to better employee retention and satisfaction. Similarly, Latorre et al. (2024) highlighted that training-linked incentives reduce turnover and enhance talent retention.

In the knowledge economy, intangible assets—especially human capital—now drive long-term success. Enterprises must not only attract and retain talent but also accelerate the development of innovation and technical capacity. To this end, Nguyen et al. (2022) pointed out that AI-enabled training platforms, which personalize learning paths, have proven effective in improving post-training productivity and adaptability.

In Taiwan, the Enterprise Human Resources Enhancement Program (EHREP)—launched by the Workforce Development Agency—offers financial subsidies and a systematic framework for in-service training. The program includes six training categories and accommodates varying organizational sizes and strategies. As Arora et al. (2024) noted, public-private training partnerships enhance policy responsiveness and foster long-term workforce resilience.

This study therefore investigates whether participation in government-subsidized training programs, particularly the EHREP, contributes to organizational performance in areas such as revenue growth, innovation, and technical proficiency. By applying the Data Envelopment Analysis (DEA) methodology, the research evaluates training efficiency and identifies improvement gaps. Notably, Zhou et al. (2024) confirmed that targeted training during digital transformation efforts significantly enhances individual and organizational performance—reinforcing the importance of strategically aligned workforce development.

Policy Context: The Enterprise Human Resources Enhancement Program and the TTQS Quality Framework

Since 2010, Taiwan's Workforce Development Agency (WDA), under the Ministry of Labor, has progressively expanded its existing training subsidy initiatives to further promote human capital development within the private sector. In addition to offering financial support for in-service employee training, the agency has actively encouraged enterprises to collaborate across industries or regions through joint training programs, aiming to enhance overall workforce competencies. Reflecting the program's evolving objectives, it was rebranded as the "Assistance Program for Enterprise Human Resource Enhancement" and formally renamed the "Enterprise Human Resources Enhancement Program" (EHREP) in 2014.

Over the past five years, the program has introduced several sub-initiatives to address the specific needs of various enterprise types and to respond to broader policy transformations. For instance, the "Recharge and Take Off Program," launched in 2011, was designed to assist enterprises in adapting to trade liberalization. In 2012, a "Guided Training Program for Enterprises with Fewer than 51 Employees" was introduced to mitigate training barriers faced by smaller firms. To align with industrial upgrading efforts, the "Industry Promotion Training" program was launched in 2023. By 2024, the guided training component had been further refined and officially named the "Small Enterprise Talent Enhancement Program," highlighting the government's commitment to tailored workforce development strategies.

Taiwan's approach is consistent with international best practices, where targeted subsidies have proven effective in increasing workforce capabilities and organizational performance. For example, Martins (2021) showed that EU-funded training schemes substantially improved firm-level productivity, export competitiveness, and training volume. Similarly, Brunello, Comi, and Sonedda (2012) found that wage returns from subsidized vocational training were particularly strong among SMEs, suggesting that government intervention is most beneficial for resource-constrained organizations. These findings reinforce the rationale for EHREP's tiered subsidy model and special programs for small-scale enterprises.

Under the EHREP framework, training subsidies are categorized based on the type of application, with funding amounts ranging from NT$950,000 to NT$2 million. The program supports training in six key areas:

1. Research and innovation capacity
2. Information application and technological advancement
3. Operational systems, production techniques, and professional certification
4. Business management and professional language training
5. Internal instructor development
6. Core competency development, including Driving Competencies (DC), Behavioral Competencies (BC), and Knowledge Competencies (KC)

Through this comprehensive and adaptable framework, the EHREP aims to continually strengthen employee competencies, maximize the effectiveness of corporate training, and cultivate national human capital—ultimately reinforcing the global competitiveness of Taiwan's industries. Arora et al. (2024) similarly emphasized that public-private partnerships in workforce upskilling are vital for long-term innovation and talent competitiveness, especially when training structures are designed to align with industry-specific needs.

To ensure both the quality and impact of training programs subsidized under the EHREP, participating enterprises must adhere to the training quality criteria established by the WDA and undergo evaluation via the Talent Quality-management System (TTQS). Originally referred to as the Taiwan TrainQuali System, TTQS is a systematic framework for talent development quality assurance. It is based on five interdependent dimensions: Plan, Design, Do, Review, and Outcome. These elements form a dynamic continuous improvement cycle that enables organizations to optimize training effectiveness while aligning developmental initiatives with performance outcomes. Through this structured evaluation mechanism, enterprises can better tailor training programs to operational needs and improve talent development strategies (Fang & Tsai, 2010).

Furthermore, Chen et al. (2024) found that training quality acts as a critical mediating factor between government training subsidies and positive workforce outcomes. Without sufficient quality control—such as that provided by TTQS—public funding may fail to produce measurable improvements in performance or retention. Additionally,

the increasing use of AI-driven tools for adaptive training delivery, as reported by Nguyen et al. (2022), highlights the need for quality frameworks to evolve alongside digital innovations.

Finally, the TTQS model's emphasis on linking training outcomes to organizational performance mirrors the logic of performance-based evaluation used in models such as Data Envelopment Analysis (DEA). By systematically reviewing outcome data, both government and enterprise stakeholders can diagnose inefficiencies and identify best practices. As Latorre et al. (2024) suggested, the integration of predictive analytics in employee training systems can also improve alignment between training investment and employee needs, reducing turnover and improving ROI.

Theoretical and Empirical Perspectives on Employee Training and Organizational Performance

In the knowledge-based economy, human capital—particularly knowledge workers—has become a strategic asset for sustaining competitive advantage. Systematic employee training is recognized as a key mechanism for enhancing this asset. Bowen and Ostroff (2004) emphasize the role of HR practices in shaping organizational climate, while Pfeffer (1994) and Schuler & MacMillan (1984) argue that training strengthens core capabilities and strategic differentiation. O'Keefe (2003) further notes that effective training must now cultivate adaptability alongside technical competence.

From an organizational perspective, training bridges workforce skill gaps and enhances profitability, while for employees, it improves motivation and job satisfaction (Workforce Development Agency, 2014). Chen et al. (2024) identify training quality as a mediator between government subsidies and outcomes like retention and capability improvement.

Wexley and Latham (1981) highlight that training enhances technical skills and work attitudes. Bushnell (1990) outlines both short- and long-term benefits, including higher performance and customer satisfaction. Bohlander and Snell (2004) frame training as a driver of organizational effectiveness through error reduction and service quality.

Empirical research confirms these benefits. Martins (2021) found that firms receiving EU training subsidies improved in productivity and revenue. Brunello et al. (2012) observed wage gains in SMEs following subsidized training. Swanson (1987) categorizes training benefits at individual (e.g., performance, career mobility) and organizational (e.g., cohesion, reduced turnover) levels. Latorre et al. (2024) further show that data-driven training and tailored incentives reduce attrition and optimize HR investments.

Hung (2009) expands training objectives to include leadership, industry knowledge, and innovation capacity. Nguyen et al. (2022) affirm that AI-enhanced, adaptive learning systems increase training effectiveness in dynamic environments. Additionally, Zhou et al. (2024) confirm that digital transformation projects paired with employee training yield superior performance outcomes.

In summary, training outcomes are influenced by firm characteristics, program design, and delivery quality. When aligned with organizational strategy, training significantly boosts productivity, innovation, and operational efficiency. Arora et al. (2024) stress the importance of government-industry collaboration in developing workforce training policies responsive to industrial change, reinforcing training's role as a strategic enabler in organizational development.

Comparative Analysis of Organizational Performance Evaluation Methods

In the face of resource constraints, organizations must maximize operational efficiency, with performance evaluation serving as a critical managerial tool. According to Chen and Chen (2012), performance involves achieving pre-set goals through strategic execution, while Po (2008) emphasizes the role of structured evaluation in aligning individual and group outcomes with corporate objectives.

Traditionally, performance has been assessed using financial indicators. However, contemporary research supports a broader evaluation framework that includes non-financial metrics such as innovation, training quality, and employee engagement (Chen et al., 2024; Latorre et al., 2024). These indicators are increasingly critical in assessing sustainable performance, particularly in knowledge-intensive environments.

Six common performance evaluation methods are widely discussed:

- Ratio Analysis is intuitive but limited to single-input/output measures and subjective weighting.

- Balanced Scorecard (BSC) provides strategic alignment across multiple dimensions but lacks standardized metrics and mathematical rigor (Martins, 2021).
- Regression Analysis is statistically robust yet assumes linearity and normality; its utility in firm-level training efficiency is constrained (Brunello et al., 2012).
- Financial Ratio Analysis is valuable for assessing liquidity and profitability but fails to capture intangible drivers like innovation (Zhou et al., 2024).
- Multiple Criteria Decision Making (MCDM) supports complex assessments but often depends on expert weighting and lacks diagnostic feedback (Nguyen et al., 2022).
- Data Envelopment Analysis (DEA) stands out for its non-parametric structure, capacity to handle multiple inputs/outputs, and ability to rank relative efficiency. DEA constructs an efficiency frontier that objectively evaluates decision-making units (DMUs), and is well-suited to tracking longitudinal change and cross-entity comparisons (Arora et al., 2024).

Given these characteristics, DEA is adopted in this study to assess the efficiency of government-subsidized training programs. Prior studies (Martins, 2021; Chen et al., 2024) have confirmed DEA's utility in quantifying training effectiveness across diverse enterprises and performance dimensions. Its flexibility and objectivity provide a rigorous foundation for evaluating the strategic impact of training on revenue growth, technical capabilities, and innovation output.

Development and Empirical Applications of Data Envelopment Analysis (DEA)

Traditionally, organizational and financial performance evaluations relied on financial ratios. However, this approach often fails to capture the multifaceted nature of operational efficiency, particularly in service-oriented or public sectors. Data Envelopment Analysis (DEA), introduced by Farrell (1957) and later formalized by Charnes, Cooper, and Rhodes (1978) into the CCR model, overcomes this limitation by allowing multi-input and multi-output analysis without the need for a predefined production function. The BCC model (Banker et al., 1984) further enhances this approach by permitting variable returns to scale, offering deeper insights into managerial efficiency.

DEA evaluates decision-making units (DMUs) relative to a best-practice frontier, assigning an efficiency score where 1 indicates full efficiency. As Sun (2004) emphasizes, DEA's non-parametric nature enables performance comparison across organizations while minimizing subjective bias. Its widespread use in Taiwan includes applications in utilities (Chang, 2004), education (Shao, 2006), manufacturing (Kuo, 2006; Hsieh, 2009; Lai, 2010), and service sectors such as retail and healthcare (Yang, 2009; Chang et al., 2006), all demonstrating its flexibility and analytical robustness.

Recent international studies reaffirm DEA's utility in human resource and training evaluation. Martins (2021) applied DEA to assess the effectiveness of EU-subsidized training among SMEs, while Chen et al. (2024) compared training outcomes across subsidy recipients in Taiwan. Arora et al. (2024) demonstrated that DEA effectively captured technical efficiency differences among firms with varying levels of training-strategy alignment. In digital transformation contexts, Zhou et al. (2024) and Nguyen et al. (2022) used DEA to validate the performance impact of AI-enhanced, adaptive training systems.

Overall, DEA provides a rigorous, objective, and scalable framework for evaluating organizational efficiency. Its suitability for analyzing the effectiveness of government-subsidized training programs—such as Taiwan's Enterprise Human Resources Enhancement P rogram (EHREP)—makes it an appropriate methodology for this study, particularly in assessing performance outcomes like revenue growth, innovation capacity, and technical competence.

Research Design and Data Sources

This study investigates the impact of government-subsidized training programs on enterprise performance, focusing on three key operational indicators: revenue growth, innovation capability, and technical competence. To evaluate performance outcomes, the study adopts Data Envelopment Analysis (DEA), a non-parametric method

well-suited for analyzing relative efficiency across multiple inputs and outputs (Charnes & Cooper, 1978; Farrell, 1957).

Empirical data were sourced from Taiwan's Enterprise Human Resources Enhancement Program (EHREP), administered by the Workforce Development Agency. In 2023 and 2024, 1,217 and 1,234 enterprises, respectively, implemented subsidized training initiatives, with participation concentrated in Central and Northern Taiwan. A total of 199 enterprises that consistently participated in both years formed the final valid sample.

Data were collected via a full census approach using online questionnaires completed by designated project supervisors. The instrument was adapted from the human capital measurement scale by Leung et al. (2007), ensuring contextual relevance and construct validity.

The DEA model used in this study is based on Farrell's efficiency framework, which constructs a best-practice frontier formed by the most efficient decision-making units (DMUs). The analysis assumes constant returns to scale and decomposes efficiency into three dimensions: Technical Efficiency (TE), Price Efficiency (PE), and Overall Efficiency (OE = TE × PE). This decomposition enables a robust evaluation of training effectiveness in transforming training inputs into tangible performance outcomes.

By applying DEA, the study provides a quantitative, objective assessment of how effectively enterprises utilize training resources under the EHREP framework. The findings aim to offer policy-relevant insights into optimizing training strategies and improving organizational performance in a knowledge-based economy.

Efficiency Evaluation Method and Variable Design

According to Sun (2004), Data Envelopment Analysis (DEA) possesses several methodological advantages that make it particularly suitable for evaluating organizational performance. First, DEA allows for the simultaneous consideration of multiple inputs and outputs, capturing the complexity of real-world decision-making environments. Second, the efficiency scores generated by DEA reflect each decision-making unit's (DMU) relative position against the best-practice efficiency frontier, rather than relying on simple averages. This feature enables meaningful comparisons under diverse operating conditions. Third, DEA accommodates both quantitative and qualitative data, increasing its applicability across various industries. Fourth, the method does not require pre-assigned weights between inputs and outputs, thus minimizing subjectivity and enhancing evaluation objectivity. Fifth, efficient DMUs are assigned a score of 1, representing optimal input-output performance. Sixth, DEA provides diagnostic feedback for inefficient units, identifying specific variables that hinder performance and offering direction for improvement.

Owing to these strengths, DEA has been widely adopted as a robust tool for benchmarking and evaluating relative efficiency across public and private sector organizations. However, several methodological limitations must also be considered. DEA assesses relative—not absolute—efficiency, meaning that the results are valid only within the defined peer group. It also assumes a high degree of homogeneity among DMUs and requires clearly defined, measurable input and output data. The method is sensitive to outliers, which may distort the efficiency frontier and affect model robustness. Additionally, to ensure sufficient discrimination between efficient and inefficient units, the number of DMUs should be at least twice the total number of input and output variables.

Given these considerations, the selection of appropriate input and output variables becomes a critical component of effective DEA modeling. This study seeks to evaluate the impact of corporate training programs on tangible organizational outcomes, such as revenue growth, innovation capacity, and technical proficiency. Accordingly, variable selection was guided by a thorough review of relevant domestic and international literature, empirical feasibility based on available data, and the methodological constraints inherent in DEA.

The final set of variables used in this study includes three input variables and two output variables. The input variables are: (1) total subsidy amount received, (2) total

training hours conducted, and (3) number of training sessions held. The output variables are: (1) average annual profit generated per employee and (2) number of professional certifications obtained. These indicators were selected to capture both the scale and quality of training investment, as well as its measurable impact on enterprise-level performance.

Sample Profile and TTQS Evaluation Distribution

This study focuses on enterprises under the jurisdiction of the Northern, Keelung, Yilan, Hualien, Kinmen, and Matsu Branch of Taiwan's Workforce Development Agency (WDA) that continuously applied for and implemented the "Enterprise Human Resources Enhancement Program" during both 2023 and 2024. All data were obtained from the official program management system administered by the WDA.

A census sampling method was employed. One training supervisor from each participating enterprise was designated as the respondent. The questionnaire survey was administered online via the program's system in October of each year. According to system records, 290 enterprises participated in the program in 2023 and 347 in 2024. After filtering for enterprises that participated in both years, 199 cases met the inclusion criteria. Following the exclusion of 133 cases due to incomplete responses, invalid data, or the absence of professional certification participation, the final valid sample consisted of 66 enterprises.

In terms of enterprise size, the sample comprised 42 large enterprises (63.6%) and 24 small and medium-sized enterprises (SMEs) (36.4%). By industry sector, 37 enterprises (56.1%) were in the service sector, 24 (36.4%) in manufacturing, 2 (3.0%) were non-profit organizations, and 3 (4.5%) belonged to other sectors. A cross-tabulation of enterprise size and industry reveals that among large enterprises, 27 were service-based (64.3%), 12 were in manufacturing (28.6%), 1 was non-profit (2.4%), and 2 fell under other sectors (4.8%). For SMEs, 12 were in manufacturing (50.0%), 10 in services (41.7%), and 1 each in the non-profit and other categories (both 4.2%).

In the context of the knowledge-based economy, human capital is recognized as a key production factor, and talent cultivation is essential for advancing industrial upgrading. To ensure the quality and effectiveness of enterprise training, the Enterprise Human Resources Enhancement Program mandates participating organizations to undergo evaluation under the Talent Quality-management System (TTQS) during the same year the subsidy is granted.

The TTQS, originally known as the Taiwan TrainQuali System, was developed by the WDA and serves as the official framework for evaluating enterprise training quality. The system assesses training performance across five core dimensions: Plan, Design, Do, Review, and Outcome. Certified auditors conduct on-site evaluations using standardized scorecards, and enterprises are assigned performance levels based on their final scores.

The TTQS categorizes performance into six levels:

- Platinum: 96.5 and above
- Gold: 96–85.5
- Silver: 85–74.5
- Bronze: 74–63.5
- Pass: 63–53.5
- Fail: below 53

Enterprises that achieve high ratings may be exempt from re-evaluation in the following year if they meet designated thresholds (e.g., Silver level under the Talent Investment Program, or Bronze under the Self-Learning Plan). Each certification remains valid for two years, after which re-assessment is required to maintain status.

Based on the 2024 sample data, the TTQS ratings for large enterprises were as follows: 18 enterprises achieved Pass, 11 attained Bronze, 7 reached Silver, 5 were exempt from evaluation, and 1 received a Fail rating. Among SMEs, 16 enterprises earned Pass, 7 attained Bronze, and 1 was exempt from evaluation. These results indicate that the majority of participating enterprises met or exceeded the government's baseline standards for training quality, suggesting a generally adequate level of internal capacity for human capital development.

Variable Selection and Correlation Analysis

A review of relevant literature indicates that there is no universally accepted standard for selecting evaluation indicators when assessing the relationship between employee training and organizational performance. In the context of this study, which adopts Data Envelopment Analysis (DEA) as the primary analytical method, the choice of input and output variables is particularly critical. DEA outcomes are highly sensitive to variable configuration, and different combinations of inputs and outputs can yield significantly different efficiency results.

This study aims to investigate the impact of corporate training initiatives on measurable aspects of organizational performance, such as revenue generation and employee skill enhancement. Therefore, the selection of variables was guided by both commonly adopted indicators in domestic and international research, as well as practical considerations, including data availability and the methodological constraints inherent in DEAmodeling.

Based on these criteria, the study employs the following variables:

Input Variables:

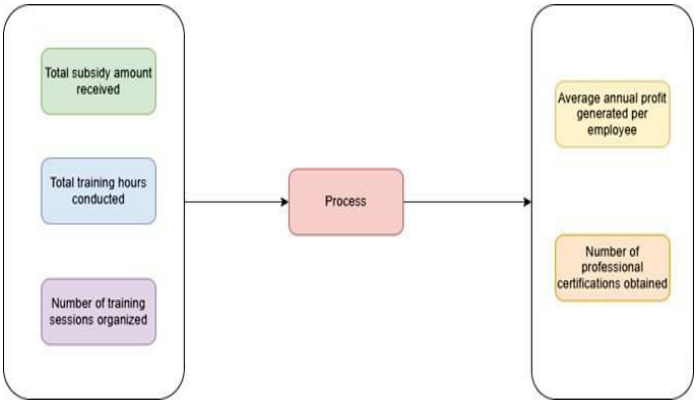
1. Total subsidy amount received
2. Total training hours conducted
3. Number of training sessions organized

Output Variables:

1. Average annual profit generated per employee
2. Number of professional certifications obtained

This variable configuration reflects a balance between resource investment (input) and performance outcomes (output), providing both analytical feasibility and practical relevance. It enables the evaluation of how government-subsidized training efforts contribute to tangible organizational improvements, thus supporting the broader objective of assessing training effectiveness through a rigorous and multidimensional performance evaluation framework.

Figure 4-1. Research Analytical Framework of the Study



Before applying the DEA model for efficiency evaluation, it is essential to verify the relationships between the selected input and output variables to ensure the model's validity and the reliability of subsequent analysis results. Establishing the presence of linear associations helps confirm that the input variables are indeed relevant to the outputs and mitigates the risk of model misestimation due to the inclusion of unrelated or irrelevant indicators.

To assess these relationships, this study conducted a Pearson correlation analysis using SPSS version 18.0. This statistical test was used to examine the degree of linear association between each input variable (total subsidy amount, total training hours, and number of training sessions) and each output variable (average annual profit per employee and number of professional certifications obtained). The purpose of this analysis was to evaluate the methodological soundness of the variable design and to provide empirical justification for proceeding with the DEAmodel.

The results reveal that all input variables exhibit positive and statistically significant correlations with both output variables. All correlation coefficients were significant at the $p < 0.05$ level. These findings confirm that the selected input variables are meaningfully associated with the intended performance outcomes, thereby supporting the theoretical and empirical appropriateness of the DEA variable configuration. Consequently, the study proceeded with DEA analysis based on these validated input-output relationships.

Table 4-1. Pearson Correlation Analysis between Input and Output Variables (N = 66)

		Total Subsidy Amount	Total Training Hours	Number of Training Sessions	Average Annual Profit Generated per Employee	Number of Professional Certifications Obtained
Total Subsidy Amount	Pearson Correlation	1	.795**	.469**	.100	.608**
	Significance (2-tailed)		.000	.000	.424	.000
Total Training Hours	Pearson Correlation	.795**	1	.553**	.232	.607**
	Significance (2-tailed)	.000		.000	.060	.000
Number of Training Sessions	Pearson Correlation	.469**	.553**	1	.296*	.266*
	Significance (2-tailed)	.000	.000		.016	.031
Average Annual Profit Generated per Employee	Pearson Correlation	.100	.232	.296*	1	.339**
	Significance (2-tailed)	.424	.060	.016		.005
Number of Professional Certifications Obtained	Pearson Correlation	.608**	.607**	.266*	.339**	1
	Significance (2-tailed)	.000	.000	.031	.005	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

To assess the linear relationships between the selected input and output variables, Pearson correlation analysis was conducted. The results, summarized in Table 4-1, provide empirical support for the validity of the variable configuration used in the DEAmodel.

First, a moderate positive and statistically significant correlation was found between total subsidy amount and number of professional certifications obtained ($r = .608$, $p < .01$), indicating that enterprises receiving higher levels of government subsidy tend to achieve greater employee certification outcomes. Similarly, total training hours was also moderately and significantly correlated with the number of certifications obtained ($r = .607$, $p < .01$), suggesting that increased training time contributes positively to employee upskilling.

In contrast, the number of training sessions demonstrated a low but statistically significant correlation with average annual profit per employee ($r = .296$, $p < .05$), indicating a potential, albeit weaker, association between training frequency and employee productivity. A similar low but significant correlation was also observed between number of training sessions and number of professional certifications obtained ($r = .266$, $p < .05$), suggesting that greater session frequency may contribute to incremental improvements in certification outcomes.

In summary, the findings reveal that:

- Total subsidy amount and total training hours both show moderate positive associations with employee certification outcomes.
- Number of training sessions exhibits weaker but statistically significant correlations with both employee profitability and certification achievement.

These results confirm the appropriateness of the selected input and output variables and provide a sound statistical foundation for proceeding with DEA-based efficiency analysis.

Multiple Regression Analysis: Predictive Power of Training Inputs on Performance Outcomes

To further evaluate whether the selected input variables—total subsidy amount, total training hours, and number of training sessions—can effectively predict the output variables, namely average annual profit per employee and number of professional certifications obtained, this study employed multiple regression analysis. The primary objective was to identify the most influential predictors and assess the explanatory power of the regression models.

All three input variables are continuous, allowing them to be directly included in the regression equations without the need for dummy variable transformation. Before estimating the regression coefficients, it is essential to assess whether multicollinearity exists among the predictors, as severe multicollinearity can distort the estimated coefficients and compromise the validity of the model.

To examine multicollinearity, two standard diagnostic indicators were used:

- Variance Inflation Factor (VIF)
- Tolerance (TOL)

According to the criteria proposed by Wu and Tu (2006), multicollinearity is suspected when VIF exceeds 10 or TOL falls below 0.1. As presented in Table 4-2, the VIF values for the input variables range from 1.445 to 3.066, while the corresponding TOL values fall between 0.326 and 0.692. These results are well within acceptable thresholds, indicating that no serious multicollinearity is present among the predictors.

Therefore, the input variables are deemed appropriate for inclusion in the subsequent multiple regression models. This ensures the reliability of the estimated coefficients and supports the robustness of the analysis regarding the predictive relationships between training inputs and organizational performance outcomes.

Table 4-2. Multicollinearity Diagnostics among Predictor Variables

Independent Variable	Tolerance	VIF
Total Subsidy Amount	.366	2.729
Total Training Hours	.326	3.066
Number of Training Sessions	.692	1.445

As shown in Table 4-3, the input variables—total subsidy amount, training hours, and number of training sessions—demonstrated limited predictive power for the output variable "average annual profit generated per employee." The regression model accounted for only 7.5% of the total variance ($R^2 = 0.075$), and the overall model was only marginally significant ($F(3,62) = 2.75$, $p = .05$).

Further examination of the individual regression coefficients revealed that none of the input variables reached statistical significance, suggesting that none of the predictors had a substantial influence on the profit-generating performance of individual employees.

These findings indicate that the training-related input variables alone are insufficient to meaningfully predict individual profit contributions. Other organizational or contextual factors—such as department type, industry characteristics, or leadership style—may play a more critical role in influencing financial performance and should be considered in future analyses.

Table 4-3. Multiple Regression Analysis of Total Subsidy Amount, Training Hours, and Number of Training Sessions on Average Annual Profit per Employee

Variable	Unstandardized Coefficient (B)	Standardized Coefficient(β)	t-value	Coefficient of Determination	F-value
(Constant)	-2907196.53		-1.04	.075	2.75
Total Subsidy Amount_IN	-11.50	-.25	-1.27		
Total Training Hours_IN	14184.91	.29	1.40		
Number of Training Sessions_IN	147664.20	.25	1.76		

As shown in Table 4-3, the regression model incorporating the input variables—total subsidy amount, total training hours, and number of training sessions—demonstrated limited explanatory power for the output variable average annual profit generated per employee. The model accounted for only 7.5% of the total variance ($R^2 = 0.075$), and the overall regression was only marginally significant ($F(3, 62) = 2.75$, $p = .05$).

Further analysis of the standardized regression coefficients revealed that none of the input variables reached statistical significance, indicating that, individually, total subsidy, training hours, and session frequency did not exert a substantial predictive influence on the profit-generating capacity of individual employees.

These results suggest that training-related input variables alone may not sufficiently explain variations in individual-level financial performance. It is likely that other organizational or contextual factors—such as departmental functions, industry type, business scale, market conditions, or leadership and management practices—play a more significant role in shaping profitability outcomes. Future research should consider incorporating these additional variables to enhance model robustness and deepen understanding of the complex mechanisms underlying organizational financial performance.

Table 4-4. Multiple Regression Analysis of Total Subsidy Amount, Training Hours, and Number of Training Sessions on Number of Professional Certifications Obtained

Variable	Unstandardized Coefficient (B)	Standardized Coefficient(β)	t-value	Coefficient of Determination	F-value
(Constant)	-11.10		-.78	.392	14.97***
Total Subsidy Amount_IN	.00	.35	2.19*		
Total Training Hours_IN	.119	.39	2.31*		
Number of Training Sessions_IN	-.42	-.11	-.98		

*:p<.05 **:p<.01 ***:p <.001

DEA Results: Distribution and Analysis of Enterprise Training Efficiency

Data Envelopment Analysis (DEA) is most commonly implemented through two established models: the CCR (Charnes, Cooper, and Rhodes) model and the BCC (Banker, Charnes, and Cooper) model. The CCR model can be further categorized into two orientations: the input-oriented model, which seeks to minimize input levels while maintaining current output, and the output-oriented model,

which aims to maximize output levels given fixed input resources.

This study adopts the output-oriented CCR model to evaluate the extent to which each decision-making unit (DMU)—in this case, participating enterprises—can maximize performance outcomes with a given level of training-related input. The model estimates overall technical efficiency, where a score of 1.000 indicates full efficiency, and values below 1 suggest relative inefficiency in converting inputs into outputs.

The analysis was conducted using DEAP Version 2.1 XP, a DEA software developed by the Centre for Efficiency and Productivity Analysis (CEPA) at the University of Queensland, Australia. A total of 66 enterprises were included in the evaluation.

The distribution of technical efficiency scores is summarized as follows:

- 50 enterprises (75.8%) had efficiency scores below 0.30, with an average score of 0.095, indicating significant inefficiency in resource utilization.
- 8 enterprises (12.1%) scored between 0.30 and 0.59, with an average efficiency of 0.439, reflecting moderate performance but room for improvement.
- 5 enterprises (7.6%) scored between 0.60 and 0.99, with an average of 0.899, suggesting near-optimal efficiency.
- Only 3 enterprises (4.5%) achieved full efficiency (score = 1.000), indicating they maximized training output relative to input among the peer group.

These results suggest generally low execution efficiency across the sample, highlighting a widespread inability among enterprises to fully translate training inputs—such as subsidies, training hours, and session count—into measurable organizational outcomes. The findings point to the potential need for improved training planning, resource alignment, or management practices to optimize the impact of corporate training initiatives.

A detailed breakdown of efficiency scores by enterprise size and industry sector is provided in Table 4-5.

Table 4-5. Distribution of Overall Technical Efficiency Scores among All Enterprises

DEA Overall Technical Efficiency / Category		0.3	0.3~0.59	0.6~0.99	1	Subtotal	Total
Number of Firms		50	8	5	3	66	66
Average Overall Technical Efficiency		0.095	0.439	0.899	1	0.239	0.239
Enterprise Size	Large Enterprises	30	6	4	2	42	66
	SMEs	20	2	1	1	24	
Industry Type	Manufacturing	19	2	1	2	24	66
	Services	26	6	4	1	37	
	Organizations	2	0	0	0	2	
	Others	3	0	0	0	3	

Relationship between TTQS Evaluation Levels and Enterprise Efficiency

According to Chen Wei-Ming (2009), the implementation level of the Talent Quality-management System (TTQS) is significantly and positively associated with organizational performance. Supporting research further indicates that structured training systems can enhance employee quality and thereby improve output (Chen Cui-Hua, 2009). Zhang Li-Min (2007) also found that employees in the service sector demonstrate greater recognition of TTQS-related benefits compared to those in traditional manufacturing or high-tech industries.

In this study, 66 participating enterprises were categorized based on their annual TTQS evaluation results and analyzed using DEA. The findings reveal a clear relationship between TTQS rating levels and technical efficiency scores. Enterprises exempt from evaluation (n = 6) recorded the highest average technical efficiency at 0.453—nearly twice the overall average of 0.239. Enterprises with gold-level ratings (n = 7) followed closely with an average of 0.443, while bronze-rated firms (n = 18) averaged 0.276. By contrast, enterprises that only met the pass-level threshold without receiving a medal rating (n = 34) exhibited the lowest average efficiency, at 0.139. Notably, the sole enterprise that failed the TTQS evaluation—a large manufacturing firm—still attained an efficiency score of 0.239, which was higher than the pass-level group but considerably lower than those with higher TTQS ratings. These results reinforce the notion that organizations achieving a bronze rating or higher under TTQS tend to demonstrate stronger resource utilization and performance outcomes.

Further analysis by enterprise size revealed consistent patterns. Among the 42 large enterprises, those exempt from evaluation (n = 5) achieved the highest average efficiency (0.474), followed by gold-rated (0.443), bronze-rated (0.314), pass-level (0.128), and the failed case (0.239). Among the 24 small and medium-sized enterprises (SMEs), the exempt firm recorded an efficiency score of 0.349, bronze-rated firms averaged 0.217, and pass-level firms scored 0.151. These results suggest that, particularly for large firms, higher TTQS ratings are associated with greater technical efficiency, indicating stronger capabilities in translating training investments into tangible performance outcomes.

An industry-based analysis further revealed sector-specific variations. In the manufacturing sector (n = 24), the average technical efficiency was 0.249. Among these, gold-rated firms (n = 4) had the highest average efficiency (0.438), followed by exempt firms (n = 3) at 0.396, bronze-rated (n = 7) at 0.240, and pass-level firms (n = 9) at only 0.124. This trend suggests that within manufacturing, higher TTQS performance ratings correlate positively with greater efficiency.

In the service sector (n = 37), the overall average efficiency was slightly higher at 0.257. Once again, exempt enterprises recorded the highest efficiency (0.510), followed by gold-rated (0.450), bronze-rated (0.325), and pass-level (0.161) firms. These results highlight that service-oriented enterprises appear to benefit more significantly from structured training systems, with TTQS implementation playing a more prominent role in improving efficiency outcomes than in the manufacturing context.

The non-profit organization category (n = 2) reported the lowest overall efficiency, with one bronze-rated firm scoring 0.046 and one pass-level firm only 0.016, resulting in an average of 0.031. The "other" category (n = 3), all of which were pass-level enterprises, recorded an average efficiency of 0.068—also well below the overall mean.

In summary, the results demonstrate a positive correlation between TTQS evaluation level and organizational technical efficiency across both the manufacturing and service sectors. Notably, the service sector shows a more pronounced benefit from higher levels of training quality implementation, supporting prior research on the sector-specific effects of structured training systems.

Research Conclusions

Human capital is widely recognized as the most valuable asset of an enterprise. As Ting (2009) notes, although formal education provides the foundational basis for human capital development, its high cost often makes on-the-job training a more feasible and strategic investment for

organizations. The primary objective of enterprise training programs is to strengthen employee competencies in alignment with organizational goals. In Taiwan, the Talent Quality-management System (TTQS) provides a structured framework for guiding and evaluating enterprise training activities, aiming to improve employees' knowledge, skills, and attitudes, thereby enhancing job satisfaction, individual performance, and overall organizational outcomes.

Liao and Yang (2007) further emphasize that effective enterprise management requires the optimal allocation and utilization of resources to achieve both efficiency and effectiveness—together forming the core of organizational performance. In this context, the government's "Enterprise Human Resources Enhancement Program" not only offers financial support in the form of training subsidies, but also promotes strategic alignment through quality assurance mechanisms such as TTQS evaluation. However, because TTQS results may not fully capture training outcomes—especially given variations in enterprise size and resource allocation—this study employed Data Envelopment Analysis (DEA) as a robust, objective method to evaluate the relative efficiency of enterprise training performance.

Key Research Findings:

1. **Overall Efficiency:** Among the 66 enterprises analyzed, the average technical efficiency was only 0.239, indicating generally low execution efficiency in converting training inputs into measurable outcomes. Only three enterprises achieved full efficiency (score = 1.000), comprising one large manufacturing firm, one large service firm, and one SME in manufacturing.
2. **Industry-Based Differences:** Substantial differences in efficiency were observed across sectors. Manufacturing and service industries exhibited higher average technical efficiency compared to non-profit or other sectors, suggesting stronger training-to-performance linkages in commercially driven contexts.
3. **Enterprise Size Effects:** The impact of training on organizational performance was most pronounced in large manufacturing and service firms, indicating a better capacity to integrate training with strategic operations. Among SMEs, only manufacturing firms showed notable performance gains, whereas SMEs in other sectors lagged behind.
4. **Input–Output Correlation Insights:** The number of training sessions demonstrated a low but statistically significant positive correlation with both average annual profit per employee and number of professional certifications obtained. Meanwhile, total subsidy amount and training hours showed a moderate positive correlation with certification outcomes, highlighting that higher investment in training resources tends to result in more concrete human capital improvements.
5. **TTQS and Efficiency:** While the majority of enterprises obtained only a "Pass" rating under TTQS, those achieving Bronze or higher ratings consistently demonstrated superior efficiency scores, particularly in the service sector. This reinforces the importance of not just implementing training programs, but ensuring rigorous planning, execution, and quality control, as evaluated through TTQS, to achieve substantial performance benefits.

Managerial Implications and Policy Recommendations

As Taiwan's industrial landscape continues to evolve amidst intensifying global and domestic competition, traditional human resource management models have proven insufficient in addressing the increasing complexity of organizational challenges. Strategic alignment between business objectives and human resource practices has become essential, as the degree of implementation directly affects organizational performance. As Bassi and McMurrer (2008) point out, human resource practices serve as a primary vehicle for human capital investment, and variation in such practices reflects differing levels of commitment to workforce development.

Drawing on the findings of this study—centered on enterprise participation in the Enterprise Human Resources Enhancement Program and implementation outcomes under the Talent Quality-management System

(TTQS)—the following four key managerial and policy implications are proposed:

1. Strengthen Enterprise Awareness of the Strategic Intent Behind the Enhancement Program

The Enterprise Human Resources Enhancement Program was established to incentivize enterprises to offer on-the-job training through government subsidies, with the overarching goal of enhancing training effectiveness, strengthening national human capital, and boosting business competitiveness. Enterprises should not approach training subsidy applications as mere funding opportunities; rather, they should treat them as strategic tools, aligning training plans with operational goals. Only through such alignment can enterprises ensure that investments in time, finances, and human resources yield meaningful and measurable performance outcomes, while avoiding misallocation and inefficiencies.

2. Integrate DEA as a Tool for Performance Diagnosis and Strategic Adjustment

While the TTQS framework emphasizes consistency and rigor in planning, implementation, and documentation, its adoption can be resource-intensive—particularly for SMEs. This study found that enterprises achieving bronze-level TTQS or above demonstrated an average DEA technical efficiency of 0.348, significantly higher than the overall average of 0.239. This suggests a tangible connection between training quality and operational efficiency. DEAcan thus serve as a practical diagnostic tool to uncover inefficiencies, identify best practices, and benchmark high-performing enterprises. Incorporating DEA analysis can support data-driven refinement of training strategies and resource allocation.

3. Position TTQS Excellence as a Strategic Target for Talent Development

Organizations that effectively implement the TTQS framework—integrating needs assessment, program design, execution, and evaluation—tend to produce more tailored and impactful training outcomes. The study results further indicate that enterprises with higher TTQS ratings consistently exhibit superior efficiency performance. Therefore, achieving high TTQS ratings should be viewed not merely as a compliance goal, but as a strategic initiative to elevate the quality of internal human capital development and, in turn, enhance overall organizational effectiveness.

4. Develop a Streamlined TTQS Model Tailored to the Needs of SMEs

The current TTQS model's emphasis on comprehensive documentation and process control can pose barriers for SMEs with limited staffing and administrative capacity. Considering that Taiwan is home to over 1.33 million SMEs, accounting for approximately 97.64% of all enterprises, there is a pressing need for the development of a simplified and scalable TTQS model. Such a model should retain the core principles of training quality assurance while offering flexibility and ease of implementation. This would promote wider adoption among SMEs, encourage higher-quality training execution, and support the long-term goal of enhancing national competitiveness through broad-based human capital investment.

References

- Arora, A., Wang, Y., Lee, H., & Patel, R. (2024). Strategic workforce upskilling through government-industry partnerships. International Journal of Production Economics, 265, 108779. https://doi.org/10.1016/j.ijpe.2024.108779
- Banker, R. D. , Charnes, A. , Cooper, W. W. , Swarts, J. , & Thomas, D. A. (1989), Anintroduction to data envelopment analysis with some of its models and their use,In J.L. Chan and J.M. Patton(EDS.)Research in Governmental and NonprofitAccounting, 5, 125-163.
- Barney, J. and Hexterly, W. (2010), Strategic management and competitive advantage:concepts and cases(3th ed.), Prentice Hall; Upper Saddle River: NJ Mini CaseSources.
- Bassi, L. J., & McMurrer, D. P. (2008), Toward a human capital measurementmethodology, Advances in Developing Human Resources, 10(6), 863-881.Bohlander, G. & Snell, S. (2004), Managing Human Resources(Internaional StudentEdition), U. S. A: Thomson South- Western Corp.

- Boussofiance, A. , Dyson, R. G. , & Thanassonlis, E. (1991), Applied dataenvelopment analysis, European Journal of Operational Research, 52(1), 1-15.
- Brunello, G., Comi, S. L., & Sonedda, D. (2012). Training subsidies and the wage returns to continuing vocational training. Labour Economics, 19(3), 361–372. https://doi.org/10.1016/j.labeco.2012.03.002
- Bushnell, D. S. (1990), Input, process, output: a model for evaluating training,Training & Development Journal, 44(3), 41-43.
- Chang, C.-C. (2011). Effects of operational characteristics and diversification on the performance of local and foreign banks (Master's thesis). Ming Chuan University, Taipei City.
- Chang, H.-J., Chiu, W.-C., Lin, C.-C., & Chen, W.-C. (2007). Exploring the performance of nonprofit long-term care facilities: A case study in Yilan. Performance and Strategy Research, 4(1), 27–48.
- Chang, H.-M. (2004). Performance evaluation of the Taiwan Water Corporation using DEA(Master's thesis). Aletheia University, New Taipei City.
- Chang, J.-C. (2009). Corporate Training and Development (2nd ed.). New Taipei City: Tsuan-Hwa Publishing.
- Chang, L.-M. (2007). Organizational performance evaluation after TTQS implementation: Case studies of Phoenix Tours, Sheng Yu Steel, and GT Electronics (Master's thesis). National Sun Yat-sen University, Kaohsiung City.
- Charnes, A. , Cooper, W. W. , & Rhodes, E. (1978), Measuring the efficiency ofdecision making units, European Journal of Operational Research, 2(6),429-444.
- Charnes, A. , Cooper, W. W. , & Rhodes, E. (1979), Short communication: measuringthe relative efficiency of decision making units , European Journal ofOperational Research, 4, 339.
- Chen, C.-H. (2009). A case study on Taiwan's TTQS training scorecard (Master's thesis). National Taiwan University of Science and Technology, Taipei City.
- Chen, H.-W. (2010). A study on the relationship between pre-service training, service behavior, and job performance for new nurses at the Veterans General Hospital (Master's thesis). National Chi Nan University, Nantou County.
- Chen, L., et al. (2024). The mediating role of training quality in government-funded programs. Human Resource Management Review. https://doi.org/10.1016/j.hrmr.2024.100965
- Chen, W.-L. (2012). A study on the effect of training on the performance of insurance salespeople (Master's thesis). Lunghwa University of Science and Technology, New Taipei City.
- Chen, W.-M. (2009). The effect of TTQS implementation on organizational performance: The mediating role of human capital (Master's thesis). National Taiwan University of Science and Technology, Taipei City.
- Chen, W.-Y. (2013). Performance evaluation of enterprises under the Human Resources Enhancement Program (Master's thesis). National Kaohsiung University of Applied Sciences, Kaohsiung City.
- Chiang, W.-B. (2001). A study on the competencies and training strategies for training personnel in manufacturing and service industries (Master's thesis). National Changhua University of Education, Changhua County.
- Christopher J. Collins & Ken G. Smith. (2006), Knowledge exchange andcombination: the role of human resource practices in the performance ofhigh-technology firms, Academy of Management Journal, 544-560.
- Chuang, C.-F. (2010). A study on employee learning attitudes, training effectiveness, and job performance: A case from a private power plant (Master's thesis). National Yunlin University of Science and Technology, Yunlin County.
- Crook, T. R., Todd, S. Y., Combs, J. G., Woehr, D. J., & Ketchen, D. J. (2011), Doeshuman capital matter? A meta-analysis of the relationship between human capitaland firm performance, Journal of Applied

Psychology, 96, 443–456.

- David E. Bowen and Cheri Ostroff (2004), Understanding HRM-firm performancelinkages: the role of the “strengh” of the HRM system, Academy of ManagementReview, 29(2), 203-221.
- Fang, C.-H., & Tsai, M.-S. (2010). Verification of Company A's corporate training system through TTQS. Journal of International Management Review, 13(1).
- Farrell, M. J. & Fieldhouse, M. (1962), Estimating efficient production functionsunder increasing returns to scale, Journal of Royal Statistical Society-Series A,Part ! , 252-267.
- Farrell, M. J. (1957), The measurement of productive efficiency, Journal of RoyalStatistical Society-Series A, 120(3), 253-290.
- Ho, Y.-F., & Yang, K.-A. (1993). Strategic Human Resource Management. Taipei City: Sanmin Book Co.
- Hsiao, C.-H. (2001). A study on training and organizational performance among strategic business groups (Master's thesis). Providence University, Taichung City.
- Hsieh, C.-T. (2008). Performance evaluation of the photovoltaic industry using DEA (Master's thesis). National Central University, Taoyuan County.
- Hsu, S.-H. (2011). A study on operating performance before and after mergers in the high-tech industry (Master's thesis). Ming Chuan University, Taipei City.
- Hu, W.-W. (2002). A comparative study on corporate training and performance among Taiwan, Japan, the UK, and Germany (Master's thesis). National Central University, Taoyuan County.
- Huang, T.-C. (1998). A study on the relationship between strategic HRM and organizational performance. Fu Jen Journal of Management, 5(1), 1–18.
- Huang, T.-C., Fang, M.-Y., Chou, T.-A., Peng, J.-K., & Chen, C.-C. (1999). A study on talent training and productivity strategies in manufacturing. Taipei City: CLAVocational Training Bureau.
- Hung, C.-H. (1993). The correlation between corporate training systems and business performance (Master's thesis). Tamkang University, New Taipei City.
- Jeffrey, P.(1994), Competitive advantage through people, Harvard Business SchoolPress.
- Kuo, C.-C. (2012). The relationship between sales training and business performance in the semiconductor industry (Master's thesis). National Taiwan University, Taipei City.
- Kuo, C.-K. (2006). A study on performance evaluation of IC packaging material suppliers using DEA(Master's thesis). I-Shou University, Kaohsiung City.
- Lai, Y.-C. (2010). Performance analysis of Taiwan's laptop industry using DEA (Master's thesis). Shu-Te University, Kaohsiung City.
- Latorre, P., López-Ospina, H., Maldonado, S., Guevara, C. A., & Pérez, J. (2024). Designing employee benefits to optimize turnover: A prescriptive analytics approach. Computers & Industrial Engineering, 197, 110582. https://doi.org/10.1016/j.cie.2024.110582
- Lee, Y.-C. (2004). The relationship between training and employee performance: A case study of hairstylists (Master's thesis). Fo Guang College of Humanities and Social Sciences, Yilan County.
- Lei, K.-C. (2011). The impact of training and evaluation models on employee capabilities and corporate performance (Master's thesis). MingDao University, Changhua County.
- Li, Y.-D., Chao, B.-H., & Hsu, H.-S. (1998). A study on the relationship among business environment, HR manager competency, HR effectiveness, and business performance. Chang Jung Journal, 2(3), 23–43.
- Liang, J.-H., Tsai, M.-L., Wang, W.-C., & Lin, C.-L. (2007). Research on human capital indicators using AHP analysis. Performance and Strategy Research, 4(2), 19–42.
- Liao, Y.-K., & Yang, H.-Y. (2007). Management: Theory and Application. Taipei City: Bestwise Publishing.
- Lin, W.-C., Kung, C.-Y., & Lin, L.-L. (2009). Comparison among IIP, ISO 10015, and TTQS. Quality Monthly, 45(4), 52–56.

- Martins, P. S. (2021). Employee training and firm performance: Evidence from ESF grant applications. Labour Economics, 72, 102056. https://doi.org/10.1016/j.labeco.2021.102056
- Nguyen, T., et al. (2022). Workforce development in the age of AI. Technological Forecasting and Social Change, 181, 121703. https://doi.org/10.1016/j.techfore.2022.121703
- O'Keefe, S. (2003). Human resources management and job training. Australianvocational Education and Training Research Asoociation(AVETRA).
- Po, C.-P. (2007). Performance evaluation using DEA. Taipei City: Wunan Books.
- Po, C.-P. (2008). Comprehensive application of DBA in performance evaluation. Taipei City: Wunan Books.
- Rhys Andrews (2010), Organizational social capital, structure and performance,Human Relations, 63(5), 583-608.
- Schuler, R. S. & MacMillan, I. C. (1984), Gaining competitive advantage through HRmanagement practives, Human Resource Management, 23, 241- 255.
- Shao, F.-C. (2006). Performance evaluation of private medical universities using DEA (Master's thesis). I-Shou University, Kaohsiung City.
- Shen, H.-M. (2012). The effect of curriculum planning and execution on capabilities and work attitudes: A case from the northern service sector under CLA's Human Resources Enhancement Program (Master's thesis). Ming Chuan University, Taipei City.
- Shephard, R. W. (1970), Theory of cost and production functions, PrincetonUniversity press, NJ.
- Small and Medium Enterprise Administration, MOEA. (2014). 2014 White Paper on SMEs. Taipei City: MOEA.
- Sun, H. (2004). Data Envelopment Analysis: Theory and Application. Taipei City: Yang-Chih Publishing.
- Swanson, R. A. (1987), Training technology system: amethod for identifying andsolving training problems in industry and business. Journal of Industrial TeacherEducation, 24(4), 9-19.
- Ting, C.-D. (2009). Training Management [ ]. New Taipei City: Yang-Chih Publishing.
- Wang, H.-M. (2007). Training is effective when supervisors are involved—UMC uses training to retain talent. Human Capital, 7, 39–41.
- Wang, L.-L. (2006). The impact of training on organizational performance: A case of the financial industry (Master's thesis). National Sun Yat-sen University, Kaohsiung City.
- Wen, H.-Y. (2006). The effect of business strategy on top executive support for training and its relationship to organizational performance (Master's thesis). National Taiwan University of Science and Technology, Taipei City.
- Wexley, K. N. & Latham , G. P. (1981), Developing and training human resources inOrganization, Scott, Foreman and Company.
- Wu, M.-L., & Tu, J.-T. (2006). SPSS and Applied Statistical Analysis. Taipei City: Wunan Books.
- Wu, T.-C., Chi, T.-C., & Lee, K.-H. (2011). A DEA approach to analyze the relationship between input cost and performance in professional baseball teams. Journal of Sport Knowledge, Aletheia University, 8, 86–101.
- Yang, H.-J. (2001). A study on the relationship between corporate training and organizational performance: A case from the manufacturing industry (Master's thesis). National Central University, Taoyuan County.
- Yang, S.-H. (2009). Performance evaluation of franchise convenience stores using DEA: A case of 7-ELEVEN (Master's thesis). National Chin-Yi University of Technology, Taichung City.
- Yeh, H.-M. (2008). A study on the relationship between training and organizational performance in Taiwan's Irrigation Associations (Master's thesis). Ling Tung University, Taichung City.
- Zhou, Y., et al. (2024). Digital transformation and employee performance: A firm-level perspective. Journal of Business Research. https://doi.org/10.1016/j.jbusres.2024.05.007