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Field Study

An Evaluation of the Participatory Action-oriented Training (PAOT) Program in Small Enterprises in Vietnam

Toai Phuong NGUYEN[1,2] and Ton That KHAI[2]

[1]The Institute of Occupational and Environmental Medicine, University of Birmingham, UK and [2]Can Tho Medical College, Vietnam

Abstract: An Evaluation of the Participatory Action-oriented Training (PAOT) Program in Small Enterprises in Vietnam: Toai Phuong NGUYEN, *et al.* The Institute of Occupational and Environmental Medicine, University of Birmingham, UK—Objectives: Participatory Action-Oriented Training (PAOT) has been known as a practical training methodology for improving health and safety at work, particularly for small- and medium-sized enterprises (SMEs). Our hypothesis is that PAOT is a better approach than a traditional local method, and the objective of this study was to evaluate the efficacy of PAOT and to make suggestions for improvement. **Methods:** An intervention was performed for one year at 20 volunteer SMEs. PAOT was applied in 10 factories, and a traditional local method was applied in the other 10 SMEs as a control. Two cross-sectional studies were performed consisting of a questionnaire and environmental measurements. Data were also collected on the number of factory improvements, productivity, worker income, accidents, and health costs. **Results:** There were significant improvements among the intervention factories in terms of work environment, number of improvements and health costs between the pre- and post- intervention phases. In terms of productivity, significant increases were seen in the civil engineering, metal, garment, and rice mill industries in the intervention group, while the metal casting and, garment industries in the control group also showed significant increase in productivity. **Conclusions:** The findings support the idea that a PAOT program produces better outcomes in SMEs. It is recommended that a PAOT program be widely applied to SMEs to improve health and safety. A fuller examination could be obtained with more environmental measurements taken over a much longer period of time, together with data on sickness absence and accidents that have been independently validated.
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Correspondence to: T. P. Nguyen, The Institute of Occupational and Environmental Medicine, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK (e-mail: phuongtoai@yahoo.com)

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Industrialization creates job opportunities and has increased the annual per capita national income in Vietnam over the last decade. However, health and safety at work in small- and medium-sized enterprises' (SMEs) is becoming an increasing concern for the Vietnamese government. Workers often work in substandard conditions and are exposed to various hazards in the workplace without appropriate safety and health training and information[1)]. There is some evidence that small industries often have hazardous working conditions, lower productivity and quality, even though, economic competitiveness is one of the most important concerns of small enterprise entrepreneurs[2)].

Many different methods of providing health and safety services rely on health education. Among them, Participatory Action-Oriented Training (PAOT) is a practical method of supporting workplace initiatives based on self-help voluntary actions[3–6)]. This PAOT approach was introduced to SMEs in Asia in the 1990s[1, 2, 7, 8)] and further to other grassroots workplaces such as home workplaces, small construction sites, agriculture and waste collection sites[9)].

PAOT program encourages workers to be involved in making their workplace safer and less damaging to their health[10, 11)]. This method, supported by the International Labour Organization (ILO), is believed to be one of the more effective techniques for improving health and safety at work. PAOT is an occupational health training program that uses a widely-applicable participatory approach involving employees and employers in making their work environment safer, more productive, and less harmful to their health[4, 5)]. It uses unique training tools including checklist exercises, low-cost improvements, continuous follow-up visits, and workshops to discuss progress and achievements[3)].

The effectiveness of the PAOT approach has been reported with reference to workplace improvements and national policy developments[1–3, 7–9]. For example, Takeyama *et al*., demonstrated reduced sound pressure levels after implementation of a PAOT program[12]. However, more comprehensive workplace assessments of the PAOT approach are needed to evaluate more fully its efficacy and strengths, as well as to identify possible improvements of the tool with the view of extending its application to a wider range of workplaces[1, 9, 16]. Furthermore there is a need to measure the effectiveness of a PAOT program and to compare it with the more conventional health and safety training methods aimed at improving work practices[12, 13]. With this mind, this study was designed to evaluate the PAOT approach in a number of SMEs.

Materials and Methods

An intervention follow-up study was carried out by the Centre for Occupational Health and Environment of Can Tho City (ECHO). ECHO is a provincial governmental center that has responsibility for providing health and safety advice and services to all businesses and workers employed in the city.

A total of 105 SME factories that had been routinely monitored by ECHO were invited to participate in the present study. They all belonged to one of the five major industry types: printing and paper, civil engineering, metal casting, textile, and rice mills. Thirty-five enterprises agreed to participate, and 34 factories refused because they were too busy conducting business or they wished to protect technological secrets. The remaining 36 enterprises did not respond to the invitation for unknown reasons.

From the 35 factories that agreed to participate in the study, twenty were randomly selected for the present study. At least two factories from each of the five industry sectors were chosen and participated in the study. Factories were randomly allocated to the two arms of the intervention (PAOT/control) as described in Table 1. Ten factories were placed in the intervention group and received a PAOT program. These ten factories had 1,678 employees in total. The remaining ten factories were placed in the control group and continued to receive conventional occupational health training consisting of training instruction (lectures with minimal discussion) covering primarily health and safety principles, legal requirements, and the importance of following existing policies and procedures.

The impact of the training program was evaluated by conducting pre- and post-intervention measurements (personal and static samples) in the factories of airborne pollutants (dusts), noise levels, lighting conditions, ambient air velocities, and air temperature and humidity. The post-intervention measurements were conducted 12 months after implementation of the intervention.

Universal sampling pumps (PCXR4 Air Sampling Pumps, SKC Ltd., Dorset, UK); flow rate range of 1,000 to 5,000 m*l*/min) were used for both personal and static sampling. Sampling for the total inhalable and respirable dust fractions was conducted according to UK HSE method MDHS14/3. Respirable sampling was conducted using a plastic cyclone sampler (SKC), and the inhalable fraction was collected with an IOM sampling head. All particulate samples were collected on 25 mm glass fiber filters. The sampling trains (sampling device with filter) were calibrated before and after sampling using a rotameter capable of measuring within 0.1 l/min.

A handheld type 1 integrating sound level meter (SLM; NL-20, Rion, Tokyo, Japan) with a measuring range from 28 to 138 dBA was used to record the following: sound pressure levels (Lp), equivalent continuous sound pressure level (Leq), and the maximum noise level (Lmax). The SLM was calibrated using the NC-74 external calibrator at 94 dB and 1,000 Hz. The lighting conditions were measured using a Konica Minolta T-10 Illuminance meter (Konica Minolta, Tokyo, Japan) range 0.01 to 299,900 lx). A Multi- Function Thermal Anemometer (Climomaster model A531, Kanomax, Osaka, Japan) was used to simultaneously measure the air temperature (range 0 to 50.0°C), air velocity (range 0.10 to 30.0 m/s), and the relative humidity (range 2.0 to 98.0% RH).

The checklist form and training package from the Work Improvement for Protection of Environment (WIPE)[14–16] programme were introduced in the PAOT courses[17–19] and were used to assess each factory and to assist staff in developing their own ideas for improving the working conditions at the ten intervention enterprises. PAOT is "a practical method to support workplace initiatives based on self-help voluntary actions". The training program made substantial changes in terms of health and safety in the SMEs, applying basic principles such as (1) building on local good practices, (2) focusing on multi-area low-cost improvements, and (3) action tools using basic ergonomics principles[3]. The PAOT methods were applied in a single two-day training program carried out by ECHO staff at the intervention factories.

A follow-up team visited all 20 factories (Table 1) every three months to collect information on the number of health and safety improvements made by workers/owners along with their total cost and their applications, types of improvement, and who actually proposed and initiated improvements.

A quarterly report containing monthly data on the following things was collected from each factory:

Table 1. Size and primary business of the participating factories

	Intervention	Control	Total
Number of employees			
100–125	7	8	15
126–150	1	0	1
301–350	0	1	1
351–400	1	0	1
501–550	1	0	1
551–600	0	1	1
Primary business			
Metal casting	2	2	4
Rice mill	3	3	6
Civil engineering	2	2	4
Garment	2	2	4
Label printing & paper container	1	1	2
Total	10	10	20

Table 2. Comparison of occupational hygiene data before and after introducing of Participatory Action-Oriented Training (PAOT)

Exposure / units	Geometric mean (GSD)		Ratio of geometric means[c]
	Pre-intervention[a]	Post-intervention[b]	
Intervention group			
Personal dust ($mg.m^{-3}$)	1.17 (2.28)	0.80 (2.26)	0.69***
Static dust ($mg.m^{-3}$)	0.77 (2.59)	0.58 (2.44)	0.75***
Noise (dBA)	80.3 (1.12)	78.6 (1.11)	0.98***
Lighting (lx)	241.8 (2.99)	348.9 (2.01)	1.44***
Control group			
Personal dust ($mg.m^{-3}$)	0.67 (1.99)	0.78 (1.88)	1.16***
Static dust ($mg.m^{-3}$)	0.54 (2.02)	0.65 (2.01)	1.21***
Noise (dBA)	79.8 (1.12)	80.8 (1.11)	1.01**
Lighting (lx)	259.1 (2.55)	318.4 (1.50)	1.23**

* p<0.05, ** p<0.01, *** p<0.001.
[a.] Pre-intervention. [b.] Post-intervention. [c.] Post-intervention / pre-intervention.

number of accidents, number of accidents leading to absence from work, days of absence due to accidents, number of workers requiring medication/treatment, and health costs per month due to illnesses/accidents; in addition, a quarterly report of data for productivity level and the average incomes of workers was prepared based on the factories reports.

Workplace measurements, factory monthly reports, and the number of improvements were compared between the post and pre-intervention phases to determine the improvements in the working environment as a result of the PAOT intervention.

Results

The environmental measurements for the intervention and control groups are summarized in Table 2 for all types of industries. Geometric means (with corresponding geometric standard deviations) are shown for phase 1 (pre-intervention) and phase 2 (post-intervention) together with the ratio of geometric means for the two phases. For the intervention group, statistically significant decreases were found for personal dust, static dust, noise, and lighting levels. For the control group, statistically significant increases were found for lighting levels, personal dust, static dust, and noise.

Changes in unexpected directions were found for some intervention industries, but this was only the case for lighting levels (one industry), air temperature (two industries), and air velocity (three industries).

Measurement results for inside air temperature, air humidity, and air velocity were available for 360 measuring points (180 points each for the intervention and control groups). The measurement results of the two groups were classified under one of four headings: both acceptable, both unacceptable, change to acceptable temperature, and change to unacceptable temperature. The results are summarized in Table 3 for all industries and both study groups. For the intervention group, significant improvements were found for air temperature and air humidity. For the control group, significant improvements were found for air temperature, air humidity, and air velocity.

The number of improvements and the number of applications are summarized in Table 4 for the two study groups. These improvements included improvements in materials handling, work stations and postures, machine and electrical safety, handling of chemicals and other hazardous materials, physical environments, work-related welfare facilities, and work organization. A larger number of improvements were implemented in the intervention group in each of the five industries studied. Many improvements were duplicated and multiplied from one section to another within the same factories.

A comparison of health-related costs and accidents rate for 12 months is shown in Table 5 for the intervention and control groups. Overall, there were fewer accidents and lower health-related costs in the intervention group.

The productivities and incomes of the workers are summarized in Table 6 for the intervention group and for the control group. For the intervention group,

Table 3. Comparison of pre- and post-intervention air temperature, air humidity, and air velocity between the intervention and control groups

Exposure / units	Measurement twice[a] (n[a])	Both acceptable[b] (1)	Both unacceptable[c] (2)	Change to acceptable value[d] (3)	Change to unacceptable value[e] (4)	p-value[f]
Intervention group						
Air temperature (°C)	180	58	79	32	11	<0.01
Air humidity (%)	180	160	5	14	1	<0.001
Air velocity (m/s)	180	28	122	14	16	0.86
Control group						
Air temperature (°C)	180	83	64	27	6	<0.001
Air humidity (%)	180	130	18	24	8	<0.01
Air velocity (m/s)	180	7	156	3	14	0.01

[a.] Number of workplaces with pre- and post-intervention measurement. [b.] Pre- and post-intervention workplaces with measurement values in acceptable ranges. [c.] Neither pre-intervention nor post-intervention workplaces with measurement values in acceptable ranges. [d.] Pre-intervention workplace values were unacceptable, and post-intervention measurement values were acceptable. [e.] Pre-intervention workplace humidity was acceptable, and post-intervention measurement values were unacceptable. [f.] Based on exact binomial probability with a null hypothesis that the ratio of discordant pairs (column (3) / column (4)) should be 1.0, the test is equivalent to McNemar's χ^2 when n ≥10.

Table 4. Comparison of improvements between the control and intervention groups

Observations	Control group		Intervention group		Number of improvements for the two groups
	Number of improvements[a]	%	Number of improvements[a]	%	
Number of improvements	87	26.0	247	74.0	334
- Improvements multiplying to other sections[b]	312	12.6	2,159	87.4	2,471
Improvement using recycled material	36	20.5	140	79.5	176
- Improvements multiplying to other sections[b]	156	18.3	698	81.7	854
Number of zero cost improvements	2	3.9	49	96.1	51
- Improvements multiplying to other sections[b]	7	2.3	291	97.7	298
Total	600	14.3	3,584	85.7	4,184

[a.] Improvements made over a 12 month period. [b.] A single type of improvement in one section was often applied in a number of other sections at one factory.

Table 5. Worker health cost reports for the control and intervention groups

Month of observation	Control group: Health cost (× 1,000 VND) Observed	Control group: Health cost (× 1,000 VND) Expected[a]	Control group: Number of workers	Intervention group: Health cost (× 1,000 VND) Observed	Intervention group: Health cost (× 1,000 VND) Expected[a]	Intervention group: Number of workers	Total: Health cost (× 1,000 VND)	Total: Number of workers
1	6,722	6,756.0	1,757	6,990	6,956.0	1,809	13,712	3,566
2	5,921	6,838.6	1,745	8,007	7,089.4	1,809	13,928	3,554
3	6,309	5,688.3	1,745	5,286	5,906.7	1,812	11,595	3,557
4	10,142	7,493.1	1,726	5,235	7,883.9	1,816	15,377	3,542
5	7,560	6,061.2	1,718	4,901	6,399.8	1,814	12,461	3,532
6	5,982	5,390.4	1,734	5,035	5,626.6	1,810	11,017	3,544
7	5,470	4,806.8	1,669	4,374	5,037.2	1,749	9,844	3,418
8	4,230	3,945.9	1,667	3,844	4,128.1	1,744	8,074	3,411
9	4,492	3,912.7	1,654	3,544	4,123.3	1,743	8,036	3,397
10	5,093	4,394.3	1,721	3,910	4,608.7	1,805	9,003	3,526
11	5,251	4,433.3	1,714	3,838	4,655.7	1,800	9,089	3,514
12	5,619	4,824.0	1,709	4,269	5,064.0	1,794	9,888	3,503
Total	72,791	64,544.6	20,559	59,233	67,479.5	21,505	132,024	42,064

[a] Calculated based on the health costs per worker for the total population (control and intervention groups combined) for each group.

Table 6. Comparison of productivity and incomes between the intervention and control groups: the first and last 3 month reports

Industry	Geometric mean (GSD) Phase 1[a]		Phase 2[b]		Ratio of geometric means[c]	95% CI of ratio
Intervention group						
Label printing & paper container (tons)	608.9	(1.16)	663.9	(1.06)	1.09	0.86 to 1.39
Civil engineering (× 1,000,000 VN Dong)	800.5	(1.25)	1,049.9	(1.14)	1.31*	1.09 to 1.57
Metal casting (tons)	7.4	(2.04)	10.4[d]	(2.54)	1.41*	1.02 to 1.96
Garment (× 1,000 pieces of product)	67,557	(1.04)	72,815	(1.01)	1.08**	1.04 to 1.12
Rice mill (tons)	1,837.3	(1.02)	1,908.1	(1.04)	1.04*	1.01 to 1.07
Workers' incomes (× 1,000 VN Dong)	1,601.0	(1.35)	2,320.3	(1.39)	1.45***	1.34 to 1.57
Control group						
Label printing & paper container (tons)	627.0	(1.12)	667.3[d]	(1.04)	1.07	0.89 to 1.29
Civil engineering (× 1,000,000 VN Dong)	712.9	(1.69)	939.9[e]	(1.15)	1.32	0.81 to 2.14
Metal casting (tons)	7.4	(1.82)	7.64[d]	(1.84)	1.04*	1.00 to 1.07
Garment (× 1,000 pieces of product)	70.0	(1.03)	71.4	(1.02)	1.02*	1.01 to 1.03
Rice mill (tons)	1,891.9	(1.06)	1,916.0	(1.04)	1.01	0.99 to 1.04
Workers' incomes (× 1,000 VN Dong)	1,768.4	(1.38)	2,183.4	(1.43)	1.23***	1.13 to 1.35

* $p<0.05$, ** $p<0.01$, *** $p<0.001$.
[a] Main productivity for the first three months. [b] Main productivity for the last three months. [c] Main productivity for the last three months / productivity for the first three months.

statistically significant increases in productivity were found for the civil engineering industry, metal casting industry, garment industry, and rice mill industry and for workers' incomes for all industries combined. For the control group, statistically significant increases in productivity were found for the metal casting industry and garment industry and for workers' incomes for all industries combined.

Discussions

The results of this study show the usefulness of a PAOT program and indicate effective ways to use it. There were highly significant differences between the intervention and control factories. For the intervention factories, the post-intervention conditions were better than the pre-intervention conditions for many of the industries studied. Paired comparisons (pre- and post-intervention measurements) were matched for industry, factory, sampling location, time of year, and sampling equipment. Consequently, there should be no confounding from these factors[20, 22]. Other differences over the course of the year between the two sets of measurements are possible, such as poor maintenance of machines and exhaust ventilation systems, and poor quality of raw materials, although we have no reason to believe that this was more of an issue for control factories than intervention factories.

The study was designed carefully and has a number of strengths. To avoid any management influence on working plans, notice the measurements would be conducted was only given to the enterprises on the same day that they would be conducted. All samples were collected with the same set of equipment and by the same team of experienced trained technicians. Pre- and post-intervention samples were obtained from the same set of sampling positions, and machines were operated at standard working speeds following ordinary production techniques. The management and workforce were not told that the post-intervention sampling positions would be the same as those used for pre-intervention sampling, so that there could be no question of management arranging for improvements to be made at only a few parts of the factory. Pre- and post-intervention samples were conducted at the same time of the year to avoid any unexpected effects from climate changes on measurements.

There were, however, some limitations to this study. The limited number of measuring positions might not reflect conditions in all parts of the factory, and the sampling positions were not necessarily close to all working locations where improvements occurred. The pre-and post-intervention personal dust measurements might relate to different workers, who might have different working behaviors. Control for all factors was not possible in this kind of intervention study in the real workplace. Two sets of measurements were carried out for each factory and the study had to assume that each of these sets of measurements was typical of the pre- and post-intervention conditions. For the control industries, if we consider all the industries together and limit ourselves to statistically significant deteriorations, then the post-intervention measured conditions were worse for personal dust, static dust, and noise. There is no obvious explanation for the apparent deterioration in conditions. These points should be considered carefully when future studies are designed.

A PAOT program enables management and workforce employees to work in groups sharing knowledge and discussing and planning their own selected best solutions. It applies simple solutions that empower people to take action immediately; participants take pride in showing the number of improvements they have made and the good zero-cost practices they have created. Several studies in Asia demonstrated that the number of improvements and good inexpensive practices were the most attractive to small scale and enterprises without budgets for improvements[19, 23, 26]. In addition, PAOT strengthens the relationship between managers and local occupational health staff and between factory owners and workers. Therefore, factory owners in the present study honestly shared their safety and health issues to the facilitators, provided opportunities for workers to raise and discuss their own simple ideas, and allowed their employees to conduct improvements with factory resources. Moreover, through PAOT and meetings, managers/owners sit together, share similar problems, and discuss the best solutions for health and safety and to produce economical, higher productivity and better products[1, 5–7, 10, 11, 17, 27]. Similarly, Kawakami described that his prior studies of PAOT in Asian countries showed a high number of improvements in SMEs beginning in the 1990's[1, 2].

Another key concern of PAOT is accident prevention. The rules for preventing accidents are simple, practical, and useful. As a result, managers and workers in the present study immediately understood the risks and knew how to prevent accidents, and how to control the mistakes in operation. Therefore, similar to other studies, the number of accidents and the health costs at the factories that applied PAOT were significantly lower than at the others factories[7, 23, 28, 30]. Takeyama *et al*. claimed that a PAOT program in the Philippines could reduce the fatigue from workloads for different industries[12].

There are some important challenges to organization of a successful PAOT intervention. Trained participants set their own priorities, propose improvements based on their resources, recognition, skills, and available time. Most plans start with low-cost, simple, and interesting improvements first, then move on to more expensive and complicated plans[1, 23, 27]. It follows that continuous support is important to sustain the employers' and workers' efforts for step-by-step improvements. Besides, management involvement and willingness to join in a PAOT program is extremely important for launching and maintaining any PAOT plans, and such management support will be available when PAOT organizers stress the benefits to businesses such as productivity enhancement and improved worker-employer relationships.

The findings of this intervention study support the idea that a PAOT program produces better outcomes in SMEs than a local traditional occupational health program. A fuller intervention and examination of PAOT in a larger study with more environmental measurements over a longer period of time and with data on sickness absences and accidents that have been independently validated are necessary in the future. Overall, PAOT is a useful program for improving working conditions in SMEs and should be widely applied as a practical intervention methodology to improve the health and safety of SMEs and other.

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