

A Study on the Impact of Age and Seniority on the Effectiveness of Practical Safety Training for Safety Supervisors in the Petrochemical Industry

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ABSTRACT

This study aims to validate the key moderating roles of age and seniority in the effectiveness of practical safety training for petrochemical safety supervisors. Through a quasi-experimental analysis of longitudinal data from 548 supervisors, the findings reveal a significant "dual-track benefit": younger and junior trainees show significant improvement in learning-oriented indicators (e.g., certification bonus), whereas older and senior trainees demonstrate exceptional performance in practical risk control (e.g., reducing audit irregularities). This differentiated outcome is supported by Socioemotional Selectivity Theory (SST) and theories of fluid/crystallized intelligence (Gf/Gc). It also confirms that corporate training and TVET should abandon traditional, monolithic models in favor of a "stratified, adaptive" strategy to maximize the learning potential of a multigenerational workforce and enhance overall organizational safety performance.

Keywords: Petrochemical Industry, Safety Supervisor, Practical Safety Course, Training Effectiveness, Kirkpatrick Model, Socioemotional Selectivity Theory (SST), Adult Learning Theory

1. INTRODUCTION

1.1 Research Background and Motivation

In the petrochemical industry, characterized by its complex processes and severe risks, the professional competence of safety supervisors serves as the cornerstone for maintaining operational safety. To this end, practical, hands-on training oriented around the principle of "learning by doing" has become the prevailing industry model. Existing research (Yeh & Liu, 2024) has already confirmed that such training is significantly effective for 548 supervisors at the "Behavior" and "Results" levels of the Kirkpatrick evaluation model.

However, that study overlooked individual learner differences. Both training transfer theory (Baldwin & Ford, 1988) and perspectives on Adult Learning Theory (Knowles, 1980) underscore that personal characteristics, such as age and seniority, are critical variables that influence training transfer effectiveness. Accordingly, this study aims to investigate the moderating effects of "age" and "seniority." The goal is to lay an empirical foundation for enterprises to construct a "stratified and adaptive" training system, thereby optimizing overall training resources and organizational safety performance.

1.2 Research Objectives

Building upon the foundation of a prior study (Yeh & Liu, 2024), this research aims to investigate how age and seniority moderate the effectiveness of hands-on safety training. The study will examine whether significant differences in training outcomes exist among supervisors of varying ages and seniorities, specifically at the 'Behavior' and 'Results' levels of the Kirkpatrick model. The findings are expected to provide an empirical basis for the petrochemical industry and Technical and Vocational Education and Training (TVET) institutions to design stratified and adaptive curricula. The ultimate goal is to enhance training transfer effectiveness and overall organizational safety performance, thereby

moving beyond the traditional "one-size-fits-all" training approach.

1.3 Research Questions

This study aims to answer the following questions:

1. Whether significant differences exist in training effectiveness, specifically at the Kirkpatrick 'Behavior' and 'Results' levels, across safety supervisors of varying age groups.
2. Whether significant differences exist in training effectiveness, specifically at the Kirkpatrick 'Behavior' and 'Results' levels, across safety supervisors of varying seniority levels.

1.4 Definitions of Terms

To ensure clarity of concepts, the following key terms are defined:

1. Petrochemical Industry: Refers to industries that use petroleum and natural gas as raw materials to produce petroleum products and chemical products.
2. Safety Supervisor: A professional responsible for overseeing safe operations during construction processes and ensuring compliance with safety regulations.
3. Training Effectiveness: Refers to the changes in behavior and outcomes of safety supervisors after receiving training, as well as the impact on organizational performance.

1.5 Scope and Limitations

This study focuses on 548 safety supervisors from Company A's various facilities in Taiwan who have passed the safety implementation training course. As this study relies on secondary data analysis, caution must be exercised when generalizing the results, and the scope of the research is limited to Company A, excluding the training effects on other companies or industries.

2. LITERATURE REVIEW

2.1 Hands-on Safety Training and Theories of Training Effectiveness Evaluation

Training effectiveness is influenced by learner characteristics, training design, and the work environment (Baldwin & Ford, 1988). This study investigates two learner characteristics, "age" and "seniority," finding that their impact does not simply decline over time but varies depending on the context (Davenport, 2022). This can be primarily understood from motivational and cognitive perspectives.

From a motivational standpoint, Socioemotional Selectivity Theory (SST) posits that an individual's perception of the future influences their goal setting. Younger employees tend to pursue knowledge-oriented goals (e.g., certifications), whereas older employees prefer emotionally meaningful goals (e.g., passing on experience, ensuring safety). Recent research also indicates that the younger generation is driven by career aspirations, while older adults are more inclined toward intrinsic motivation (Shi, Yang, Sun, Zeng, & Cai, 2023). Consequently, different generations may derive different forms of value from the same training program (Kooij, Bal, & Kanfer, 2014).

From a cognitive psychology perspective, intelligence can be distinguished into fluid intelligence (Gf), which involves processing new information, and crystallized intelligence (Gc), which pertains to the application of existing knowledge and experience. This distinction provides an important foundation for understanding adult learning. While Gf may decline with age, Salthouse (2012) noted that the "lab-life paradox" demonstrates that older adults can compensate for this decline with their rich Gc. Consequently, they may perform even better in jobs that require experiential judgment.

In summary, the successful aging at work framework (Kooij, Zacher, Wang & Heckhausen, 2020) suggests that older employees proactively adjust their strategies, engage in developmental activities that leverage their strengths, and highlight the value of their experience through job crafting. Integrating the

perspectives of Kanfer and Ackerman, younger employees may excel in knowledge-oriented training, whereas older employees hold an advantage in areas requiring experience and practical application. This challenges the stereotype that older employees have a lower willingness to learn (Li, Turek, Henkens, & Wang, 2023).

2.2 Safety Education and Human Factors Risk Management in the Petrochemical Industry

The petrochemical industry, characterized by high risks and complexity, places stringent professional demands on its safety supervisors (Cheng & Yao, 2013). Analysis of occupational accidents by the Ministry of Labor indicates that human error is a primary cause of incidents. In response, many companies have established simulation plants to enhance on-site emergency response capabilities through realistic, hands-on training. The preceding study (Yeh & Liu, 2024) confirmed that this training improves job performance. However, it only assessed overall effectiveness and did not explore how differences in trainee backgrounds might affect training outcomes. This study will conduct an in-depth analysis to address this specific gap.

2.3 Related Empirical Studies and Research Gap

In recent years, although the influence of individual backgrounds on training effectiveness has garnered attention (Tullo, Feng, Pahor, Cote, Seitz, & Jaeggi, 2023), related research within the petrochemical industry remains insufficient. Most of the existing literature only examines the overall benefits of training without conducting in-depth analyses of performance differences among employees of different generations.

This study aims to investigate the motivational and cognitive mechanisms underlying training effectiveness for safety supervisors across different generational and seniority cohorts. The goal is to provide empirical evidence and theoretical support for a "stratified and adaptive" approach to designing safety training programs.

3. RESEARCH METHODS AND DESIGN

3.1 Research Framework and Hypotheses

This study extends the findings of Yeh and Liu (2024), adopting the training transfer model proposed by Baldwin and Ford (1988). The primary focus is to investigate the influence of age and seniority on learner behavior and organizational results, as defined by the third ("Behavior") and fourth ("Results") levels of the Kirkpatrick model. The research framework is detailed in Figure 3-1.

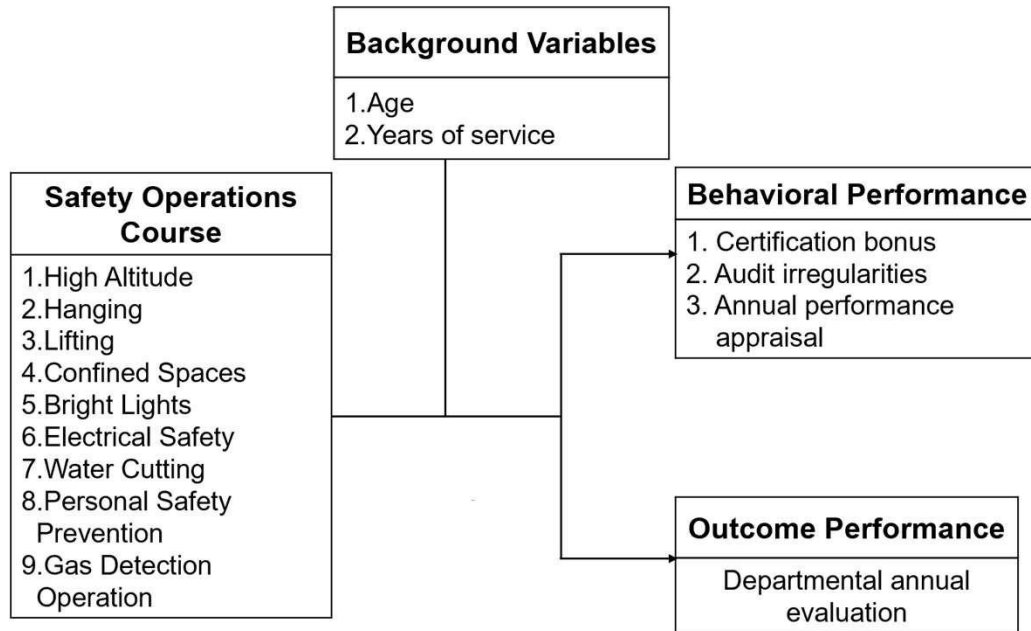


Figure 3-1 Research Framework Diagram

This study proposes the core hypothesis that practical safety training will produce significant positive effects for all trainees, regardless of their "age" and "seniority."

H1: Training effectiveness indicators for all age groups will show significant improvement.

H2: Training effectiveness indicators for all seniority groups will show significant improvement.

3.2 Research Participants and Design

This study utilizes purposive sampling. The research participants are 548 in-service safety supervisors from a benchmark petrochemical company in Taiwan (hereafter referred to as Company A) who completed and passed a practical industrial safety course between 2018 and 2020. The study employs a one-group pre-test/post-test quasi-experimental design. The pre-test baseline is established by the average of various performance indicators over the three years prior to the training, while the post-test measurement is the average of those same indicators over the two years following the training. This approach is used to assess the longitudinal impact of the training.

3.3 Operational Definitions of Research Variables

The **independent variables** consist of the trainees' "age" and "seniority."

1.**Age**: Calculated as the completed years of age on January 1, 2018, and categorized into five groups: "20–29 years," "30–39 years," "40–49 years," "50–59 years," and "60 years and above."

2. **Seniority**: Calculated as the years of service at Company A as of January 1, 2018, and categorized into four groups: "Under 10 years," "10–19 years," "20–29 years," and "30 years and above."

The dependent variables, based on the Kirkpatrick evaluation model, include four performance indicators spanning the "Behavior" and "Results" levels.

1.**Behavior**: This level includes "Certification Bonus," "Audit Irregularities," and "Annual Performance Appraisal."

2.**Results**: This level is represented by the "Departmental Annual Evaluation."

3.4 Data Analysis Method

This study utilizes longitudinal secondary data obtained from the aforementioned company's ERP

(Enterprise Resource Planning) and Human Resources systems. The data were analyzed using IBM SPSS Statistics 26.0, with the significance level (α) set at .05. The following statistical methods were employed:

1. Descriptive Statistics: Used to present the demographic characteristics of the sample.
2. Paired Samples t-test: After stratifying the sample according to the independent variables (age and seniority), paired t-tests were conducted on the pre-training and post-training data for the four dependent variables within each subgroup. This was done to compare the differences in training effectiveness among the various groups.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics of the Research Sample

The participants in this study were 548 safety supervisors who had completed a practical industrial safety training course. In terms of age distribution, the largest groups were those aged 30–39 (34.12%) and 40–49 (29.20%). Regarding seniority, the majority of participants had less than 10 years of service (54.74%), followed by those with 20–29 years of service (27.19%). For a detailed breakdown of the distribution, please refer to Table 4-1.

Table 4-1 Distribution Statistics of Safety Supervisors

Background Variable	Groups (years)	2018	2019	2020	Number of Participants (N)	Percentage (%)
Age	20-29	45	26	26	97	17.7
	30-39	92	32	63	187	34.12
	40-49	74	27	59	160	29.20
	50-59	30	19	31	80	14.60
	≥60	14	5	5	24	4.38
Seniority	<10	150	59	91	300	54.74
	10-19	25	14	25	64	11.68
	20-29	67	25	57	149	27.19
	≥30	13	11	11	35	6.39
Total					548	100

4.2 Analysis of Differences in Training Effectiveness

4.2.1 The Impact of Age on Training Effectiveness

The t-tests conducted by age group (see Tables 4-2 to 4-5 for details) support H1, indicating that age is a key moderating variable in training effectiveness, with different generational cohorts demonstrating distinct advantages:

1. Certification Bonus: Younger trainees showed the strongest motivation, with the 20–29 age group exhibiting the greatest improvement (MD=2.108, $t=6.169$, $p<.001$).
2. Audit Irregularities: The value of experience in older employees was evident. All age groups 30 and over showed a significant reduction in abnormalities ($p<.05$), with the ≥60 age group showing the most significant improvement (MD=0.542, $t=-2.275$, $p<.05$).
3. Annual Performance Appraisal: The training's effect on performance was generally significant, with the 20–29 age group improving the most (MD=0.531, $t=14.847$, $p<.001$). Only the 40–49 age group did not reach a significant level.

4. Departmental Annual Evaluation: The training's contribution was primarily reflected in the departments of younger employees. All groups in the 20–59 age range showed significant growth ($p < .05$), with the contribution from the 20–29 age group being the most significant ($MD=43.491$, $t=15.582$, $p < .001$).

Table 4-2 Paired Samples t-Test on Pre- and Post-Training Certification Bonus by Age Group

Age Group(years)	Time	Mean	SD	MD	t (df)	p
20-29	Post-training	2.634	3.221	2.108	6.169(96)	.000**
	Pre-training	0.526	1.018			
30-39	Post-training	1.361	2.314	0.281	1.361(186)	.175
	Pre-training	1.080	1.426			
40-49	Post-training	1.475	2.050	0.771	4.139(159)	.000**
	Pre-training	0.704	1.186			
50-59	Post-training	0.681	1.308	0.264	1.517(79)	.133
	Pre-training	0.417	0.942			
≥60	Post-training	0.500	1.511	0.431	1.484(23)	.152
	Pre-training	0.069	0.240			

* $p < .05$; ** $p < .001$

Table 4-3 Paired Samples t-Test on Pre- and Post-Training Audit Irregularities by Age Group

Age Group(years)	Time	Mean	SD	MD	t (df)	p
20-29	Post-training	0.000	0.000	-0.003	-1.000(96)	.320
	Pre-training	0.003	0.034			
30-39	Post-training	0.008	0.063	-0.144	-3.258(186)	.001*
	Pre-training	0.152	0.597			
40-49	Post-training	0.057	0.949	-0.090	-3.182(159)	.002*
	Pre-training	0.165	1.252			
50-59	Post-training	0.013	0.079	-0.150	-2.226(79)	.029*
	Pre-training	0.163	0.600			
≥60	Post-training	0.000	0.000	-0.542	-2.275(23)	.033*
	Pre-training	0.542	1.166			

* $p < .05$; ** $p < .001$

Table 4-4 Paired Samples t-Test on Pre- and Post-Training Annual Performance Appraisal by Age Group

Age Group(years)	Time	Mean	SD	MD	t (df)	p
20-29	Post-training	0.964	0.355	0.531	14.847(96)	.000**
	Pre-training	0.433	0.388			
30-39	Post-training	0.984	0.351	0.139	6.321(187)	.000**
	Pre-training	0.845	0.429			
40-49	Post-training	0.991	0.374	0.016	1.598(159)	.112
	Pre-training	0.975	0.384			
50-59	Post-training	1.000	0.390	0.054	2.187(79)	.032*

Age Group(years)	Time	Mean	SD	MD	t (df)	p
≥60	Pre-training	0.946	0.448			
	Post-training	0.917	0.408	0.320	3.607(23)	.001*
	Pre-training	0.597	0.547			

*p < .05; **p < .001

Table 4-5 Paired Samples t-Test of Pre- and Post-Training Departmental Annual Evaluation by Age Group

Age Group(years)	Time	Mean	SD	MD	t (df)	p
20-29	Post-training	73.499	26.485	43.491	15.582(96)	.000**
	Pre-training	30.008	24.818			
30-39	Post-training	75.991	22.600	15.920	7.454(186)	.000**
	Pre-training	60.071	33.886			
40-49	Post-training	75.883	23.625	5.693	3.674(159)	.000**
	Pre-training	70.190	28.799			
50-59	Post-training	74.277	24.997	9.036	3.546(79)	.001*
	Pre-training	65.241	31.385			
≥60	Post-training	36.754	40.840	2.384	1.507(23)	.145
	Pre-training	34.370	38.682			

*p < .05; **p < .001

4.2.2 The Impact of Seniority on Training Effectiveness

The t-tests conducted by seniority level (see Tables 4-6 to 4-9 for details) support H2, indicating that seniority is a key moderating variable in training effectiveness, with junior and senior employees demonstrating different strengths:

1. Certification Bonus: Employees in the career growth stage showed higher motivation. All groups with less than 29 years of seniority showed significant improvement ($p < .05$), with the 10–19 years group exhibiting the greatest increase ($MD = 0.971$, $t = 2.529$, $p < .05$).
2. Audit Irregularities: The training's effectiveness was universal, as all seniority groups experienced a significant reduction in abnormalities ($p < .05$). The most senior employees (≥ 30 years) showed the most significant improvement ($MD = -0.529$, $t = -2.769$, $p < .05$).
3. Annual Performance Appraisal: The training had the greatest positive impact on junior employees, with only the group having < 10 years of seniority showing a significant improvement ($MD = 0.304$, $t = 13.622$, $p < .001$).
4. Departmental Annual Evaluation: The contribution of junior employees to the organization was most prominent. The departments of the < 10 years seniority group showed the greatest improvement ($MD = 24.471$, $t = 13.548$, $p < .001$), while the departments of senior employees (≥ 20 years) also showed significant growth ($p < .05$).

Table 4-6 Paired Samples t-Test on Pre- and Post-Training Certification Bonus by Seniority Level

Seniority Level(years)	Time	Mean	SD	MD	t (df)	p
<10	Post-training	1.680	2.582	0.816	4.747(299)	.000**
	Pre-training	0.864	1.296			
10-19	Post-training	1.633	2.661	0.971	2.529(63)	.014*
	Pre-training	0.662	1.280			

Seniority Level(years)	Time	Mean	SD	MD	t (df)	p
20-29	Post-training	1.238	1.865	0.652	3.895(148)	.000**
	Pre-training	0.586	1.083			
≥30	Post-training	0.557	1.181	0.224	1.049(34)	.302
	Pre-training	0.333	0.859			

*p < .05; **p < .001

Table 4-7 Paired Samples t-Test of Pre- and Post-Training Audit Irregularities by Seniority Level

Seniority Level(years)	Time	Mean	SD	MD	t (df)	p
<10	Post-training	0.007	0.057	-0.097	-3.447(299)	.001**
	Pre-training	0.103	0.481			
10-19	Post-training	0.000	0.000	-0.037	-2.171(63)	.034*
	Pre-training	0.037	0.134			
20-29	Post-training	0.081	0.983	-0.112	-2.930(148)	.004*
	Pre-training	0.192	1.327			
≥30	Post-training	0.014	0.085	-0.529	-2.769(34)	.009*
	Pre-training	0.543	1.123			

*p < .05; **p < .001

Table 4-8 Paired-Samples t-Test of Pre- and Post-Training Annual Performance Appraisal by Seniority Level

Seniority Level(years)	Time	Mean	SD	MD	t (df)	p
<10	Post-training	0.973	0.334	0.304	13.622(299)	.000**
	Pre-training	0.669	0.459			
10-19	Post-training	0.984	0.418	0.010	1.000(63)	.321
	Pre-training	0.974	0.400			
20-29	Post-training	0.993	0.394	-	-	-
	Pre-training	0.993	0.394			
≥30	Post-training	1.000	0.420	-	-	-
	Pre-training	1.000	0.420			

*p < .05; **p < .001

Table 4-9 Paired-Samples t-Test of Pre- and Post-Training Departmental Annual Evaluation by Seniority Level

Seniority Level(years)	Time	Mean	SD	MD	t (df)	p
<10	Post-training	70.615	29.389	24.471	13.548(299)	.000**
	Pre-training	46.144	35.170			
10-19	Post-training	73.888	26.157	2.991	1.532(63)	.130
	Pre-training	70.897	28.392			
20-29	Post-training	78.548	18.858	7.600	4.309(148)	.000**
	Pre-training	70.948	27.310			
≥30	Post-training	76.809	19.295	6.333	2.122(34)	.041*

Seniority Level(years)	Time	Mean	SD	MD	t (df)	p
	Pre-training	70.476	24.692			

*p < .05; **p < .001

4.3 Comprehensive Discussion

This study reveals the distinct impacts of age and seniority on the effectiveness of safety training in the petrochemical industry, providing an empirical basis for curriculum design in corporate training and Technical and Vocational Education and Training (TVET). The following sections will explain the observed "dual-track benefit" phenomenon from three theoretical perspectives: motivation, cognition, and successful aging.

1. Explaining Motivational Differences: Socioemotional Selectivity Theory (SST)

The "dual-track benefit" phenomenon can be explained by Socioemotional Selectivity Theory (SST). Younger trainees (20–29 years old) showed significant improvement in growth-oriented indicators like certifications and performance appraisals. This is because their long-term career perspective motivates them to invest in activities that enhance their personal capital (Carstensen, 2021; Shi et al., 2023). Conversely, older trainees (≥ 60 years old) excelled at reducing audit abnormalities. They apply their experience to enhance on-site safety, which allows them to feel a stronger sense of intrinsic motivation and job satisfaction (Shi et al., 2023; Kooij et al., 2020).

2. Complementary Cognitive Resources: Fluid and Crystallized Intelligence

This study demonstrates the complementary roles of fluid intelligence (Gf) and crystallized intelligence (Gc). Younger employees, with their higher fluid intelligence, are able to learn quickly and improve their performance. In contrast, senior employees rely on their accumulated crystallized intelligence to adeptly apply knowledge and make sound judgments. Davenport (2022) noted that experience can compensate for a decline in fluid abilities, enhancing performance in complex tasks. Correspondingly, this study found that senior employees were highly effective at reducing audit abnormalities.

3. An Integrative Framework: Successful Aging at Work

This research validates the application of the "successful aging at work" theory (Kooij et al., 2020) in a high-risk industry. The results show that employees of different generations proactively choose different methods to achieve their work goals and personal growth. Younger employees accumulate professional capital by pursuing external recognition (e.g., certifications, performance appraisals), while older employees leverage their experiential advantages (e.g., reducing risks) to actualize their value and contribute to the organization. Notably, the way older employees integrate training with their experience to optimize methods demonstrates the behavior of "job crafting" (Zhuo, Wu, Cong, & Bao, 2025), through which they proactively adapt and maintain performance.

4. Summary and Theoretical Implications

This research finds that while the younger generation responds more quickly to learning, the senior generation possesses a wealth of experience. This supplements the training transfer model of Baldwin and Ford (1988) by demonstrating that learner characteristics, shaped by career stage, motivation, and cognitive structures, influence training outcomes. The results also refute the stereotype that "older employees are unwilling to learn," supporting the view of Zhuo et al. (2025) that as long as training content aligns with job demands and the organizational climate is positive, older employees can actively engage in learning activities and create significant value for the organization.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Research Conclusion

This study finds that age and seniority significantly influence the effectiveness of safety training.

The training outcomes exhibit a "dual-track phenomenon": younger and less experienced employees improve more rapidly on learning-oriented indicators (e.g., certification acquisition, performance appraisal scores), whereas older and more senior employees perform better in risk control (e.g., reducing audit abnormalities). This demonstrates that experience and learning potential each offer distinct, complementary advantages in safety training. An effective training system should cater to the unique characteristics of different employees rather than focusing on a single type of outcome.

5.2 Research Contributions

This study makes two primary contributions:

1. Theoretical Contributions: This study is the first to apply Kirkpatrick's higher-level evaluation metrics in conjunction with adult learning theory to safety training in the petrochemical industry. In doing so, it addresses a significant gap in the empirical literature and deepens the understanding of adult learning motivation and cognitive change in this context.
2. Practical Contribution: The results indicate that corporate training and TVET should adopt "adaptive training" models instead of a one-size-fits-all approach. It also validates the "realistic simulation + hands-on practice" method as an effective model for developing industry-academia collaborative courses.

5.3 Research Recommendations and Limitations

Recommendations for Enterprises and Technical and Vocational Education (TVET):

1. Enterprises should adopt adaptive training, designing curricula and incentive systems based on the needs of different generational cohorts.
2. Establish a comprehensive post-training follow-up and coaching system where supervisors are responsible for providing support and feedback. This ensures that trainees can apply what they have learned in the workplace, enhancing training transfer effectiveness.
3. Continue to invest resources in strengthening hands-on training facilities to improve the ability of safety supervisors to manage high-risk operations.

Recommendations for Future Research and Limitations:

1. The sample for this study was drawn from a single company, which limits the external validity of the findings when generalizing to other companies or industries. It is recommended that future research expand the sample to validate the stability of these results.
2. Psychological variables such as "learning motivation" and "self-efficacy" were not included. Future research could further investigate the role of these factors.
3. Subsequent research could employ methods such as ANOVA or HLM to more precisely compare group differences and interaction effects.

REFERENCES

中文部份：

鄭慶武、姚宏慶（2013）。台灣石化工業職業災害調查與預防措施探討。《工業安全衛生月刊》，293，43-63。

外文部份：

Baldwin, T. T., & Ford, J. K. (1988). Transfer of training: A review and directions for future research. *Personnel Psychology*, 41(1), 63–105. <https://doi.org/10.1111/j.1744-6570.1988.tb00632.x>

Carstensen, L. L. (2021). Socioemotional selectivity theory: The role of perceived time in human development. In R. J. Sternberg & J. Glück (Eds.), *The Cambridge handbook of wisdom* (pp. 124–143). Cambridge University Press.

- Davenport, M. K. (2022). A lifespan development perspective and meta-analysis on the relationship between age and organizational training. *Personnel Psychology*, 75(2), 317–347. <https://doi.org/10.1111/peps.12535>
- Kanfer, R., & Ackerman, P. L. (2004). Aging, adult development, and work motivation. *Academy of Management Review*, 29(3), 440–458. <https://doi.org/10.5465/amr.2004.13670969>
- Kirkpatrick, D. L. (1959). Techniques for evaluating training programs. *Journal of the American Society of Training Directors*, 13(11), 21–26.
- Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy*. Cambridge Books.
- Kooij, D. T. A. M., Bal, P. M., & Kanfer, R. (2014). Future time perspective and promotion focus as determinants of intraindividual change in work motivation. *Psychology and Aging*, 29(2), 319–328. <https://doi.org/10.1037/a0036768>
- Kooij, D. T. A. M., Zacher, H., Wang, M., & Heckhausen, J. (2020). Successful aging at work: A process model to guide future research and practice. *Industrial and Organizational Psychology*, 13(3), 345–365. <https://doi.org/10.1017/iop.2020.1>
- Li, Y., Turek, K., Henkens, K., & Wang, M. (2023). Retaining retirement-eligible older workers through training participation: The joint implications of individual growth need and organizational climates. *Journal of Applied Psychology*, 108(6), 954–976. <https://doi.org/10.1037/apl0001065>
- Salthouse, T. A. (2012). Consequences of age-related cognitive declines. *Annual Review of Psychology*, 63, 201–226. <https://doi.org/10.1146/annurev-psych-120710-100328>
- Shi, J., Yang, Y., Sun, S., Zeng, X., & Cai, W. (2023). Do people become more proactive at work as they grow older? Examining the mediating roles of intrinsic motivation, emotional exhaustion, and career aspiration. *Frontiers in Psychology*, 14, 1154861. <https://doi.org/10.3389/fpsyg.2023.1154861>
- Tullo, D., Feng, Y., Pahor, A., Cote, J. M., Seitz, A. R., & Jaeggi, S. M. (2023). Investigating the role of individual differences in adherence to cognitive training. *Journal of Cognition*, 6(1), 48. <https://doi.org/10.5334/joc.315>
- Yeh, K. L., & Liu, W. T. (2024). A study on the training effectiveness of safety practical course for safety supervisor in the petrochemical industry. *Journal of Asian Vocational Education and Training*, 17, 20–27.
- Zhuo, L., Wu, Q., Cong, Y., & Bao, X. (2025). Linking proactive personality to successful aging at work: A moderated mediation model. *Frontiers in Psychology*, 16, 1616092. <https://doi.org/10.3389/fpsyg.2025.1616092>