A TRIAL EVALUATION OF THE PARTICIPATORY ACTION ORIENTED TRAINING PROGRAMME IN SMALL AND MEDIUM SCALE ENTERPRISES IN VIETNAM

by

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Abstract

Adverse work environments, occupational sickness and accidents are common problems for many 'Small and Medium Scale Enterprises' (SMEs) in different parts of the world. Seeking better ways to improve health and safety in SMEs is a key target for national authorities and international agencies. This study aims to apply and evaluate the effectiveness of an occupational health training method called 'Participatory Action Oriented Training' (PAOT); claims have been made that PAOT is an effective technique for improving health and safety at SMEs in developing countries.

An intervention study was performed with the assistance of 20 volunteer SMEs from five major industries in Can Tho City, Vietnam, between May 2007 and May 2008, to evaluate the effectiveness of the PAOT programme. The programme was applied in 10 factories and the traditional local health and safety methods were applied to the 10 'control' factories. The research was conducted in two phases (pre-intervention and post-intervention) and consisted of matched cross-sectional studies using managers' questionnaires (n=69), environmental measurements (personal dust (n=360), static dust (n=360), toxic gases (n=72), noise (n=540), lighting (n=900), air temperature (n=720), air humidity (n=720), air velocity (n=720)). Data were also collected quarterly follow-up visits to record the number of improvements that had been made, and to obtain monthly factory reports on productivity, workers' income, accidents, sickness absence, health visits, and health costs.

There were significant improvements among intervention factories after one year in terms of environment measurements, numbers of improvements, numbers of cases of sickness and accidents, health costs, productivity and workers' incomes. The findings of the intervention study support the idea that a PAOT programme produces better outcomes in SMEs than a local traditional occupational health programme. The current study was limited, however, in a number of ways, and a fuller examination of PAOT will require a larger study 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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Table of content

List of tables

List of figures

List of appendices

1 Introduction

Economic growth has significantly increased the number of enterprises in Vietnam within the last decade. Industrialisation creates job opportunities, which increases annual per capita national income. However, health and safety at work in Small and Medium Scale Enterprises (SMEs) is becoming an increasing concern for the Vietnamese government. Small and medium scale enterprises are defined by the Vietnamese Ministry of Planning and Investigation as independent businesses which operate in accordance with company law (Ministry of Finance, 2008); their capital investment should be less than 10 billion VND (about £325,669.3) or the average number of employees should not exceed 300. Depending on the local circumstances, SMEs can be defined by one or both of the above criteria.

Kawakami claimed "many workers in Asia are in informal sectors. They often work in substandard conditions, exposed to various hazards in the workplace without having appropriate safety and health training and information" (Kawakami, 2006). There is some evidence that small industries often have hazardous working conditions, low productivity and their output is poor quality, even though, economic competitiveness is one of the most important concerns of small enterprise entrepreneurs (Kawakami *et al*., 2004). There are many different methods of providing health education. However, the results of some training programmes can be difficult to measure and benefits difficult to ascertain.

Participatory Action Oriented Training (PAOT), a method supported by the International Labour Organisation (ILO_UNDP), is believed to be one of the more effective techniques for improving health and safety at work. PAOT is an occupational health training programme which uses a participatory approach so that workers are involved in making their workplace safer and less damaging to their health (International Labour Organisation, 1995; International Labour Organisation, 1987). It was introduced to SMEs in Asia in the 1990s. To date there are few comprehensive assessments of the PAOT approach to evaluate its efficacy, strengths, and weaknesses, and to make suggestions for improvement.

The first part of this study explains the history of industries in Vietnam, and how the target industries were selected. Secondly, it describes PAOT and a cross-sectional interventional study performed in Can Tho City, Vietnam.

2 Occupational Health in Vietnam

2.1 Vietnam

The Socialist Republic of Vietnam is a developing country located in the Eastern part of the Indochinese peninsula in Southeast Asia. Its latitude is from 102º 08' to 109º 28' East and the longitude is from 8º 02' to 23º 23' North. The country has borders with China to the North, Laos to the North West and Cambodia to the South West, the East Sea to the East and the Pacific Ocean to the East and South. The mainland territory is approximately 331,688 square kilometres. The coastline is 3,260 kilometres long and the inland border is approximately 4,510 kilometres long. Vietnam has a population of 84,115,800 inhabitants, of whom 86.2 percent are Vietnamese people or “Kinh”, the remainder being made up of more than 54 ethnic minorities. The Kinh dominate the authority and culture throughout the country (Vietnam country-people, 2009). Vietnam has a tropical climate and has hot and humid weather throughout the year. The average temperature fluctuates from 22ºC to 27ºC and relative humidity is constant at around 80 percent. Every year, Vietnam has about 100 rainy days and 1,500 to 2,000 sunny hours and the average irradiated heat is 100 kcal/cm^2 (Vietnam tourism, 2007).

The country is divided into 64 provinces. The capital, Hanoi, and some other large cities such as Quang Ninh which has the Ha Long Bay World Heritage Site, are located in the North of the country. In the central part, Hue City was once an ancient capital of Vietnamese feudalism. In the South of the country, Ho Chi Minh City (formerly Saigon) was the old capital of the south government until 1975. To the South approximately 170 kilometres is the Mekong Delta River, the location of the country’s rice milling industry. Can Tho City is located at the centre of the delta region.

Vietnam has a socialist economy. However, since 1986 the Communist party has applied free-market reforms known as "doi moi" ("New Age"), in which the Government has accepted private companies and farms in order to improve the national economy. As a result of these reforms, thousands of private companies were founded in the 1990s, and the national economy has become one of the fastest developing among Asian countries. Based on a 2007 report of the Parliament Assembly, the economic growth rate rose by 8.3% in the first nine months of that year and exports increased by 20% (Ministry of Foreign Affairs, 2007). The majority of the new companies were agricultural and industrial production, construction, infrastructure, foreign investment and exports.

2.2 Occupational Health problems in Vietnam

In general, owners of private companies in Vietnam start their businesses with a small investment. Enterprises are usually simple and underdeveloped and involve manual manufacturing processes. Working conditions in these companies are often hazardous and detrimental to health. Many health and safety problems have been identified including the prolonged handling of heavy materials, work-stations which were not suitable for local workers and use of hazardous substances which are banned or strictly regulated in industrially developed countries (Kawakami *et al.*, 2004). In addition, personal protective equipment was either not provided or if it was available, the equipment was of poor quality. Occupational diseases such as hearing loss, pneumoconiosis and atopic dermatitis are found frequently in workers employed in SMEs. Machinery and equipment may be poorly maintained and unsafe. Consequently workers are at risk of fatal or serious injuries.

As alternative employment options are limited, workers have little choice but to continue working in these dangerous workplaces in order to earn a living.

There is anecdotal evidence that awareness of health and safety among Vietnamese workers is typically poor. In both factories and government agencies, health and safety budgets and staffing levels are insufficient. Consequently, the number of cases of work-related diseases and accidents are still high in this sector (ECHO, 2005). The national report in the year 2006 showed the occupational diseases rates to be 9.4%. In addition, 5,881 work accidents caused 6,088 casualties including 536 fatalities and 1,142 serious injuries. Between 2005 and 2006, total accident rates increased by 31.1% and fatal accident rate increased by 11.8% (VOV, 2007). Accidents and work related diseases have tended to increase for a number of years causing many fatalities and high costs on national and factory budgets (Chinh, 2007).

2.3 Organisation of Health and safety in Vietnam

The Occupational Health organisations in Vietnam are governed by the Ministry of Health; the Department of Preventive Medicine and the National Institute for Occupational Health and Environmental Hygiene. Each province or city has a Centre for Occupational Health and Environment. In addition, each Centre has between six and twenty Occupational Health and Environmental Units that are managed by the Centre for Preventive Medicine at district level. At the local level, there are Primary Health Care stations in each community hamlet and health care units within factories.

2.4 Government enforcement

Most national governments legislate to manage the employment and to protect workers' rights. These laws regulate, among other things, working hours, holidays, salaries, recruitment, working conditions, health reporting and inspection. In Vietnam, the Labour Code gives rights and stipulates regulations for employers, employees and appropriate authorities. There should be enforcement of legislation. However, the Labour Laws in Vietnam are not rigorous enough to force all employers to implement occupational health policies. Consequently, the level of health and safety measures implemented in SMEs is often inadequate.

The majority of SME owners invest in their business, rather than investing in health and safety. The absence of Government staff to carry out labour inspections exacerbates this problem. As a result, health and safety problems are not addressed in Vietnam because of the weakness of the law and the shortage of Government inspectors to ensure that policies are enforced.

2.5 Traditional health education methods

National Public Health departments use health education to persuade people to change their behaviour and adopt a healthier lifestyle. These programmes are conducted via mass media to disseminate knowledge on aspects of well-being such as causes of diseases, healthy diet, personal protective equipment and regular exercise. It is believed that people adopt better behaviour and practices whenever they have appropriate information (Francis, 2006). However, many well-educated people have negative lifestyles. For example, there is anecdotal evidence that in Vietnam some medical doctors and teachers are smokers and drink alcohol excessively. Consequently, the belief that there is a direct link between knowledge and healthy practices is not always true. Traditional health education programmes which use seminars, television broadcasts, and leaflets may have a limited impact on public awareness. In addition, there are some obstacles to behaviour changes, such as unwillingness to change unhealthy habits, the requirement of expensive equipment, insufficient resources and lack of time. Although the government has spent large sums of money on traditional methods of health and safety education, the occupational health problems remain (Khai *et al.,* 2005).

2.6 Health and Safety services in Can Tho City

The Centre for Occupational Health and Environment (ECHO) in Can Tho City is a provincial governmental centre which has responsibility for providing health and safety advice and services to all businesses and workers employed in the city. Most health and safety activities are based on the National Labour Code and Health Protection Law signed by the Prime Minister and Minister of Health. The ECHO in Can Tho City has 14 professional medical staff including four medical doctors and seven occupational hygienists, environmental engineers and nurses. The centre has been equipped by the Government to perform annual health screening examinations, health education training and environmental measurement at 105 small and medium scale enterprises. The ECHO directs eight district Occupational Health and Environmental Units that provide services to factories within their region.

3 History of PAOT

3.1 General systematic review

A systematic review was conducted by searching articles online from the search engines of "university E-learning", "Pubmed" websites and "Endnote software". The following key words were used: 'participatory', 'intervention', 'ergonomics', and 'oriented'. The search results showed 242 studies published from 1971 to 2009, and all were reviewed. Finally, 23 articles were selected because they were relevant to the topic of the thesis.

3.2 Participatory approach

The definition of participatory approaches includes interventions at macro (organisation, systems) as well as micro levels (individual), where workers are given the opportunity and power to use knowledge to address ergonomic problems relating to their own working activities (Hignett *et al*., 2005).

Pace (1978) states "Participation is an outward manifestation of a philosophy about how people ought to behave towards each other in an ideal state. An expression of freedom, equality and adult relationships". The author also concludes that participative management (PM) could bring additional responsibilities for union representatives. Pace found that PM is most effective where community members have a high degree of agreement. In this situation, it can bring about a big change in behaviour. Based on practical experience, Pace found that PM needs a monitoring system in the organization that encourages staff to modify it if they willing to do so. Moreover, PM was most successful in workplaces where employees are interested in the programme and the participative factory should provide an informal monitoring that ensures all staff engage in the programme. Both the PM committee and individual workers in the factory should feel able to consult with a programme facilitator whenever they have problems in the workplace (Pace, 1978). Perfect representation, complete participation and full unanimity about decisions are impossible to achieve, a consensus around a compromise are the closest that can be achieved.

Research of participatory action (PA) focuses on motivating people's knowledge of their own situation and presumes that adults are able to learn, change and act to improve their own situation. Interestingly, PA research also intends to improve the lives of those involved in the research (Reid, 2000).

Poole noted that strength of participation has long been recognised as a way to promote personal freedom and individual esteem among people in a group or community. Thus, participation encourages individuals to become involved in their future opportunities. Moreover, the worthiest power of community participation is the acts in which people are involved and change their behaviour from passive to active (Poole, 1975).

3.3 Ergonomics and Participatory approach

Hendrick mentioned that a key outcome of macro-ergonomic intervention is a culture change, both of traditions and written and unwritten rules (Hendrick *et al.,* 1995). Wilson and Haines (1997) illustrated the advantages of participatory ergonomics by two direct benefits. Firstly, employees have knowledge and experience of work. Therefore, they can easily realise working problems and create appropriate solutions. Secondly, people involvement in the analysis, development and implementation of improvements with a greater commitment of change. In addition, Tarasek and Theorell (1990) recognise that participants who involve in participatory ergonomics could obtain various benefits such as more self-confidence, competence, independence, personal development, social contact, feed back, influence, challenge and variability, and that 'good' working condition could help reduce stress at work.

Henrick and Kleiner (2001) state macro-ergonomics may be top-down, bottom-up and middle-out because it may be applied by strategic approach to analysis, participatory, or focus on process, respectively. However, the key point of macro-ergonomics is the requirement of analysis and design of work systems will be participatory in nature (Imada, 1986; Imada and Nagamachi, 1995).

Ergonomics training was first introduced to developing countries over thirty years ago by the World Health Organisation (International Labour Office, 1995). An inter-regional course was established to encourage the creation and implementation of ergonomics knowledge in developing countries. As a result of this requirement some ergonomists have introduced new ways of training in order to raise awareness among workers. Due to the nature of the relationship between workers, factory owners and occupational health professionals. In the 1970s, some authors started to combine the theory of participatory approach and ergonomics into training. One noted team of ergonomics experts from the International Labour Office (ILO) (Thurman, Kogi, Louzine, Imada and Wisner) began to implement Participatory Ergonomics training for employers and employees to improve both productivity and working conditions (Khai, 2005).

An International Programme for the Improvement of Working Conditions and Environment (PIACT) was launched by the ILO in 1982 at the request of the International Labour Conference and after extensive consultation with member States. PIACT is designed to promote or support action by member States to set and attain definite objectives aimed at "making work more human", (International Labour Office, 1995). As a result of the benefits of the programme, the ILO ergonomics team published a training manual entitled "Higher productivity and a better place to work" in 1988. This programme was one of the early achievements of participatory ergonomics approach (Thurman *et al*, 1988). This document was widely implemented in the Philippines from 1994 to 1996 with the financial support of the United Nation Development Program (UNDP) and technical guidance from ILO. Based on the work of Khai (2005), PIACT was the first participatory ergonomics approach introduced by ILO. This initiative was a training technique designed to assist SMEs to implement substantial voluntary improvements. In 1995, a new PIACT training programme based on the systematic participatory approach technique, and also supported by ILO, was introduced. This proved to be a low cost way to improve the working environment and increase productivity and was implemented in SMEs in India, Indonesia, the Philippines, Thailand and Argentina.

3.4 The PAOT programme

The PAOT is "a practical method to support workplace initiatives based on self-help voluntary actions" (Khai *et al.,* 2005). Kogi and Kawakami concluded the ergonomics participatory action-oriented programme can make impressive changes in term of health and safety in small and medium-sized enterprises, based on three aspects: (1) building on local good practice; (2) focus on multi-area low-cost improvements; and (3) action tools using basic ergonomics principles (Kawakami and Kogi, 2001; Kogi *et al.,* 2003).

Batino in his Work Improvement in Small Enterprises programme (WISE) stated "the approach of using low-cost solutions is acceptable because it does not impose too much on the finances of the enterprises and indeed is linked to management goals in improving enterprise productivity and competitiveness" (Batino, 1997). The WISE programme was implemented in the Philippines from 1994 to 1996. The guidelines are based on two books introduced by the ILO; Higher Productivity and a Better Place to Work (Thurman *et al.,* 1988) and Ergonomics Checkpoints (International Labour Office, 1996). Batino also provides evidence that the WISE approach was accepted by thousands of small enterprises because many small enterprises owners and managers recognised that improvement of working conditions might help their industries in terms of protecting workers health and also increasing productivity (Batino, 1997). Since then, the participatory methods were applied and modernised gradually based on lessons learned from WISE model (Kogi, 2006b).

In summary, the participatory approach encourages good practices by use of local resources, promotes collaboration between managers and workers to determine their work problems and to solve them by low cost solutions, and uses the experiences of co-workers and other enterprises.

3.4.1 The principles of PAOT programme

The programme uses a participatory approach on training and has six main principles. These are described below:

1. *Build on good examples.* The training programme uses actual problems. Participants are asked to look at pictures of good practice that have been found in local factories. The subsequent discussion of good practice is intended to influence participant's actions. Based on the real examples, the participants are encouraged to contribute new ideas which can be implemented in their workplace.

2. *Focus on achievement only*. Programme facilitators try to recognise laudable accomplishments and avoid criticism, because positive feedback is more likely to encourage workers to contribute their ideas.

3. *Link working conditions with other management goals*. The health of the labour force may be associated with better quality of production, and safety improvements may lead to higher productivity. Improvement of working conditions may lead to a stronger, more competitive business and increase the number of customers. This key point is important to attract factory owners to become part of the programme, because their foremost concern is profits rather than working conditions. If entrepreneurs can see a benefit for themselves, then they are more likely to participate in the programme and apply health and safety requirements.

4. *Learning by doing*. Surprisingly, the programme does not spend time on theoretical training. A checklist exercise guides managers and workers discover for themselves the problems in their own workplace. Group discussions are then organised among participants to choose the cheapest, simplest, and the most effective methods of addressing the problems identified. The PAOT facilitators are only involved in examining factory plans, and collecting practical actions from participants at follow-up visits.

5. *Encourage the exchange of experience among participants*. In the training course and achievement workshop, the group discussions are organised among groups of managers or workers from different factories. They share their own experience and good practices with counterparts to obtain solutions and gain a broader view. Moreover, the exchange of experiences seems to be most informative to the group.

6. *Promote worker involvement*. Many entrepreneurs do not believe their workers could contribute any useful ideas for the improvement of working conditions. In addition, many workers lack the confidence to express their initiatives. The PAOT experts have found that workers themselves are best placed to understand and solve their own problems. In the PAOT factory, managers and section heads always ask their labourers how to improve working conditions and increase productivity. As a result, most recommendations from PAOT courses are simple, inexpensive, effective

and practical. In this approach PAOT differs from other techniques because the labour force is the power of the enterprise (Batino 1997).

3.4.2 The strategies of PAOT programme

To refine the participatory approach, Batino implemented his findings from the WISE programme in the Philippines. The WISE facilitators visited work places to assess working condition and collect data to improve training materials. Training documents are industry specific so that workers of all abilities can use them. In addition, the organization of training courses and practice checklist exercises must be done in the community. The programme seeks to empower people to take actions. Visible achievements may bring a feeling of pride and satisfaction to workers. It is an activity all individuals can be involved in regardless of their level of education. When workers see the improvements made in other factories, they are willing to change their own actions to achieve similar improvements. Seeing that a suggestion has come from a colleague helps PAOT participants to overcome any feelings of inferiority. The programme promotes equal participation among men and women because both play different roles in their businesses, and collaboration between male and female workers is good for morale. In training courses male workers are often more willing to participate than females. An effective training course should involve all participants. There are no inactive members in the PAOT class because all participants must have their own action plan at the end of the course.

The PAOT course should focus on self-help initiatives which are inexpensive or free to implement because these are most likely to be supported by factory owners. Many SMEs owners do their business with limited capital and most of their finance is used where it will lead to greatest profits. Once one measure is implemented successfully, managers are more likely to implement other ideas. PAOT consultants combine the improvements of working conditions and productivity gains. If labourers feel safe and comfortable in their working environment, this would increase productivity and result in higher quality output. It is important to train local trainers and develop a useful package of training materials. A local trainer, who works in the community or is a senior person at the factory, may help to conduct and maintain the programme better, and at a lower cost, than a project facilitator from outside the community. In addition, the local trainer may better understand the participants and their language.

3.5 Other studies on PAOT

In 1976, Pace investigated job satisfaction among different jobs of a major government statistical office of the Central Computer Agency in the United Kingdom by a participation approach study; 258 questionnaires were distributed, with 150 usable replies returned (Pace, 1978). The two main aims of the evaluation were "to involve the staff in decision making, to involve them more in their work etc" and "to improve and increase job satisfaction". The staff were also asked to grade the aims by degree of importance and extent of achievement. 73% of the aims were considered very important and 66% of those were claimed to have been achieved. The two main aims "involvement" and "job satisfaction" were believed to have been achieved to some or a great extent in 71% and 62% of respondents respectively. In general, 52% of the respondents thought that there had been practical changes. Some 71% of the most senior managers recognized their job satisfaction had improved due to the participative management (PM), whereas only 44% of the junior and 39% of the middle grade managers thought likewise. Overall, 39% of those supplying feedback felt the intervention had been “good for me” and 45% felt it had been “valuable to Computer Division”; only 9% claimed it was “bad for me” and “harmful to Computer Division”. The study concluded that the most satisfied groups comprised those who had most participated. In addition, the author concluded that the close relationship the already existed in the workforce had contributed to the success of the study. Close relationship are more likely to be formed in small workplaces. The most active group to participate in the intervention was normally the senior managers and these key persons were very important for the project’s achievements.

Several PAOT intervention projects in SMEs reported summaries of achievements (Kogi and Kawakami, 1996; Batino, 1997; Kawakami *et al.*, 1999; Kogi, 2006b). Information from these studies has been used in the current project, especially intervention methods, participant recruitment, training materials, organising workshops, follow-up visits and report items. Lessons from these studies confirmed achievements of participatory approach by applying methods on several different communities, for instance industrial and home workers, farmers, and Trade Union staff (Kogi, 2006b).

The WISE project in Philippine held 136 intensive courses during 1994-1998 for 3,375 enterprise managers. Trainers were recruited and trained from labour inspectors. The WISE workshops lasted for 4-10 days with a checklist exercise, technical sessions on basic ergonomics principles and local good practices, voluntary group work for several days and final presentations on implementation improvements. Since 2005, over 9,000 improvements were reported from trained managers mainly in materials handling, workstation design and physical environment. Case studies at separate enterprises recognized some low-cost improvements had been created and the participants confirmed positive changes in both working conditions and productivity. The WISE methodology has also encouraged small enterprises to comply with existing regulation and has ameliorated the relationship between mangers and health inspectors (Batino, 1997; Kawakami *et al.*, 1999). The WISE programme created a standard model of participatory approach on occupational health to SMEs based on trained trainers from governmental labour inspectors. The programme focused on factories' managers and attracted their involvement by combining improvement of working conditions with higher productivity for SMEs. In addition, the programme could reinforce Labour Laws among informal sectors, which was usually violated in industrial developing countries.

In the study of the POSITIVE programme (Participation-Oriented Safety Improvement by Trade Union Initiative) in Nepal, 4-day courses for trainers were carried out in 1994 and 1995 among Trade Union (TU) members. Since then, over 150 trade union trainers have trained 1,251 workers, confirming the high sustainability of the project. There were at least 45 seminars at the "easy access" factory level. The workshops introduced five technical sessions: materials handling, workstation design, machine safety, physical environment and welfare facilities. Training steps consisted of an action checklist exercise that helped trainees identify good examples and raised ideas for action plans. The checklist exercise with the following 46 items was applied in this workshop (Kogi and Kawakami, 1996). This programme applied participatory approach which relied on social civil organisation of TU.

Materials storage and handling
1, Clear transport ways;
2, Wide and even transport ways;
3, Carts and other wheeled devices;
4, Multi-level shelves or storage racks;
5, Pallets or containers;
6, Mobile storage racks;
7, Hoists and conveyors;
8, Grips or holding points

Machine safety
9, Guards to dangerous moving parts of machines;
10, Safety devices protecting the worker's hands;
11, Feeding to avoid hazards;
12, Easy-to-read labels and signs;
13, Good machine maintenance;
14, Clearly visible emergency controls

Work-stations
15, Working at elbow height;
16, Platforms for small workers and work item holders for tall workers;
17, Tools, controls and materials within easy reach of workers;
18, Jigs, clamps, vices or other fixtures to hold items;
19, Hanging tools or conveniently fixed tools;
20, Home for each tool;
21, Alternate standing and sitting while at work;
22, Chairs or benches of correct height

Physical environment
23, Skylights and clean windows;
24, Ceilings and walls in light colours;
25, General artificial lighting;
26, Local task-lights for precision and inspection work;
27, Relocate light sources to eliminate direct glare;
28, Move hazard sources out of the workplace;
29, Screens, partitions or barriers to reduce the harmful effects of hazardous agents;
30, Labels on all the containers of hazardous chemicals;
31, Covered containers for organic solvents;
32, Personal protective equipment;
33, Local exhaust ventilation;
34, Safe wiring connectors for supplying electricity;
35, Heat protection of the building by backing up walls or roofs;
36, Natural ventilation by more openings, windows or open doorways;
37, Fire extinguishers within easy reach;
38, At least two unobstructed ways out of every floor or every big room

Welfare facilities and work organization
39, Adequate supply of cool, safe drinking water;
40, Cleaned toilets and washing facilities close to the work area;
41, Resting corners and a separate hygienic place for eating meals;
42, First-aid equipment and a qualified first-aider;
43, Combine tasks so that each worker can perform varied and interesting work;
44, Buffer stock of unfinished products between different work-stations;
45, Layout and the order of operations to ensure smooth flow of work;
46, Short breaks for strenuous work or work requiring continuous attention

The basic improvement principles used "local good examples", group work based on roles of TUs and short-term action plans. An example of group work from the project showed group discussion on good points and points to be improved at the checking sites based on technical sessions (Kogi and Kawakami, 1996).

Group discussion results in a garment factory

Technical areas	Three good points	Three points to be improved
Materials handling	1. Clear passageways	1. Mobile storage trolleys
	2. Carts and hand trolleys	2. More mechanical aids for materials loading
	3. Organized storage systems	3. Multi-level racks for storage chemical containers
Work-stations	1. Appropriate working height	1. Chairs for standing workers
	2. Tools, switches placed within easy reach areas	2. Work height adjustment in the cutting section
	3. Chutes for collecting wastes	3. Use more fixing devices
Machine safety	1. Safe guards	1. Moving chains and gears to be covered
	2. Clear instructions for safe machine operation	2. Clear labels and signs
	3. Emergency stop switches	3. More feeder systems
Physical environment	1. Full use of skylights and artificial lighting	1. More local task lights
	2. Local ventilation and exhaust fans	2. Proper lids for all chemical containers
	3. Proper storage of chemical containers	3. Increasing ventilation in the chemical storage area
Welfare facilities	1. Resting corners	1. First aid boxes in the workplace
	2. Sufficient number of toilets	2. Recreation facilities
	3. Drinking water facilities at the workplace	3. Changing rooms and lockers especially for women

Case studies evaluated the relationship between trainers' skills and the quality of "core trainers" and evaluated the roles of trainers at different levels and the training courses. The four important skills that a successful trainer must have and their related measuring tools were defined as follows (Kogi and Kawakami, 1996).

Key elements to become successful trade union trainers

Key elements	Measures
Organization skills	Planning effective workshops and recruit appropriate participants
Technical knowledge	Understanding and applying basic rules of the five technical areas
Group work skills	Guiding and facilitating active group discussions
Presentation skills	Speaking in a clear and concise manner using audio visual aids effectively

A further report analysed 74 improvements from the POSITIVE programme, with many of them at low-cost. There were higher concerns on physical environment, welfare facilities and machine safety among their changes (Kawakami *et al*., 2004).

Improvement examples classified by technical areas and costs

Area/ Cost (USD)	0	<20	<100	≥100	Total
Materials handling	2	1	3	0	6
Work-stations	1	5	3	0	9
Machine safety	3	7	1	4	15
Physical environment	1	9	12	2	24
Welfare facilities	1	7	8	4	20
Total	**8**	**29**	**27**	**10**	**74**

The POSITIVE project applied the participatory approach to improve health and working conditions for workers based on TU networks. In addition, the programme shared benefits between managers and workers by low-cost improvements to enhance business and improve working conditions. The project was maintained for more than 10 years by a grass-roots network from the social civil organization that often exists at any workplace.

A review article based on different participatory Occupational Health projects among Asian countries concluded participatory programmes for occupational risk reduction are gaining importance particularly in small workplaces (Kogi, 2006b). The paper aimed to identify what types of good practices can be achieved by small enterprises and how we can take advantage of achievement from informal workplaces. Improvements were due to practical goal setting, the “self-help stepwise action” based on inexpensive solutions, and continuous encouragement by local trained facilitators. In addition, the experiences confirm that participatory programmes are more successful when they address the advantages for small workplaces rather than merely the constraints faced by them. There are two advantages for small and medium enterprises. First, local key persons are important to identify suitable group work. Second, workers are able to understand technical problems of their daily work and find out flexible solution to solve them. Moreover, the exchange of “easy-to-implement good practices and action-suggesting tools” among the network partners has proven extremely useful.

4 Objectives of current study

4.1 General objectives

To investigate the effectiveness of the PAOT approach in terms of health and environmental protection among SMEs in Can Tho City.

To investigate the effects of the PAOT on factory income and productivity.

To determine the advantages and disadvantages of the PAOT when applied to local SMEs.

4.2 Specific objectives

For specific quantitative objectives, data will be collected before and after the PAOT programme intervention, in order to compare whether there was a significant change in working condition after the intervention. Information will be collected on accidents at work, sickness absence, health cost, factory productivity, worker income, and environmental conditions (dust, carbon dioxide, carbon monoxide, noise, lighting, air temperature, air humidity, and air velocity).

5 Materials and Methods

5.1 Overview of Study design

An intervention follow-up study of twenty factories was carried out. Ten factories were placed in the intervention group and received the PAOT programme. The remaining ten factories were placed in the control group and applied the local existing occupational health programme instead of the PAOT programme. In order to assess whether the programme had an impact on working conditions, a set of parameters were measured before the programme was implemented and then again one year after the PAOT programme.

5.2 The industry sectors under study

The industries in Can Tho City are mainly small and medium scale enterprises similar to those in other cities in the Mekong delta area. Since the beginning of the 1990's, the main industries are rice-milling, civil/agricultural engineering, garments production, recycling of metal castings, paper and printing. Other, smaller or larger industries which were not representative of the area were excluded from the study.

5.3 Selection of study factories

Different methods have been used in the past to select factories from local communities for participation in an intervention study. In particular, the three following methods have been used, namely 1). convenience sampling by selecting from easily accessible areas, 2). purposive sampling by selecting from a representative project area, and 3). random sampling by putting all names in a hat and picking out the number the study plan to evaluate (Catle *et al,.* 2008). In summary, convenience sampling is the least reliable approach and random sampling is the most reliable. However, each approach has its own advantages and disadvantages. For example, the convenience method may save time by only using factories that easy to travel to, but the selected factories may not provide representative populations and may suffer from "road side bias". By contrast, random sampling of facilities may provide a more reliable scientific study but it may consume more time and budget. Furthermore, it has been claimed that, there is no right or wrong technique for sampling, and that the adopted method for the participatory investigation depends on academic purpose or internal uses (Catley *et al,.* 2008). Besides, the PAOT programme requires volunteer organisations. Consequently, it is not possible to use random sampling at the beginning of the selection process.

For that reason, study factories were selected from the list of 105 enterprises currently covered by ECHO (see Appendix 1 to Appendix 6). All factory owners/managers were invited to join the study by a letter from ECHO (Appendix 7) which requested their attendance at an introductory meeting. A second request was sent to owners/managers who did not reply to the first letter. ECHO received responses from 69 enterprises. A total of 35 enterprises agreed to join the PAOT programme and 34 others refused. The 36 managers who did not respond to the invitation are also assumed to have refused, but for unknown reasons. Agreement to participate was thus made by 33% (35/105) of the available factories (see Table 1 and Table 2). Information on non-participant (factory structures, annual turn over, profits, exporters/non-exporters) was not available.

Table 1. Factories participating in the PAOT study

Industry	n	%
Printing - paper	3	8.6
Civil engineering	6	17.1
Metal casting	5	14.3
Garment	5	14.3
Rice mill	7	20.0
Beverage	1	2.9
Cement	1	2.9
External medicine	1	2.9
Food cans	1	2.9
Footwear	1	2.9
Food	1	2.9
Leather	1	2.9
PP bags	1	2.9
Printing	1	2.9
Total	35	100.0

Table 2. Factories which refused to participate in PAOT study[a]

Industry	n	%
Printing - paper	8	11.4
Civil engineering	10	14.3
Metal casting	13	18.6
Garment	12	17.1
Rice mill	17	24.3
Beverage	2	2.9
Wood processing	2	2.9
Vetinary medicines	1	1.4
Steel	1	1.4
Tyres	1	1.4
Paint	1	1.4
Feather	1	1.4
Fine art handicraft	1	1.4
Total	70	100.0

a. includes non-responders

The study group was chosen randomly from industries for which at least two factories had agreed to participate in the PAOT programme (Appendix 8). These enterprises belong to five major industries in this area including, printing and paper, civil engineering, metal casting, garment, and rice mill industries. Ten intervention and ten matching control factories were selected randomly by choosing “names out of the hat” for enrolment in the intervention arm of the PAOT programme.

The factories in each group have a general compatibility of products, sizes, sorts and management programme. The study factories were classified into four categories of ownership, namely Limited Company, Micro Enterprise, Stock Company, and State Company (see Table 3). The limited companies and micro enterprises are private enterprises. State companies receive one hundred percent of their capital from the government. Stock companies may be formed as either fully private or state funded or a combination of both depending on the stockholders. Both state and private managers have the same goal, that is to have a successful business. To achieve this aim, entrepreneurs may need to improve both working conditions and trading activities. There is anecdotal evidence that the PAOT might be less successful in state companies because managers have limited scope to make their own decisions regarding trading plans. A study of the application of PAOT among different types of industry may provide valuable conclusions about the intervention programme. In general, SME entrepreneurs do not strive for endorsement of their management systems from international standards organisations, such as ISO 9001 (International quality management systems) and ISO 14001 (International environmental management systems), because these programme are difficult to achieve and involve a high cost for the SMEs (see Table 4).

Table 3. Size and primary business of 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 4. Company type and management programmes implemented in participating factories.

	Intervention	Control	Total
Type of company			
Limited	4	5	9
Micro	2	1	3
Stock	2	2	4
State	2	2	4
Management programme			
ISO 9001	2	2	4
None	8	8	16
Total	10	10	20

However, exporting garment companies are required to have management certification to trade with their customers. Many SMEs in Vietnam provide products solely for local markets or supply to another exporting corporation and therefore ISO standards are not an important concern. In effect, control factories were matched on compliance with ISO 9001 (garment factories = yes, other factories = no).

The state and garment enterprises usually have health units with at least one trained health staff and a separate room for health care services, whereas private and micro-enterprises have only primary care units with limited health care facilities. The primary care units or health care units usually provide simple treatments and first aid to workers who require these services. For patients who need further treatment, these units send them to local hospitals and provide essential support. Most factory reports were submitted by health units with assistance from managers/owners and accountant units.

5.4 Intervention factories

Intervention factories were chosen from the factories which agreed to apply the PAOT programme in their workplaces for one year. The factories have to meet the same definitions as the control factories. The only difference between the intervention and control factories is that managers and key workers (i.e. health and safety staff, section heads) in the intervention factories have to attend the PAOT training course. In the intervention factories, employers and employees are encouraged to improve their working conditions and use good practice learnt from the training. Both intervention and control groups received the traditional health and safety services over the 13 month period. An agreement was signed between ECHO and intervention factory's manager/owner for the intervention (Appendix 9).

5.5 Control factories

The manager of each control factory was approached and agreed to continue to apply a traditional occupational health programme in the factory. Instead of attending the PAOT training course, managers and workers were provided with normal training about health hazards and occupational disease prevention. The factory manager and the director of ECHO signed an agreement to co-operate in 13 months of health and safety services. An agreement was signed between ECHO and the control factory's manager/owner for the intervention (Appendix 10).

5.6 Recruitment and training investigators

Five investigators were recruited from the staff of ECHO in Can Tho City. All were experienced in occupational health and environmental investigation, and were confident in operating the measuring equipment. Investigators were trained to carry out the interview and workplace measurements.

5.7 Pilot study

A pilot survey was conducted in a garment factory. The purpose of the pilot was to test the questionnaire and practice the environmental measurement techniques. The study team comprised 10 investigators and included occupational health hygienists, environmental engineers, and assistant physicians working for ECHO, the centre for Health Education in

Can Tho City and three centres for Preventive Medicine in Cai Rang, Phong Dien and Ninh Kieu districts. The team started at 7 A.M. and finished at 4 P.M. A pocket meeting was organised the next morning for listening to all members' comments and informing a working plan of future investigations.

5.8 Data collection

These are two phases to the cross-sectional evaluations; before the PAOT programme and one year afterwards. At each phase the following activities were carried out in both factory groups; collecting general site information, making environmental measurements, and photographing the workplace. A checklist form from the WIPE programme was used to assess each factory and also to evaluate the working conditions at all enterprises. Checklist response and workplace measurements will be compared between the two phases to determine an improvement in the working environment as a result of the PAOT intervention. A separate evaluation of changes in the management of health and safety was carried out by interviewing all owners/managers using a questionnaire to determine their knowledge and attitude towards the PAOT programme.

Employers and employees were encouraged to improve their working conditions and apply good practices based on the results of the first cross-sectional study. Each factory makes a plan of improvement with support from ECHO staff. The plan was reviewed when the study group repeats the follow-up walk through visit.

5.8.1 General site information

At the evaluation the following data items were collected from each site: name and address of factory, contact details of key personnel, products manufactured, number and name of sections/departments, number of employees and sex ratio, health, safety and welfare services provided, average worker income, and productivity output.

5.8.2 Managers' interviewing

To learn managers' perceptions of the PAOT programme and why they agree or refuse to participate is useful for any project manager considering introducing the programme. A face-to-face interview with factory owners to discuss these issues was carried out before the programme was introduced at the introductory meeting (see the questionnaire at Appendix 11). The opinions among managers/owners who gave feedback to the ECHO showed statistically significant relation between manager's decision and their recognition of the PAOT programme (Table 5).

The interview among 35 managers/owners who accepted the intervention showed several beliefs that might affect acceptance, including the beliefs that PAOT could help protect general environment, bring health and safety to the factory, protect the work environment and bring new experiences to the factory (Table 6). By contrast, the opinions from the 34 managers who expressed their reasons for rejection were that the programme might bring benefits to workers only, be too expensive, and the programme might waste time of workers (Table 7).

Table 5. Managers awareness and decision on joining PAOT programme.

	Aware of PAOT			
	Yes	No	Total	%
Accepted	25	10	35	50.7
Refused	13	21	34	49.3
Total	38	31	69	100.0

$\chi^2_{(1)} = 7.68$, $p<0.01$

Table 6. Reasons for participation in the study[a]

	Yes	No
PAOT benefits my factory	20	15
PAOT protects the general environment	33	2
PAOT benefits my workers	21	14
PAOT protects the work environment	31	4
PAOT brings social benefits to my factory	18	17
Applying PAOT means we execute occupational health rules	22	13
Applying PAOT because managers believe in the OHS staff	17	18
PAOT saves OHS expenditure	15	20
PAOT brings health and safety to my factory	32	3
PAOT brings new experiences to my factory	29	6
Other reason	30	5

a. n = 35 managers

Table 7. Reasons for refusal to participate in the study[a]

	Yes	No
Loss of factory time	26	8
Loss of worker time	25	9
Distrust the advantages of PAOT programme	20	14
Lack of knowledge of PAOT programme	14	20
PAOT programme is not business related	5	29
Improvement of Health and Safety too expensive	27	7
Do not want visitors in the factory	5	29
Focusing on business only	23	11
PAOT brings benefit to my workers only	27	7
PAOT will have a negative effect on business	21	13
Factory does not need improvements	11	23
Other reason	16	18

a. n=34 managers were interviewed only.

5.8.3 Follow-up visits and improvements collection

A follow-up team from ECHO visited all 20 factories under study every three months to collect information on good practices, and number of improvements with their total cost, the number of work places affected by improvements, improvements using recycled material, zero cost improvement, type of improvement and author of improvement. Evidence of good practice and its effects were photographed during these follow-up visits.

5.8.4 Factory monthly reports

A member of the health and safety personnel in each factory agreed to complete a quarterly report on health and safety to ECHO. The report showed monthly data on number of accidents, number of accidents leading to absence from work, days of absence due to accidents, number of workers requiring medication, health costs per month due to illnesses/accidents, and the number and type of good practice identified together with data of productivity level and workers' average income. Staff were paid by ECHO for each report submitted. This report should also have a plan of action for the next term (see report forms at Appendix 12 to Appendix 14).

5.8.5 Work environment measurement

The following measurements were taken in each department during working hours. A short visit to the factory was made before the measurements were taken in order to determine how and where measurements would be taken (Appendix 15 to Appendix 41). The equipment was calibrated and serviced by qualified companies before the first and second phase investigation. In addition, the investigators checked the equipment at the beginning of every working day.

5.8.5.1 Dust

Both static and personal respirable dust measurements were taken when the factory was in full operation. The results were recorded and calculated in mg/m^3. Two static samples, one in the morning and one in the afternoon, were taken in each department. The static sampling measured the respirable fraction 5 microns diameter and less and cotton dust particulate which is also called inhalable dust and can pass through the nose and throat and reach into the lungs. For each factory, three personal respirable dust samples were taken from three staff working in the three dustiest departments (nine samples in all). The dustiest departments were selected on the basis of historical data from the factory. Personal respirable sampling was conducted over an eight hour shift. The static sampling also measures the respirable fraction. It is defined as the most dangerous particulate size to the lung (Ashton and Gill, 1982; Parrette technical development, 2007). The dust samples filters were pre-conditioned, weighed and calculated into unit of $mg.m^{-3}$ for both personal and static dust samples (see Appendix 42).

5.8.5.2 Toxic gas

Carbon dioxide and carbon monoxide hazardous gases present in the atmosphere of garment factories and the furnaces were measured. The short term colorimetric tubes (Kitagawa, Japan) were used and the mean was derived from the three samples at one monitoring point. One sampling point was chosen at the centre of department and the sample taken during the chemical operating process. The results were given in mg/m^3. The number of samples in each department was obtained from the samples in the morning (9:00 – 10:00 AM) and in the afternoon (3:00 to 4:00 PM). At the same time, a parallel measurement of temperature and pressure was conducted at the same sampling points for the result's standardization. The monitoring points and work activities were recorded exactly, so that they could be re-used for the post-intervention measurement (see Appendix 43).

5.8.5.3 Noise

Noise level was measured in each department by a sound level meter. The results were given in dBA, equivalent continuous sound pressure level (Leq) by time in minutes. Three samples, each of ten minutes duration were taken to obtain the Leq and highest intensity of noise (Lmax) with all machines in full operation. Sampling points were recorded so that measurements could be taken in the same position at the follow-up study (see Appendix 44).

5.8.5.4 Lighting

Five samples were taken in each department, using a light meter which gives measurements in Lux. The sampling points in each department depended on where workers required good lighting for their work. Of the five samples performed in each department four were taken at work stations in each corner of the room and one at a work station in the centre. The lighting condition while sampling was noted (i.e. with or without natural lighting) along with the sampling points (see Appendix 45).

5.8.5.5 Air temperature, air humidity, and air velocity.

The three parameters of temperature, humidity and wind speed were measured together by an electronic multifunction thermal anemometer, with the trade name CLIMOMASTER. Measurement units were ^{o}C, H%, and $m.s^{-1}$, for temperature, humidity, and wind speed respectively. Four samples were taken in each department, of these, two were measured in the morning (8:00 to 9:00 AM) and the other two samples in the afternoon (2:00 to 3:00 PM), cyclical measuring every two hours. At the same time, parallel measurements outside the working site were taken in order to measure the differences between inside and outside physical environment. Monitoring points and work activities were recorded for the second survey (see Appendix 46).

5.9 The PAOT training course

The training course used in the study was taken from the Trainer's manual of Participatory Action Oriented Training (Khai *et al*., 2005) and the training package from WIPE (Work Improvement by Protection of Environment) programme (Khai *et al*., 2004). The training course followed strictly defined PAOT steps at each stage (Kawakami *et al*., 2004).

Factory visit with checklist exercise → Trainer shares rules and local examples → Group discussion for priority action → To build skills to propose changes

5.9.1 Participant recruitment and factory visit

The most important requirement to be a participant on the PAOT course is experience of the workplace. Participants must also be literate in order to complete the checklist exercise and action plan at the end of the course. Factory managers, because they will easily understand the requirements of the course and apply them to their business, should participate in the course. In addition, this will help them support their staff in changing working conditions. The number of attendees from each factory should be approximately 10% of the workforce. If enterprises have a large number of departments, there should be at least one representative from each department, usually a section head or member of senior staff, so that they have authority and experience. After the course, each representative should share their knowledge with colleagues in order to obtain as much input as possible on how to solve problems.

The number of participants in each course was approximately 25 to 30 to ensure active participation from all attendees. For group discussions, the course delegates were divided into groups of 6 to 8 members. Each course comprised participants from similar industries so that they could share knowledge and discuss solutions. Before the training course, all lists of participants were submitted to the ECHO for confirmation that the workplace was registered and participant names could be recorded.

5.9.2 Preparing the workshop

Participants were recruited by a discussion between managers and ECHO before workshops. Most participants were section heads, technicians, or senior workers who were representative for their sections. Sending key staff for training is a tough decision for any manager because their absence may have an impact on the operation of the factory. Therefore, a short visit to the factory to explain the study and reassure the owner/manager of the benefits of the course may encourage them to release key staff to take part in the course.

Ideally the workshop venue should be at a local factory in a similar industry to that of the participants, in order to reduce travelling time and make the workers feel confident in a familiar environment. However, such venues were not always available. If the factory did not have a suitable place to hold the training, the workshop organiser used a meeting hall at the ECHO or the District Health Centre. These meeting rooms have been designed for training so they have adequate seating and air conditioning. At the course venue there should be an electricity supply and a back-up system in case of power cut, a portable screen, multimedia projector and laptop with the "WIPE training package" for the technical sessions of the course.

The activities of the workshop are a combination of technical input and group work, so the tables and chairs of meeting room must be movable not only to provide a private atmosphere for group discussion but also to give a good view to all trainees when they have to join the technical input and listen to presentations.

Refreshment was provided twice a day and lunch was supplied to all trainees, trainers and staff who assisted the training course. In order to adhere to the course schedule and keep sessions timely, course participants took lunch together to prevent participants returning to work during the break and returning late.

5.9.3 Opening ceremony

The training team arrived at the venue 30 minutes in advance of registration, which began at 7.30am. An informal opening ceremony started approximately 30 minutes after registration with a short opening speech from a leader of the local health office. The content of the speech focused on practical value of the training, participants' interest and some course regulations. The opening activity ended with participants introducing themselves.

5.9.4 Action checklist exercise

After a short opening ceremony, the training course began with an action checklist exercise and an enterprise walk through at a related workplace. The WIPE checklist applied Ergonomics checkpoints from ILO documents (International Labour Office, 1996). It was modified into the WIPE action checklist, which included seven technical sessions, with a total of 42 items. The content of the checklist exercise corresponded with technical sessions introduced to participants later on together with local good practices.

At the beginning of exercise, the facilitator read loudly and explained the meaning of each checkpoint item, including an illustration for a single good practice by words, or words and pictures. To make each checkpoint participants had to read each checkpoint, observe the working condition at the visited factory and answer a question "do you propose any action?". The word "action" implied a requirement of change or improvement. A three multiple-choice answer by sticking boxes were "yes", "no" and "priority", the word priority expressed an action that must be done urgently. The checkpoint ended with space for participants to write down their own comments on how the improvement should be done based on his/her own opinion and knowledge. The following 42 items listed in the action checklist exercise was applied in the WIPE workshop (Khai *et al*., 2004).

Materials storage and handling

1, Clear and mark transport routs;
2, Provide ramps with small inclination instead of stairways within the workplace;
3, Avoid placing materials on the floor but on a special storage;
4, Save space by introducing multi-level shelves or racks near the work area;
5, Use mobile storage racks;
6, Use carts, hand-trucks or other wheeled devices or rollers when moving materials;
7, Provide good handholds, grips or holding points for all packages and containers;
8, Reduce manual handling of materials by using conveyers, hoists and other mechanical means of transport

Work-stations

9, Place frequently used materials, tools and controls within easy reach;
10, Provide “home” for tools;
11, Adjust the working height for each worker at elbow level or slightly below it;
12, Provide sitting workers with good adjustable chairs with a backrest;
13, Allow workers to alternate standing and sitting at work as much as possible;
14, Use jigs, vices and clamps to hold materials;
15, Use markings, colors or attach simple worded labels in the local language on displays to help workers understand what to do;
16, Make emergency controls and switches clearly visible

Productive machine safety

17, Use safe feeding and ejection devices to keep the hands away from dangerous parts of machinery;
18, Use properly fixed guards or barriers to prevent contact with moving parts of machines;
19, Inspect, clean and maintain machines regularly including electric wiring;

Physical environment

20, Increase the use of daylight and use light colors for walls and ceilings;
21, Relocate light sources and provide local lights for precision or inspection work;
22, Increase the use of natural ventilation;
23, Protect the workplace from excessive outside heat;
24, Move heat, noise, dust and chemical sources from general work area;
25, Use partitions to screen heat, noise, dust and chemical sources;
26, Use local exhaust ventilation systems against heat, dust and chemicals;
27, Provide enough fire extinguishers near the work area and be sure that workers know how to use them;
28, Ensure electrical circuits are enclosed, insulated and properly fused;

Environment protection

29, Select raw materials using minimal necessary packages;
30, Substitute reusable containers for disposable containers;
31, Place separate waste containers in the workplace for different types of waste such as metals, bottles, cans ssand plastics;
32, Develop a mechanism to recycle and reuse collected separate waste;
33, Adopt batch washing when washing materials and minimize continuous rinsing;
34, Provide separate switches for lights to save electricity and reduce heat;
35, Prepare special containers having clear signs and instructions for collecting hazardous waste;

Welfare facilities
36, Provide drinking facilities, eating areas and rest rooms to ensure good performance and well being;
37, Provide and maintain good changing, washing and sanitary facilities to ensure good hygiene and tidiness;
38, Provide personal protective equipment that gives adequate protection;
39, Provide first aid equipment and train a qualified first-aider;
40, Establish health promotion program to prevent professional diseases and provide good health services;

Work organisation
41, Provide opportunities to take frequent short breaks for strenuous work requiring continuous attention;
42, Establish an OSH policy and provide adequate safety and health training to all workers;

(see the WIPE checklist form at Appendix 47).

One well-known PAOT contributor clamed that, this exercise is a "self-help practice" therefore each participant must observe, define or ask the responsible persons at visited factory for the necessary information. The roles of facilitators are to explain difficult words or motivate participants to finish independently their practices on time but not disturb his/her answers to the checklist questions. The successful checklist practice will bring many advantages to the workshop. For that reason, the facilitators did not modify or skip any step or content of this important exercise (Khai *et al*., 2005).

5.9.5 Group work

Returning to the training venue from the checklist workplace, the participants were divided into small groups, comprising 6-7 members for group work sessions. The agenda for the first group work was as follows:

From the results of the checklist exercise, please identify one good point and one point to be improved (for that workplace)

The main purpose of the first group work was to introduce participants to group work, to consolidate the role of group leaders, and to encourage communicative skills of participants among group members. The group works were repeated following each technical session and these discussion solved problems quickly by team brainstorming. The first group work was not longer than 15 minutes. After that, each group chose one representative for presenting the group's ideas to all participants using overhead projector and transparencies. The good group leaders knew how to compromise ideas among participants and selected only one priority point from many. A good presentation could explain the point in a specific and concise manner (Khai, *et al*., 2005).

A facilitator led the group work presentations by summarising the participant's ideas and appraised their good observation. He/she avoided critical comments. The best way to resolve all conflicts of group presentation was to create a general discussion among groups' representatives in a positive atmosphere. This session provided a good chance for facilitators to apply a positive view of participatory approach to enterprise managers, for instance "points to be improved" instead of "bad or wrong points". Khai explained the spirit of the concept of "points to be improved" rather than "bad points". The latter is insulting and subjective and unintentional criticism may break the relationship among facilitators and participants (Khai *et al*., 2005).

5.9.6 Sharing low cost good practices through the technical sessions

In this session, the facilitators had opportunities to share with participants the good practices and solutions which they have collected. Local good practices were strongly encouraged. The training courses took advantage of the visual aids such as multi data projector for displaying practical and inexpensive good practices. As mentioned above, there are seven technical sessions in total and experience has recommended each session should not go over 20 minutes.

Good practices were collected at the workplaces from the first cross-sectional study, together with accompanying photographs, and these were inserted into seven technical sessions of training documents. Participants felt excited while watching the photos of their workplaces shown as "good examples" in the technical input presentations. They were so proud of their achievements and promised that they would apply various improvements to achieve better workplaces.

Each session included technical principles, low cost good practices and group work. The topic of group discussion always related the technical session with the practical checklist exercise. Nonetheless, the group work agenda was different from the first one:

Based on the technical input and the results of checklist exercise, please identify three good points, three points to be improved and your best solutions

Khai explained that, after “participants have just seen many good examples and solutions from technical session. Based on their own knowledge and experience, they will be able to formalise their understanding and gradually change their old recognition towards specific actions” (Khai *et al*., 2005).

From the special ways of teaching, almost imperceptibly, the PAOT trainees obtained skills on how to recognise good practices in the community, prioritise their problems, and create the simplest, inexpensive and most effective solutions based on available resources.

5.9.7 Implementation of improvements

This was one of the most important sections of PAOT workshop. After two days practice on improving familiar workplaces with low cost good practices, participants were now required to improve their own workplaces. They worked with members of their own factories to identify the real problems and suggest suitable solutions with available resources. The agenda was now as follow:

Please define for your factory:

- **3 immediate action plans (within 1-3 months)**
- **3 long-term action plans (within 6 months to 1 year)**

It is not easy to solve daily problems. To help participants, some principles were highlighted at the workshop:

- **start improvement with simple and low cost ways;**
- **use local available skills and materials; and**
- **practice your improvements step by step**

A display of success stories from other enterprises using photographs before and after improvements assisted the participants to work on their plans. The checkpoints in checklist document were also an essential tool to point out quickly many urgent problems and suggest better solutions. The immediate action plans and long-term action plans could be classified as urgent or unimportant, cheap or expensive, easy or difficult, simple or complicated. At the end of the group discussion and planning, a representative from each group presented their action plans in front of the hall as a commitment to participants and facilitators. Two copies were made of the plan, one given back to managers and the other kept at ECHO for further follow-up activities.

5.9.8 Evaluation and closing

Actions and improvements are the achievements of PAOT. Therefore, an evaluation by a questionnaire was made, using the participants' feedback for improving future training courses. The comments obtained including strengths and weaknesses of time schedule, training venue and training facilities, checklist exercise site, transportation between training hall and factory, lexicon terms of checklist and technical sessions. One facilitator summarized the course results. Finally, a senior lecturer gave a short speech to thank all participants, and explained the follow-up plans before distributing training certificates to all participants. The following feedback was obtained from 52 participants at two WIPE training courses hold in Can Tho City, from the question: Do you consider the content of each of the following eight technical sessions was useful?

Technical sessions	Strongly agree	Agree	Disagree	Strongly disagree
Checklist exercises	33	16	3	0
Materials storage and handling	34	17	1	0
Productive machine safety	31	20	1	0
Work-stations	29	22	1	0
Physical environment	28	21	3	0
Environment protection	22	25	5	0
Welfare facilities	35	15	2	0
Work organisation	27	23	2	0

5.10 Statistical Methods

It will first be necessary to establish whether variables (dust levels, noise levels etc) are normally distributed or log-normally distributed. This will be achieved by inspecting frequency distributions for the various variables using phase 1 (pre-intervention data) and examining the best fitting normal distribution for these distributions. This will be done both for untransformed data and for 'logged' (log-transformed) data.

Given that each measurement in phase 1 had a matching measurement in phase 2 (post-intervention), the statistical method of choice for comparing phase 2 and phase 1 data will be the paired t-test (Kirkwood, 1988). A paired t-test using untransformed data will provide the difference in mean values (together with a corresponding 95% confidence interval) between phase 2 and phase 1 data. A paired t-test using log-transformed data will provide the ratio of the geometric means from phase 2 and phase 1 data (together with a corresponding 95% confidence interval) (Altman, 1991).

6 Results

6.1 First cross sectional study: Phase I, pre-intervention

6.1.1 Work environment

6.1.1.1 Dust

Summaries of dust measurements from the first cross-sectional study (phase 1, pre-intervention) are shown in Table 8 by type of sample (personal/static), by industry and by all industries combined. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were always lower than arithmetic means, indicating that the dust measurements are positively skewed. Dust levels, both personal and static, were highest in the rice-mill industry and in civil engineering. Corresponding frequency distributions for these dust measurements are shown in Figure 1 to Figure 12, with best fitting normal distributions. In general, log-transformed data offered a better summary of the data. This was particularly true for personal dust levels in all industries combined (Figure 1), the printing industry (Figure 2), civil engineering industry (Figure 3), metal casting (Figure 4), and the rice-mill industry (Figure 6), and for static dust measurements in all industries combined (Figure 7), civil engineering industry (Figure 9), metal casting industry (Figure 10), and the rice-mill industry (Figure 12).

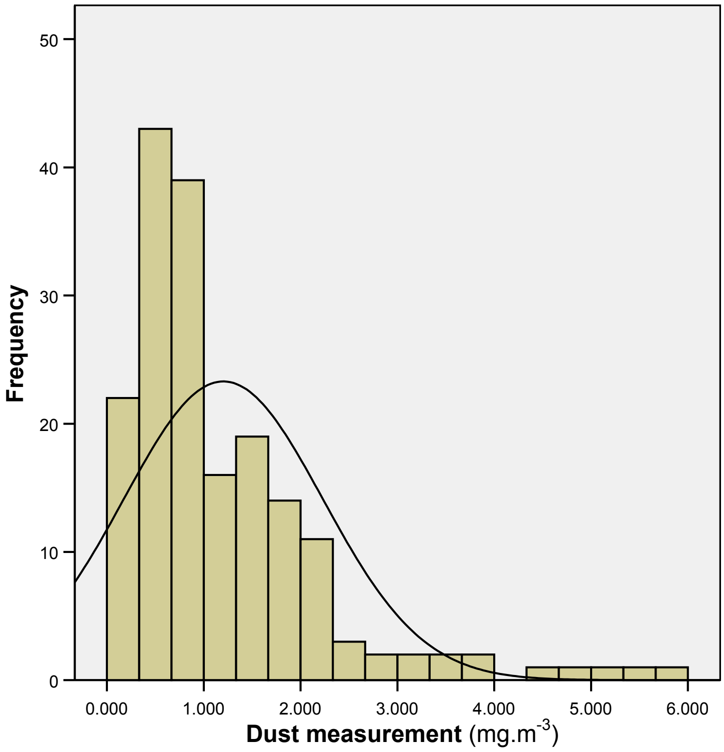
Table 8. Dust concentration[a] by industry: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Personal respirable dust							
Label printing & paper container	18	0.23	2.14	1.06	0.53	0.93	1.77
Civil engineering	36	0.25	5.33	1.55	1.37	1.10	2.38
Metal casting	36	0.11	2.61	0.87	0.63	0.70	2.10
Garment	36	0.18	1.45	0.75	0.38	0.64	1.81
Rice mill	54	0.12	5.71	1.54	1.21	1.12	2.44
Total	180	0.11	5.71	1.20	1.03	0.88	2.24
Static dust							
Label printing & paper container	20	0.26	1.41	0.64	0.36	0.56	1.71
Civil engineering	36	0.16	4.11	1.14	1.06	0.80	2.34
Metal casting	36	0.09	4.22	0.69	0.76	0.46	2.51
Garment	40	0.16	1.13	0.48	0.25	0.42	1.70
Rice mill	48	0.27	6.91	1.52	1.40	1.10	2.30
Total	180	0.09	6.91	0.95	1.02	0.65	2.34

a. All measurements are $mg.m^{-3}$

Figure 1. Frequency distribution of personal dust measurement, phase I- all five industries combined

a. Unadjusted data



b. Log_{10} (dust measurement)

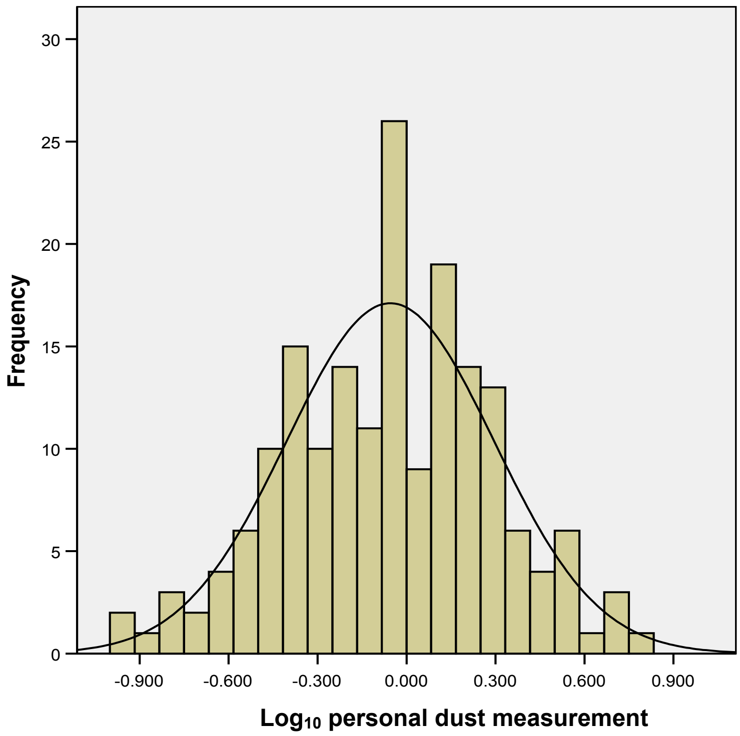
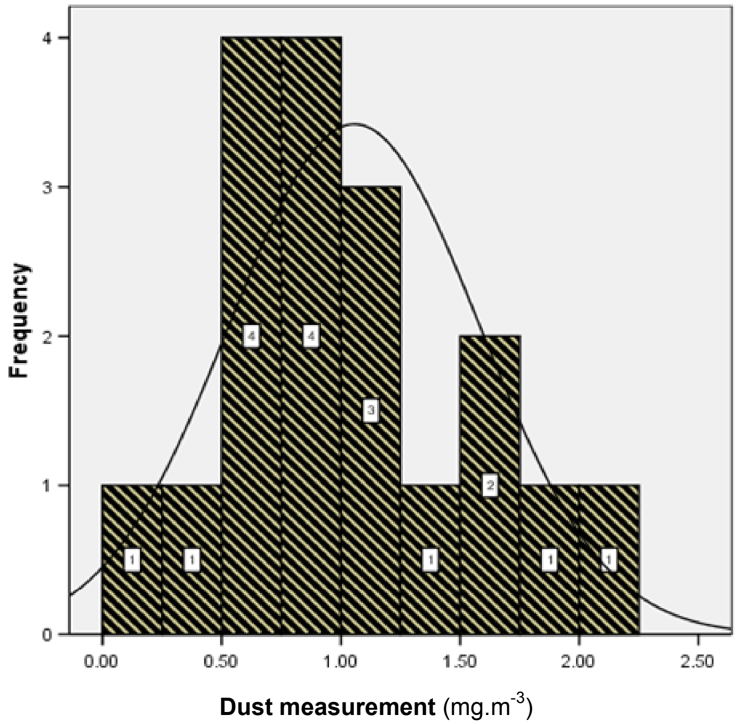


Figure 2. Frequency distribution of personal dust measurement, phase I – Printing - paper industry

a. Unadjusted data



b. Log_{10} (dust measurement)

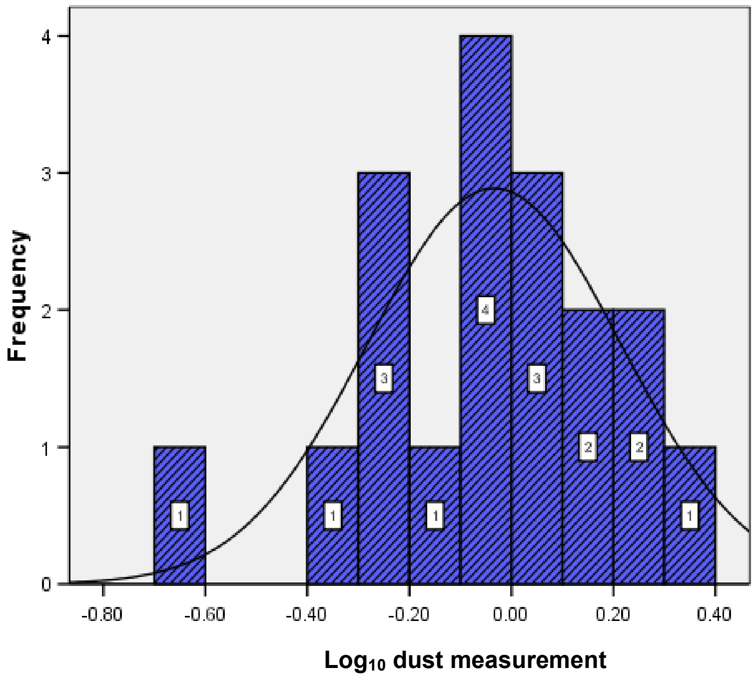
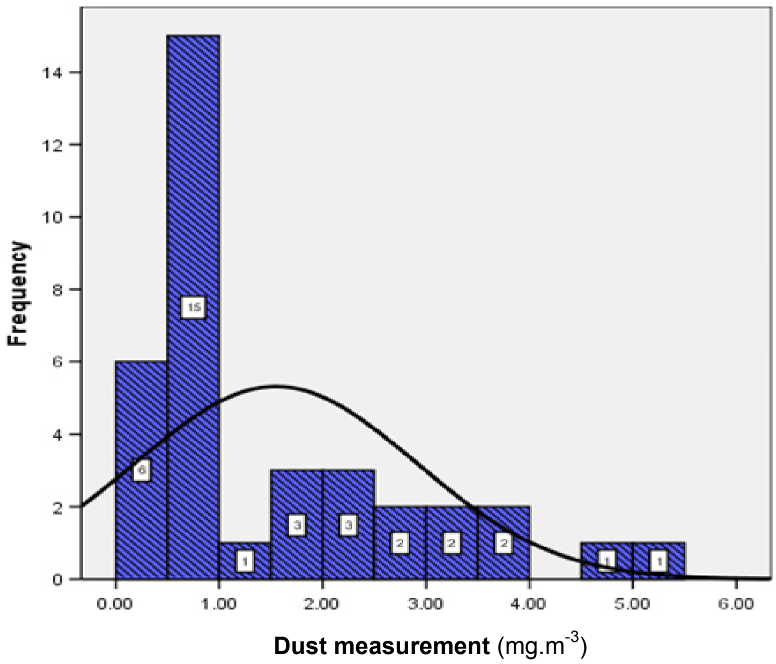


Figure 3. Frequency distribution of personal dust measurement, phase I – Civil engineering industry

a. Unadjusted data



b. Log_{10} (dust measurement)

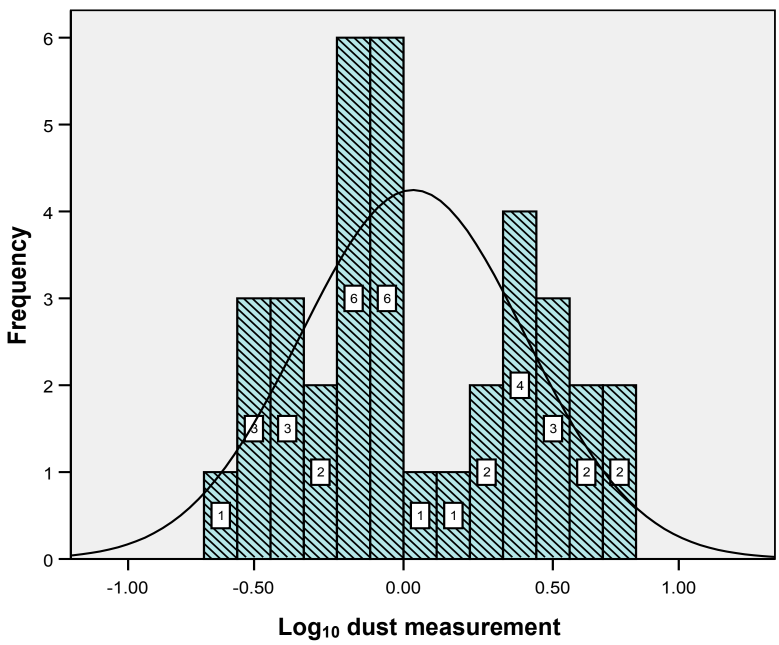
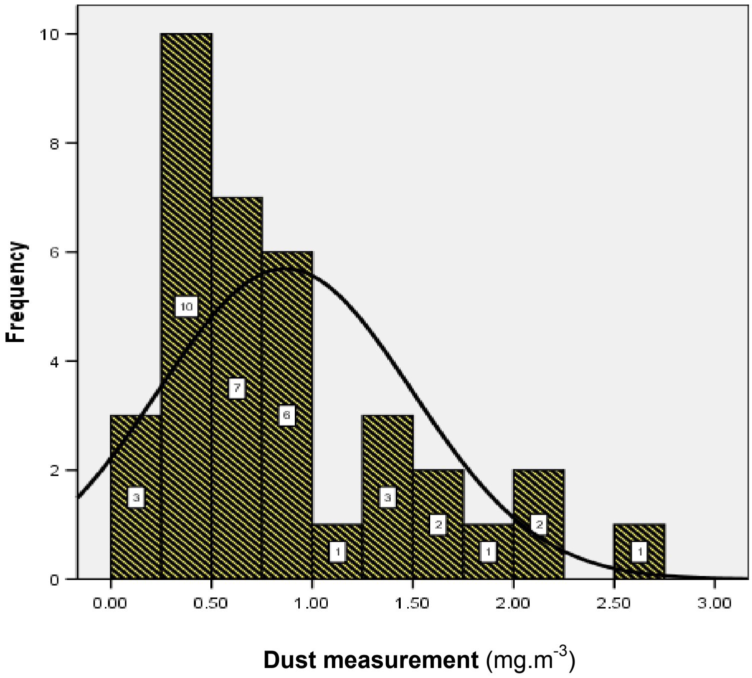


Figure 4. Frequency distribution of personal dust measurement, phase I – Metal casting industry

a. Unadjusted data



b. Log_{10} (dust measurement)

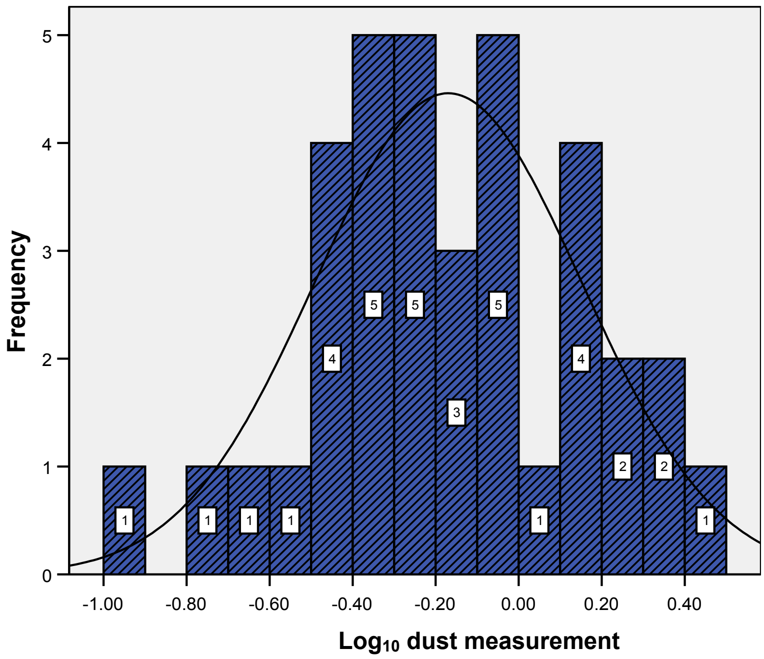
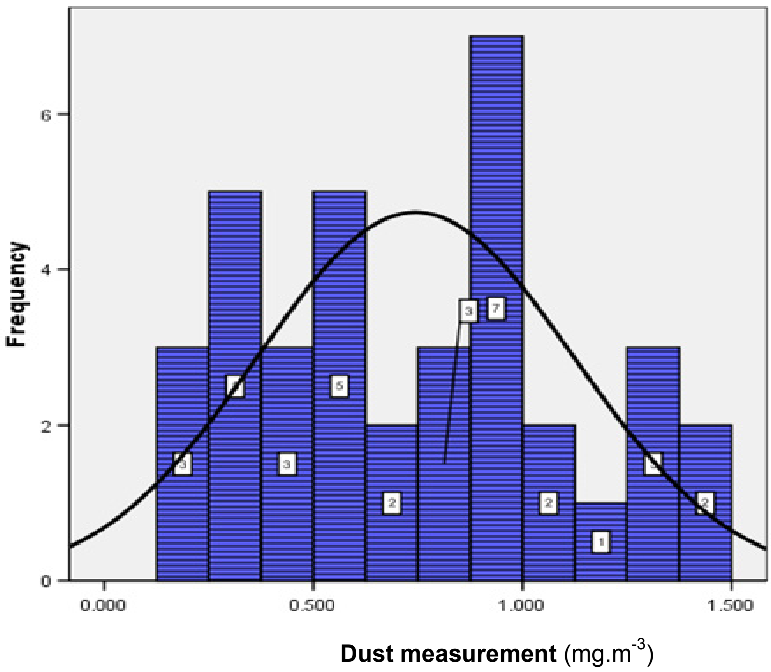


Figure 5. Frequency distribution of personal dust measurement, phase I – Garment industry

a. Unadjusted data



b. Log$_{10}$ (dust measurement)

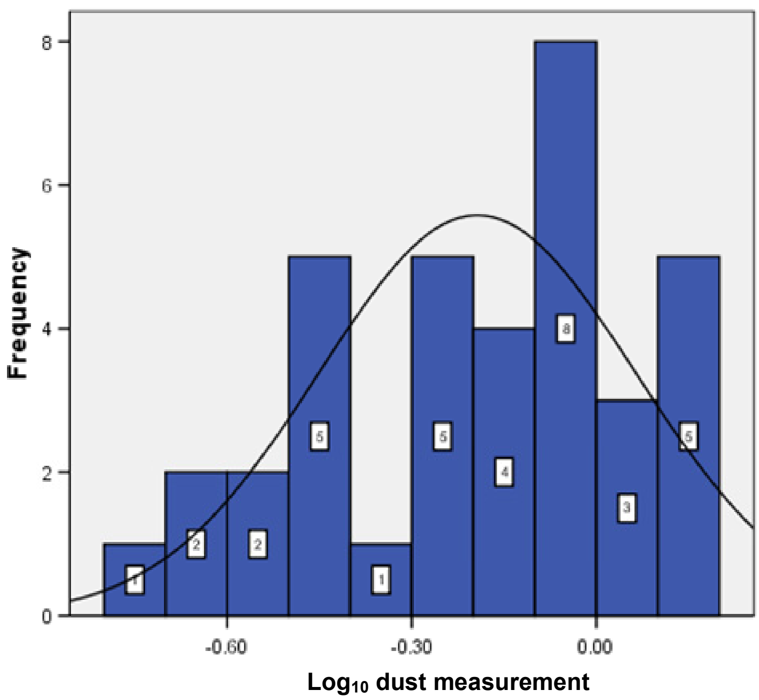
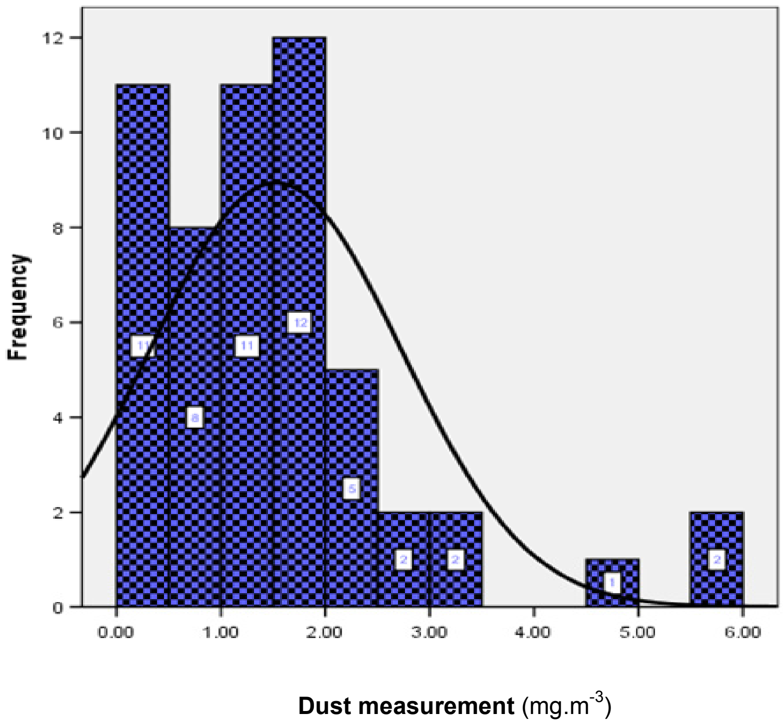


Figure 6. Frequency distribution of personal dust measurement, phase I – Rice-mill industry

a. Unadjusted data



b. Log_{10} (dust measurement)

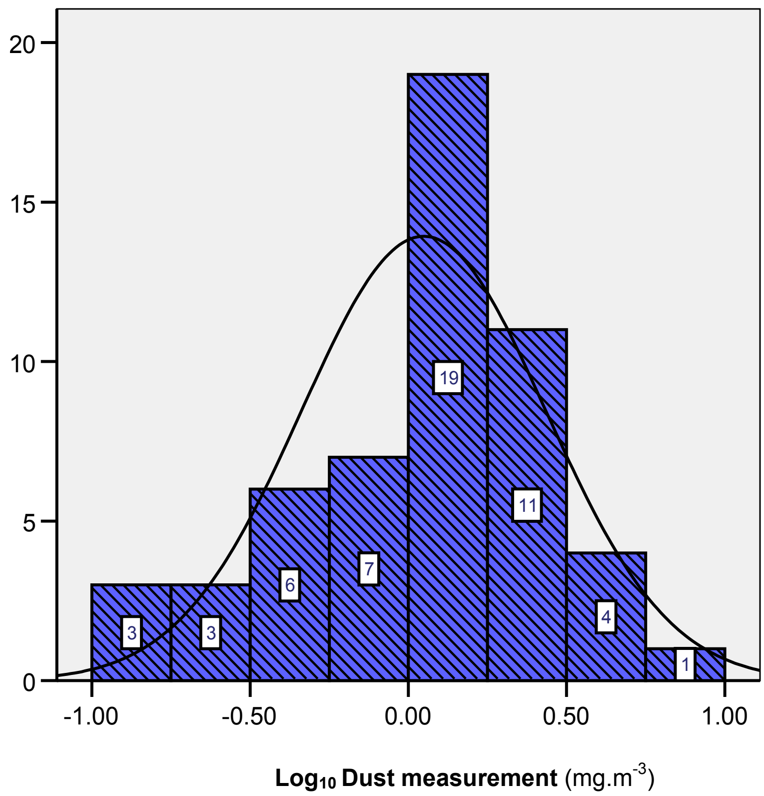
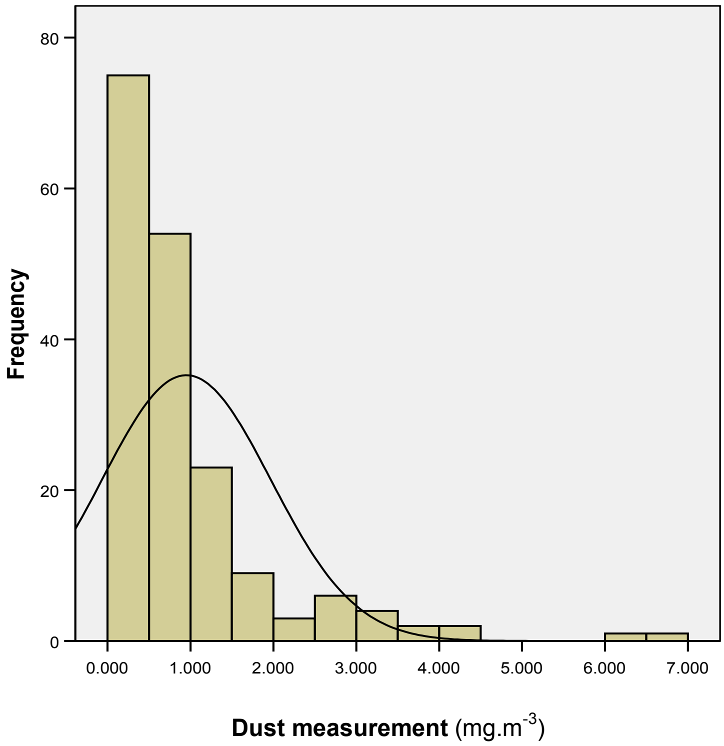


Figure 7. Frequency distribution of static dust measurement, phase I - all five industries combined

a. Unadjusted data



b. Log_{10} (dust measurement)

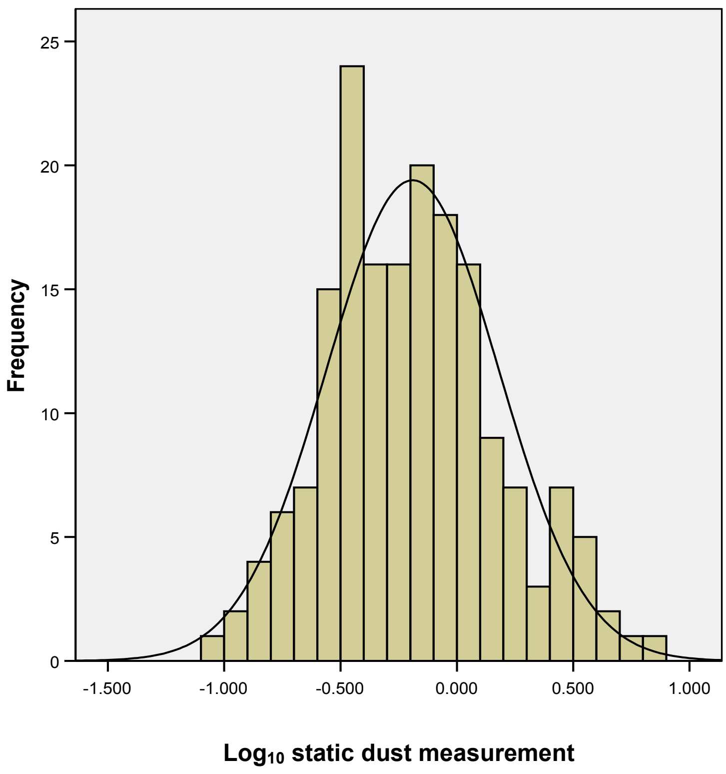
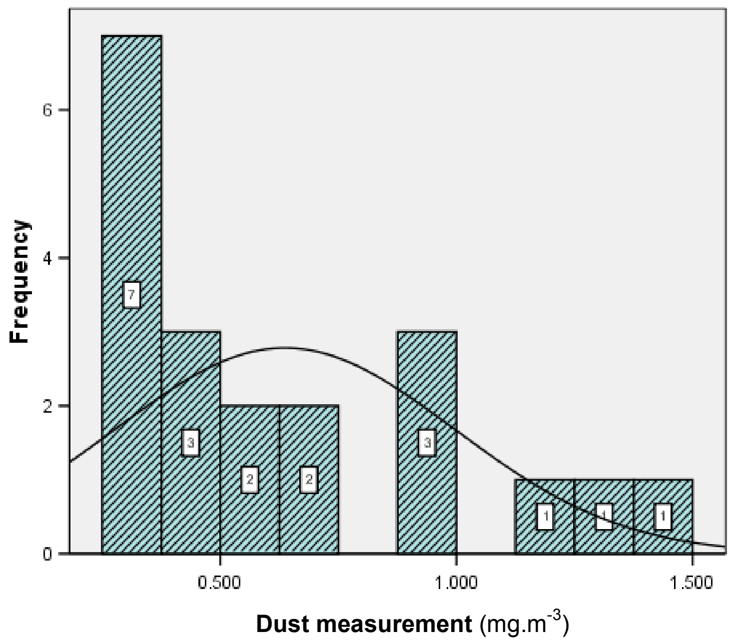


Figure 8. Frequency distribution of static dust measurement, phase I – Printing - paper industry

a. Unadjusted data



b. Log_{10} (dust measurement)

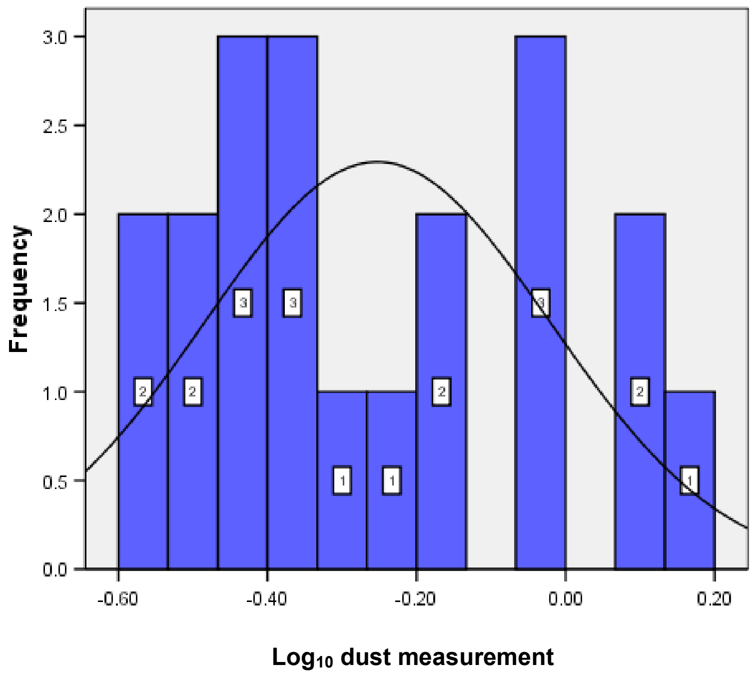
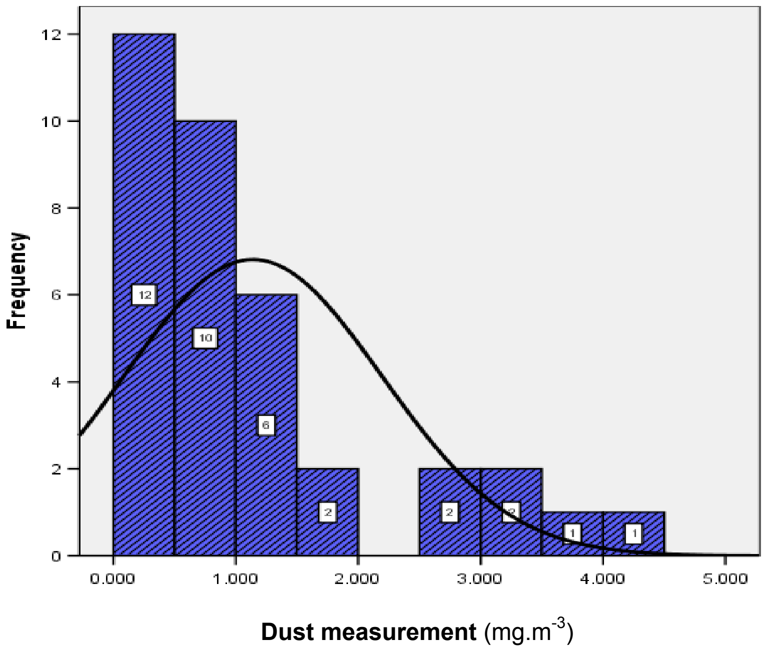


Figure 9. Frequency distribution of static dust measurement, phase I – Civil engineering industry

a. Unadjusted data



b. Log$_{10}$ (dust measurement)

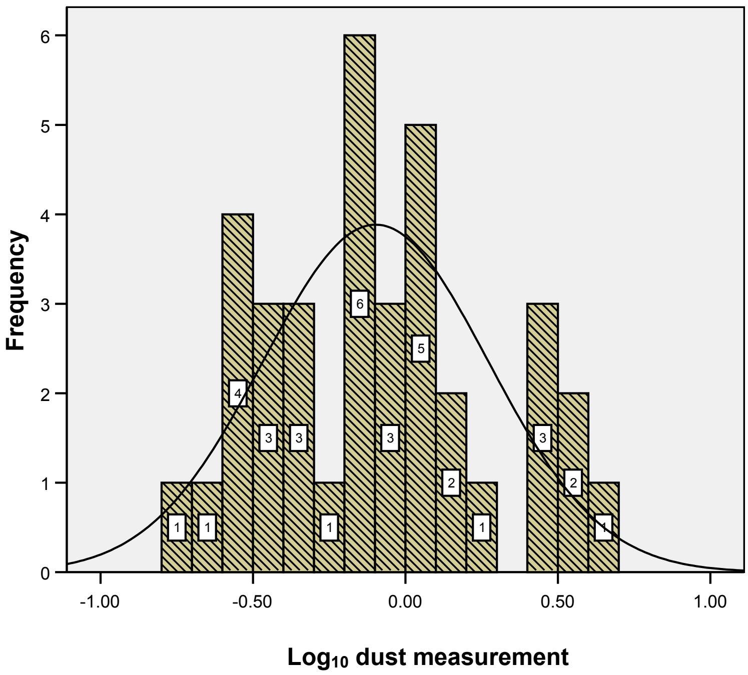
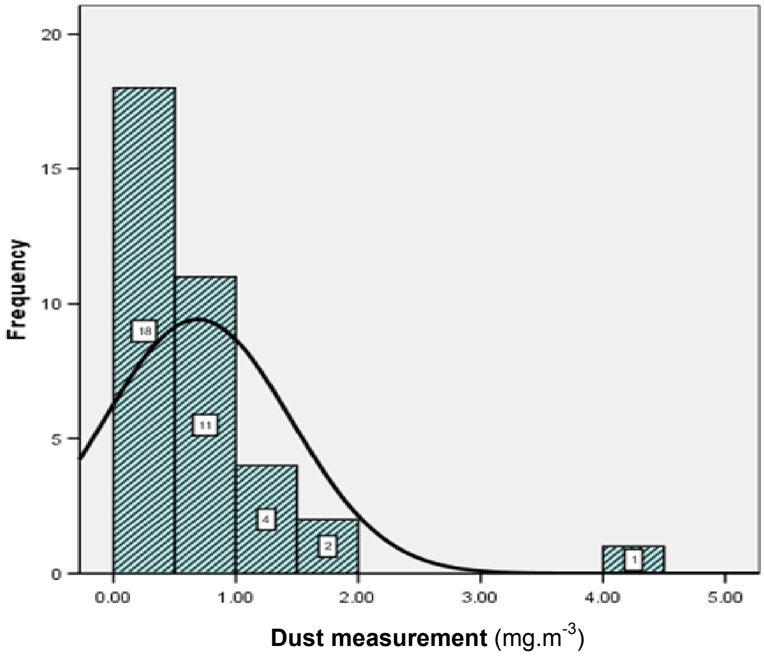


Figure 10. Frequency distribution of static dust measurement, phase I – Metal casting industry

a. Unadjusted data



b. Log_{10} (dust measurement)

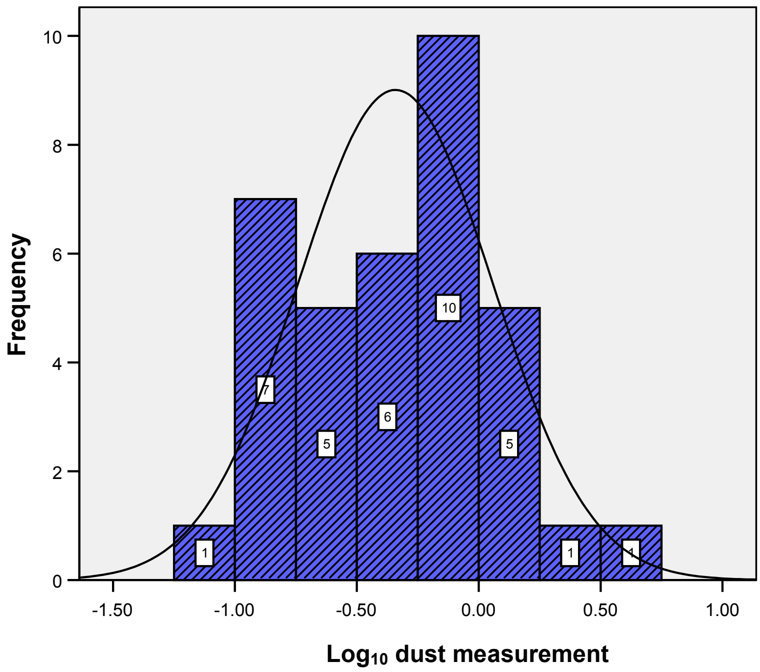
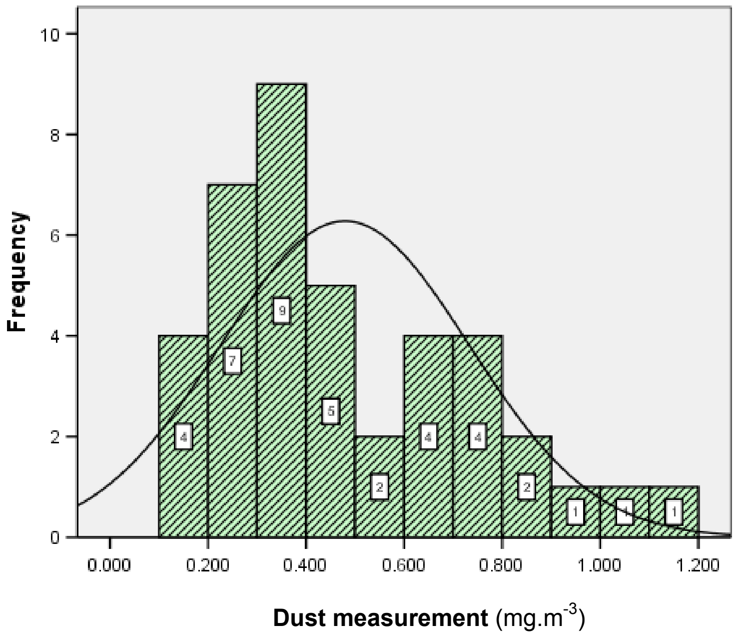


Figure 11. Frequency distribution of static dust measurement, phase I – Garment industry

a. Unadjusted data



b. Log_{10} (dust measurement)

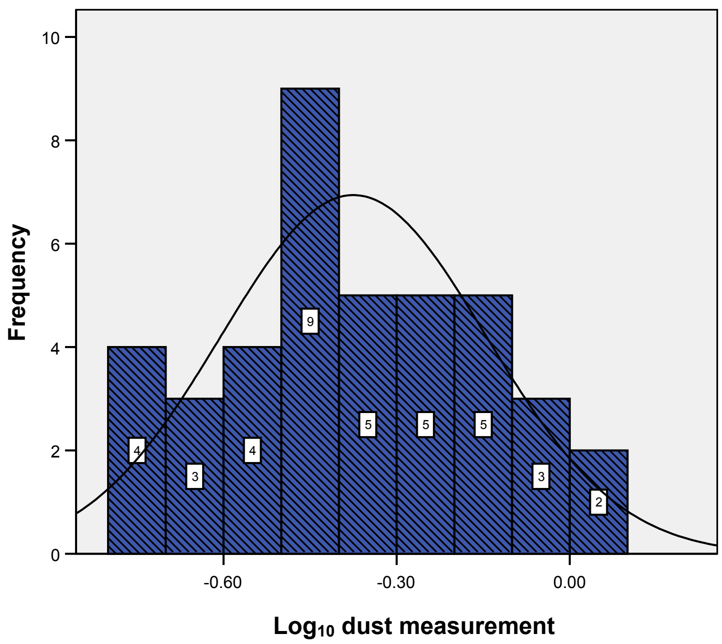
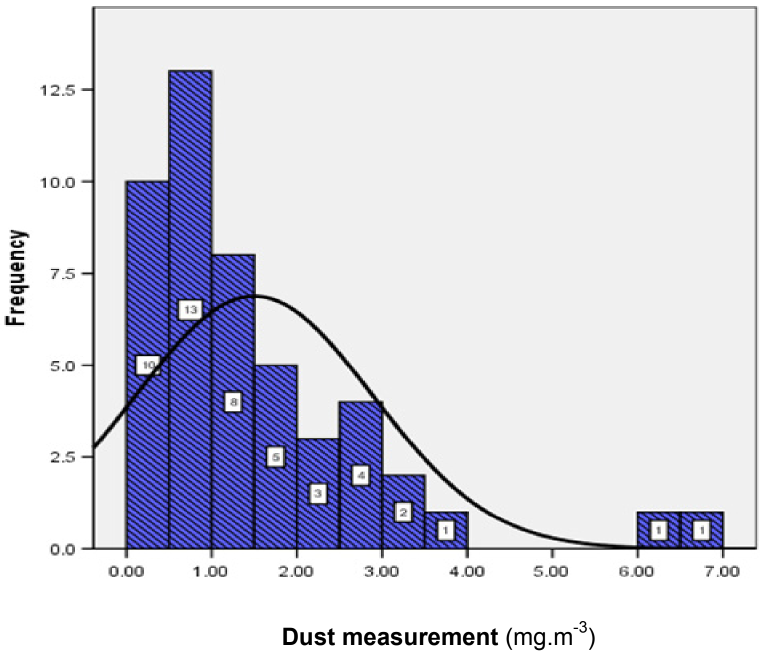
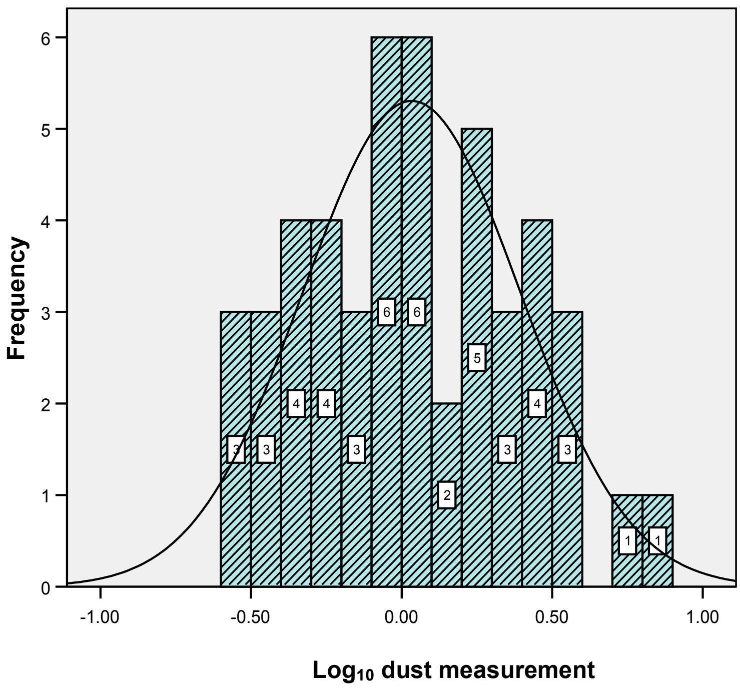


Figure 12. Frequency distribution of static dust measurement, phase I – Rice-mill industry

a. Unadjusted data



b. Log_{10} (dust measurement)



6.1.1.2 Toxic gas

Summaries of toxic gas measurements (carbon monoxide and carbon dioxide) from the first cross-sectional study are summarised in Table 9 for three industries. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were slightly lower than arithmetic means, indicating that the toxic measurements are positively skewed. Both carbon dioxide and carbon monoxide levels were higher in the metal casting industry than the other industries.

6.1.1.3 Noise

Summaries of noise measurements from the first cross-sectional study are summarised in Table 10 by industry and for all industries combined. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were similar to arithmetic means, indicating that the noise measurements were not skewed. Noise levels were highest in the metal casting and rice mill industries. Corresponding frequency distribution for these measurements are shown in Figure 13 to Figure 18, with best fitting normal distributions. In general, both unadjusted data and log-transformed data followed normal distributions.

Table 9. Toxic gas measurements[a] by industry: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Carbon dioxide (CO_2)							
Metal casting	8	4049.1	5650.7	4593.5	584.3	4562.5	1.1
Garment	16	1529.7	2573.4	1972.2	296.0	1951.6	1.2
Carbon monoxide (CO)							
Metal casting	8	10.3	25.2	16.5	4.4	16.0	1.3
Label printing & paper container	4	9.7	12.1	11.2	1.4	11.1	1.1

a. All measurements are $mg.m^{-3}$

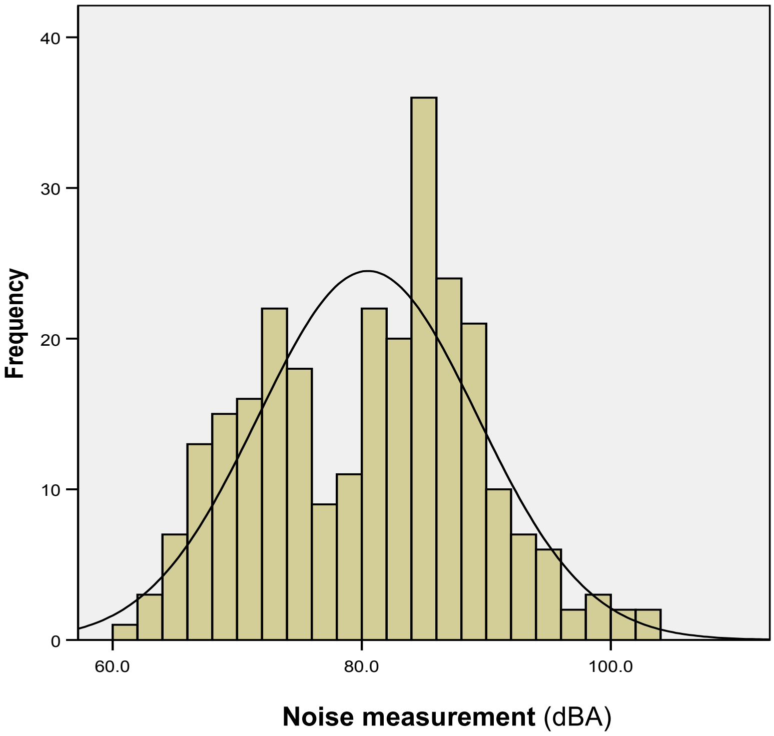
Table 10. Noise measurements[a] by industry: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Printing & paper container	30	66.1	88.6	77.3	7.4	76.9	1.1
Civil engineering	54	60.4	94.3	78.9	8.0	78.5	1.2
Metal casting	54	63.7	103.3	85.9	8.6	85.6	1.2
Garment	60	63.2	90.6	72.2	5.9	73.0	1.1
Rice mill	72	73.4	103.5	85.9	5.0	85.7	1.1
Total	270	60.4	103.5	80.5	8.8	80.0	1.1

a. All measurements are dBA

Figure 13. Frequency distribution of noise level measurement, phase I - all five industries combined

a. Unadjusted data



b. Log_{10} (noise measurement)

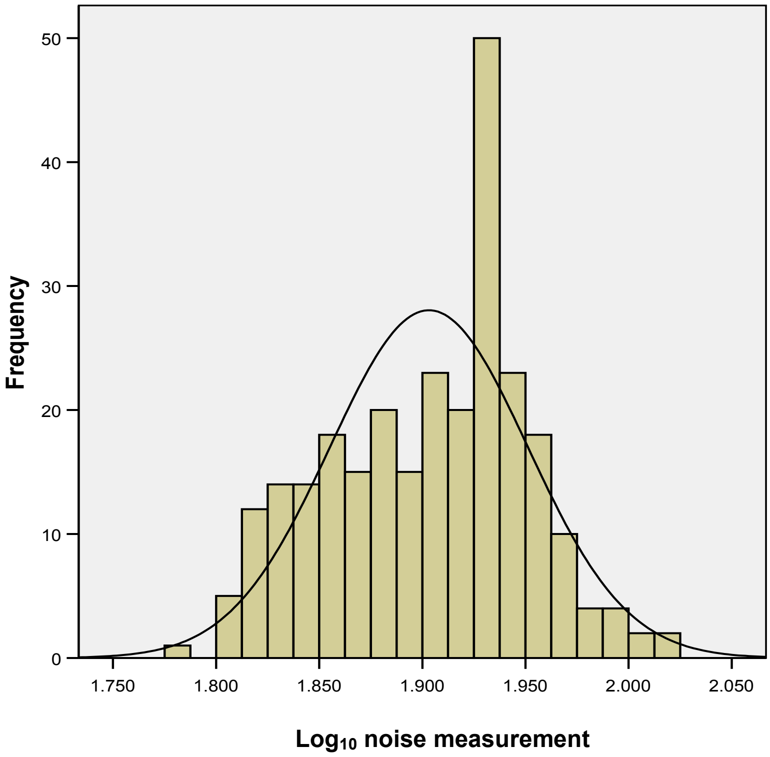
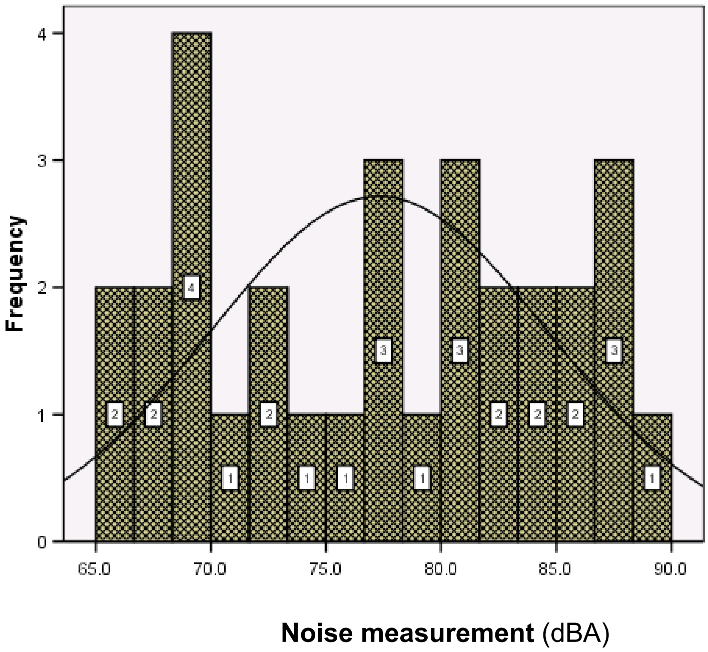


Figure 14. Frequency distribution of noise level measurement, phase I – Printing - paper industry

a. Unadjusted data



b. Log_{10} (noise measurement)

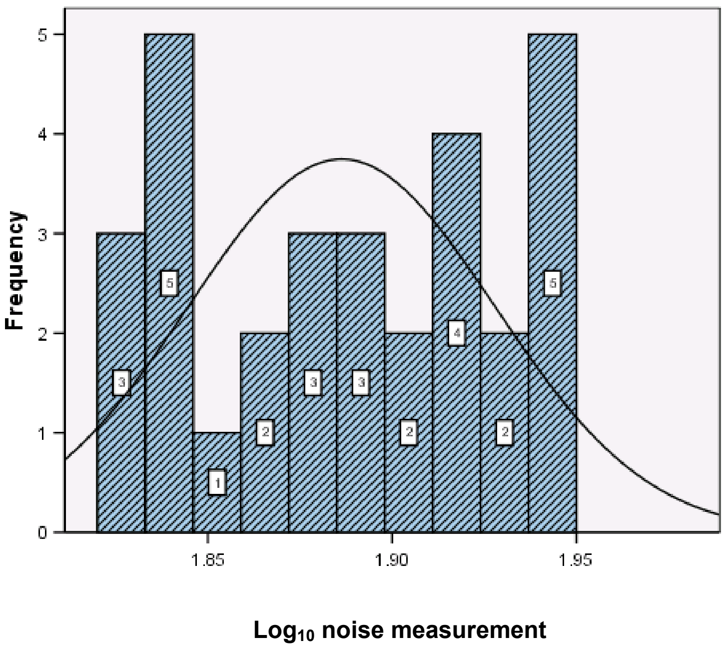
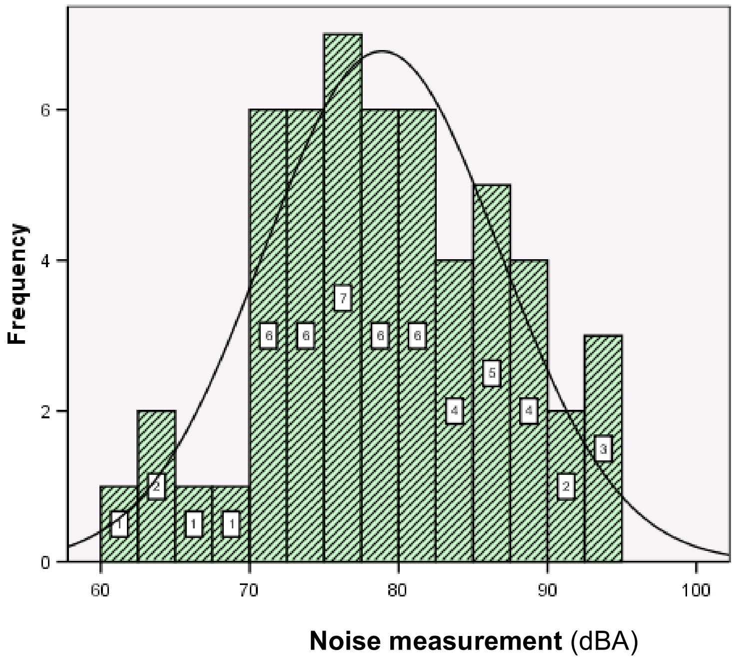


Figure 15. Frequency distribution of noise level measurement, phase I – Civil engineering industry

a. Unadjusted data



b. Log_{10} (noise measurement)

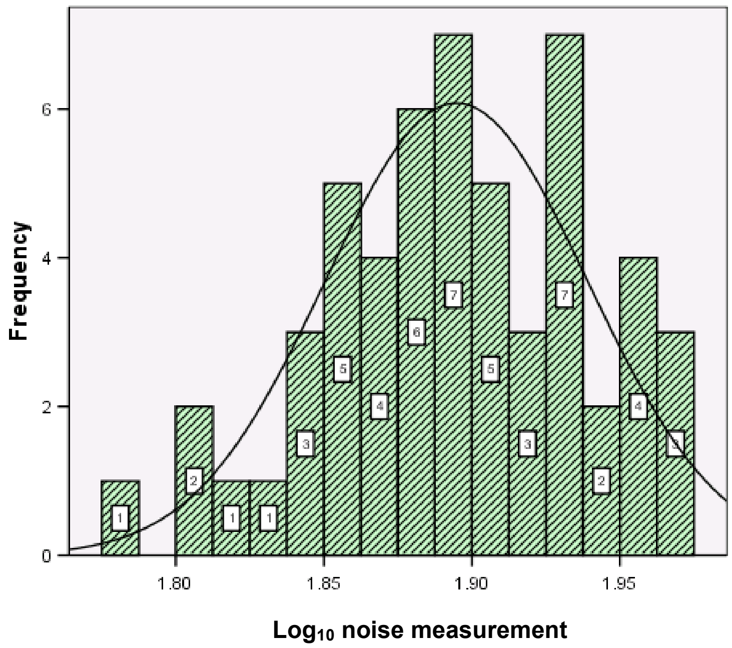
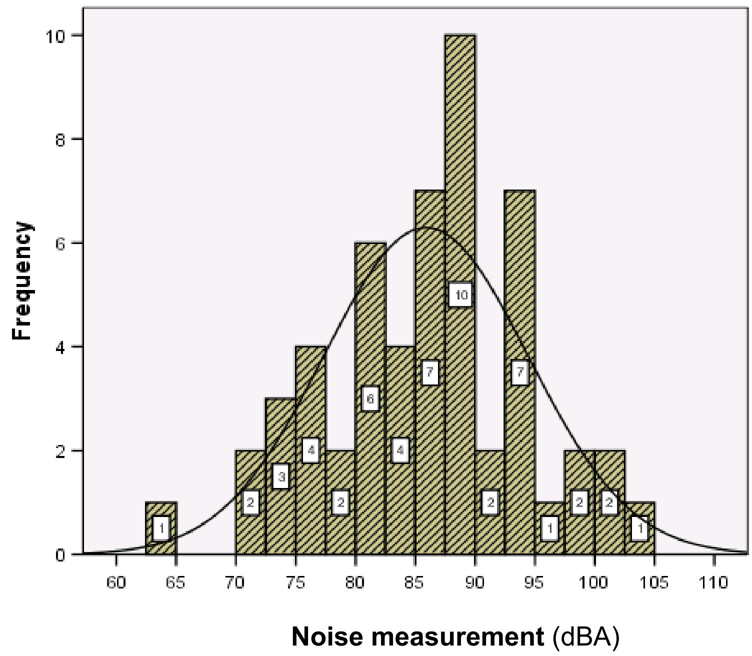


Figure 16. Frequency distribution of noise level measurement, phase I – Metal casting industry

a. Unadjusted data



b. Log_{10} (noise measurement)

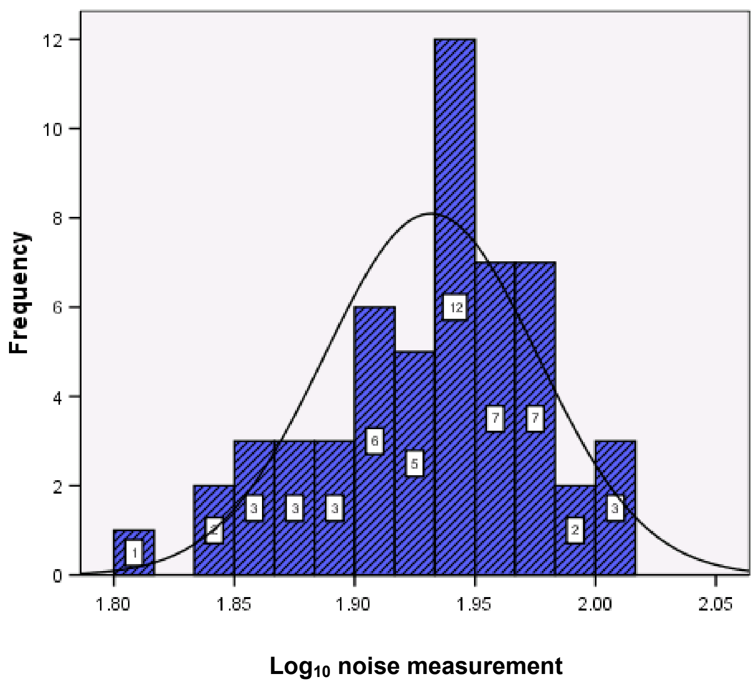
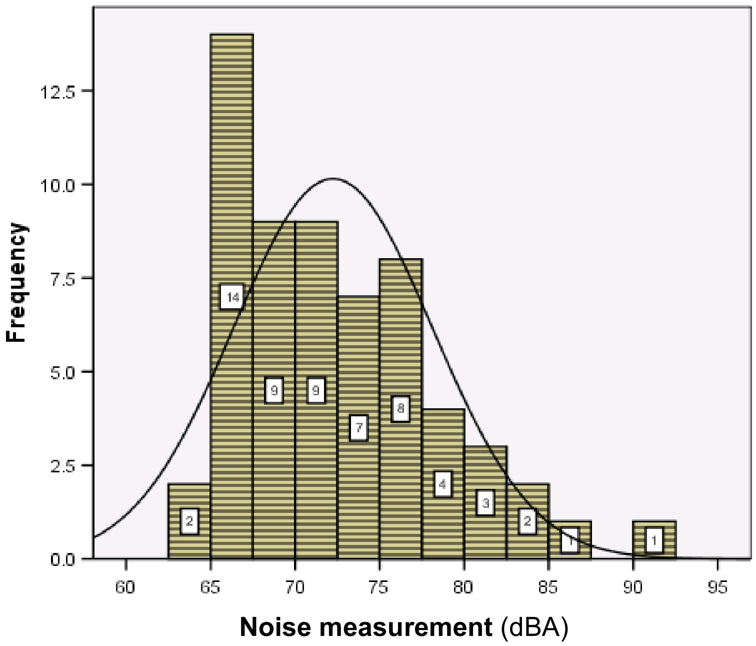


Figure 17. Frequency distribution of noise level measurement, phase I – Garment industry

a. Unadjusted data



b. Log_{10} (noise measurement)

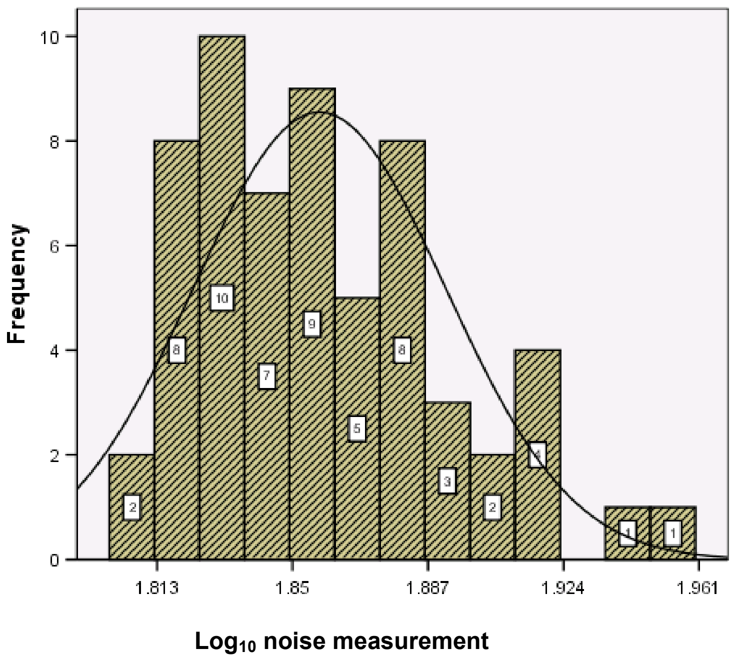
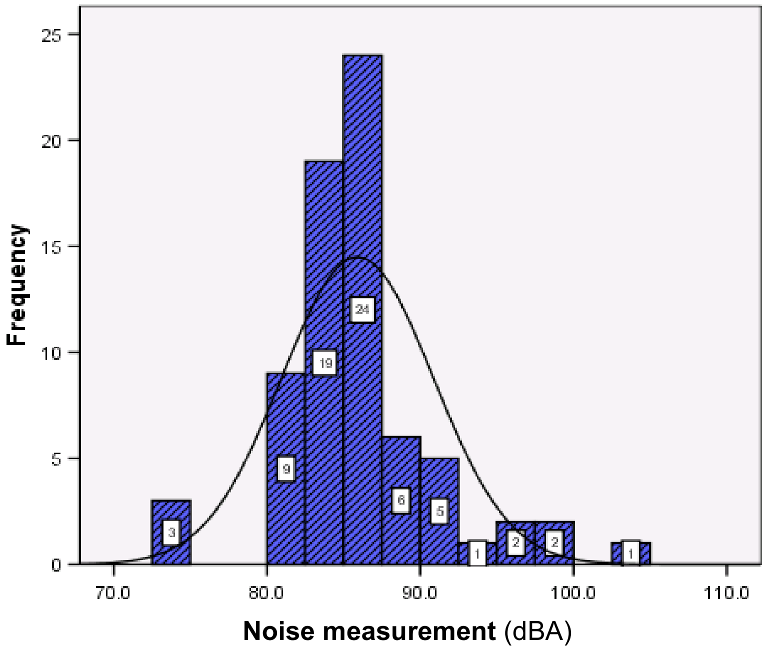
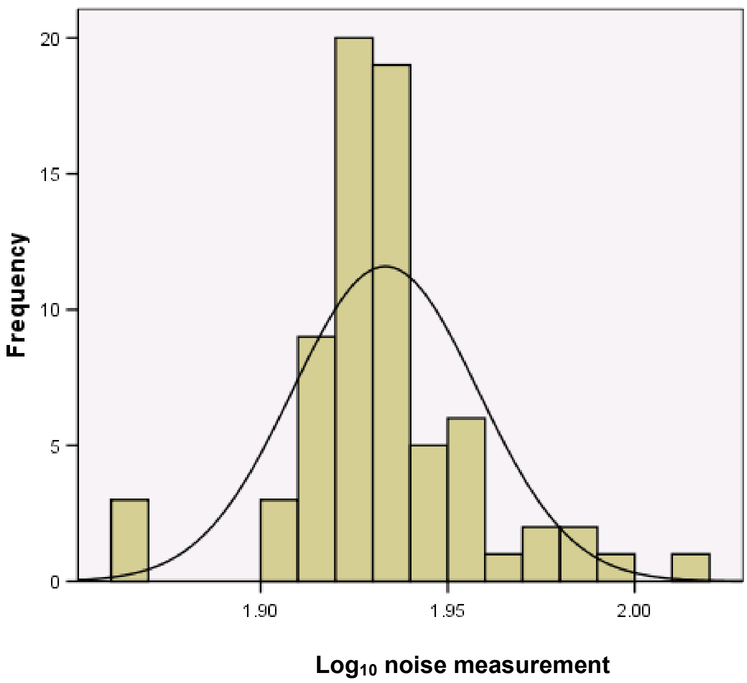


Figure 18. Frequency distribution of noise level measurement, phase I – Rice-mill industry

a. Unadjusted data



b. Log_{10} (noise measurement)



6.1.1.4 Lighting

Summaries of lighting measurements from the first cross-sectional study are summarised in Table 11 by industry and for all industries combined. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were always lower than arithmetic means, indicating that the lighting measurements are positively skewed. Lighting measurements were highest in the metal casting and garment industries. Corresponding frequency distributions for these measurements are shown in Figure 19 to Figure 24, with best fitting normal distributions. In general, log-transformed data offered a better summary of the data. This was true for all five industries under study.

6.1.1.5 Air temperature

Summaries of air temperature measurements from the first cross-sectional study are summarised in Table 12 by industry and for all industries combined. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were similar to arithmetic means, indicating that the air temperature measurements were not skewed. Air temperature levels were highest in the rice mill industry. Corresponding frequency distribution for these measurements are shown in Figure 25 and Figure 26, with best fitting normal distributions. In general, both unadjusted data and log-transformed data followed normal distributions.

Table 11. Light measurements[a]: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Printing & paper container	50	44.4	387.0	189.3	100.7	162.2	1.8
Civil engineering	90	65.9	2021.0	478.1	496.5	309.7	2.5
Metal casting	90	30.5	4300.0	568.4	762.2	328.1	2.9
Garment	100	179.0	1506.0	633.7	275.4	580.8	1.5
Rice mill	120	7.6	895.0	201.8	182.6	132.1	2.7
Total	450	7.6	4300.0	425.0	473.9	267.1	2.8

a. All measurements are Lux

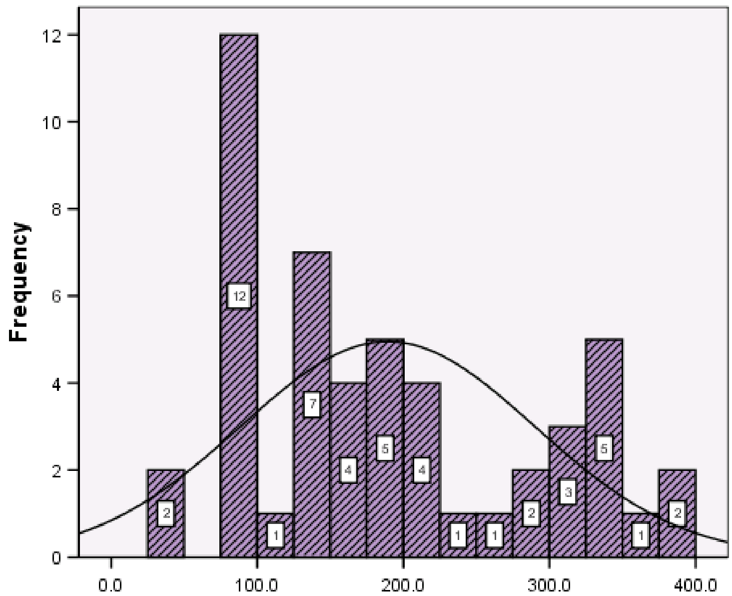
Table 12. Air temperaturea: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Printing & paper container	40	27.3	34.8	31.8	2.2	31.7	1.1
Civil engineering	72	27.5	34.1	31.4	1.9	31.4	1.1
Metal casting	72	27.4	44.1	32.5	3.8	32.3	1.1
Garment	80	28.8	35.1	32.5	1.7	32.5	1.1
Rice mill	96	28.0	36.2	32.9	1.8	32.9	1.1
Total	360	27.3	44.1	32.3	2.4	32.2	1.1

a. All measurements are °C

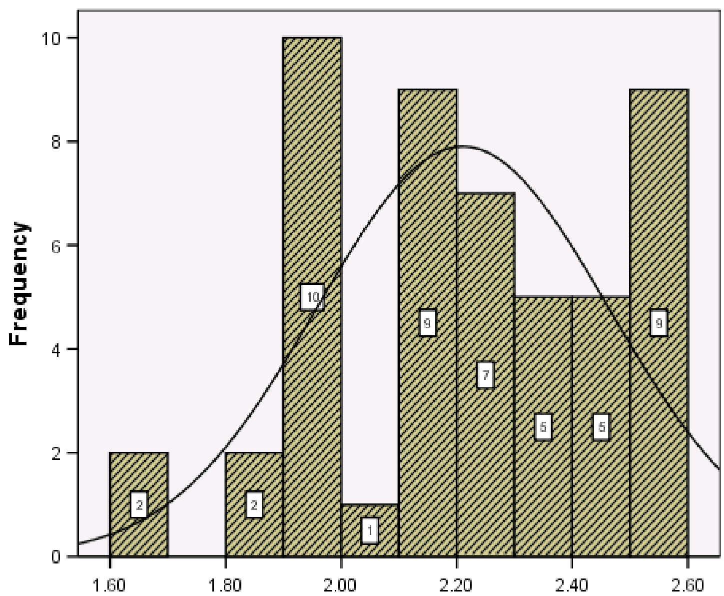
Figure 19. Frequency distribution of lighting measurement, phase I – Printing - paper industry

a. Unadjusted data



Lighting measurement (Lux)

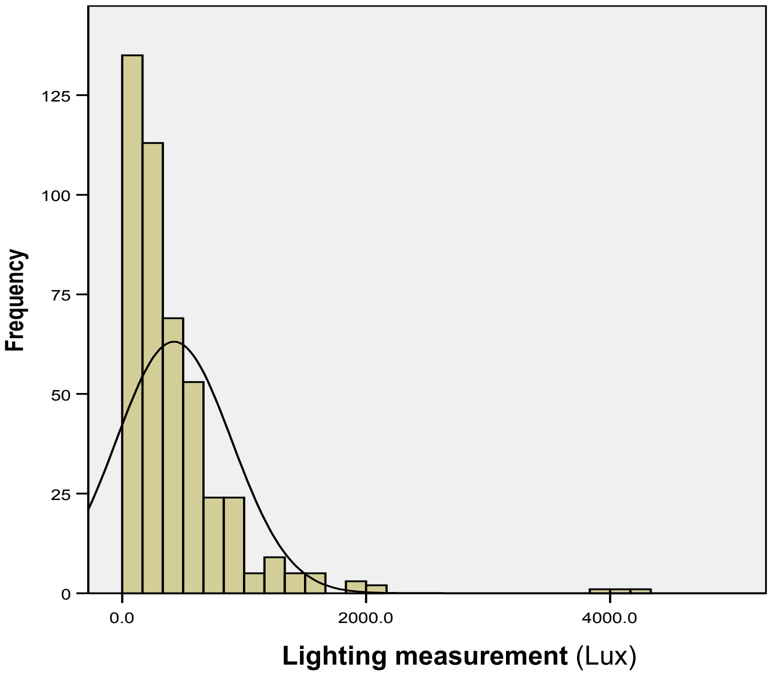
b. Log_{10} (Lighting measurement)



Log_{10} lighting measurement

Figure 20. Frequency distribution of lighting measurement, phase I - all five industries combined

a. Unadjusted data



b. Log_{10} (Lighting measurement)

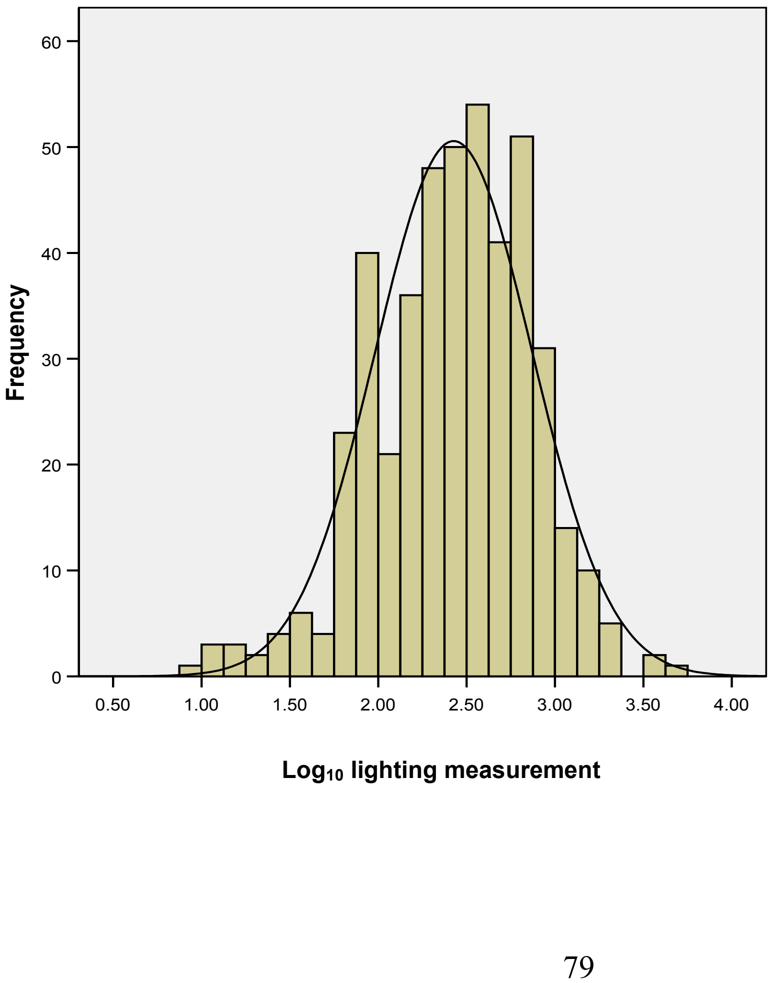
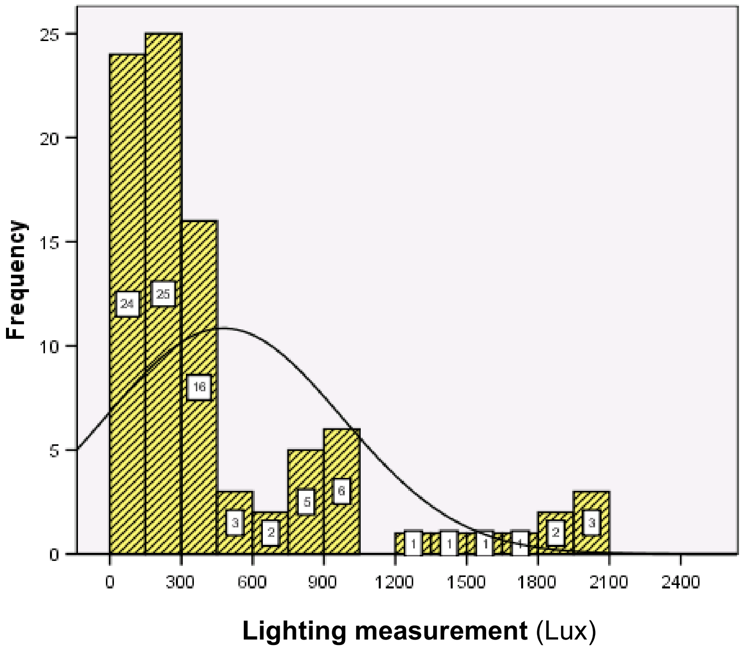


Figure 21. Frequency distribution of lighting measurement, phase I – Civil engineering industry

a. Unadjusted data



b. Log_{10} (Lighting measurement)

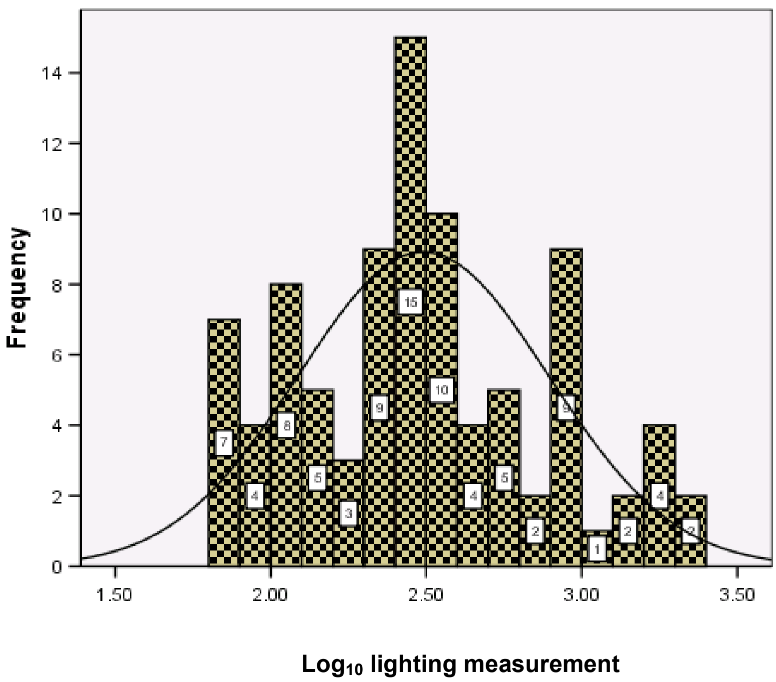
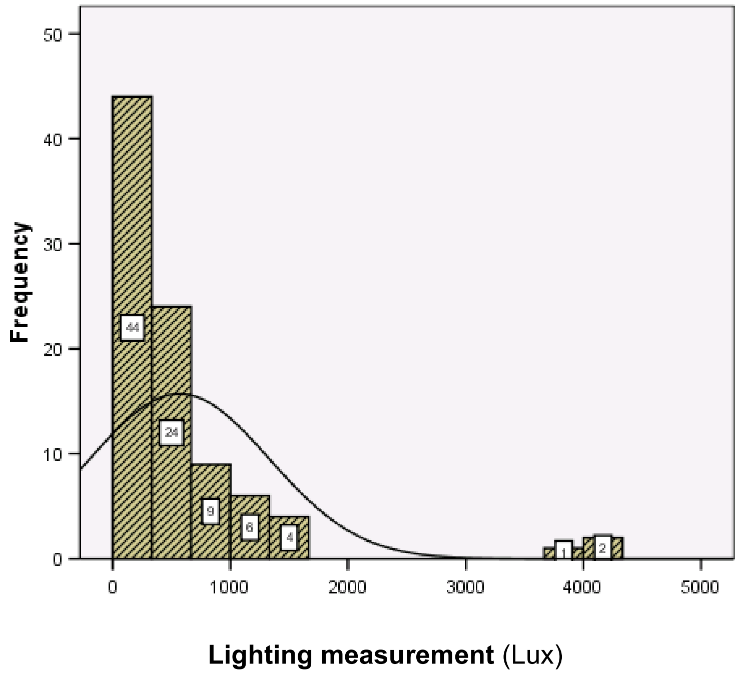


Figure 22. Frequency distribution of lighting measurement, phase I – Metal casting industry

a. Unadjusted data



b. Log_{10} (Lighting measurement)

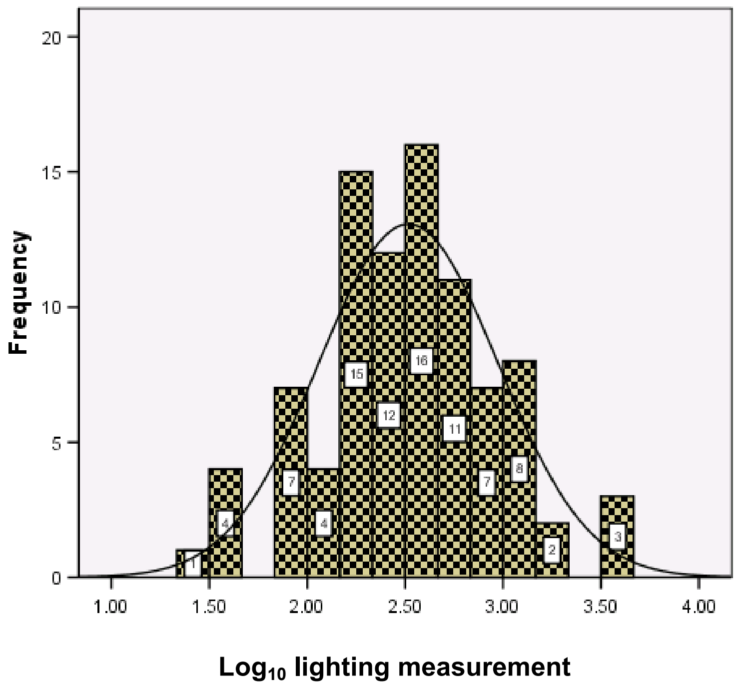
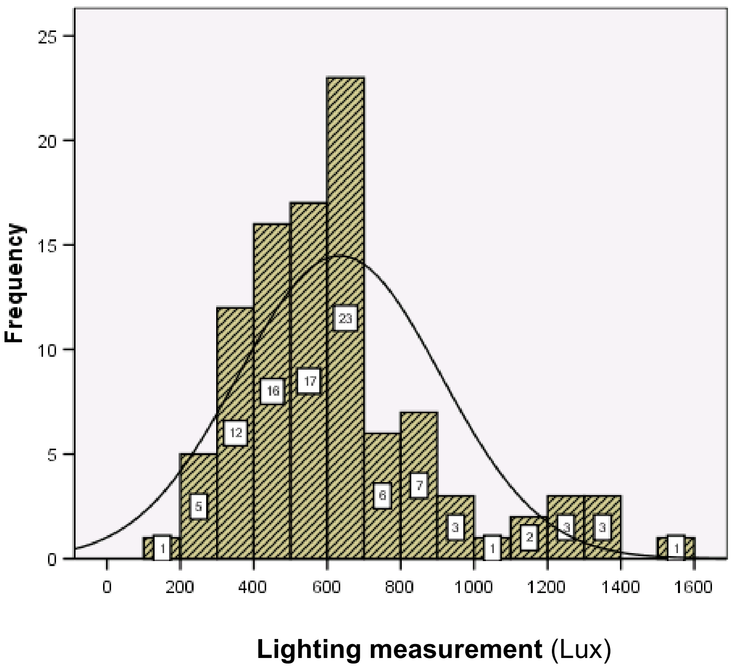


Figure 23. Frequency distribution of lighting measurement, phase I – Garment industry

a. Unadjusted data



b. Log_{10} (Lighting measurement)

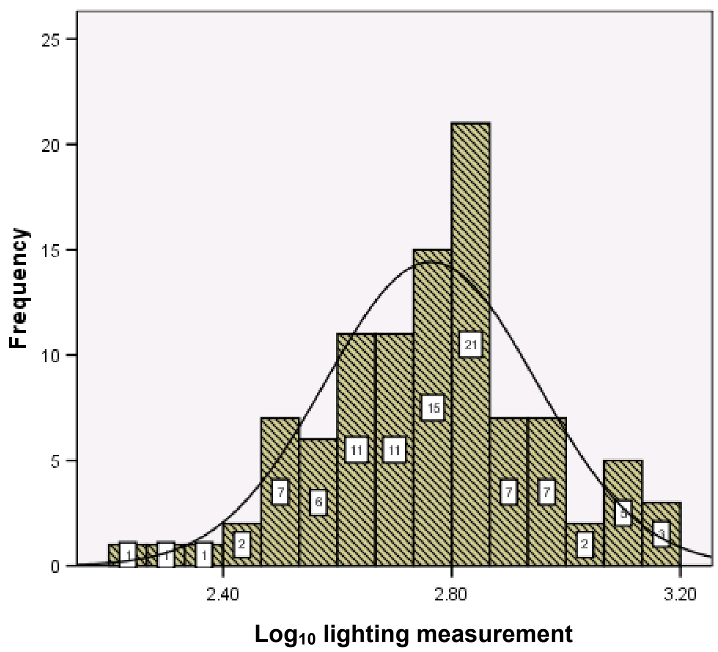
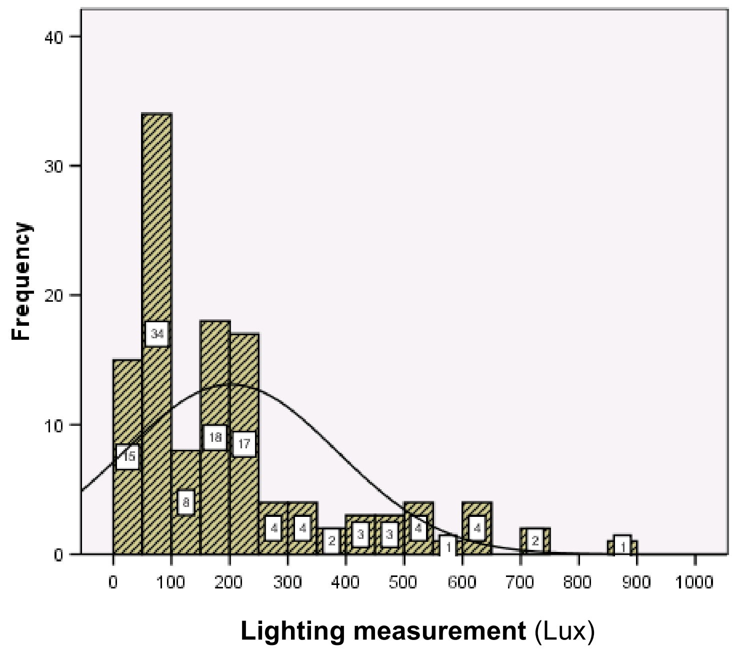


Figure 24. Frequency distribution of lighting measurement, phase I – Rice-mill industry

a. Unadjusted data



b. Log_{10} (Lighting measurement)

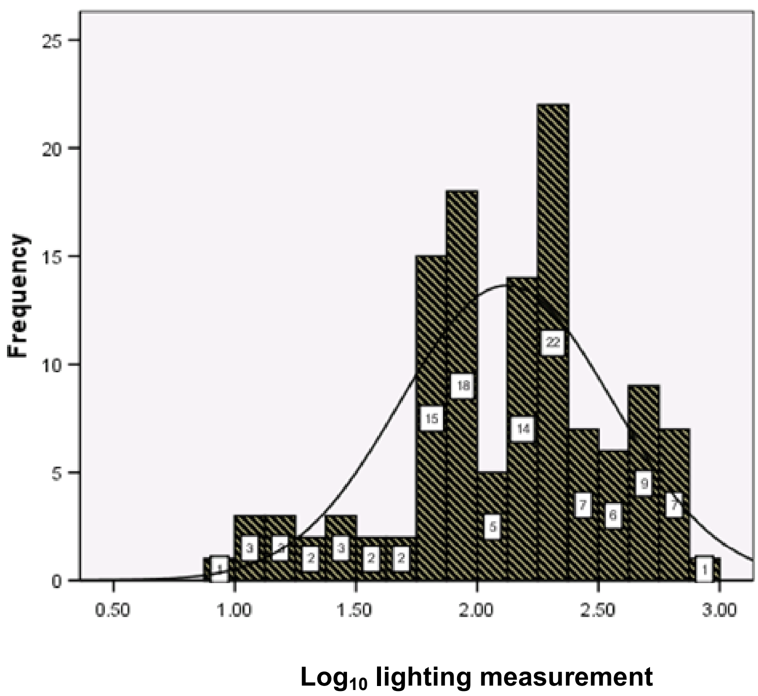
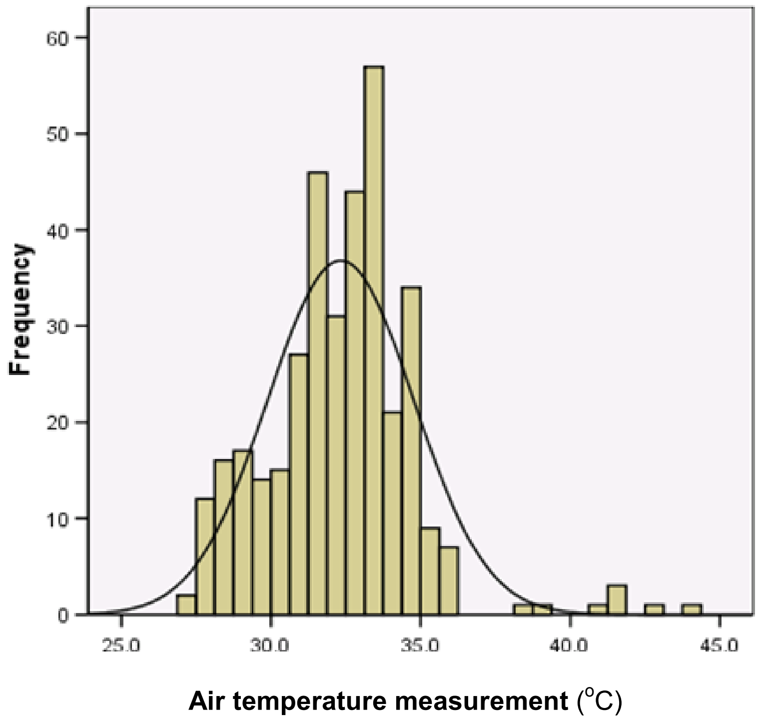


Figure 25. Frequency distribution of inside temperature measurement, phase I - all five industries combined

a. Unadjusted data



b. Log_{10} (Temperature measurement)

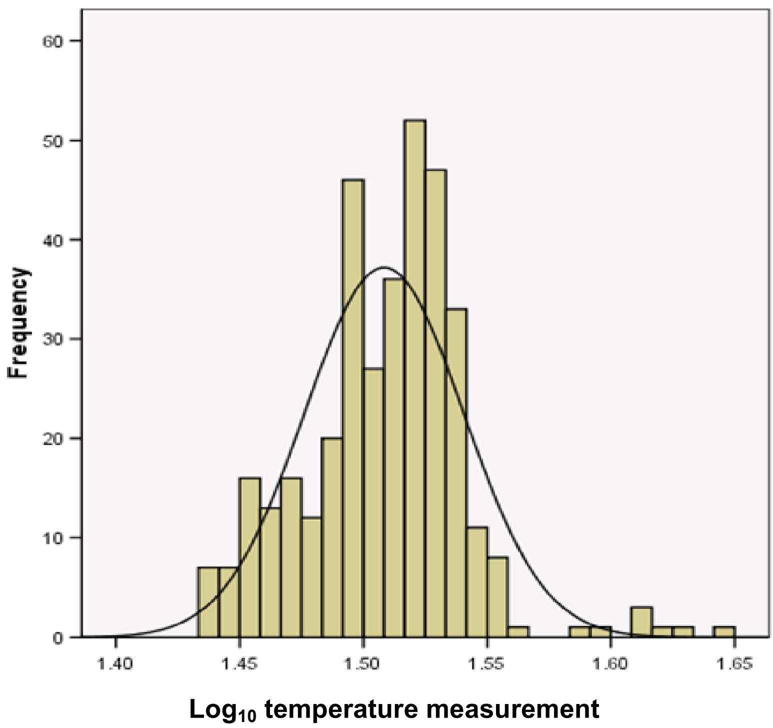
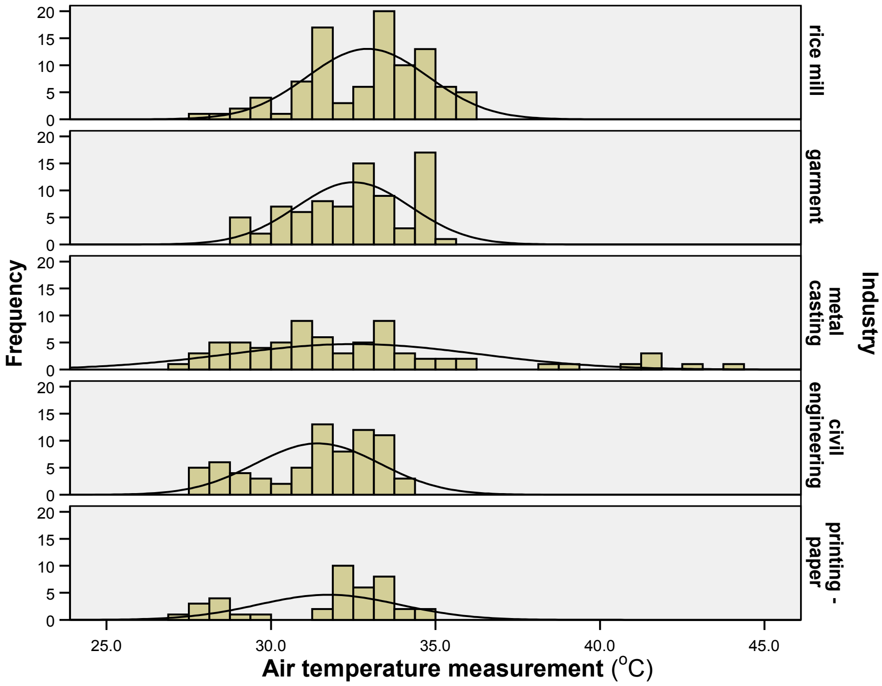
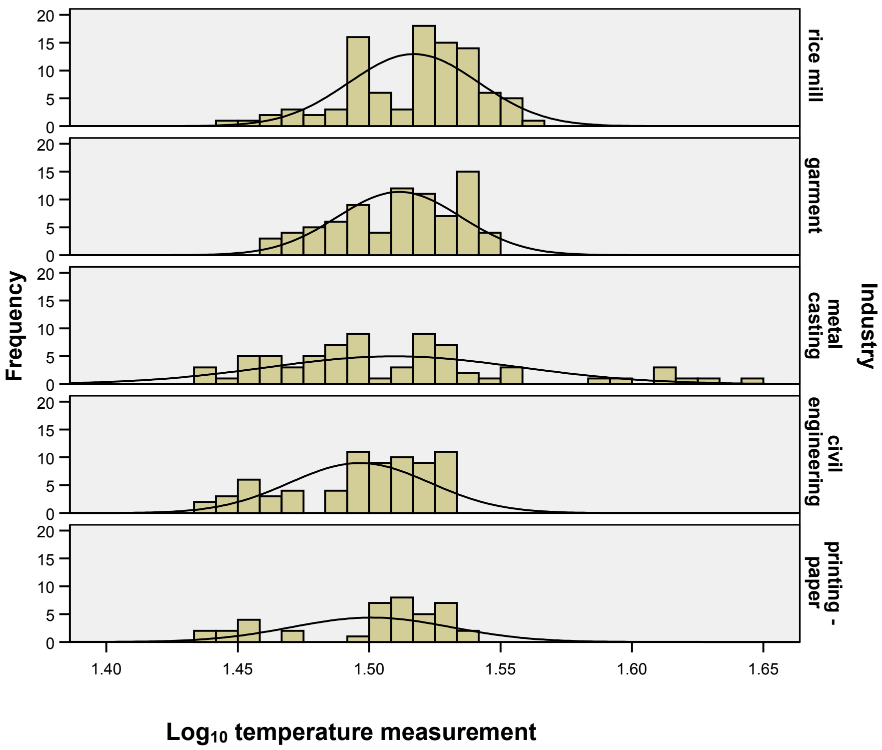


Figure 26. Frequency distribution of inside temperature measurement, phase I - in five industries

a. Unadjusted data



b. Log_{10} (Temperature measurement)



6.1.1.6 Air humidity

Summaries of air humidity measurements from the first cross-sectional study are summarised in Table 13 by industry and for all industries combined. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were similar to arithmetic means, indicating that the air humidity measurements were not skewed. Air humidity levels were highest in the metal casting industry. Corresponding frequency distribution for these measurements are shown in Figure 27 and Figure 28, with best fitting normal distributions. In general, both unadjusted data and log-transformed data followed normal distributions.

6.1.1.7 Air velocity

Summaries of air velocity measurements from the first cross-sectional study are summarised in Table 14 by industry and for all industries combined. Arithmetic means (with standard deviations) are shown alongside geometric means (with geometric standard deviations). Geometric means were always lower than arithmetic means, indicating that the air velocity measurements are positively skewed. Inside air velocity measurements were lowest in the rice mill and printing industries. Corresponding frequency distributions for these measurements are shown in Figure 29 and Figure 30, with best fitting normal distributions. In general, log-transformed data offered a better summary of the data. This was true for all five industries under study.

Table 13. Relative humidity[a] measurements: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Printing & paper container	40	56.9	75.9	69.1	5.7	68.8	1.1
Civil engineering	72	54.8	78.2	69.8	4.4	69.6	1.1
Metal casting	72	54.2	86.8	71.1	8.4	70.6	1.1
Garment	80	60.1	89.7	69.2	7.5	68.8	1.1
Rice mill	96	51.2	86.2	67.6	9.0	67.0	1.1
Total	360	51.2	89.7	69.2	7.5	68.8	1.1

a. All measurements are %

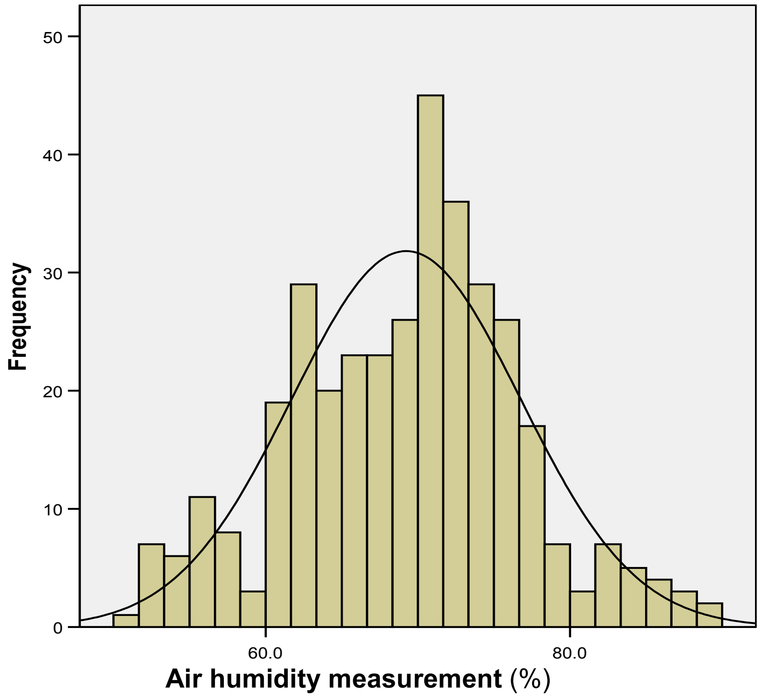
Table 14. Air velocity[a]: first cross-sectional study (phase 1: pre-intervention)

Industry	n	Minimum	Maximum	Arithmetic Mean	SD	Geometric Mean	GSD
Printing & paper container	40	0.06	0.64	0.32	0.28	0.27	1.88
Civil engineering	72	0.11	0.93	0.43	0.22	0.38	1.70
Metal casting	72	0.15	1.72	0.72	0.39	0.61	1.86
Garment	80	0.07	2.40	0.54	0.41	0.42	2.07
Rice mill	96	0.11	0.86	0.30	0.15	0.27	1.58
Total	360	0.06	2.40	0.46	0.33	0.37	1.93

a. All measurements are $m.s^{-1}$

Figure 27. Frequency distribution of inside humidity measurement, phase I - all five industries combined

a. Unadjusted data



b. Log_{10} (air humidity measurement)

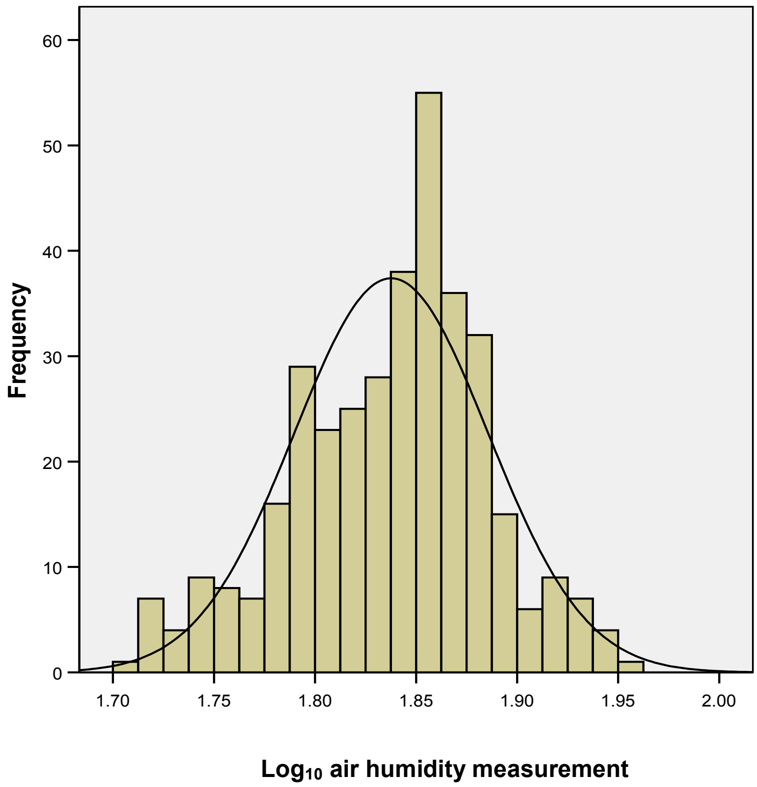
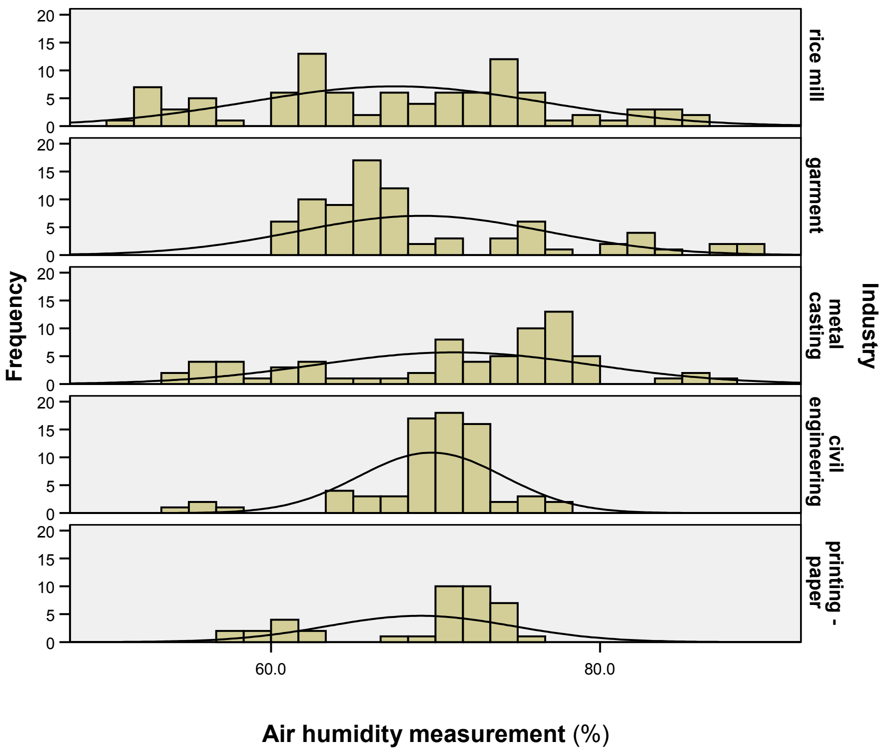


Figure 28. Frequency distribution of inside air humidity measurement, phase I - in five industries

A. Unadjusted data



B. Log_{10} (Humidity measurement)

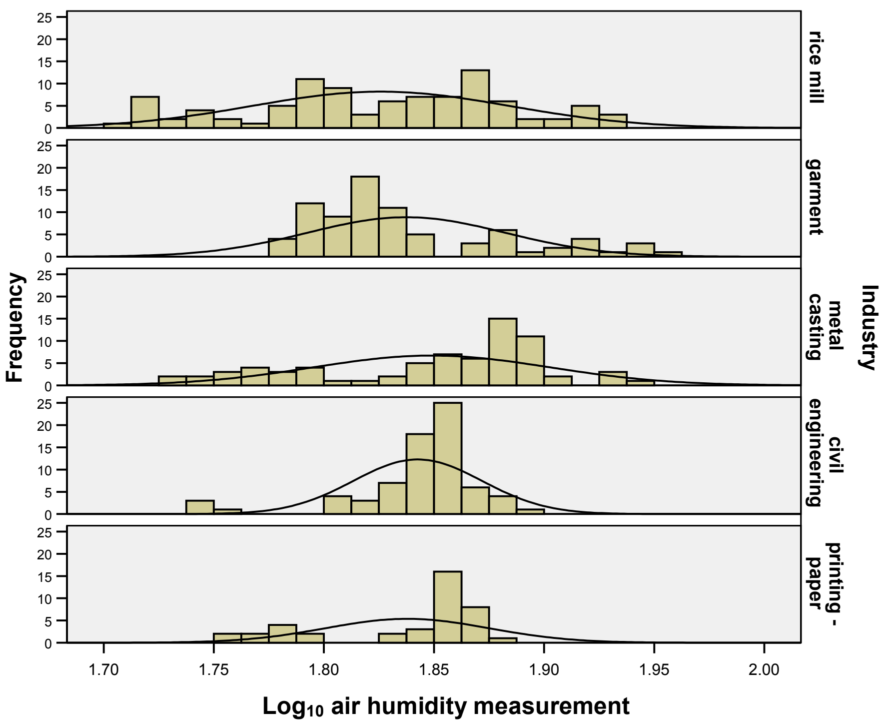
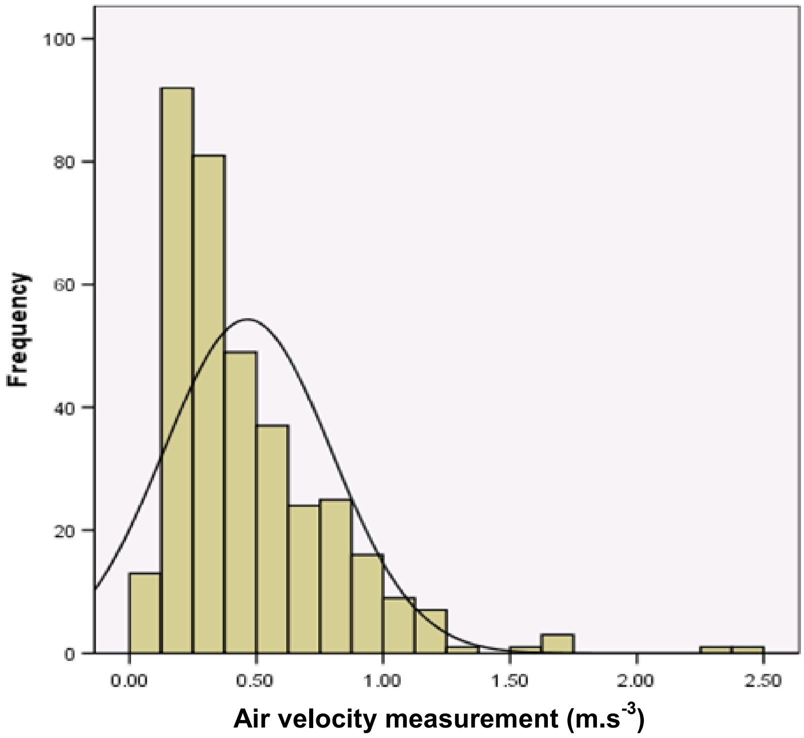


Figure 29. Frequency distribution of inside air velocity measurement, phase I - all five industries combined

a. Unadjusted data



b. Log_{10} (air velocity measurement)

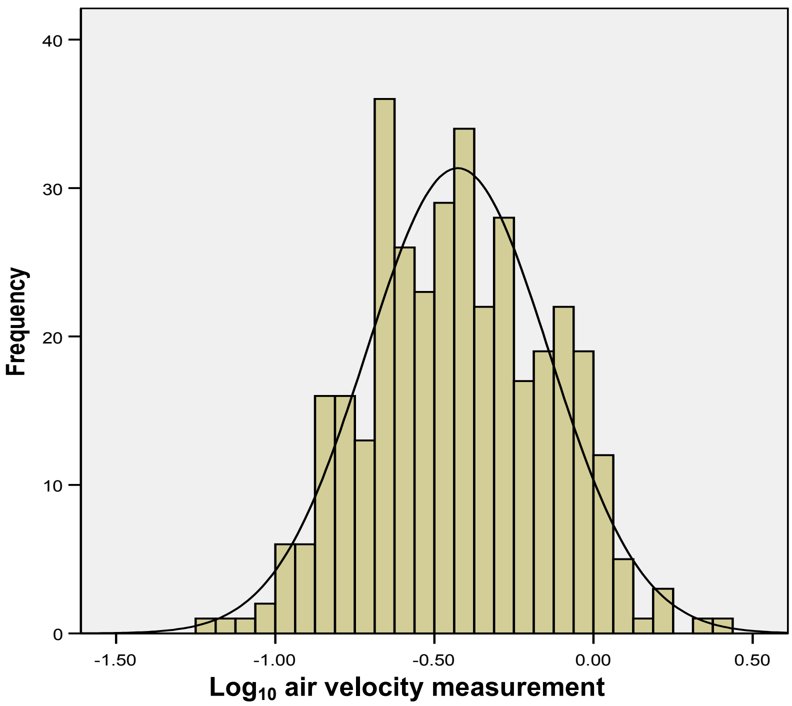
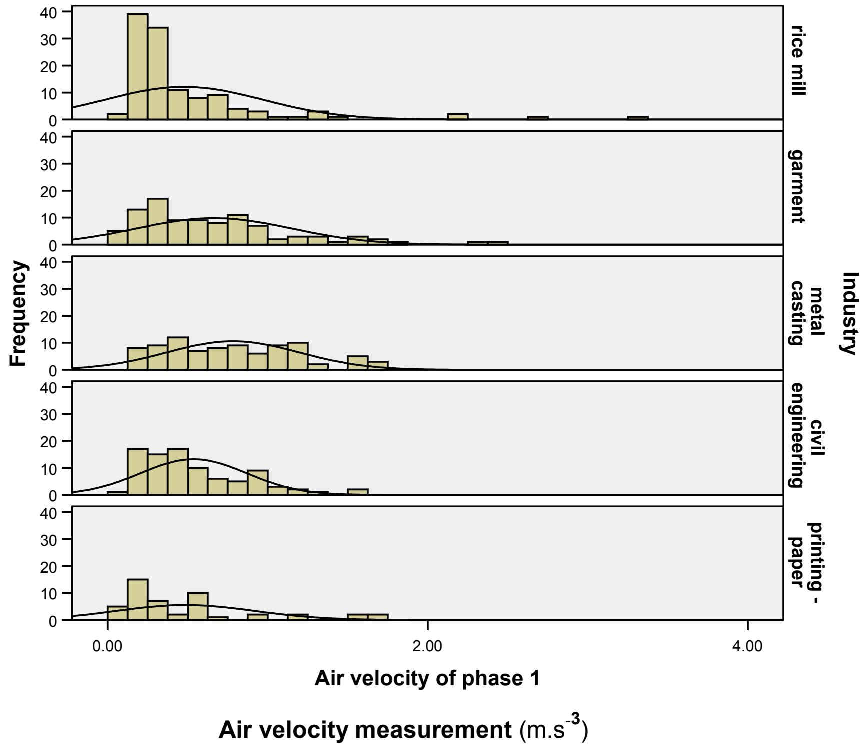
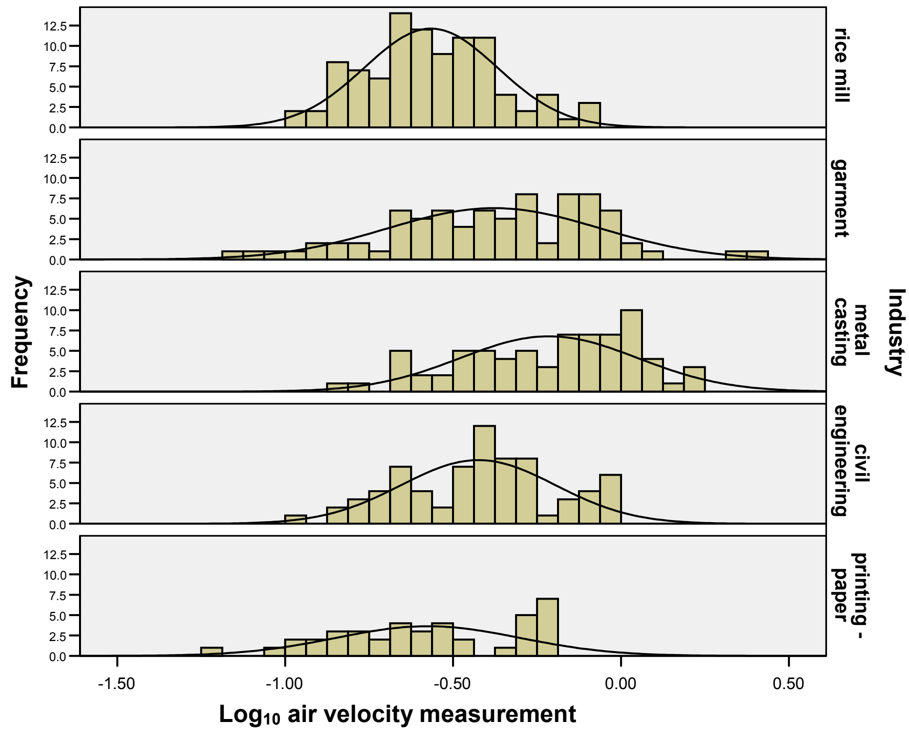


Figure 30. Frequency distribution of inside air velocity measurement, phase I - in five industries

a. Unadjusted data



b. Log_{10} (air velocity measurement)



6.2 Comparison pre-intervention (phase I) and post-intervention (phase II) *data*

6.2.1 Follow-up visits and improvement collection

A large number of photographs were taken at the factories both at the pre-intervention phase and at the quarterly factory visits. A small selection is shown in Appendix 48.

6.2.2 Work environment changes

6.2.2.1 Personal dust samples

Measurements of personal dust are summarised in Table 15 for the five industries under study and for all industries combined. 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 these two phases. Statistically significant reductions in personal dust levels were shown for all industries combined (ratio of GM 0.90, 95% CI 0.83 to 0.96), and for the garment industry (ratio of GM 0.77, 95% CI 0.67 to 0.88).

Measurements of personal dust are summarised in Table 16 for the five industries under study and for all industries combined, both for the intervention group and for the control group. 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 these two phases.

Table 15. Comparison of personal dust measurements: phase 1 and phase 2

Industry	Geometric mean ($mg.m^{-3}$)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Printing & paper container	0.93	0.70	1.77	1.27	0.76	0.58 to 1.01	18	0.06
Civil engineering	1.08	1.03	2.37	1.93	0.95	0.86 to 1.06	36	0.34
Metal casting	0.68	0.63	2.10	1.76	0.94	0.79 to 1.11	36	0.43
Garment	0.64	0.49	1.81	2.01	0.77***	0.67 to 0.88	36	<0.001
Rice mill	1.12	1.10	2.44	2.17	0.98	0.83 to 1.15	54	0.80
Total	0.88	0.79	2.24	2.07	0.90**	0.83 to 0.96	180	<0.01

** p<0.01, *** p<0.001

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 16. Comparison of personal dust measurements between intervention and control groups: phase 1 and phase

Industry	Geometric mean ($mg.m^{-3}$)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure -ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Label printing & paper container	0.83	0.60	2.10	1.24	0.72	0.40 to 1.31	9	0.24
Civil engineering	2.05	1.62	1.98	1.79	0.79**	0.68 to 0.91	18	<0.01
Metal casting	0.99	0.67	1.93	1.80	0.68***	0.56 to 0.82	18	<0.001
Garment	0.53	0.34	1.95	2.05	0.65***	0.52 to 0.81	18	<0.001
Rice mill	1.70	1.11	1.89	1.98	0.65***	0.55 to 0.77	27	<0.001
Total	1.17	0.80	2.28	2.26	0.69***	0.63 to 0.76	90	<0.001
Control group								
Label printing & paper container	1.03	0.83	1.42	1.13	0.80*	0.65 to 0.99	9	0.04
Civil engineering	0.54	0.66	1.59	1.43	1.15**	1.04 to 1.25	18	<0.01
Metal casting	0.46	0.60	1.88	1.73	1.29*	1.06 to 1.57	18	0.02
Garment	0.78	0.71	1.55	1.57	0.91	0.80 to 1.03	18	0.12
Rice mill	0.74	1.08	2.51	2.38	1.47***	1.22 to 1.76	27	<0.001
Total	0.67	0.78	1.99	1.88	1.16***	1.07 to 1.27	90	<0.001

* p<0.05, ** p<0.01, *** p<0.001

a. Pre-intervention

b. Post-intervention

c. Post-intervention / pre-intervention

For the intervention group, statistically significant reductions in dust levels were shown for all industries combined (ratio of GM 0.69, 95% CI 0.63 to 0.76), for the civil engineering industry (ratio of GM 0.79, 95% CI 0.68 to 0.91), for the metal casting industry (ratio of GM 0.68, 95% CI 0.56 to 0.82), for the garment industry (ratio of GM 0.65, 95% CI 0.52 to 0.81), and for the rice mill industry (ratio of GM 0.65, 95% CI 0.55 to 0.77).

For the control group, there was a statistically significant reduction in dust levels for the printing industry (ratio of GM 0.80, 95% CI 0.65 to 0.99). Statistically significant increase in dust exposures were shown for all industries combined (ratio of GM 1.16, 95% CI 1.07 to 1.27), for civil engineering (ratio of GM 1.15, 95% CI 1.04 to 1.25), for metal casting (ratio of GM 1.29, 95% CI 1.06 to 1.57) and for the rice mill industry (ratio of GM 1.47, 95% CI 1.22 to 1.76).

6.2.2.2 Static dust samples

Measurements of static dust are summarised in Table 17 for the five industries under study and for all industries combined. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. The only statistically significant reduction in dust levels was that shown for the garment industry (ratio of GM 0.84, 95% CI 0.73 to 0.96), although the reduction for all industries combined approached statistical significance (ratio of GM 0.95, 95% CI 0.89 to 1.01).

Table 17. Comparison of static dust measurements: phase 1 and phase 2

Industry	Geometric mean ($mg.m^{-3}$)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure -ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Printing & paper container	0.56	0.49	1.71	1.70	0.87	0.71 to 1.06	20	0.16
Civil engineering	0.80	0.78	2.34	1.95	0.98	0.87 to 1.09	36	0.66
Metal casting	0.46	0.47	2.50	2.27	1.03	0.89 to 1.19	36	0.69
Garment	0.42	0.35	1.70	1.89	0.84	0.73 to 0.96	40	0.01
Rice mill	1.08	1.09	2.30	1.94	1.01	0.86 to 1.18	48	0.93
Total	0.65	0.61	2.34	2.23	0.95	0.89 to 1.01	180	0.12

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Measurements of static dust are summarised in Table 18 for the five industries under study and for all industries combined, both for the intervention group and for the control group. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, statistically significant reductions in the dust levels were shown for all industries combined (ratio of GM 0.75, 95% CI 0.69 to 0.81), for civil engineering (ratio of GM 0.84, 95% CI 0.72 to 0.97), for metal casting (ratio of GM 0.81, 95% CI 0.71 to 0.93), for the garment industry (ratio of GM 0.71, 95% CI 0.57 to 0.88), and for the rice mill industry (ratio of GM 0.68, 95% CI 0.57 to 0.82). For the control group, there were no statistically significant reductions in dust levels. Significant increase in dust exposure were shown, however, for all industries combined (ratio of GM 1.21, 95% CI 1.12 to 1.30), for metal casting (ratio of GM 1.30, 95% CI 1.05 to 1.62), and for the rice-mill industry (ratio of GM 1.48, 95% CI 1.28 to 1.72).

6.2.2.3 Toxic gas measurements

Measurements of carbon monoxide levels are summarised in Table 19 for the metal casting and the printing industry, both for the intervention group and for the control group. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, there were no statistically significant changes in carbon monoxide levels. For the control group, statistically significant decreases were shown for both industries combined (ratio of GM 0.95, 95% CI 0.93 to 0.98), and for the metal casting industry (ratio of GM 0.95, 95% CI 0.90 to 0.99).

Table 18. Comparison of static dust measurements between intervention and control groups: phase 1 and phase 2.

Industry	Geometric mean ($mg.m^{-3}$)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure -ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Label printing & paper container	0.53	0.38	1.68	1.55	0.73	0.50 to 1.05	10	0.08
Civil engineering	1.28	1.07	1.93	1.93	0.84*	0.72 to 0.97	18	0.02
Metal casting	0.59	0.48	2.52	2.52	0.81**	0.71 to 0.93	18	<0.01
Garment	0.32	0.23	1.57	1.57	0.71**	0.57 to 0.88	20	<0.01
Rice mill	1.57	1.07	1.78	1.78	0.68***	0.57 to 0.82	24	<0.001
Total	0.77	0.58	2.59	2.44	0.75***	0.69 to 0.81	90	<0.001
Control group								
Label printing & paper container	0.59	0.62	1.77	1.70	1.04	0.88 to 1.23	10	0.63
Civil engineering	0.50	0.57	1.93	1.70	1.14	0.99 to 1.31	18	0.07
Metal casting	0.35	0.46	2.09	2.10	1.30*	1.05 to 1.62	18	0.02
Garment	0.56	0.55	1.50	1.59	0.99	0.86 to 1.16	20	0.94
Rice mill	0.74	1.10	2.26	2.13	1.48***	1.28 to 1.72	24	<0.001
Total	0.54	0.65	2.02	2.01	1.21***	1.12 to 1.30	90	<0.001

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 19. Comparison of carbon monoxide measurements between intervention and control groups: phase 1 and phase 2

Industry	Geometric mean ($mg.m^{-3}$)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Metal casting	14.3	6.7	1.28	2.25	0.47	0.16 to 1.37	4	0.11
Label printing & paper container	10.8	10.1	1.16	1.15	0.94	0.86 to 1.01	2	0.06
Total	13.0	7.7	1.28	1.95	0.59	0.31 to 1.14	6	0.10
Control group								
Metal casting	17.8	16.9	1.31	1.31	0.95*	0.90 to 0.99	4	0.04
Label printing & paper container	11.4	11.0	1.15	1.13	0.97	0.83 to 1.13	2	0.22
Total	15.4	14.6	1.37	1.36	0.95*	0.93 to 0.98	6	0.01

* $p<0.05$

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Measurements of carbon dioxide levels are summarised in Table 20 for the metal casting and garment industries, both for the intervention group and for the control group. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, a statistically significant decrease in carbon dioxide levels was shown for the garment industry (ratio of GM 0.93, 95% CI 0.89 to 0.97). For the control group, statistically significant decreases were shown for both industries combined (ratio of GM 0.96, 95% CI 0.95 to 0.98), and for the garment industry (ratio of GM 0.96, 95% CI 0.95 to 0.98).

6.2.2.4 The noise levels

Measurements of noise levels are summarised in Table 21 for the five industries under study and for all industries combined. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. There was no statistical significant change in noise exposure shown for any of the five industries under study. Measurements of noise levels are summarised in Table 22 for the five industries under study and for all industries combined, both for the intervention group and for the control group. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, statistically significant decrease in noise levels were shown for all industries combined (ratio of GM 0.98, 95% CI 0.97 to 0.99), for the printing industry (ratio of GM 0.94, 95% CI 0.91 to 0.96), for metal casting (ratio of GM 0.97, 95% CI 0.95 to 0.99), and the rice mill industry (ratio of GM 0.99, 95% CI 0.99 to 0.99).

Table 20. Comparison of carbon dioxide measurements between intervention and control groups: phase 1 and phase 2.

Industry	Geometric mean ($mg.m^{-3}$)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Metal casting	4315.2	1962.9	1.05	2.33	0.46	0.12 to 1.70	4	0.15
Garment	2021.6	1871.1	1.16	1.19	0.93**	0.89 to 0.97	8	<0.01
Total	2602.6	1901.1	1.48	1.59	0.73	0.51 to 1.04	12	0.08
Control group								
Metal casting	4825.0	4631.3	1.17	1.21	0.96	0.91 to 1.02	4	0.11
Garment	1884.5	1817.6	1.16	1.15	0.97**	0.95 to 0.98	8	<0.01
Total	2578.1	2482.6	1.62	1.62	0.96***	0.95 to 0.98	12	<0.001

** p<0.01, *** p<0.001

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 21. Comparison of noise measurements: phase 1 and phase 2.

Industry	Geometric mean (dBA)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure -ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Label printing & paper container	77.0	77.3	1.10	1.11	1.00	0.97 to 1.04	30	0.82
Civil engineering	78.5	78.4	1.11	1.11	1.00	0.99 to 1.01	54	0.77
Metal casting	85.5	84.4	1.11	1.09	0.99	0.98 to 1.00	54	0.05
Garment	72.0	71.6	1.08	1.08	0.99	0.98 to 1.01	60	0.54
Rice mill	85.8	85.5	1.06	1.05	1.00	1.00 to 1.00	72	0.12
Total	80.0	79.7	1.12	1.11	1.00	0.99 to 1.00	270	0.18

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 22. Comparison of noise measurements between intervention and control groups: phase 1 and phase 2.

Industry	Geometric mean (dBA)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure -ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Label printing & paper container	79.7	74.7	1.07	1.11	0.94***	0.91 to 0.96	15	<0.001
Civil engineering	77.0	76.6	1.10	1.10	1.00	0.98 to 1.01	27	0.41
Metal casting	86.2	83.5	1.12	1.09	0.97**	0.95 to 0.99	27	<0.01
Garment	72.0	70.6	1.07	1.07	0.98	0.95 to 1.01	30	0.25
Rice mill	86.2	85.4	1.08	1.07	0.99***	0.99 to 0.99	36	<0.001
Total	80.3	78.6	1.12	1.11	0.98***	0.97 to 0.99	135	<0.001
Control group								
Label printing & paper container	74.3	79.9	1.11	1.11	1.10*	1.02 to 1.13	15	0.01
Civil engineering	80.0	80.2	1.11	1.11	1.00	0.99 to 1.01	27	0.67
Metal casting	84.7	85.3	1.10	1.09	1.01	0.99 to 1.02	27	0.35
Garment	72.1	72.7	1.09	1.10	1.01**	1.00 to 1.01	30	<0.01
Rice mill	85.3	85.7	1.03	1.03	1.00	1.00 to 1.01	36	0.09
Total	79.8	80.8	1.12	1.11	1.01**	1.01 to 1.02	135	<0.01

** p<0.01, *** p<0.001

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

For the control group, statistically significant increases in noise levels were shown for all industries combined (ratio of GM 1.01, 95% CI 1.01 to 1.02), for the printing industry (ratio of GM 1.10, 95% CI 1.02 to 1.13), and for the garment industry (ratio of GM 1.01, 95% CI 1.00 to 1.01).

6.2.2.5 Lighting samples

Measurements of lighting levels are summarised in Table 23 for the five industries under study and for all industries combined. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. Statistically significant increases in lighting levels were shown for all industries combined (ratio of GM 1.25, 95% CI 1.18 to 1.32), for civil engineering (ratio of GM 1.15, 95% CI 0.1.09 to 1.21), for metal casting (ratio of GM 1.23, 95% CI 0.1.13 to 1.34) and for the rice-mill industry (ratio of GM 1.65, 95% CI 1.42 to 1.92). Measurements of lighting levels are summarised in Table 24 for the five industries under study and for all industries combined, both for the intervention group and for the control group. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, statistically significant increases in lighting levels are shown for all industries combined (ratio of GM 1.44, 95% CI 1.32 to 1.58), for the civil engineering industry (ratio of GM 1.15, 95% CI 1.07 to 1.23), for the metal casting industry (ratio of GM 1.31, 95% CI 1.17 to 1.47), and for the rice mill industry (ratio of GM 2.68, 95% CI 2.10 to 3.42).

Table 23. Comparison of lighting measurements: phase 1 and phase 2.

Industry	Geometric mean (Lux)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Label printing & paper container	162.3	193.3	1.79	1.92	1.19	0.99 to 1.43	50	0.06
Civil engineering	309.5	356.0	2.53	1.29	1.15***	1.09 to 1.21	90	<0.001
Metal casting	328.3	403.6	2.87	1.50	1.23***	1.13 to 1.34	90	<0.001
Garment	580.1	576.9	1.53	1.44	0.99	0.93 to 1.07	100	0.88
Rice mill	132.2	218.3	2.74	2.33	1.65***	1.42 to 1.92	120	<0.001
Total	267.1	333.3	2.78	1.80	1.25***	1.18 to 1.32	450	<0.001

*** p<0.001.

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 24. Comparison of lighting measurements between intervention and control groups: phase 1 and phase 2

Industry	Geometric mean (Lux)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Label printing & paper container	195.4	193.2	1.84	1.66	0.99	0.80 to 1.22	25	0.92
Civil engineering	402.5	461.6	2.79	1.26	1.15***	1.07 to 1.23	45	<0.001
Metal casting	288.7	378.9	2.48	1.46	1.31***	1.17 to 1.47	45	<0.001
Garment	539.1	598.4	1.53	1.50	1.11	0.99 to 1.25	50	0.07
Rice mill	81.0	216.8	2.50	2.58	2.68***	2.10 to 3.42	60	<0.001
Total	241.8	348.9	2.99	2.01	1.44***	1.32 to 1.58	225	<0.001
Control group								
Label printing & paper container	134.8	193.0	1.64	2.08	1.43*	1.06 to 1.94	25	0.02
Civil engineering	237.9	274.5	2.09	1.33	1.15**	1.06 to 1.26	45	<0.01
Metal casting	373.3	429.8	3.25	1.54	1.15*	1.01 to 1.31	45	0.03
Garment	624.2	556.2	1.52	1.32	0.89**	0.82 to 0.96	50	<0.01
Rice mill	215.8	219.8	2.35	1.29	1.02	0.95 to 1.09	60	0.58
Total	259.1	318.4	2.55	1.50	1.08**	1.02 to 1.14	225	<0.01

* p<0.05, ** p<0.01, *** p<0.001.

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

For the control group, statistically significant increases in lighting were shown for all industries combined (ratio of GM 1.08, 95% CI 1.02 to 1.14), for the printing industry (ratio of GM 1.43, 95% CI 1.06 to 1.94), for civil engineering (ratio of GM 1.15, 95% CI 1.06 to 1.26), and for metal casting (ratio of GM 1.15, 95% CI 1.01 to 1.31). A statistically significant decrease in lighting levels was shown for the garment industry (ratio of GM 0.89, 95% CI 0.82 to 0.96).

6.2.2.6 Air temperature

Measurements of external temperature are summarised in Table 25 for the five industries under study and for all industries combined. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. There was no statistically significant change of external temperature shown between the two study phases for all industries combined or for any of the five industries under study.

Pre- and post-intervention measurements of inside air temperature were available for a total of 360 workplaces. Because the air temperature might be unacceptably high or unacceptably low, the two measurements were classified under one of four headings: both acceptable, both unacceptable, change to acceptable temperature and change to unacceptable temperature. Air temperature measurements are summarised in Table 26 for the five industries under study and for all industries combined, both for the intervention group and for the control group. For the intervention group, significant improvements are shown for all industries combined, for metal casting, and for the garment industry. For the control group, significant improvements are shown for all industries combined, for the garment industry and for the rice-mill industry.

Table 25. Comparison of external temperature: phase 1 and phase 2.

Industry	Geometric mean (°C)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Label printing & paper container	31.5	31.8	1.07	1.07	1.01	1.00 to 1.03	8	0.09
Civil engineering	1.07	1.08	30.9	31.0	1.00	0.98 to 1.01	16	0.50
Metal casting	30.7	30.2	1.07	1.05	0.99	0.97 to 1.01	16	0.13
Garment	31.2	31.1	1.06	1.10	1.00	0.99 to 1.01	16	0.71
Rice mill	31.4	31.4	1.07	1.05	1.00	0.99 to 1.01	24	0.79
Total	31.1	31.0	1.07	1.07	1.00	0.99 to 1.00	80	0.43

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 26. Comparison of pre- and post-intervention air temperature: intervention and control groups.

Industry	Paired (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						
Printing & paper container	20	0	17	0	3	0.25
Civil engineering	36	11	23	1	1	1.00
Metal casting	36	13	8	14	1	<0.001
Garment	40	14	10	16	0	<0.001
Rice mill	48	20	21	1	6	0.13
All industries combined	180	58	79	32	11	<0.01
Control group						
Printing & paper container	20	10	9	0	1	-
Civil engineering	36	26	6	2	2	1.00
Metal casting	36	26	7	0	3	0.25
Garment	40	14	10	16	0	<0.001
Rice mill	48	7	32	9	0	<0.01
All industries combined	180	83	64	27	6	<0.001
Total	360	141	143	59	17	<0.001

a. Number of work places with pre- and post-intervention measurement of temperature

b. Pre- and post-intervention work places with temperature in acceptable ranges of 16-32°C or 16-37°C in casting operation.

c. Neither pre-intervention nor post-intervention work places with temperature in acceptable ranges.

d. Pre-intervention work place temperatures were unacceptable and post-intervention work place temperatures were acceptable.

e. Pre-intervention work place temperatures were acceptable and post-intervention work place temperatures 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, test is equivalent to McNemar χ^2 when $n \geq 10$.

6.2.2.7 Air humidity

Measurement of external humidity are summarised in Table 27 for the five industries under study and for all industries combined. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. Statistically significant increases of external humidity measurements were shown for all industries combined (ratio of GM 1.02, 95% CI 1.00 to 1.05), and for the rice mill industry (ratio of GM 1.08, 95% CI 1.04 to 1.12).

Pre- and post-intervention measurements of inside air humidity were available for a total of 360 workplaces. Because the air humidity might be unacceptably high or unacceptably low, the two measurements were classified under one of four headings: both acceptable, both unacceptable, change to acceptable humidity and change to unacceptable humidity. Air humidity measurements are summarised in Table 28 for the five industries under study and for all industries combined, both for the intervention group and for the control group. For the intervention group, significant improvements are shown for all industries combined, and for the rice-mill industry. For the control group, significant improvements are shown for all industries combined and for the civil engineering and garment industry.

6.2.2.8 Air velocity

Measurement of external air velocity are summarised in Table 29 for the five industries under study and for all industries combined. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. A statistically significant increase of external air velocity measurements was shown for the garment industry

Table 27. Comparison of external air humidity measurements: phase 1 and phase 2.

Industry	Geometric mean (H%)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure -ment (n)	p-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Label printing & paper container	68.3	68.9	1.11	1.04	1.01	0.91 to 1.12	8	0.83
Civil engineering	67.7	70.0	1.10	1.03	1.03	0.99 to 1.08	16	0.11
Metal casting	72.5	71.0	1.08	1.05	0.98	0.96 to 1.00	16	0.10
Garment	68.0	67.3	1.11	1.08	0.99	0.92 to 1.07	16	0.77
Rice mill	64.7	69.7	1.15	1.06	1.08**	1.04 to 1.12	24	<0.01
Total	67.8	69.5	1.12	1.06	1.02*	1.00 to 1.05	80	0.04

* p<0.05, ** p<0.01.

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

Table 28. Comparison of pre- and post-intervention air humidity: intervention and control groups.

Industry	Paired (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						
Printing & paper container	20	19	0	1	0	-
Civil engineering	36	35	0	1	0	-
Metal casting	36	36	0	0	0	-
Garment	40	40	0	0	0	-
Rice mill	48	30	5	12	1	<0.01
All industries combined	180	160	5	14	1	<0.001
Control group						
Printing & paper container	20	8	7	5	0	0.06
Civil engineering	36	27	3	6	0	0.03
Metal casting	36	31	0	2	3	1.00
Garment	40	27	3	10	0	<0.001
Rice mill	48	37	5	1	5	0.22
All industries combined	180	130	18	24	8	<0.01
Total	360	290	23	38	9	<0.001

a. Number of work places with pre- and post-intervention measurement of relative humidity.

b. Pre- and post-intervention work places with relative humidity in acceptable ranges of 75%-85%.

c. Neither pre-intervention nor post-intervention work places with humidity in acceptable ranges.

d. Pre-intervention work place humidity were unacceptable and post-intervention work place humidity were acceptable.

e. Pre-intervention work place humidity were acceptable and post-intervention work place humidity 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, test is equivalent to McNemar χ^2 when $n \geq 10$.

Table 29. Comparison of external air velocity measurements: phase 1 and phase 2.

Industry	Geometric mean (H%)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired measure-ment (n)	p-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Label printing & paper container	1.29	1.13	1.30	1.21	0.88	0.74 to 1.05	8	0.13
Civil engineering	0.97	1.02	1.40	1.27	1.05	0.92 to 1.20	16	0.43
Metal casting	0.96	0.92	1.68	1.36	0.96	0.83 to 1.11	16	0.53
Garment	1.26	1.47	1.31	1.50	1.16*	1.01 to 1.34	16	0.04
Rice mill	1.02	1.15	1.68	1.56	1.13	0.90 to 1.42	24	0.27
Total	1.06	1.13	1.54	1.46	1.06	0.97 to 1.15	80	0.19

* $p<0.05$.

a. Pre-intervention
b. Post-intervention
c. Post-intervention / pre-intervention

(ratio of GM 1.16, 95% CI 1.00 to 1.34). Pre- and post-intervention measurements of inside air velocity were available for a total of 360 workplaces. Because the air velocity might be unacceptably high or unacceptably low, the two measurements were classified under one of four headings: both acceptable, both unacceptable, change to acceptable velocity and change to unacceptable velocity. Air velocity measurements are summarised in Table 30 for the five industries under study and for all industries combined, both for the intervention group and for the control group. For the intervention group, there were no significant changes in air velocity shown for all industries combined, or for any of the five industries under study. For the control group, significant worsening of condition is shown for all industries combined and for the metal casting industry.

6.2.3 Factory monthly reports

6.2.3.1 Accident rates and its results

Observed and expected numbers of reported accidents at work are shown in Table 31 by month of observation for the intervention and control groups. Overall, there were significantly fewer accidents in the intervention group ($p<0.001$). The illustration between two groups in Figure 31 showed a higher number of accidents at work for control group (black line) than in intervention group (red line).

Observed and expected numbers of reported accidents leading to absence from work are shown in Table 32 by month of observation for the intervention and control groups. Overall, there were significantly fewer accidents leading to absence from work in the intervention group ($p<0.001$). The illustration between two groups in Figure 32 showed a higher number of accidents leading to absence from work for control group (black line) than in intervention group (red line).

Table 30. Comparison of pre- and post-intervention air velocity: intervention and control group.

Industry	Paired (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						
Printing & paper container	20	0	19	0	1	-
Civil engineering	36	2	29	2	3	1.00
Metal casting	36	7	20	5	4	1.00
Garment	40	9	24	5	2	0.45
Rice mill	48	10	30	2	6	0.29
All industries combined	180	28	122	14	16	0.86
Control group						
Printing & paper container	20	0	20	0	0	-
Civil engineering	36	0	36	0	0	-
Metal casting	36	4	18	0	14	<0.001
Garment	40	0	34	3	3	1.00
Rice mill	48	0	48	0	0	-
All industries combined	180	7	156	3	14	0.01
Total	360	35	278	17	30	0.08

a. Number of work places with pre- and post-intervention measurement of air velocity.

b. Pre- and post-intervention work places with air velocity in acceptable ranges of 0.2 – 1.5 $m.s^{-3}$.

c. Neither pre-intervention nor post-intervention work places with air velocity in acceptable ranges.

d. Pre-intervention work place air velocities were unacceptable and post-intervention work place air velocities were acceptable.

e. Pre-intervention work place air velocities were acceptable and post-intervention work place air velocities 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, test is equivalent to McNemar χ^2 when $n \geq 10$.

Table 31. Accident reports: control and intervention groups.

Month of observation	Control group			Intervention group			Total	
	Accident cases		Number of workers	Accident cases		Number of workers	Accident cases	Number of workers
	Observed	Expected [a]		Observed	Expected [a]			
1	142	137.5	1757	137	141.5	1809	279	3566
2	131	112.9	1745	99	117.1	1809	230	3554
3	129	105.0	1745	85	109.0	1812	214	3557
4	134	108.7	1726	89	114.3	1816	223	3542
5	125	101.2	1718	83	106.8	1814	208	3532
6	128	96.4	1734	69	100.6	1810	197	3544
7	111	86.9	1669	67	91.1	1749	178	3418
8	84	65.5	1667	50	68.5	1744	134	3411
9	85	66.7	1654	52	70.3	1743	137	3397
10	100	82.5	1721	69	86.5	1805	169	3526
11	127	96.1	1714	70	100.9	1800	197	3514
12	118	94.6	1709	76	99.4	1794	194	3503
Total	1414	1153.5	20,559	946	1206.5	21,505	2360	42,064

$\chi^2_{(1)} = 115.1$ $p<0.001$, from Mantel Haenszel test

a. Assuming accident rates in total population (control and intervention groups combined) were present in each of the two groups.

Table 32. Accidents leading to absence from work: control and intervention groups

Month of observation	Control group			Intervention group			Total	
	Accident cases [a]		Number of workers	Accident cases [a]		Number of workers	Accident cases [a]	Number of workers
	Observed	Expected [b]		Observed	Expected [b]			
1	51	47.8	1757	46	49.2	1809	97	3566
2	45	38.8	1745	34	40.2	1809	79	3554
3	42	37.3	1745	34	38.7	1812	76	3557
4	49	39.0	1726	31	41.0	1816	80	3542
5	48	35.5	1718	25	37.5	1814	73	3532
6	44	32.8	1734	23	34.2	1810	67	3544
7	37	28.3	1669	21	29.7	1749	58	3418
8	27	21.5	1667	17	22.5	1744	44	3411
9	30	20.9	1654	13	22.1	1743	43	3397
10	34	25.9	1721	19	27.1	1805	53	3526
11	35	24.9	1714	16	26.1	1800	51	3514
12	38	29.3	1709	22	30.7	1794	60	3503
Total	480	381.7	20,559	301	399.3	21,505	781	42,064

$\chi^2_{(1)}$= 49.44 p<0.001, from Mantel Haenszel test

a. Accidents leading to absence from work
b. Assuming accident rates in total population (control and intervention groups combined) were present in each of the two groups

Figure 31. The accident rate per 1000 person days in control and intervention groups

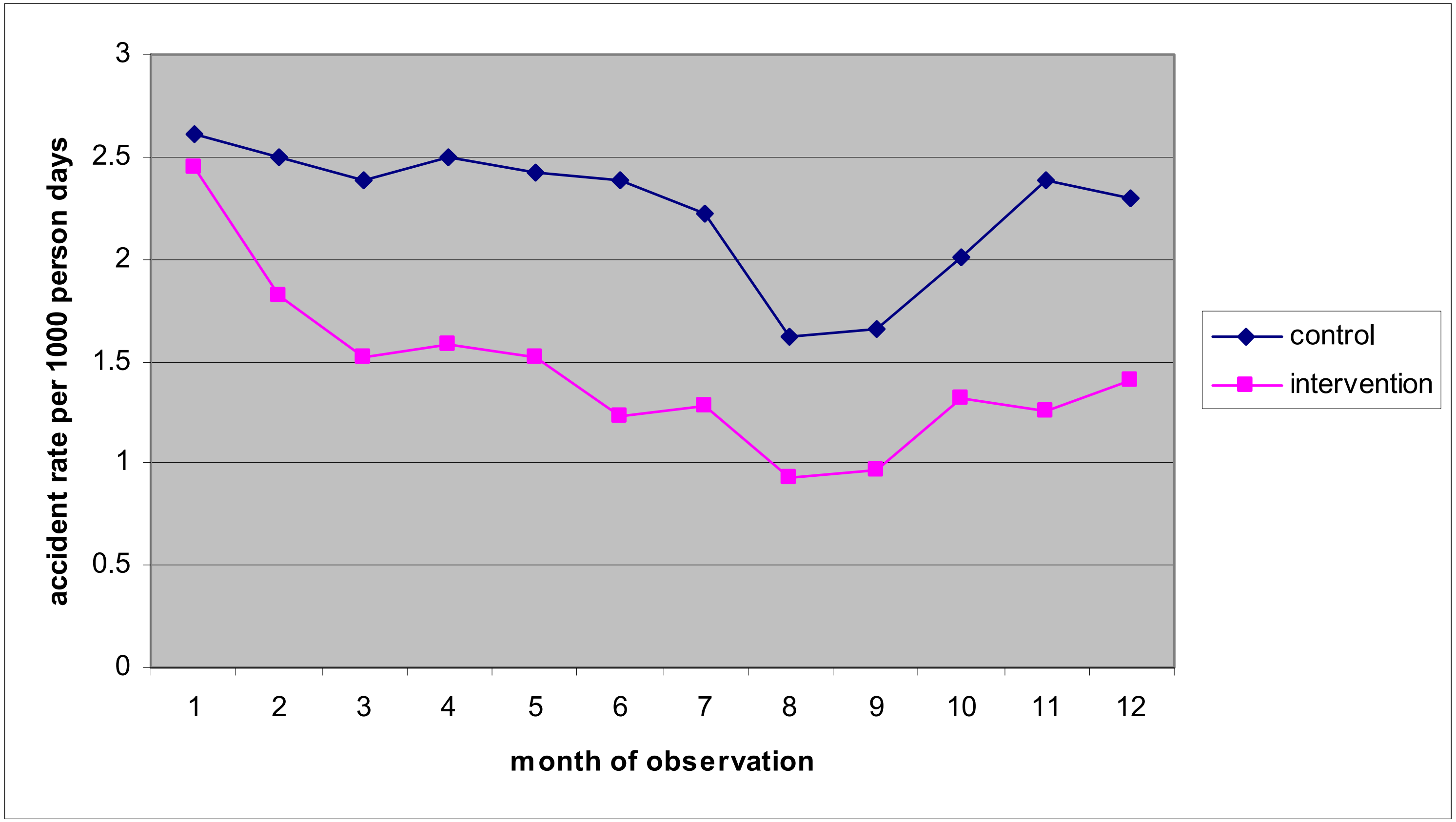
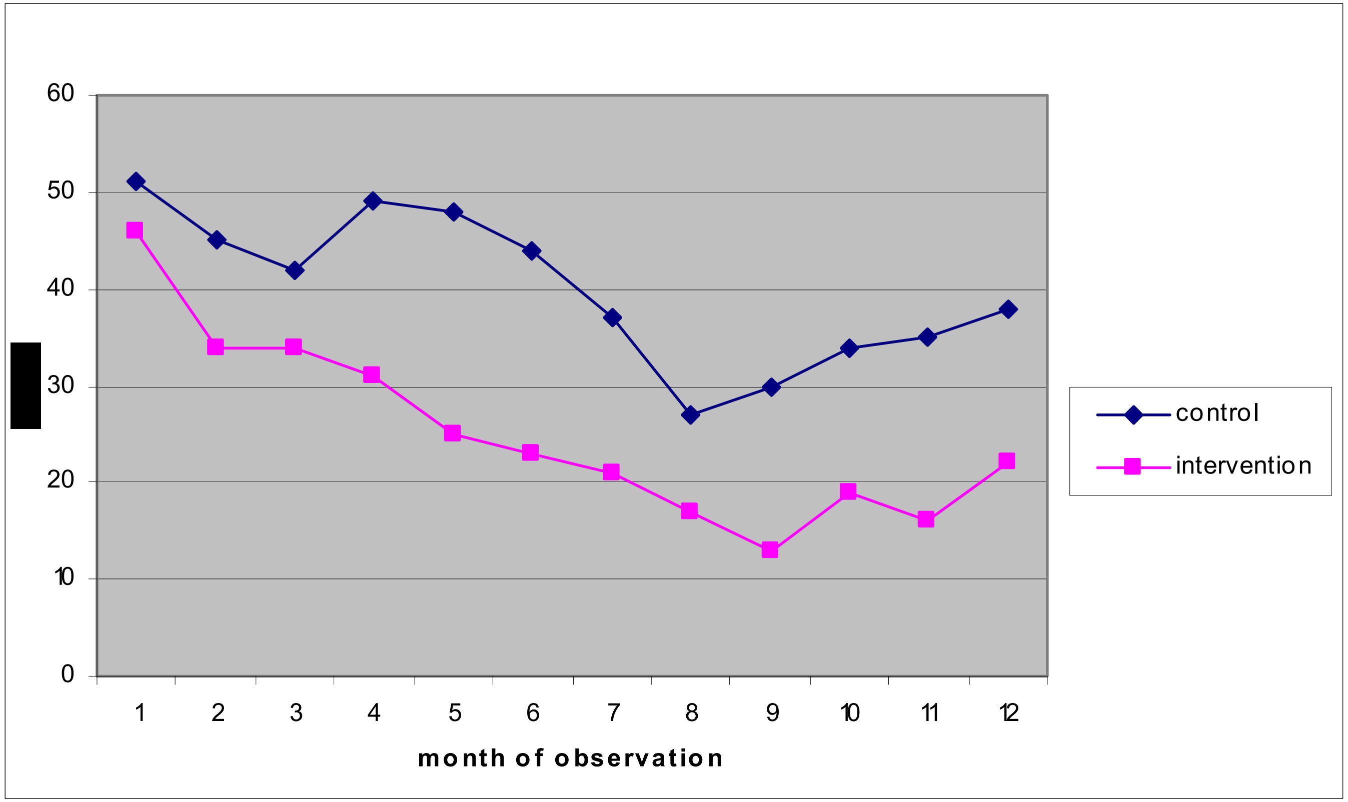


Figure 32. Accidents leading to absence from work in control and intervention groups



Observed and expected numbers of reported days of absence due to accidents are shown in Table 33 by month of observation for the intervention and control groups. Overall, there were fewer days of absence due to accidents in the intervention group. A value of χ^2 has not been calculated as the units of measurement (days) is arbitrary. The illustration between two groups in Figure 33 showed a comparison between two groups. The intervention group had higher number of report days of absence due to accidents (red line) in the first two month under study. However, it was decreasing and kept lower number than control group (black line) at the end.

6.2.3.2 Workers' health visits

Observed and expected numbers of reported worker health visits are shown in Table 34 by month of observation for the intervention and control groups. Overall, there were significantly fewer worker health visits in the intervention group ($p<0.001$). The illustration between two groups in Figure 34 showed a higher number of health visits for control group (black line) than in intervention group (red line).

6.2.3.3 Health costs

Observed and expected health costs are shown in Table 35 by month of observation for the intervention and control groups. Overall, there were lower health costs in the intervention group, comprising cost of treatments, transportation, and gifts provided to patients during sickness. A value of χ^2 has not been calculated as the unit of measurement (Vietnamese currency) is arbitrary. The illustration in Figure 35 showed a comparison between two groups. The intervention group had higher health costs (red line) in the first two month under study. However, it was decreasing and kept lower number than control group (black line) at the end.

Table 33. Days of absence due to accidents: control and intervention groups

Month of observation	Control group			Intervention group			Total	
	Number of days absent		Number of workers	Number of days absent		Number of workers	Number of day-off	Number of workers
	Observed	Expected [a]		Observed	Expected [a]			
1	79.5	87.0	1757	97	89.5	1809	176.5	3566
2	78.5	89.6	1745	104	92.9	1809	182.5	3554
3	68.5	66.0	1745	66	68.5	1812	134.5	3557
4	123	83.1	1726	47.5	87.4	1816	170.5	3542
5	89.5	62.5	1718	39	66.0	1814	128.5	3532
6	66.5	53.6	1734	43	55.9	1810	109.5	3544
7	48	37.1	1669	28	38.9	1749	76.0	3418
8	43.5	31.8	1667	21.5	33.2	1744	65.0	3411
9	55	33.8	1654	14.5	35.7	1743	69.5	3397
10	45.5	36.1	1721	28.5	37.9	1805	74.0	3526
11	48.5	32.7	1714	18.5	34.3	1800	67.0	3514
12	47.5	36.3	1709	27	38.2	1794	74.5	3503
Total	793.5	649.6	20,559	534.5	678.4	21,505	1328.0	42,064

a. Assuming days-off in total population (control and intervention groups combined) were present in each of the two groups

Table 34. Worker health visit reports: control and intervention groups

Month of observation	Control group			Intervention group			Total	
	Number of health visits		Number of workers	Number of health visits		Number of workers	Health visits	Number of workers
	Observed	Expected [a]		Observed	Expected [a]			
1	482	455.8	1757	443	469.2	1809	925	3566
2	433	390.8	1745	363	405.2	1809	796	3554
3	430	410.6	1745	407	426.4	1812	837	3557
4	486	430.3	1726	397	452.7	1816	883	3542
5	473	426.1	1718	403	449.9	1814	876	3532
6	491	430.6	1734	389	449.4	1810	880	3544
7	451	385.3	1669	338	403.7	1749	789	3418
8	355	319.1	1667	298	333.9	1744	653	3411
9	358	309.2	1654	277	325.8	1743	635	3397
10	441	374.4	1721	326	392.6	1805	767	3526
11	468	387.8	1714	327	407.2	1800	795	3514
12	497	420.1	1709	364	440.9	1794	861	3503
Total	5365	4739.5	20,559	4332	4957.5	21,505	9697	42,064

$\chi^2_{(1)}$= 161.2 $p<0.001$, from Mantel Haenszel test

a. Assuming health visits in total population (control and intervention groups combined) were present in each of the two groups

Table 35. Worker health cost reports in control and intervention groups

Month of observation	Control group			Intervention group			Total	
	Health cost (x1000VND)		Number of workers	Health cost (x1000VND)		Number of workers	Health cost (x1000VND)	Number of workers
	Observed	Expected [a]		Observed	Expected [a]			
1	6722	6756.0	1757	6990	6956.0	1809	13712	3566
2	5921	6838.6	1745	8007	7089.4	1809	13928	3554
3	6309	5688.3	1745	5286	5906.7	1812	11595	3557
4	10142	7493.1	1726	5235	7883.9	1816	15377	3542
5	7560	6061.2	1718	4901	6399.8	1814	12461	3532
6	5982	5390.4	1734	5035	5626.6	1810	11017	3544
7	5470	4806.8	1669	4374	5037.2	1749	9844	3418
8	4230	3945.9	1667	3844	4128.1	1744	8074	3411
9	4492	3912.7	1654	3544	4123.3	1743	8036	3397
10	5093	4394.3	1721	3910	4608.7	1805	9003	3526
11	5251	4433.3	1714	3838	4655.7	1800	9089	3514
12	5619	4824.0	1709	4269	5064.0	1794	9888	3503
Total	72,791	64,544.6	20,559	59,233	67,479.5	21,505	132,024	42,064

a. Assuming health cost per worker in total population (control and intervention groups combined) were present in each of the two groups

Figure 33. Total number of days-off from accidents in control and intervention groups

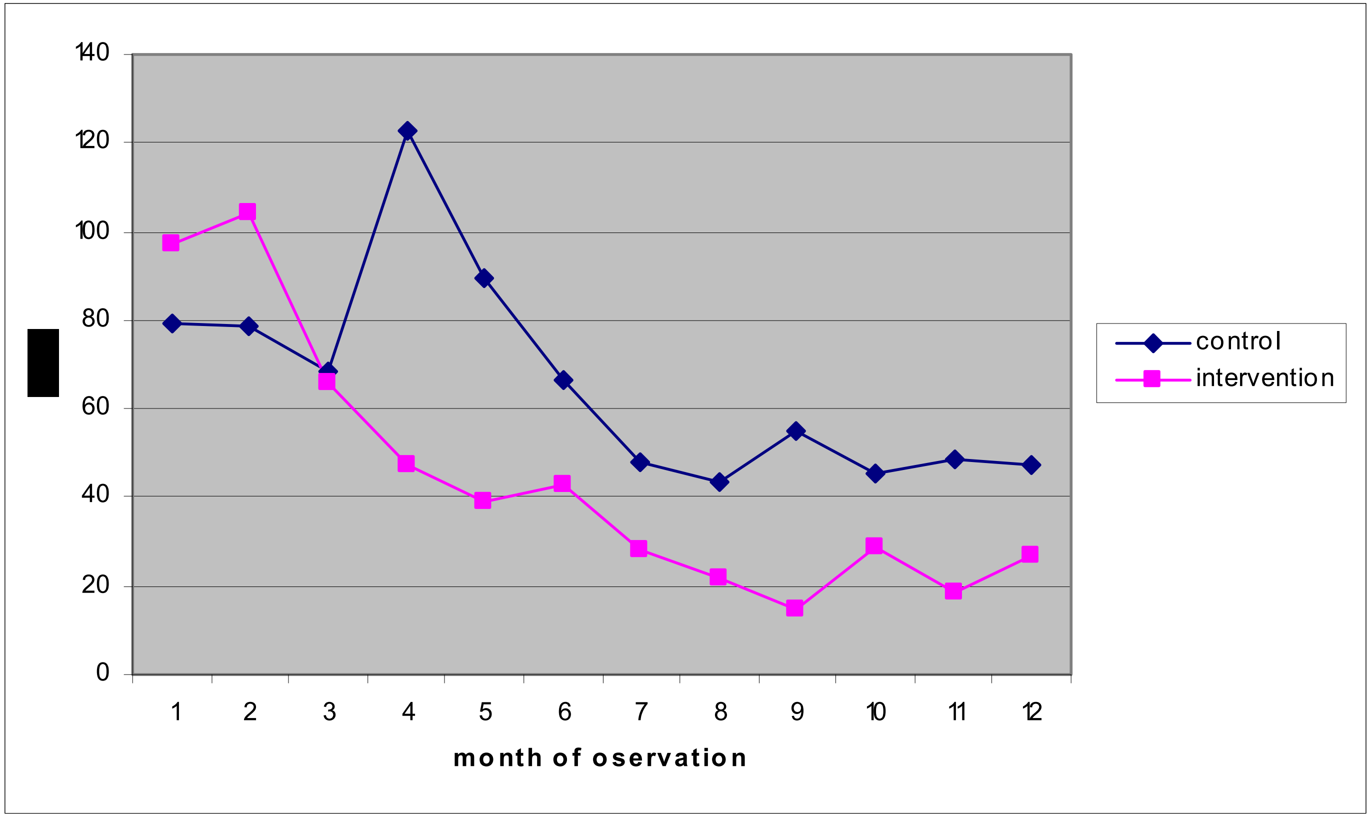


Figure 34. The total of health visits in control and intervention groups

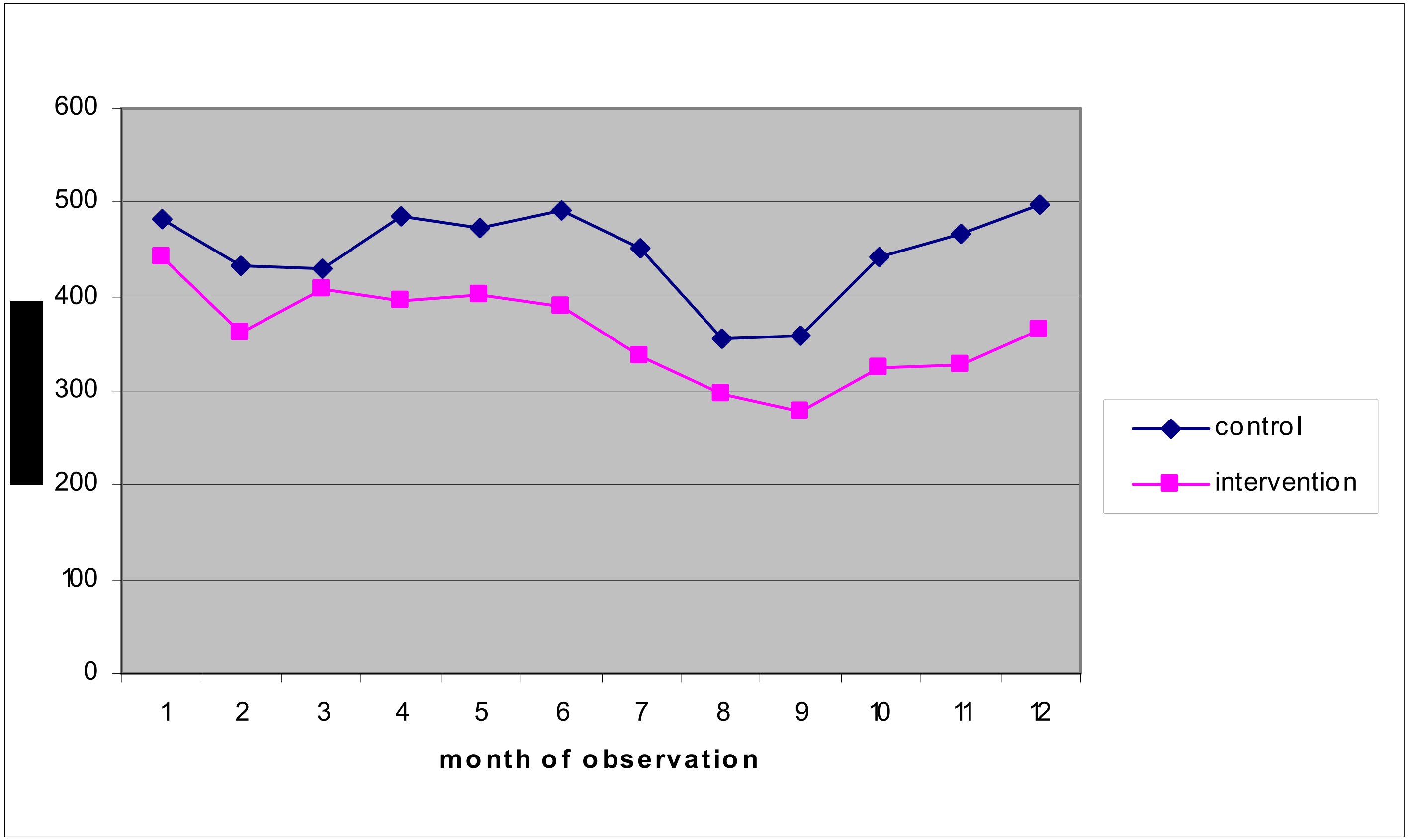
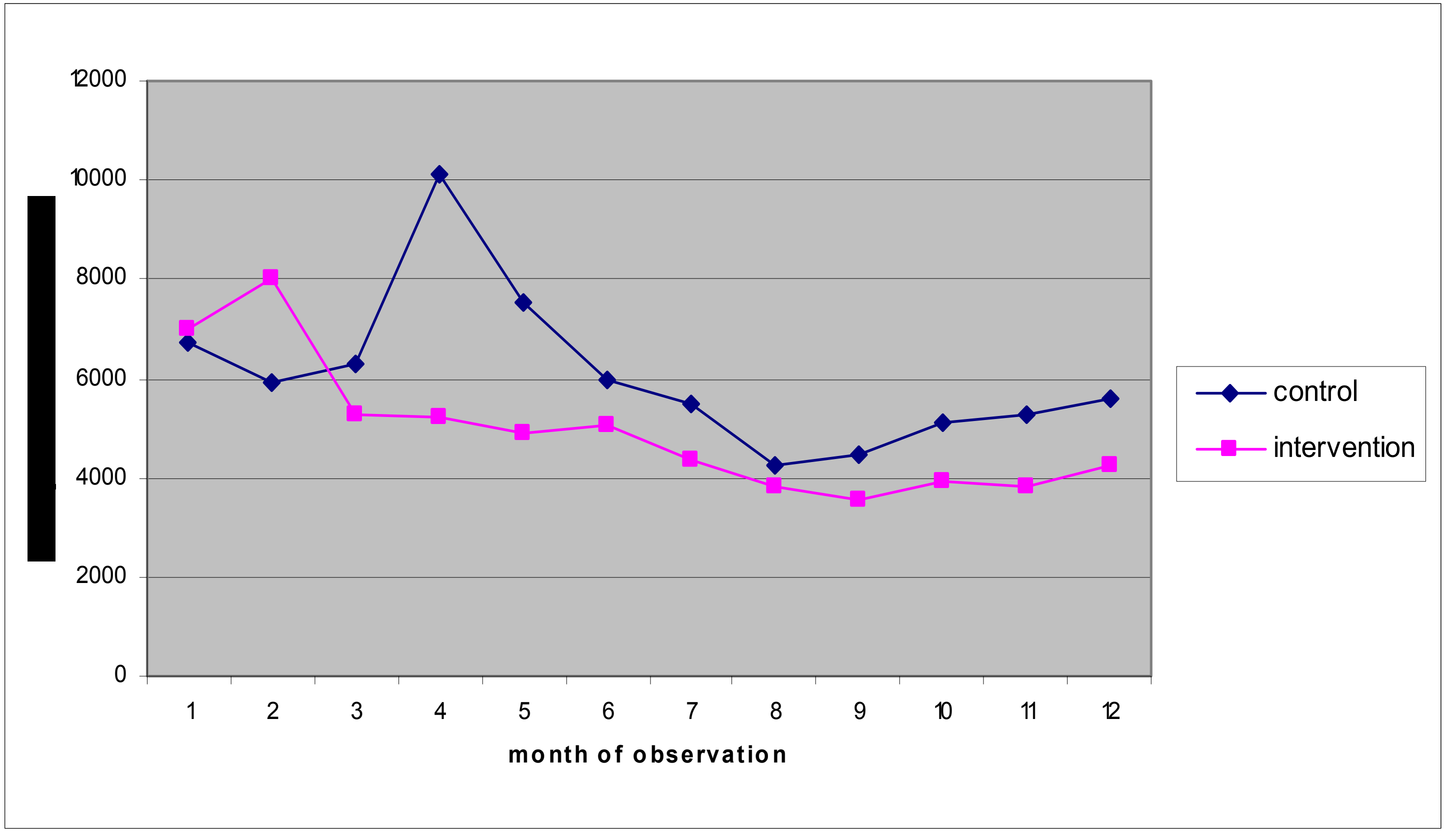


Figure 35. The total health cost between control and intervention groups



6.2.3.4 The improvement and its characteristics

The number of improvements and the number of workplaces affected by these improvements are summarised in Table 36 by industry and by study group (intervention and control). There were more improvements and more workplaces affected by those improvements in the intervention group, for each of the five industries under study. Figure 36 shows a higher total number of improvements and a higher number of workplaces affected by these improvements in the intervention group overall compared to control industries.

The number of improvements achieved from the use of recycled material and the number of workplaces affected by these improvements are summarised in Table 37 and Figure 37 by industry and by study group (intervention and control). There were more improvements by using recycled material and more workplaces affected from those improvements in the intervention group, for four of the five industries under study.

The number of zero cost improvements and the number of workplaces affected by these improvements are summarised in Table 38 and Figure 38 by industry and by study group (intervention and control). There were more zero cost improvements and more workplaces affected by those improvements in the intervention group, for each of the five industries under study.

Table 36. Number of improvements and application, by industry

Industry	Control group		Intervention group		Total	
	Number of improvements[a]	Number of applications[b]	Number of improvements[a]	Number of applications[b]	Number of improvements[a]	Number of applications[b]
Printing & paper container	10	18	14	37	24	55
Civil engineering	15	81	51	124	66	205
Metal casting	17	40	62	163	79	203
Garment	18	102	78	1,680	96	1,782
Rice mill	27	71	42	155	69	226
Total	87	312	247	2159	334	2,471

a. improvements made over twelve month period
b. a single type of improvement was often copied in a number of workplaces

Table 37. Number of improvements using recycled material.

Industry	Control group		Intervention group		Total	
	Number of improvements[a]	Number of applications[b]	Number of improvements[a]	Number of applications[b]	Number of improvements[a]	Number of applications[b]
Printing & paper container	2	7	2	7	4	14
Civil engineering	9	46	36	73	45	119
Metal casting	12	26	41	102	53	128
Garment	5	39	38	396	43	435
Rice mill	8	38	23	120	31	158
Total	36	156	140	698	176	854

a. improvements made over twelve month period
b. a single type of improvement was often copied in a number of workplaces

Table 38. Number of zero cost improvements.

Industry	Control group		Intervention group		Total	
	Number of improvements[a]	Number of applications[b]	Number of improvements[a]	Number of applications[b]	Number of improvements[a]	Number of applications[b]
Printing & paper container	1	6	1	6	2	12
Civil engineering	0	0	10	15	10	15
Metal casting	1	1	12	40	13	41
Garment	0	0	18	193	18	193
Rice mill	0	0	8	37	8	37
Total	2	7	49	291	51	298

a. improvements made over twelve month period
b. a single type of improvement was often copied in a number of workplaces

Figure 36 Number of improvements and the number of applications

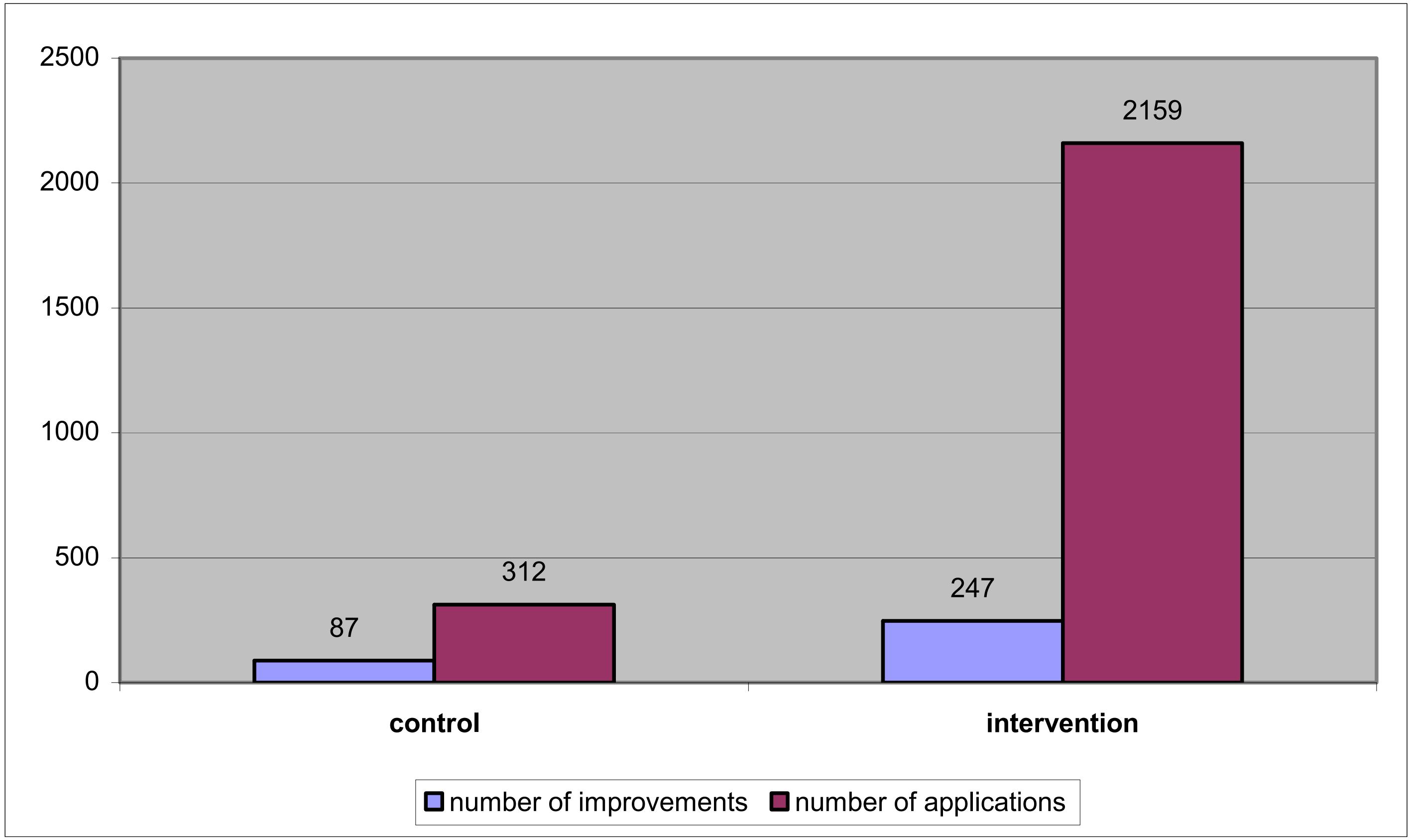


Figure 37. Comparison of improvement using recycled materials by industries

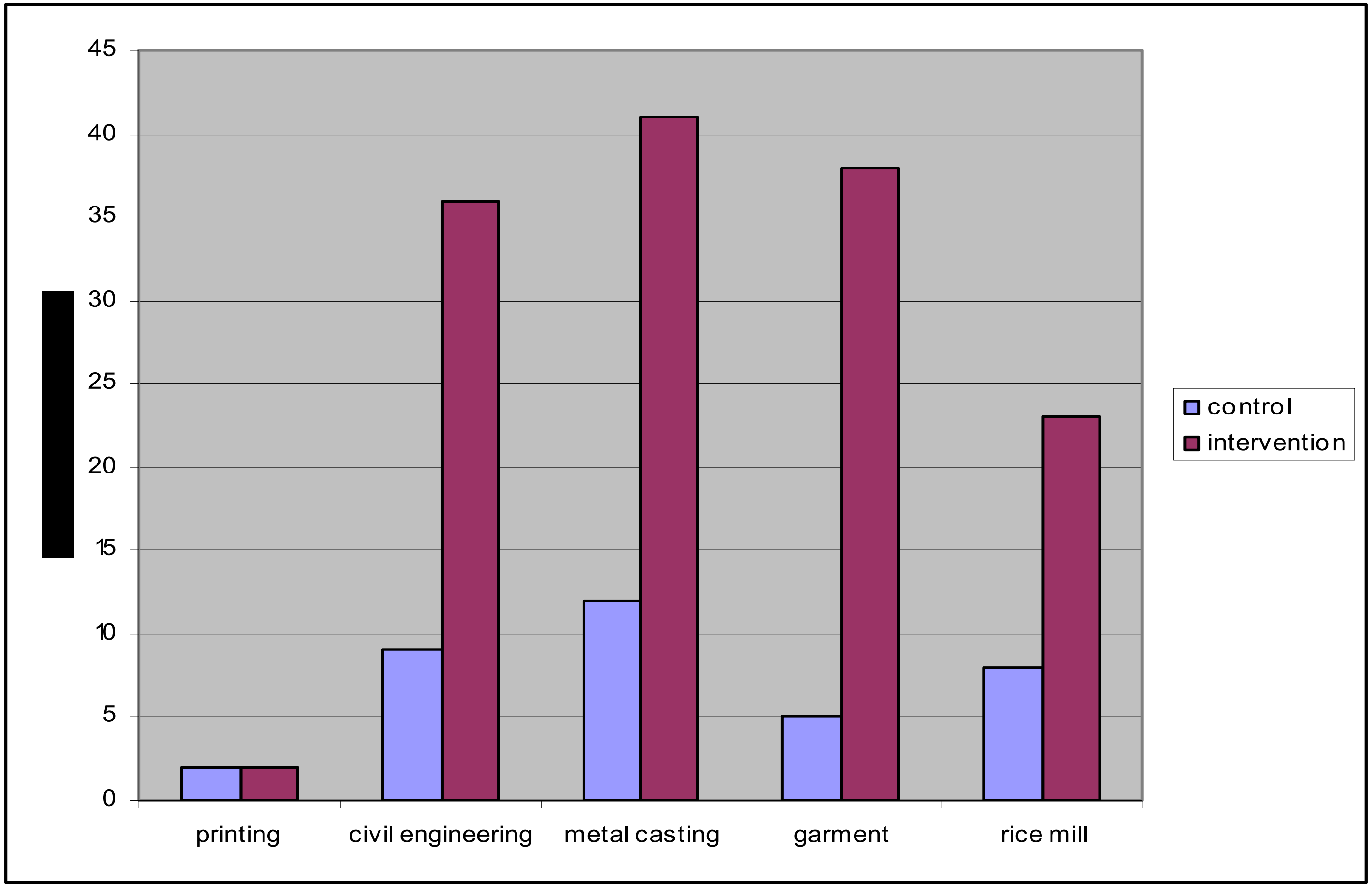
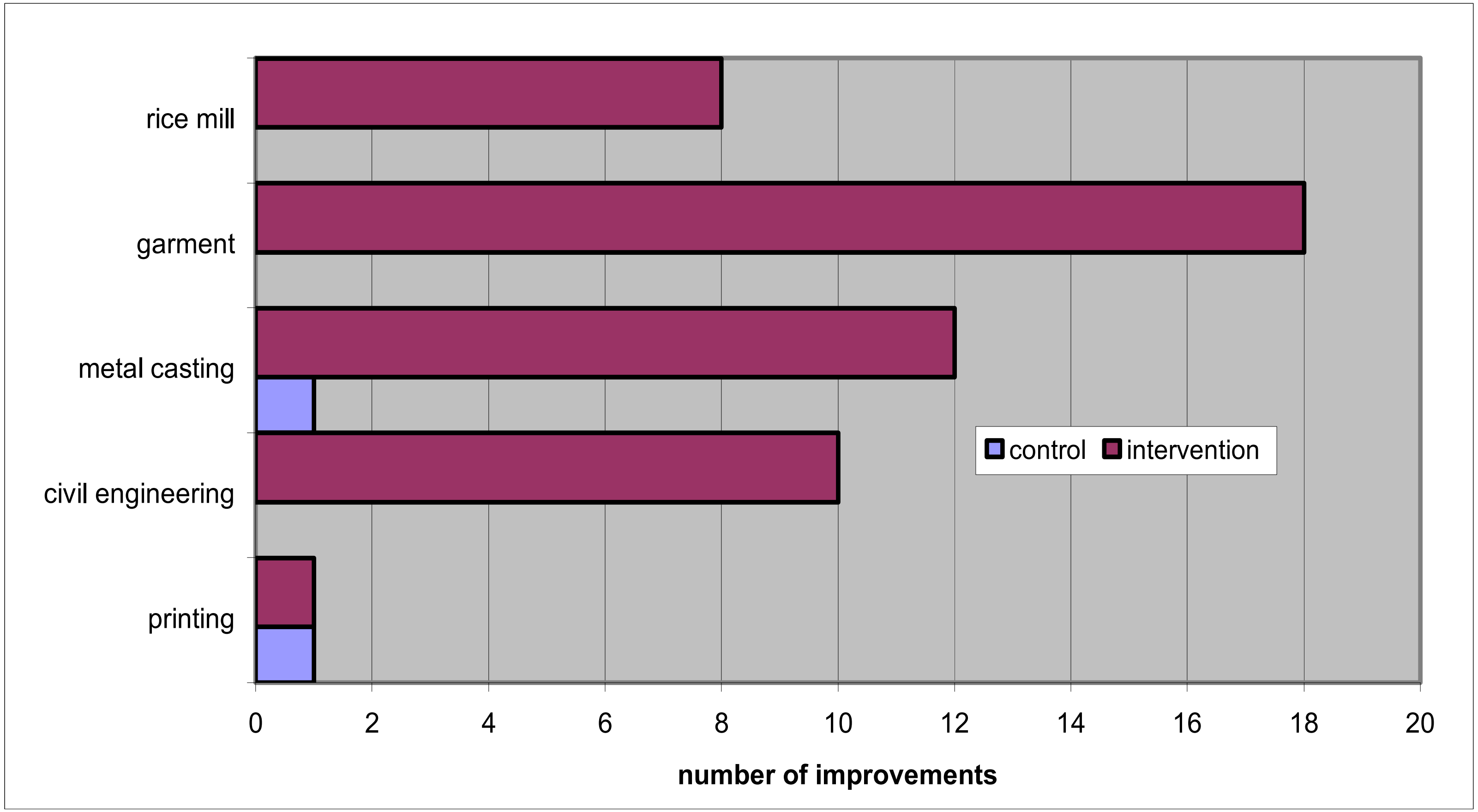


Figure 38. Comparison of zero cost improvements between 2 groups by industries



The number of improvements by type of improvement between intervention and control groups are summarised in Table 39 and Figure 39. The largest percentage of improvements in the control group related to Machine Safety and there were no improvements for Work Station Design or for Environment Protection. The largest percentage of improvement in the intervention group related to Work Environment and Machine Safety. There were few improvements relating to Work Organisation in either group.

The number of improvements classified by author of improvement are summarised in Table 40 and Figure 40. Major improvements in both control and intervention enterprises were ordered by factory owners. However, the total number of improvements initiated by workers in the intervention group was higher than in the control group.

The number of improvements, total cost and average cost per improvement over the twelve month period are summarised in Table 41 by study group (intervention and control). There was a marginally higher total cost for intervention industries. However, the average cost per improvement was lower for intervention industries due to the higher total number of improvement. Figure 41 shows a higher number of improvements with lower average cost per improvement in the intervention industries overall compared to those in the control industries.

Table 39. Comparison of improvements between intervention and control groups.

Improvement	Control group		Intervention group		Total	
	Number of improvements	%	Number of improvements	%	Number of improvements	%
Material Handling	16	18.4	42	17.0	58	17.0
Work Station Design	0	0.0	20	8.1	20	6.0
Machine Safety	35	40.2	62	25.1	97	29.0
Work Environment	20	23.0	74	30.0	94	28.0
Work Organisation	1	1.1	6	2.4	7	2.0
Welfare Facilities	15	17.2	34	13.8	49	15.0
Environment Protection	0	0.0	9	3.6	9	3.0
Total	87	100.0	247	100.0	334	100.0

Table 40. Number of improvements classified by initiator of improvement

Initiator	Control group		Intervention group		Total	
	Number of improvements	%	Number of improvements	%	Number of improvements	%
Factory owner	48	55.2	82	33.2	130	39.0
Section Head	21	24.1	41	16.6	62	19.0
Technician	12	13.8	74	30.0	86	16.0
Worker	6	6.9	50	20.2	56	17.0
Total	87	100.0	247	100.0	334	100.0

Table 41. Number of improvements and costs, by industry

Industry	Control group			Intervention group			Total	
	Number of improvements	Total cost[a] (x1000 VND)	Average cost/ improvements	Number of improvements	Total cost[a] (x1000 VND)	Average cost/ improvements	Number of improvements	Total cost[a] (x1000 VND)
Printing & paper container	10	8,912,200	891,200.0	14	7,545,600	538,971.4	24	16,457,800
Civil engineering	15	108,400	7,226.7	51	281,528	5,520.2	66	389,928
Metal casting	17	56,410	3,318.2	62	1,987,060	32,049.4	79	2,043,470
Garment	18	1,447,140	80,396.7	78	1,110,806	14,241.1	96	2,557,946
Rice mill	27	736,826	27,289.9	42	422,200	10,052.4	69	1,159,026
Total	87	11,260,976	129,436.5	247	11,347,194	45,940.1	334	22,608,170

a. cost over twelve month period

Figure 39. Comparison of improvements between 2 study groups

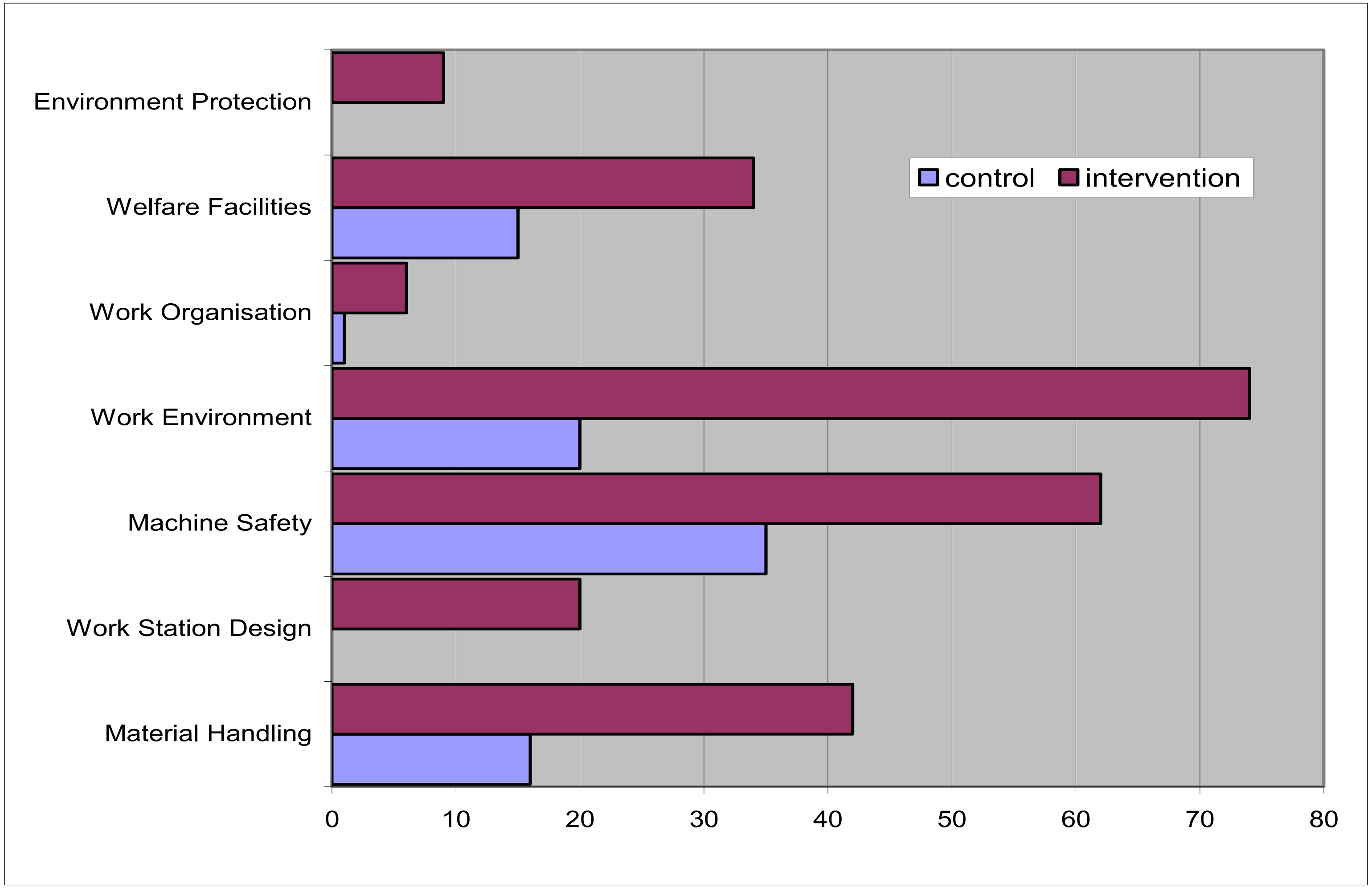


Figure 40. Number of improvements classified by initiator of improvement

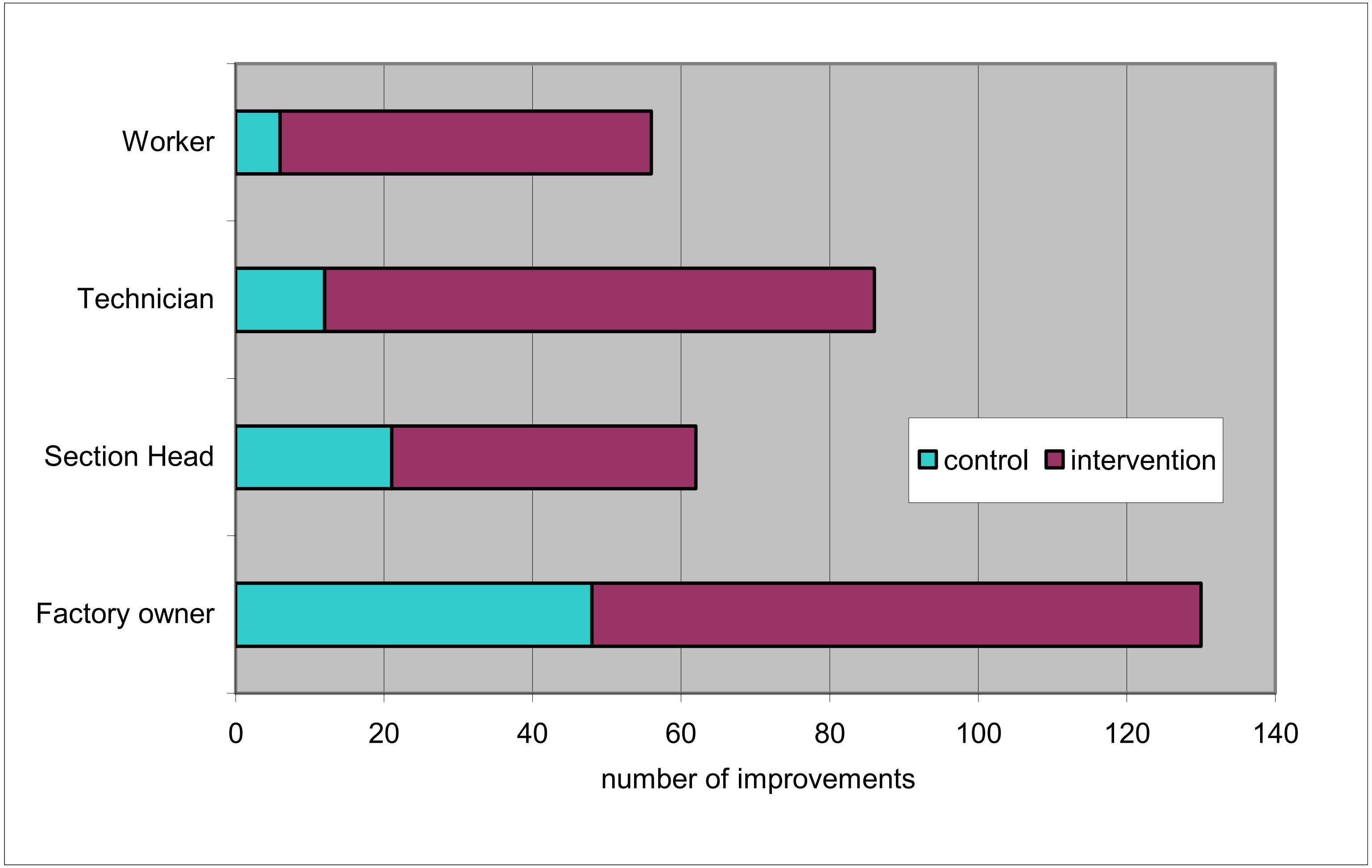


Figure 41. Number of improvements and average costs between 2 study groups

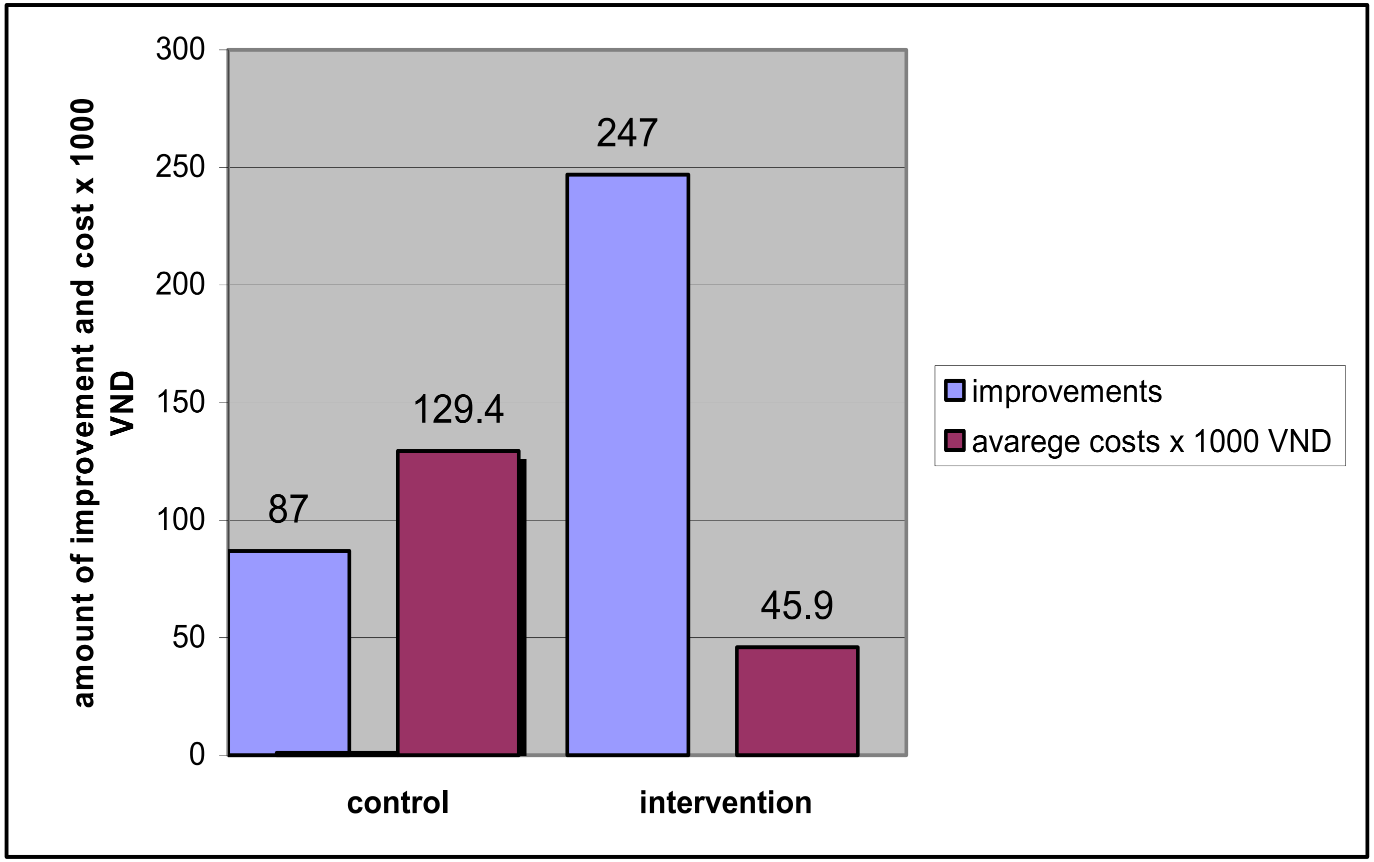


Table 42 compared number of improvements among intervention factories in relation to whether or not owners attended the WIPE training courses. The factories with owners who attended the PAOT training courses had significantly higher number of improvements than other factories. Figure 42 shows a higher mean number of improvements in the intervention factories, where their owners attended the PAOT training courses, compared to the factories with absent owners and control enterprises.

6.2.3.5 Average productivity

Workers' productivities are summarised in Table 43 for the five industries under study, both for the intervention group and for the control group. Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, statistically significant increases in productivities were shown for the civil engineering industry (ratio of GM 1.31, 95% CI 1.09 to 1.57), for metal casting (ratio of GM 1.41, 95% CI 1.02 to 1.96), for the garment industry (ratio of GM 1.08, 95% CI 1.04 to 1.12), and for the rice mill industry (ratio of GM 1.04, 95% CI 1.01 to 1.07). For the control group, statistically significant increases in productivities were shown for the metal casting industry (ratio of GM 1.04, 95% CI 1.00 to 1.07), and for the garment industry (ratio of GM 1.02, 95% CI 1.01 to 1.03). The different industries produced information on productivity, either in terms of monthly output measured in tonnes or value in money.

6.2.3.6 Workers' incomes

Workers' incomes are summarised in Table 44 for the five industries under study and for all industries combined, both for the intervention group and for the control group.

Table 42. Comparison of ownership of factory, attendance on WIPE training course and number of improvements.

Name of factory	Industry	Managers/owners attending PAOT training course	Number of improvements
CKSH	Metal casting	attendance	45
VT	Garment	attendance	43
MK	Garment	attendance	39
TA	Civil engineering	attendance	32
CDCT	Civil engineering	attendance	23
DT	Metal casting	attendance	23
TT CD	Rice mill	attendance	20
HL	Printing paper	absence	20
TP	Rice mill	absence	19
NSTP CR	Rice mill	absence	15

$\chi^2_{(1)}$= 20.626 $p<0.05$, from Mantel Haenszel test

Table 43. Comparison of productivity between intervention and control groups: first and the last 3 month reports.

Industry	Geometric mean		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Label printing & paper container	608.9[d]	663.9[d]	1.16	1.06	1.09	0.86 to 1.39	3	0.26
Civil engineering	800.5[e]	1,049.9[e]	1.25	1.14	1.31*	1.09 to 1.57	6	0.01
Metal casting	7.4[d]	10.4[d]	2.04	2.54	1.41*	1.02 to 1.96	6	0.04
Garment	67,557[f]	72,815[f]	1.04	1.01	1.08**	1.04 to 1.12	6	<0.01
Rice mill	1,837.3[d]	1,908.1[d]	1.02	1.04	1.04*	1.01 to 1.07	9	0.02
Control group								
Label printing & paper container	627.0[d]	667.3[d]	1.12	1.04	1.07	0.89 to 1.29	3	0.26
Civil engineering	712.9[e]	939.9[e]	1.69	1.15	1.32	0.81 to 2.14	6	0.20
Metal casting	7.4[d]	7.64[d]	1.82	1.84	1.04*	1.00 to 1.07	6	0.04
Garment	70.0[f]	71.4[f]	1.03	1.02	1.02*	1.01 to 1.03	6	0.01
Rice mill	1,891.9[d]	1,916.0[d]	1.06	1.04	1.01	0.99 to 1.04	9	0.27

* p<0.05, ** p<0.01.

a. Main productivity for the first three months
b. Main productivity for the last three months
c. Main productivity for the last three months / Main productivity for the first three months
d. A unit of weight equal to one ton (of paper, metal or rice)
e. An amount of currency equal to 1,000,000 Vietnamese Dong
f. An amount of product equal to one thousand (of shirts, trousers, or jackets).

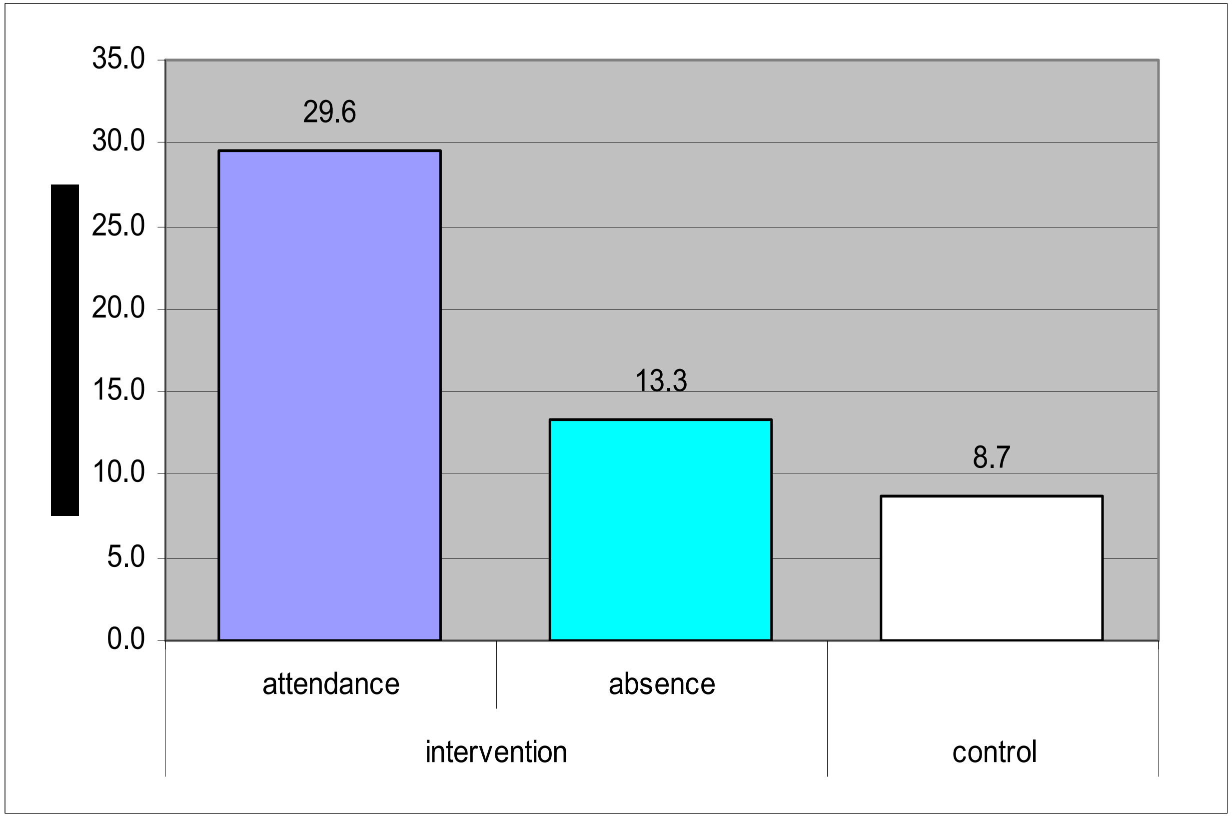
Table 44. Comparison of workers' income between intervention and control groups: first and the last 3 month reports.

Industry	Geometric mean (x1000VND)		GSD		Ratio of geometric means [c]	95% CI of ratio	Paired (n)	P-value
	Phase 1[a]	Phase 2[b]	Phase 1[a]	Phase 2[b]				
Intervention group								
Printing & paper container	1,684.4	2,593.4	1.16	1.28	1.54	0.84 to 2.83	3	0.09
Civil engineering	1,303.2	1,991.2	1.19	1.43	1.53*	1.19 to 1.97	6	0.01
Metal casting	1,361.4	2,265.6	1.16	1.35	1.66*	1.07 to 2.58	6	0.03
Garment	1,253.6	1,778.3	1.10	1.32	1.42*	1.06 to 1.90	6	0.03
Rice mill	2,367.9	3,215.8	1.13	1.15	1.36**	1.19 to 1.55	9	0.001
All industries combined	1,601.0	2,320.3	1.35	1.39	1.45***	1.34 to 1.57	30	<0.001
Control group								
Printing & paper container	1,967.6	2,360.6	1.08	1.42	1.20	0.51 to 2.81	3	0.45
Civil engineering	1,345.0	1,622.0	1.17	1.41	1.21	0.88 to 1.66	6	0.19
Metal casting	1,972.7	2,500.1	1.31	1.39	1.27*	1.03 to 1.57	6	0.04
Garment	1,221.3	1,673.2	1.02	1.30	1.37*	1.04 to 1.80	6	0.03
Rice mill	2,437.1	2,829.6	1.77	1.22	1.16*	1.01 to 1.34	9	0.04
All industries combined	1,768.4	2,183.4	1.38	1.43	1.23***	1.13 to 1.35	30	<0.001

* p<0.05, ** p<0.01, *** p<0.001.

a. Income for the first three months
b. Income for the last three months
c. Income for the last three months / Income for the first three months

Figure 42. Comparison of ownership of factory attendance on PAOT training course and mean of improvement



Geometric means (with corresponding geometric standard deviations) are shown for pre-intervention and post-intervention, together with the ratio of geometric means for these two phases. For the intervention group, statistically significant increases in workers' incomes were shown for all industries combined (ratio of GM 1.45, 95% CI 1.34 to 1.57), for the civil engineering industry (ratio of GM 1.53, 95% CI 1.19 to 1.97), for metal casting (ratio of GM 1.66, 95% CI 1.07 to 2.58), for the garment industry (ratio of GM 1.42, 95% CI 1.06 to 1.90), and for the rice mill industry (ratio of GM 1.36, 95% CI 1.19 to 1.55). For the control group, statistically significant increases in workers' incomes were shown for all industries combined (ratio of GM 1.23, 95% CI 1.13 to 1.35), for metal casting (ratio of GM 1.27, 95% CI 1.03 to 1.57), for the garment industry (ratio of GM 1.37, 95% CI 1.04 to 1.80), and for the rice mill industry (ratio of GM 1.16, 95% CI 1.01 to 1.34).

7 Discussion

7.1 Main findings

Findings for an intervention study are apparently most easily interpreted when there is little change in the control factories and marked improvements in the intervention factories. This study, however, produced a mixture of findings, some that were easy to interpret and some which did not lend themselves to obvious explanations. Findings from observational intervention studies have the same possible explanations as any epidemiological study, namely a causal relationship (the intervention works), chance (a much larger study would not have shown the difference), confounding (some other causal factor was in operation and this tended to operate in the intervention factories rather than the control factories, or vice versa), or bias (the intervention was not a fair test and intervention factories were given some unfair advantage). All of these possible explanations will need to be considered in turn.

For the intervention factories, post-intervention measured conditions were better than those found pre-intervention for many of the industries under study (without regard for statistical significance). This was the case for personal and static dust levels for all five industries under study. It was also the case for carbon monoxide (two industries), carbon dioxide (two industries), noise (four industries), lighting levels (four industries), air temperature (two industries), air humidity (one industry), and air velocity (two industries). If we consider all industries together, and limit ourselves to statistically significant improvements, then post-intervention measured conditions were better for personal dust, static dust, noise, lighting, air temperature, and air humidity.

For the control industries, the picture was more complex. For many industries, measured conditions were *worse* in the post-intervention period than the pre-intervention period (without regard for statistical significance). This was the case for personal dust levels (three industries), static dust levels (four industries), noise levels (three industries), lighting (one industry), air temperature (one industry), air humidity (two industries), and air velocity (one industry). If we consider all industries together, and limit ourselves to statistically significant deteriorations, then post-intervention measured conditions were worse for personal dust, static dust, and noise. There is no obvious explanation for the apparent deterioration in conditions at the control factories. It is possible that the deterioration in dust and noise levels is a consequence of using ageing and poorly maintained equipment or of using lower quality raw materials, but data are not available to investigate either possibility. Changes in the same unexpected direction were shown for some intervention industries, but this was only the case for lighting levels (one industry), air temperature (two industries), and air velocity (three industries).

There were also many improvements for intervention industries compared to control industries shown in the variables for which monthly data had been supplied in the form of factory reports. Improvements (all factories combined) were shown for a number of variables including total number of accidents, number of accidents leading to absence from work, days of absence due to accidents, worker health visits, worker health costs, the number of improvements, the number of workplaces affected by improvements, the number of improvements using recycled materials, the number of zero-cost improvements, the enterprises' productivity, and workers' income. Significance tests, when carried out, indicated that these differences were highly significant. Although the intervention factories performed significantly better than the control factories, there were improvements in the control factories but these improvements were not as marked as those shown for the intervention factories.

7.2 The strengths of the intervention study

The study has a number of strengths. The measurements were conducted with notice only given to the enterprises on the same day of measuring, to avoid any management influence on working plans or cleaning schedules. This condition was agreed in the research contract at the beginning, between the ECHO and enterprises' managers. [The author is aware of factory visits, previous to this study, where managers stopped dusty machines and only allowed the clean machines to operate.] In addition, all the samples for both pre- and post-intervention phases were conducted with the same set of equipment and by the same team of experienced trained technicians, to limit human error from measurements. Moreover, 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 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 year (i.e. the second evaluation was carried out twelve months after the first evaluation) to avoid any unexpected effects from climate changes on measurements of air temperature, air humidity and air velocity.

7.3 The limitations of the intervention study

There were, however, various 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. Accordingly, the study results might not identify all environmental improvements. In addition, the pre- and post-intervention personal dust measurements might relate to different workers, who might have different working behaviours and these behaviours might affect the measured results. Control for all factors was not possible. For example, the quality of materials might have changed between pre- and post-intervention measurements, and any differences found might only reflect this change. There was economically important inflation in the period of the study; annual inflation was 10% in November 2007 and 20% in March 2008 (Bonobo Land, 2008). Consequently, many entrepreneurs attempted to stabilise production costs by searching for cheaper raw materials, including rice grains, recycled metal and paper, fabrics and fuel. Such effects would, of course, only influence the study results if they operated on control factories more than intervention factories (or *vice versa*).

Only two sets of measurements were carried out for each factory, and each set took three to five days to complete. The study had to assume that each of these sets of measurements was typical of pre-and post-intervention conditions. It has not been possible to test this assumption because data are not available for typical weekly changes in exposure conditions. Many different exposures were measured because it was not known which of them would show any improvement, and calculations of statistical power were not performed before data collection commenced because the total available staff resources were already being used. With hindsight it might have been better to take more measurements over a longer time period for a restricted set of exposures, with numbers based on statistical power calculations. The study focussed on environmental conditions and the use of personal protective equipment (PPE) was not considered in the evaluation of the environmental measurements, although the introduction of such equipment was counted as an improvement.

The primary health care units in the enterprises could not count minor accidents and cases of mild sickness if workers did not request assistance for these conditions. At private enterprises, workers might not get paid if they were absent from work. Consequently, many workers would not contact the health unit until they were unable to continue working. Such influences will affect the absolute prevalence of accidents and illness recorded in the study but would only influence the evaluation of PAOT if they operated on control factories more than intervention factories (or *vice versa*).

7.4 Interpretation of the main findings

There were many highly significant differences between intervention and control factories, and chance does not offer a plausible explanation for all of them. It is, of course, possible that some of the more detailed findings for specific industries are chance findings, because these were often based on small numbers of measurements. Paired comparisons (pre-intervention 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. 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 quality of raw materials, although we have no reason to believe that this was more of an issue for control factories than intervention factories. It is possible, however, that pre-intervention samples were not representative of factory conditions prior to the intervention. Equally, it is possible that post-intervention samples were not representative of factory conditions following the intervention. This could only be established by taking many more measurements over a much longer time period. Unfortunately, resources were not available to this project to fully explore this issue.

The current investigator was able to guarantee the quality of the measurements by having direct control of all aspects of their collection. The same cannot be said for the factory reports, and it is not possible to assess the standard of record-keeping in the different factories. It is for this reason that more importance can be given to the findings for the measurements. It was assumed that the age profile of each factory population did not change over the course of the intervention (thirteen months). Consequently, no attempt was made to adjust changes in sickness absence and accident rates for changes in age differences.

7.5 Hawthorne effect (HE)

One possible bias that needs to be considered is the "Hawthorne Effect". The Hawthorne effect was defined in 1955 by Landsberger in the course of examining a series experiments on productivity from 1924-1932 at the Hawthorne Works, Chicago, USA (Landsberger 1958). The Hawthorne effect was explained as "*a short term improvement caused by observing worker performance*" (Landsberger 1958).

Studies of The Hawthorne Effect have had an impressive consequence on management in organisations and how people respond to different phenomenon (Austin 2002). Illumination studies are the earliest and best known studies about the Hawthorne Effect. Three series of experiments were conducted between 1924 and 1927 by industrial engineers at the Western Electric Company Works in Cicero, outside Chicago. The first experiment involved three departments without a control group; productivity increased irrespective of whether the levels of illumination were increased or decreased. The second experiment compared productivity between experimental groups with continuously increased illumination, and a control group with a stable lighting level; productivity increased in both experimental groups. The third experiment compared the effects of continuously decreased illumination with a control group with a stable illumination level. Astonishingly, the productivity in both experimental groups continuously increased until workers in the experimental group could not work due to very low lighting levels, at which time workers' productivity became lower. It is now thought that the workers worked harder because they thought that they were being monitored individually (Steven *et al.,* 2009).

For five years from 1927 to 1932, researchers tried to determine how changes in other conditions could affect productivity, including salaries, break rules, and working schedules. The Bank wiring room experiments were conducted by Mayo Lloyd Warner between 1931 and 1932. These studies investigated how payment encouragement would affect group productivity. Even though workers were observed intensively and workers were paid by individual productivity, the group productivity did not increase. The researchers concluded that workers were concerned that payment rates might be lowered by the employer. The researchers described the existence of informal groups or "cliques" within formal groups. These cliques set internal rules that could determine the members' behaviour. The results showed that workers were more influenced by the "social force of their peer groups than to the control and incentives of management" (Mayo, 1945).

Following on from these and other experiments, researchers have widened the definition of the Hawthorne effect to be a positive change in behaviour and performance that follows from any new attention. This definition is stated more formally as follows: "*The Hawthorne Effect is a form of reactivity, and describes a temporary change of behaviour and performance in response to a change in the working conditions, with the response being typically an improvement* (Steven *et al.,* 2009). People singled out for a study of any kind may improve their performance or behaviour, not because of any specific condition being tested, but simply because of all the attention they receive (Olson *et al.,* 2004).

There is no doubt that in the current investigation, workers in the intervention group would have been aware that they were participating in a new regime, even though there would have been limited contacts with the research team. A Hawthorne Effect could, therefore, have influenced the findings for productivity in the intervention group, but can offer no explanation for the positive changes in exposure levels.

7.6 Practical experience of PAOT

In general, managers and owners join the PAOT programme because they are concerned about the environment, health and safety, and they refuse to join the programme because of concerns about costs and a belief that it will not lead to benefits for their business.

The PAOT programme enables management and workforce employees to work in groups sharing knowledge, and discussing and planning their own selected best solutions. The training techniques empower participants by emphasising that many improvements have been devised from similar work conditions, with the same limited resources, and by ordinary colleagues. Participation in PAOT leads to a higher number of improvements in working conditions, often using "low-cost" solutions, local skills and local materials, such as recycled and inexpensive materials. The PAOT applied simple solutions that empowered people to take action immediately; participants take pride in showing the number of zero-cost improvements they have brought about.

Another key concern of the PAOT is accident prevention. The rules for preventing accidents are simple, practical and useful, such as “to use safe feeding and ejection devices to keep the hands away from dangerous parts of machinery”, “to use properly fixed guards or barriers to prevent contact with moving parts of machines”, “to inspect, clean and maintain machines regularly including electric wiring” and so on. These rules were expanded into detail lists in each technical section. As a result, the managers and workers immediately understood the risks and knew how to prevent accidents by safety guards, controlling mistakes on operation, and preventing electricity shocks. Accident rates were decreased and the work environment was improved among intervention industries. Both changes might lead to a lower number of the worker health visits and could reduce health costs for the factories.

In the PAOT training course, a series of ergonomics rules were introduced including, for instance, “to place frequently used materials, tools and controls within easy reach”, “to provide home for tools”, “to adjust the working height for each worker at elbow level or slightly below it”, and so on. The technicians and workers among intervention group applied these rules quickly by improving work station design and saving time on tools and materials arrangements.

In addition, the PAOT intervention applied participatory approach to strengthen the relationship between managers and local occupational health staff. Therefore, factory owners honestly shared their safety and health issues, and obtained good advice from project facilitators. By contrast, in the existing traditional relationship to investigators, managers tend to hides factory safety and health problems because they worry about criticisms and the threats of fines. As a result, those problems cannot be solved properly.

Besides, relationship between factory owners and workers were completely changed inside intervention factories. Managers gave opportunities to workers to raise and discuss their own simple ideas and allowed their employees to conduct the improvements with factory resources. The labourers had confident and useful feeling in their working communities and were willing to contribute their knowledge and experience for the improvement. At control enterprises, workers seemed to be less happy, and often accepted their existing working conditions. Managers did not expect any complaints from workers but were happy to rebuke them for violating factory rules. The managers sometimes imposed changes on working conditions aimed at higher productivity or the production of better quality products. However, these changes were not always welcomed by workers because they brought inconvenient working procedures to the tasks. The real problems were not recognised by managers, and improvements were not based on working experience. Most of improvements in the control factories were expensive and based on managing benefits.

Moreover, relationship among SMEs managers from the same industries in Can Tho City can be competitive. Through PAOT training and meetings, they sit together, share similar problems and discuss the best solutions. Isolation was removed and changed to friendship. Co-operation will be even more important now that the Vietnamese government has decided to join both the World Trade Organisation and the regional trading market, erasing tax barriers among countries and putting more pressure on local SMEs to produce cheaper and better products.

Furthermore, the PAOT did not require high levels of education from participants but they must be experienced on existing jobs. The participants could immediately show their achievements without further skills training being required. There were even illiterate workers who were able to fulfil their training, share ideas confidently and contribute to the action plans. However, to deal with such special trainees, trainers and training facilitators must give them special care and show them how to do the checklist exercise with illustrations and take note by their own ways. In planning processes, PAOT training encouraged both group and individual planning, such that employees were not always waiting for a higher authority to make final financial decisions. The implementation allowed planners to make company action plans based on group work or an individual could make his or her own plan without higher authority.

Above all, new ideas of protecting the surrounding environment were generated in the course of the study including raw materials selection, recycling and reusing waste, and exploiting daylight and fresh air to save electricity. These ideas brought some improvements for protecting general environment into the intervention group that have seldom happened among small private factories in the country.

There are, of course, limitations to any PAOT intervention. Accordingly, participants form their own priorities, proposing improvements based on their resources, recognition, skills, and available time. Most plans start with cheap, simple and interesting improvements first, then upgrade to more expensive and complicated plans. It follows that not all work environment problems will be resolved immediately. Besides, management involvement is extremely important for launching and maintaining any PAOT plans, and such support will not always be available; some managers do not understand that good health is good business. Moreover, PAOT interventions do cost money and financial support is not always available for follow-up visits, travel from one factory to another, preparing training materials, and organising training courses. It is not possible to assess, from this study, the long-term benefit of a one-year PAOT programme, and refresher session to re-energise staff might be well worthwhile.

8 Conclusions

There were significant improvements among intervention factories after thirteen months follow-up evaluation in term of environment measurements, numbers of improvement, numbers of cases of sickness and accidents, health costs, productivity and workers' incomes. The findings of the intervention study support the idea that a PAOT programme produces better outcomes in SMEs than a local traditional occupational health programme. The current study was limited, however, in a number of ways, and a fuller examination of PAOT will require a larger study with more environmental measurements taken over a much longer period of time, and data on sickness absence and accidents that have been independently validated.

9 Appendices

Appendix 1. Factory list of rice mill industry in 2006 – Centre for Occupational Health and Environment of Can Tho City

	Factories' name	Tel.	Address	Workers	ISO	Sort	Responded	Accepted
1	NMXX MY PHUOC		Cai rang district	116	0	State Co.	yes	yes
2	CBLT HUNG PHAT		Thonot district	124	0	Ltd. Co.	no	
3	HTX THANH PHONG		Cai rang district	108	0	Micro Co	yes	yes
4	DN TIN THANH		My Khanh hamlet	114	0	Ltd. Co.	yes	no
5	DNTN TRUNG TIN		Thonot district	124	0	Ltd. Co.	yes	no
6	KHO DUC HUY		Thonot district	105	0	Ltd. Co.	yes	no
7	Nha may TAN THANH NTCD		Cai rang district	114	0	State Co.	yes	yes
8	NM TRUNG AN		Thonot district	109	0	Ltd. Co.	yes	no
9	DNTN TAN THANH MY KHANH		My Khanh hamlet	105	0	Ltd. Co.	yes	yes
10	CB LT NAM THANH HUNG		Thonot district	102	0	Ltd. Co.	no	
11	LBG VAN LOI		Cai rang district	118	0	Micro Co	yes	no
12	Xay Xat THANH HUNG		Omon district	107	0	Ltd. Co.	no	
13	NM MY KHANH		My Khanh hamlet	115	0	Ltd. Co.	yes	no
14	NM VAN HOA		Thonot district	104	0	Micro Co	yes	no
15	DNTN DUC LOC		Ninh kieu Cantho	128	0	Ltd. Co.	yes	no
16	KHO THOI THUAN		Ninh kieu Cantho	106	0	State Co.	yes	no
17	LBG DUNG LIEM		Thonot district	107	0	Ltd. Co.	yes	no
18	NMXX MY KHANH		My Khanh hamlet	115	0	State Co.	yes	yes
19	CBLT VINH PHAT		Thonot district	114	0	Ltd. Co.	yes	no
20	NM TAI THANH		Omon district	113	0	Micro Co	no	
21	CBLT NTSH CAI RANG		Cai rang district	126	0	State Co.	yes	yes
22	NM OMON		Omon district	101	0	Ltd. Co.	no	
23	XX THANH CONG		Cai rang district	101	0	Micro Co	yes	yes
24	DNTN PHUC LOC		Thonot district	116	0	Ltd. Co.	yes	no

Total 24, responded 19, accepted 7, refused 12

Appendix 2. Factory list of civil engineering industry in 2006– Centre for Occupational Health and Environment of Can Tho City

	Factories' name	Tel.	Address	Workers	ISO	Sort	Responded	Accepted
25	CK TRINH THI CHANH		Ninh kieu Cantho	57	0	Micro Co.	no	
26	CK THOI HUNG		Ninh kieu Cantho	106	0	Ltd. Co.	yes	yes
27	DNTN CK MINH		Ninh kieu Cantho	125	0	Ltd. Co.	no	
28	CD CAN THO		Ninh kieu Cantho	123	0	Joint stock	yes	yes
29	MITAGAS		Ninh kieu Cantho	48	0	State Co.	yes	yes
30	CTY XANG CANTHO		Ninh kieu Cantho	176	0	State Co.	yes	no
31	DINH KIM XUAN		Binh thuy district	89	0	Joint stock	yes	no
32	CK MINH TUAN		Phongdien district	42	0	Micro Co.	yes	no
33	DIEN NUOC CONG NGHIEP		Ninh kieu Cantho	108	0	Joint stock	yes	yes
34	CTY XAY LAP DIEN CT		Binh thuy district	112	0	State Co.	yes	no
35	TIEN HAN NAM DUONG		Ninh kieu Cantho	12	0	Micro Co.	no	
36	HOI KY NGHE CAN THO		Binh thuy district	47	0	State Co.	yes	no
37	NM CK 721		Ninh kieu Cantho	123	0	State Co	yes	no
38	CK TRUNG ANH		Cai rang district	113	0	Ltd. Co.	yes	yes
39	XN CAU NONG THON		Phongdien district	147	0	Ltd. Co.	no	
40	XN DONG TAU THUY		Binh thuy district	125	0	State Co.	yes	yes

Total 16, responded 12, accepted 6, refused 6

Appendix 3. Factory list of garment industry in 2006– Centre for Occupational Health and Environment of Can Tho City

	Factories' name	Tel.	Address	Workers	ISO	Sort	Responded	Accepted
41	XN MAY RANG DONG		Ninh kieu Cantho	384	0	Ltd. Co.	yes	no
42	May MEKO		Binh thuy district	503	9001	Joint stock	yes	yes
43	CH MAY XK VIET TIEN		Ninh kieu Cantho	43	0	State Co.	yes	no
44	CH MAY SAIGON		Ninh kieu Cantho	68	0	State Co.	no	
45	CTY MAY TAY DO 2		Omon district	358	9001	Joint stock	yes	yes
46	CH CTY MAY BINH TAY		Ninh kieu Cantho	20	0	State Co.	no	
47	CTY MAY XK PHONG DIEN		Phongdien district	157	0	Ltd. Co.	yes	no
48	CTY MAY TAY DO		Ninh kieu Cantho	560	9001	Joint stock	yes	yes
49	CH CTY DET BINH TIEN		Ninh kieu Cantho	59	0	State Co.	no	
50	CTY GIAY CANTHO		Binh thuy district	560	0	State Co.	yes	no
51	CTY GIAY TAY DO		Binh thuy district	482	9001	Joint stock	yes	no
52	CH CTY DET THANG LOI		Ninh kieu Cantho	53	0	State Co.	no	
53	MAY HAO TAN		Ninh kieu Cantho	315	9001	Ltd. Co.	yes	yes
54	CH CTY MAY 10		Ninh kieu Cantho	76	0	State Co.	no	
55	CTY MAY VIET THANH		Ninh kieu Cantho	380	9001	Ltd. Co.	yes	yes
56	CO SO MAY BHLD		Ninh kieu Cantho	74	0	Ltd. Co.	no	
57	CH CTY MAY HANOI		Ninh kieu Cantho	57	0	State Co.	no	

Total 17, responded 10, accepted 5, refused 5

Appendix 4. Factory list of printing and paper industry in 2006– Centre for Occupational Health and Environment of Can Tho City

	Factories' name	Tel.	Address	Workers	ISO	Sort	Responded	Accepted
58	BB TAN HUNG		Ninh kieu Cantho	107	0	Ltd. Co.	yes	yes
59	CTY PHAT HANH SACH		Ninh kieu Cantho	49	0	State Co.	no	
60	CTY GIAY BINH THUY		Binh thuy district	76	0	Micro Co.	no	
61	XN IN TH CAN THO		Ninh kieu Cantho	236	9001	State Co.	yes	yes
62	DNTN IN HONG TRUNG		Ninh kieu Cantho	123	0	Ltd. Co.	no	
63	XUONG IN TAY DO		Binh thuy district	159	0	State Co.	no	
64	BB LE KHANG		Ninh kieu Cantho	52	0	Ltd. Co.	yes	no
65	CO SO IN LES		Ninh kieu Cantho	44	0	Micro Co.	no	
66	BB HOANG LOC		Cai rang district	125	0	Ltd. Co.	yes	yes
67	DNTN GIAY TIGON		Thonot district	84	0	Ltd. Co.	no	
68	IN HOA PHUONG		Ninh kieu Cantho	66	0	Ltd. Co.	yes	no

Total 11, responded 5, accepted 3, refused 2

Appendix 5. Factory list of metal casting industry in 2006– Centre for Occupational Health and Environment of Can Tho City

	Factories' name	Tel.	Address	Workers	ISO	Sort	Responded	Accepted
69	NHA TIEN CHE CUU LONG		Binh thuy district	88	0	Ltd. Co.	no	
70	TAN THANH CONG		Ninh kieu Cantho	107	0	Ltd. Co.	yes	yes
71	XUONG NHOM CAI RANG		Cai rang district	26	0	Micro Co.	no	
72	NHOM CAN THO		Ninh kieu Cantho	118	0	Micro Co.	yes	yes
73	TAN DUC THANH		Ninh kieu Cantho	82	0	Micro Co.	yes	yes
74	NHOM HIEP THANH		Ninh kieu Cantho	20	0	Micro Co.	no	
75	NHOM CAN THO 2		Ninh kieu Cantho	67	0	Micro Co.	no	
76	LO NHOM THANH HIEP		Ninh kieu Cantho	27	0	Micro Co.	no	
77	ACCU DUC THANH		Ninh kieu Cantho	45	0	Micro Co.	no	
78	NM CAN TOLE MOTILEN		Ninh kieu Cantho	127	0	State Co.	yes	no
79	LO CHI THOT NOT		Thonot district	16	0	Micro Co.	no	
80	THEP TAY DO		Binh thuy district	126	0	State Co.	yes	no
81	LO CHI AN BINH		Ninh kieu Cantho	25	0	Micro Co.	no	
82	NM THEP MEKONG		Binh thuy district	87	0	Ltd. Co.	yes	no
83	NHOM DUC THANH		Cai rang district	102	0	Micro Co.	yes	yes
84	DUC PISTON HIEP		Ninh kieu Cantho	32	0	Micro Co.	no	
85	DNTN CKSH		Ninh kieu Cantho	125	0	Ltd. Co.	yes	yes
86	LO CHI MY KHANH		Phongdien district	14	0	Micro Co.	no	

Total 18, responded 8, accepted 5, refused 3

Appendix 6. Factory list of other industries in 2006– Centre for Occupational Health and Environment of Can Tho City

	Factories' name	Tel.	Address	Workers	ISO	Sort	Responded	Accepted
87	CTY NGK HAU GIANG		Ninh kieu Cantho	55	0	State Co.	yes	yes
88	PATAYA		Binh thuy district	647	0	Ltd. Co.	yes	yes
89	SON DONG A		Binh thuy district	130	0	Ltd. Co.	no	
90	CTY GIAY		Ninh kieu Cantho	482	0	Ltd. Co.	yes	yes
91	CTY BIA NGK CANTHO		Ninh kieu Cantho	196	0	State Co.	no	
92	CH THEP XAY DUNG		Ninh kieu Cantho	112	0	State Co.	yes	no
93	BB PP 2		Binh thuy district	130	0	State Co.	yes	yes
94	THUOC DA TAY DO		Binh thuy district	126	0	State Co.	yes	yes
95	XI MANG CANTHO		Thonot district	221	0	State Co.	yes	yes
96	LONG VU MEKO		Binh thuy district	88	0	Ltd. Co	yes	no
97	DNTN TAN PHU		Binh thuy district	76	0	Ltd. Co.	yes	yes
98	CUA XE GO VINH LONG		Ninh kieu Cantho	66	0	State Co.	no	
99	THU Y A CHAU		Cai rang district	86	0	Ltd. Co.	yes	no
100	TC MY NGHE MEKO		Ninh kieu Cantho	112	0	Ltd. Co	yes	no
101	CAO SU DUC THANH		Cai rang district	115	0	Micro Co.	yes	no
102	DUOC PHAM NAM TIEN		Ninh kieu Cantho	49	0	Micro Co.	yes	yes
103	BIA QK 9		Binh thuy district	67	0	State Co.	no	
104	CTY IN NHUA		Ninh kieu Cantho	136	0	State Co.	yes	yes
105	CUA XE GO QUOC TRAN		Thonot district	18	0	Ltd. Co.	yes	no

Total 19, responded 15, accepted 9, refused 6

Appendix 7. PAOT invitation letter to manager/owners

From: Centre for Occupational Health and Environment of Cantho city
Department of Health Cantho city
Document number: ……/SKLDMT/2006

To: Manager of …………………………………………………………..

Address ……………………………………………………….

The director of Centre for Occupational Health and Environment (ECHO) is delighted to invite you and your factory to join a health and safety intervention Participatory Oriented Action Training programme named Work Improvement for Protection of Environment (WIPE), which is conducting by ECHO for local enterprises. The project will last for about one year from May 1st 2007 to May 31st 2008. The selected factories will be providing to the several free of charge occupational health services, including:

- To train managers/owners and key workers by PAOT method.
- To measure work environment.
- To consult working condition improvements

All the feedback please sends to ECHO at 154 Nguyen an Ninh street, Ninh Kieu district, Can tho city. Any queries please call to [number], from Monday to Friday at working time.

We look forward to hearing from you very soon.

Sincerely yours,

Director of ECHO

(signed and stamped)

Dr. Nam Phuong Nguyen

Appendix 8. The selected factories

Codes	Factory name	Industry	Study group
1	BB HL	Printing – paper container	Intervention
2	BB TH	Printing – paper container	Control
3	CK TA	Civil engineering	Intervention
4	CK TH	Civil engineering	Control
5	CTCP CDCT	Civil engineering	Intervention
6	CTCP DN CN	Civil engineering	Control
7	Nh DT	Metal casting	Intervention
8	Nh CT	Metal casting	Control
9	CKSH	Metal casting	Intervention
10	TTC	Metal casting	Control
11	VT	Garment	Intervention
12	MK	Garment	Intervention
13	HT	Garment	Control
14	TD	Garment	Control
15	NSTP CR	Rice mill	Intervention
16	NMXX MP	Rice mill	Control
17	TTNTCD	Rice mill	Intervention
18	NMXX MK	Rice mill	Control
19	HTX TP	Rice mill	Intervention
20	NMXX TT	Rice mill	Control

Appendix 9. Project contract for intervention factory

OCCUPATIONAL HEALTH INTERVENTION CONTRACT

On the date of / / 2007

We are:

Side A. Dr. Nam Phuong Nguyen,
Director of Centre for Occupational Health and Environment of Cantho city
Address 154 Nguyen An Ninh, Ninh Kieu district, Cantho city
Telephone [number],

And;

Side B. Mr/Ms ………………………………………………………………………...

Manager/Owner of …………………………………………………………...

Address ………………………………………………………………………..

Telephone ……………………………………………………………………..

These following are an agreement between both sides

1. Responsibilities of side A: provide free of charge following services

   - Organise training WIPE (Work Improvement for Protection of Environment) for managers and representative workers from each department in the factory.
   - Measure work environment twice before and after one year and explain results to factory.
   - Follow up visits every 3 month to find out any health problem on working condition and give the suitable advices to factory.
   - Provide monthly report forms and pay for reporters every three months.

2. Responsibilities of side B:
   - Manager/owner himself/herself has to attend WIPE training course 1 day in full.
   - Choose key workers from each department and allow them to attend the WIPE training course with working salary on the training time.
   - Encourage workers apply group discussions and support them improve their working condition.
   - Accept work environment measurement and follow up visits with notices within for a month.
   - Assign a staff (health or safety personnel staff) to collect monthly data and report to Centre for Occupational Health and Environment of Cantho city every three months.

   We agreed these above items and no any single side can break this contract by any exception.

Side A	**Side B**
Director of ECHO (sign and stamp)	Manager/Owner of … (sign and stamp)

Appendix 10. Project contract for control factory

OCCUPATIONAL HEALTH INTERVENTION CONTRACT

On the date of / / 2007

We are:

Side A. Dr. Nam Phuong Nguyen,
Director of Centre for Occupational Health and Environment of Cantho city
Address 154 Nguyen An Ninh, Ninh Kieu district, Cantho city
Telephone [number],

And;
Side B. Mr/Ms ………………………………………………………………...

Manager/Owner of …………………………………………………………...

Address ……………………………………………………………………..

Telephone …………………………………………………………………..

These following are an agreement between both sides

3. Responsibilities of side A: provide free of charge following services

    - Organise health education depending on factory requirements.
    - Measure work environment twice before and after one year and explain results to factory.
    - Follow up visits every 3 month to find out any health problem on working condition and give suitable advices to factory.
    - Provide monthly report forms and pay for reports every three months.

4. Responsibilities of side B:

    - Accept work environment measurement and follow up visits with notice one month.
    - Encourage employees to improve their working condition.
    - Assign a staff (health or safety personnel staff) to collect monthly data and report to Centre for Occupational Health and Environment of Cantho city every three months.

We agreed these above items and no single side can break this contract by any exception.

Side A	**Side B**
Director of ECHO (sign and stamp)	Manager/Owner of … (sign and stamp)

Appendix 11. Questionnaire of the popularity of PAOT

1. Name of enterprise ……………………………..………………..Tel……………..
2. Address ……………………………………………………………………………
3. Production ………………………………………..……………………………..
4. Interviewee (top Manager) ………………………..……………………………..
5. The understanding of PAOT: Attended training course Just heard a little
   Do not know

After introducing and inviting the manager to join the PAOT programme. This is his/her decision:

6. **Agree to sign a contract to conduct the PAOT programme for my enterprise because:** (go to number 7 if you refuse to join the PAOT programme)
   6.1. PAOT programme brings benefit to my enterprise. Yes No
   6.2. PAOT programme protects general environment. Yes No
   6.3. PAOT programme brings benefit to your workers. Yes No
   6.4. PAOT programme improves working condition for my workers. Yes No
   6.5. PAOT programme brings social benefit to your enterprise. Yes No
   6.6. Join PAOT means that your enterprise applies national Labour Laws. Yes No
   6.7. You believe in the health staff who introducing this programme. Yes No
   6.8. Your enterprise may save budget for health and safety. Yes No
   6.9. PAOT could bring safer work condition and reduce accidents in your workplaces. Yes No
   6.10. PAOT could bring experience from other enterprises. Yes No
   6.11. Apply PAOT because of other reasons. Yes No
   Please specific …………………………………………………………………….
   ……………………………………………………………………………………

7. **Disagree to sign a contract to conduct the PAOT programme for my enterprise because:**
   7.1. Does the PAOT spend managers/owners time? Yes No
   7.2. Does the PAOT spend your workers' time? Yes No
   7.3. Do you distrust the advantages of the project to your enterprise? Yes No
   7.4. You do not understand clearly about this PAOT technique. Yes No
   7.5. The programme is not business related. Yes No
   7.6. Are work improvements expensive? Yes No
   7.7. You do not like many visitors to visit your enterprise. Yes No
   7.8. You like to focus on your business only. Yes No
   7.9. This PAOT offers advantages to workers only. Yes No
   7.10. This PAOT may give negative effects to your business. Yes No
   7.11. Your enterprise does not need any further improvement. Yes No
   7.12. Do not apply PAOT because of other reasons. Yes No

   Please specific ………………………………………………………………..

Thanks you very much

Appendix 12. Workers health status monthly report

Report from / / to / /

This form fills in by factory staff monthly

Name of factory ……………………………………………………… Address …………………………………..
Reporter ………………………………………………………… Phone number ……………………………

Month of report	No of workers	No of health visits	No of accidents	Accidents leading to absence from work	workers' total absence days	Total health costs	Remarks

- The report applies monthly and submits to ECHO quarterly.
- Health cost comprising cost of treatments, transportation, and gifts provided to patients during sickness.
- Any queries please call [number] Mr [name].

REPORTER

Appendix 13. Monthly report of workers' productivity and income

Report from / / to / /

Factory name.................................... Address …………………………… Telephone number ………………..

Sections/ department	No of workers	Productions	Workers’ average productivity	Workers’ incomes			Remarks
				Lowest	Highest	Average	

REPORTER

Appendix 14. Follow-up sheet for work improvement at factory

Report from / / to / /

Factory name.................................... Address …………………………… Telephone number ………………..

Name of improvement	**Cost (VND)**	**Re-use materials**	**No of workplaces affected**	**Authors/creator**			**Date of improvement**	**Remark**
				Manager	Technician, head section	Workers		
Planning for next term								

ECHO STAFF **REPORTER**

Appendix 15. Description of data collection for temperature, humidity and air velocity - printing-paper industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
1. HL printing Co.	Shutting boxes department	Large machine number 4	shut mc 4 m1 shut mc 4 m2 shut mc 4 a1 shut mc 4 a2
	Pressing paper department	Centre of Pressing paper department	press cen m1 press cen m2 press cen a1 press cen a2
	Printing department	Centre of Printing department	print cen m1 print cen m2 print cen a1 print cen a2
	Label pasting department	Centre of Label pasting department	label cen m1 label cen m2 label cen a1 label cen a2
	Gas furnace	Centre of Gas furnace	furnace cen m1 furnace cen m2 furnace cen a1 furnace cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
2. TH printing Co.	Printing and Shutting box department 1	Centre of Printing and Shutting box department 1	print1 cen m1 print1 cen m2 print1 cen a1 print1 cen a2
	Printing and Shutting box department 2	Centre of Printing and Shutting box department 2	print2 cen m1 print2 cen m2 print2 cen a1 print2 cen a2
	Label pasting department	Centre of Label pasting department	label cen m1 label cen m2 label cen a1 label cen a2
	Making paper departmethanh phongnt	Centre of Making paper department	make pap cen m1 make pap cen m2 make pap cen a1 make pap cen a2
	Waving paper department	Centre of Waving paper department	wave pap cen m1 wave pap cen m2 wave pap cen a1 wave pap cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables

Appendix 16. Description of data collection for temperature, humidity and air velocity - Civil engineering industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
3. CK TA civil engineering Co.	Welding section	Centre of Welding section	weld cen m1 weld cen m2 weld cen a1 weld cen a2
	Adaptor department	Centre of Adaptor department	adap cen m1 adap cen m2 adap cen a1 adap cen a2
	Machinery department	Centre of Machinery department	machry cen m1 machry cen m2 machry cen a1 machry cen a2
	Metal cutting department	Centre of Metal cutting department	cut cen m1 cut cen m2 cut cen a1 cut cen a 2
	Assembling department	Centre of Assembling department	assemb cen m1 assemb cen m2 assemb cen a1 assemb cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
4. CD TH civil engineering Co.	Machinery department A	Centre of Machinery department A	machryA cen m1 machryA cen m2 machryA cen a1 machryA cen a2
	Machinery department B	Centre of Machinery department B	machryB cen m1 machryB cen m2 machryB cen a1 machryB cen a2
	Assembling department	Centre of Assembling department	assemb cen m1 assemb cen m2 assemb cen a1 assemb cen a2
	Adaptor department	Centre of Adaptor department	adap cen m1 adap cen m2 adap cen a1 adap cen a2
	Welding section	Centre of Welding section	weld cen m1 weld cen m2 weld cen a1 weld cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
5. CD CT civil engineering Co.	Metal cutting department	Centre of Metal cutting department	cut cen m1 cut cen m2 cut cen a1 cut cen a2
	Welding section	Centre of Welding section	weld cen m1 weld cen m2 weld cen a1 weld cen a2
	Winding adaptor department	Centre of Winding adaptor department	wind cen m1 wind cen m2 wind cen a1 wind cen a2
	Adaptor department	Centre of Adaptor department	adap cen m1 adap cen m2 adap cen a1 adap cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
6. DN CN civil engineering Co.	Machinery department 1	Centre of Machinery department 1	machry1 cen m1 machry1 cen m2 machry1 cen a1 machry1 cen a2
	Machinery department 2	Centre of Machinery department 2	machry2 cen m1 machry2 cen m2 machry2 cen a1 machry2 cen a2
	Winding adaptor department	Centre of Winding adaptor department	wind cen m1 wind cen m2 wind cen a1 wind cen a2
	Adaptor department	Centre of Adaptor department	adap cen m1 adap cen m2 adap cen a1 adap cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Appendix 17. Description of data collection for temperature, humidity and air velocity - Metal casting industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
7. DT metal casting Co.	Aluminous smelting furnace	Centre of Aluminous smelting furnace	smelt cen m1 smelt cen m2 smelt cen a1 smelt cen a2
	Drilling department	Drilling machine number 7	drill mc 7 m1 drill mc 7 m2 drill mc 7 a1 drill mc 7 a2
	Grinding department	Centre of Grinding department	grind cen m1 grind cen m2 grind cen a1 grind cen a2
	Polishing department	Polishing machine number 3	polish mc 3 m1 polish mc 3 m2 polish mc 3 a1 polish mc 3 a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
8. NCT metal casting Co.	Cutting department	Centre of Cutting department	cut cen m1 cut cen m2 cut cen a1 cut cen a2
	Pressing material department	Centre of Pressing material department	press cen m1 press cen m2 press cen a1 press cen a2
	Forging department	Centre of Forging department	forge cen m1 forge cen m2 forge cen a1 forge cen a2
	Pressing bowl department	Centre of Pressing bowl department	press bowl cen m1 press bowl cen m2 press bowl cen a1 press bowl cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
9. CKSH metal casting Co.	Lathe department	Centre of Lathe department	lathe cen m1 lathe cen m2 lathe cen a1 lathe cen a2
	Moulding department	Centre of Moulding department	mould cen m1 mould cen m2 mould cen a1 mould cen a2
	Making mould section	Centre of Making mould section	make mould cen m1 make mould cen m2 make mould cen a1 make mould cen a2
	Smelting furnace	Centre of Smelting furnace	smelt cen m1 smelt cen m2 smelt cen a1 smelt cen a2
	Machinery department	Centre of Machinery department	machry cen m1 machry cen m2 machry cen a1 machry cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
10. TTC metal casting Co.	Machinery department 1	Centre of Machinery department 1	machry1 cen m1 machry1 cen m2 machry1 cen a1 machry1 cen a2
	Machinery department 2	Centre of Machinery department 2	machry2 cen m1 machry2 cen m2 machry2 cen a1 machry2 cen a2
	Making moulding section	Centre of Making moulding section	make mould cen m1 make mould cen m2 make mould cen a1 make mould cen a2
	Grinding department	Centre of Grinding department	grind cen m1 grind cen m2 grind cen a1 grind cen a2
	Copper smelting furnace	Centre of Copper smelting furnace	smelt cen m1 smelt cen m2 smelt cen a1 smelt cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Appendix 18. Description of data collection for temperature, humidity and air velocity -Garment industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
11. VT garment Co.	Sewing section 1	Sewing machine 28(c2)	sew1 mc 28(c2)m1 sew1 mc 28(c2)m2 sew1 mc 28(c2)a1 sew1 mc 28(c2)a2
	Sewing section 3	Sewing machine 132(c3)	sew3 mc 132(c3)m1 sew3 mc 132(c3)m2 sew3 mc 132(c3)a1 sew3 mc 132(c3)a2
	Sewing section 2 (C7-8)	Sewing machine 78(c7)	sew2 mc 78(c7)m1 sew2 mc 78(c7)m2 sew2 mc 78(c7)a1 sew2 mc 78(c7)a2
	Iron section	Table number 15U	iron tab 15u m1 iron tab 15u m2 iron tab 15u a1 iron tab 15u a2
	Cutting department	Table number 4C	cut tab 4c m1 cut tab 4c m2 cut tab 4c a1 cut tab 4c a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
12. HT garment Co.	Sewing section 1	Sewing machine 21(C7-8)	sew1 mc 21(c7-8)m1 sew1 mc 21(c7-8)m2 sew1 mc 21(c7-8)a1 sew1 mc 21(c7-8)a2
	Sewing section 2	Sewing machine 105(C5-6)	sew2 mc 105(c5-6)m1 sew2 mc 105(c5-6)m2 sew2 mc 105(c5-6)a1 sew2 mc 105(c5-6)a2
	Sewing section 3 (C1-2)	Sewing machine 173(C1-2)	sew3 mc 173(c1-2)m1 sew3 mc 173(c1-2)m2 sew3 mc 173(c1-2)a1 sew3 mc 173(c1-2)a2
	Finished product section	Table number 34	finish tab 34 m1 finish tab 34 m2 finish tab 34 a1 finish tab 34 a2
	Cutting department	Centre of Cutting department	cut cen m1 cut cen m2 cut cen a1 cut cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
13.MK Co.	Sewing section 2.1	Sewing machine 38	sew2.1 mc 38 m1 sew2.1 mc 38 m2 sew2.1 mc 38 a1 sew2.1 mc 38 a2
	Sewing section 2.2	Sewing machine 150	sew2.2 mc 150 m1 sew2.2 mc 150 m2 sew2.2 mc 150 a1 sew2.2 mc 150 a2
	Sewing section 2.3	Sewing machine 271	sew2.3 mc 271 m1 sew2.3 mc 271 m2 sew2.3 mc 271 a1 sew2.3 mc 271 a2
	Cutting department B	Centre of Cutting department	cut b cen m1 cut b cen m2 cut b cen a1 cut b cen a2
	Ironing and Quality control department B	Iron table B20	iron b tab b20 m1 iron b tab b20 m2 iron b tab b20 a1 iron b tab b20 a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
14. MTD garment Co.	Ironing and Quality control section F1	Ironing table 36(F1)	ironf1 tab 36(f1)m1 ironf1 tab 36(f1)m2 ironf1 tab 36(f1)a1 ironf1 tab 36(f1)a2
	Sewing section F2	Sewing machine 67(F2)	sewf2 mc 67(f2)m1 sewf2 mc 67(f2)m2 sewf2 mc 67(f2)a1 sewf2 mc 67(f2)a1
	Sewing section F4	Sewing machine 151(F4)	sewf4 mc 151(f4)m1 sewf4 mc 151(f4)m2 sewf4 mc 151(f4)a1 sewf4 mc 151(f4)a1
	Sewing section F5	Sewing machine 238(F5)	sewf5 mc 238(f5)m1 sewf5 mc 238(f5)m2 sewf5 mc 238(f5)a1 sewf5 mc 238(f5)a2
	Cutting department A (F1)	Centre of Cutting department A (F1)	cutA(f1) cen m1 cutA(f1) cen m2 cutA(f1) cen a1 cutA(f1) cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Appendix 19. Description of data collection for temperature, humidity and air velocity -Rice mill industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
15. CP NSTP CR rice mill Co.	Polishing rice department B	Machine number 3B	polishB mc 3b m1 polishB mc 3b m2 polishB mc 3b a1 polishB mc 3b a2
	Polishing rice department A	Machine number 4A	polishA mc 4a m1 polishA mc 4a m2 polishA mc 4a a1 polishA mc 4a a2
	Rice packing department C	Machine number 3C	packC mc 3c m1 packC mc 3c m2 packC mc 3c a1 packC mc 3c a2
	Bran collecting section D	Cyclone number 2D	bran cyclo 2d m1 bran cyclo 2d m2 bran cyclo 2d a1 bran cyclo 2d a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
16. MP rice mill Co.	Polishing rice section 1	Machine number BVN4	polish1 mc bvn4 m1 polish1 mc bvn4 m2 polish1 mc bvn4 a1 polish1 mc bvn4 a2
	Polishing rice section 2	Machine BVN number 10	polish2 mc bvn10 m1 polish2 mc bvn10 m2 polish2 mc bvn10 a1 polish2 mc bvn10 a2
	Rice packing section	Machine HG-15	pack mc hg15 m1 pack mc hg15 m2 pack mc hg15 a1 pack mc hg15 a2
	Bran collecting section	Large cyclone number 3	bran cyclo 3 m1 bran cyclo 3 m2 bran cyclo 3 a1 bran cyclo 3 a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Factory	*Department*[a]	*Sampling spots/ job title*	*Shorthand description*[a]
17. TT CD CD rice mill Co.	Polishing rice department 1	Machine number DB-3	polish1 mc db3 m1 polish1 mc db3 m2 polish1 mc db3 a1 polish1 mc db3 a2
	Polishing rice department 2	Machine number DB-10	polish2 mc db10 m1 polish2 mc db10 m2 polish2 mc db10 a1 polish2 mc db10 a2
	Storage	Rice spot number 3	storage spot 3 m1 storage spot 3 m2 storage spot 3 a1 storage spot 3 a2
	Final Polishing department	Machine number DBX-18	finalpoli mc dbx18 m1 finalpoli mc dbx18 m2 finalpoli mc dbx18 a1 finalpoli mc dbx18 a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
18. MK rice mill Co.	Polishing department 1	Machine number LB-3	polish1 mc lb3 m1 polish1 mc lb3 m2 polish1 mc lb3 a1 polish1 mc lb3 a2
	Polishing department 2	Machine number LB-11	polish2 mc lb11 m1 polish2 mc lb11 m2 polish2 mc lb11 a1 polish2 mc lb11 a2
	Rice packing department	Rice packing machine number 18	pack mc 18 m1 pack mc 18 m2 pack mc 18 a1 pack mc 18 a2
	Bran collecting section	Centre of Bran collecting section	bran cen m1 bran cen m2 bran cen a1 bran cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
19. TP rice mill Co.	Rice packing department zone 1	Machine number 3-1	pack1 mc3-1 m1 pack1 mc3-1 m2 pack1 mc3-1 a1 pack1 mc3-1 a2
	Bran collecting section zone 1	Old cyclone number 8-1	bran1 cyclo 8-1 m1 bran1 cyclo 8-1 m2 bran1 cyclo 8-1 a1 bran1 cyclo 8-1 a2
	Rice drying section zone 1	Drying spot number 5	dry1 spot 5 m1 dry1 spot 5 m2 dry1 spot 5 a1 dry1 spot 5 a2
	Rice input section zone 1	Rice input door C-1	input1 door c1 m1 input1 door c1 m2 input1 door c1 a1 input1 door c1 a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2
20. DNTN TT CD rice mill Co.	Polishing rice zone A	Machine number BVN4	polishA mc bvn4 m1 polishA mc bvn4 m2 polishA mc bvn4 a1 polishA mc bvn4 a2
	Polishing rice zone B	Machine number BVN10	polishB mc bvn10 m1 polishB mc bvn10 m2 polishB mc bvn10 a1 polishB mc bvn10 a2
	Rice packing zone	Machine number HG 3	pack mc hg3 m1 pack mc hg3 m2 pack mc hg3 a1 pack mc hg3 a2
	Bran collecting zone	Centre of Bran collecting zone	bran cen m1 bran cen m2 bran cen a1 bran cen a2
	Outside factory	Outside the front door of factory	outside m1 outside m2 outside a1 outside a2

[a] *At each spot two samples in the morning (m1 and m2) and the other two in the afternoon (a1 and a2) were collected for three variables*

Appendix 20. Description of data collection for lighting samples -Printing and paper industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
1. HL printing Co.	Shutting boxes department	Large machine number 1	shut mc 1
		Large machine number 2	shut mc 2
		Large machine number 3	shut mc 3
		Small machine number 4	shut mc 4
		Small machine number 5	shut mc 5
	Pressing paper department	Pressing machine number 6	press mc 6
		Pressing machine number 7	press mc 7
		Pressing machine number 8	press mc 8
		Pressing machine number 9	press mc 9
		Small machine number 10	press mc 10
	Printing department	Printing offset machine O1	print mc O1
		Printing offset machine O2	print mc O2
		Printing offset machine O3-1	print mc O3-1
		Printing offset machine O3-2	print mc O3-2
		Centre of department	print cen
	Label pasting department	Team A	label team a
		Team B	label team b
		Team C	label team c
		Team D	label team d
		Team E	label team e
	Gas furnace	Working table, spot 1	furnace tab spot 1
		Watching point 3	furnace watch spot 3
		Watching point 4	furnace watch spot 4
		Working table, spot 2	furnace tab spot 2
		Centre of department	furnace cen
2. TH printing Co.	Printing and Shutting box department 1	Machine number 2	print1 mc 2
		Machine number 4	print1 mc 4
		Machine number 5	print1 mc 5
		Machine number 6	print1 mc 6
		Centre of department	print1 cen
	Printing and Shutting box department 2	Machine number 7	print2 mc 7
		Machine number 9	print2 mc 9
		Machine number 10	print2 mc 10
		Machine number 11	print2 mc 11
		Centre of department	print2 cen
	Label pasting department	Job number 1	label job 1
		Job number 2	label job 2
		Job number 3	label job 3
		Job number 4	label job 4
		Centre of department	label cen
	Making paper department	Machine number SG1	make pap mc sg1
		Machine number SG2	make pap mc sg2
		Machine number SG3-1	make pap mc sg3-1
		Machine number SG3-2	make pap mc sg3-2
		Centre of department	make pap cen
	Waving paper department	Job number 1	wave pap job 1
		Job number 2	wave pap job 2
		Job number 3	wave pap job 3
		Job number 4	wave pap job 4
		Centre of department	wave pap cen

[a] *At each spot one sample was collected*

Appendix 21. Description of data collection for lighting samples -Civil engineering industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
3. CK TA civil engineering Co.	Welding section	Job welding pipe HO1	weld job ho1
		Job welding bar HT2	weld job ht2
		Job welding box HH3	weld job hh3
		Job welding column HC4	weld job hc4
		Centre of department	weld cen
	Adaptor department	Winding machine number 1	adap mc 1
		Winding machine number 2	adap mc 2
		Winding machine number 3	adap mc 3
		Winding machine number 4	adap mc 4
		Centre of department	adap cen
	Machinery department	Screw-Lathe machine 2	machry mc 2
		Auto-Lathe machine PC4	machry mc pc4
		Lathe machine 5	machry mc 5
		Lathe machine 6	machry mc 6
		Lathe machine 7	machry mc 7
	Metal cutting department	Small machine number N1	cut mc n1
		Large machine L2 spot 1	cut mc L2-1
		Large machine L2 spot 2	cut mc L2-2
		Small machine number N3	cut mc n3
		Centre of department	cut cen
	Assembling department	Job frame group 1	assemb frame 1
		Job machinery, group 1	assemb machry gr 1
		Job machinery, group 2	assemb machry gr 2
		Job operation	assemb opera
		Centre of department	assemb cen
4. CD TH civil engineering Co.	Machinery department A	Lathe machine 1A	machryA mc 1a
		Lathe machine 3A	machryA mc 3a
		Lathe machine 4A	machryA mc 4a
		Large lathe machine 5A	machryA mc 5a
		Centre of department	machryA cen
	Machinery department B	Lathe machine 6B	machryB mc 6b
		Lathe machine 8B	machryB mc 8b
		Lathe machine 10B	machryB mc 10b
		Auto-Lathe machine 12B	machryB mc 12b
		Centre of department	machryB cen
	Assembling department	Team 1	assemb team 1
		Team 2	assembl team 2
		Team 3	assembl team 3
		Team 4	assembl team 4
		Centre of department	assemb cen
	Adaptor department	Machine number 1	adap mc 1
		Machine number 2	adap mc 2
		Machine number 3	adap mc 3
		Machine number 4	adap mc 4
		Centre of department	adap cen
	Welding section	Team 1	weld team 1
		Team 2	weld team 2
		Team 3	weldteam 3
		Team 4	weld team 4
		Centre of department	weld cen

[a] *At each spot one sample was collected*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
5. CD CT civil engineering Co.	Metal cutting department	Large machine CSL22 spot 1	cut mc CSL22-1
		Large machine CSL22 spot 2	cut mc CSL22-2
		Machine CS11	cut mc CS11
		Machine number CS41	cut mc CS41
		Centre of department	cut cen
	Welding section	Welding box, job 2B	weld box job 2b
		Welding column 1, job 2C	weld col 1 job 2c
		Welding column 2, job 3C	weld col 2 job 3c
		Welding column 2, job 5C	weld col 3 job 5c
		Centre of department	weld cen
	Winding adaptor department	Auto-Winding machine TD1	wind mc td1
		Winding machine QD2	wind mc qd2
		Large machine L33 spot 1	wind mc L33-1
		Large machine L33 spot 2	wind mc L33-2
		Centre of department	wind cen
	Adaptor department	Team 1	adap team 1
		Team 2	adap team 2
		Team 3	adap team 3
		Team 4	adap team 4
		Centre of department	adap cen
6. DN CN civil engineering Co.	Machinery department 1	Lathe machine T1	machry1 mc t1
		Lathe machine T2	machry1 mc t2
		Lathe machine T3	machry1 mc t3
		Cutting machine C4	machry1 mc c4
		Centre of department	machry1 cen
	Machinery department 2	Lathe machine T5	machry2 mc t5
		Lathe machine T7	machry2 mc t7
		Lathe machine T8	machry2 mc t8
		Cutting machine C9	machry2 mc c9
		Centre of department	machry2 cen
	Winding adaptor department	Machine number 1	wind mc 1
		Auto-machine TD2	wind mc td2
		Machine number 3	wind mc 3
		Manual machine 4	wind mc 4
		Centre of department	wind cen
	Adaptor department	Team 1	adap team 1
		Team 2	adap team 2
		Team 3	adap team 3
		Team 4	adap team 4
		Centre of department	adap cen

[a] *At each spot one sample was collected*

Appendix 22. Description of data collection for lighting samples - Metal casting industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
7. DT metal casting Co.	Aluminous smelting furnace	Job Smelter 1	smelt smelter 1
		Job Pouring worker 2	smelt pour 2
		Job Moulding worker 3	smelt mould 3
		Job Moulding worker 4	smelt mould 4
		Centre of department	smelt cen
	Drilling department	Machine number 06	drill mc 06
		Machine number 07	drill mc 07
		Machine number 08	drill mc 08
		Machine number 09	drill mc 09
		Centre of department	drill cen
	Grinding department	Large machine number 1L	grind mc 1L
		Large machine number 3L	grind mc 3L
		Small machine number 4N	grind mc 4n
		Small machine number 5N	grind mc 5n
		Centre of department	grind cen
	Polishing department	Sitting machine 01	polish mc 01
		Machine number 02	polish mc 02
		Machine number 03	polish mc 03
		Machine number 04	polish mc 04
		Machine 05	polish mc 05
8. NCT metal casting Co.	Cutting department	Round machine 1T	cut mc 1t
		Small machine number 2N	cut mc 2n
		Round machine 3T	cut mc 3t
		Large machine number 4L	cut mc 4L
		Centre of department	cut cen
	Pressing material department	Machine number 5N	press mc 5n
		Machine number 6N	press mc 6n
		Machine number 7L	press mc 7L
		Machine number 8N	press mc 8n
		Centre of department	press cen
	Forging department	Machine number 10L	forge mc 10L
		Small machine number 12L	forge mc 12L
		Large machine number 14L	forge mc 14L
		Large machine number 16L	forge mc 16L
		Centre of department	forge cen
	Pressing bowl department	Pressing machine 17E	press bowl mc 17e
		Pressing machine 18E	press bowl mc 18e
		Pressing machine 19E	press bowl mc 19e
		Pressing machine 20E	press bowl mc 20e
		Centre of department	press bowl cen

[a] *At each spot one sample was collected*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
9. CKSH metal casting Co.	Lathe department	Machine number T7	lathe mc t7
		Machine number T9	lathe mc t9
		Machine number T11	lathe mc t11
		Machine number T12	lathe mc t12
		Centre of department	lathe cen
	Moulding department	Spot left 1	mould spot left 1
		Spot left 2	mould spot left 2
		Spot right 3	mould spot right 3
		Spot right 4	mould spot right 4
		Centre of department	mould cen
	Making mould section	Spot left 1	makemould left 1
		Spot left 2	makemould left 2
		Spot right 3	makemould right 3
		Spot right 4	makemould right 4
		Centre of department	makemould cen
	Smelting furnace	Smelter 1	smelt smelter 1
		Smelter 2 job 1	smelt smelter 2-1
		Smelter 2 job 2	smelt smelter 2-2
		Pouring worker job 2	smelt pour 2
		Centre of department	smelt cen
	Machinery department	Machine number T1	machry mc t1
		Machine number T2	machry mc t2
		Machine number T3	machry mc t3
		Machine number TTD4	machry mc ttd4
		Machine number TTD5	machry mc ttd5
10. TTC metal casting Co.	Machinery department 1	Machine number 1	machry1 mc 1
		Machine number 2	machry1 mc 2
		Machine number 3	machry1 mc 3
		Machine number 4	machry1 mc 4
		Centre of department	machry1 cen
	Machinery department 2	Machine number 5	machry2 mc 5
		Machine number 6	machry2 mc 6
		Machine number 7	machry2 mc 7
		Machine number 8	machry2 mc 8
		Centre of department	machry2 cen
	Making moulding section	Making mould press 1	makemould pres 1
		Making mould press 2	makemould pres 2
		Making mould press 3	makemould pres 3
		Dry mould job 4	makemould dry 4
		Dry mould job 5	makemould dry 5
	Grinding department	Old machine 1	grind mc 1
		New machine number 3	grind mc 3
		New machine number 5	grind mc 5
		New machine number 6	grind mc 6
		Centre of department	grind cen
	Copper smelting furnace	Smelter 1	smelt smelter 1
		Smelter 2	smelt smelter 2
		Pouring 3	smelt pour 3
		Pouring 4	smelt pour 4
		Centre of department	smelt cen

[a] *At each spot one sample was collected*

Appendix 23. Description of data collection for lighting samples -Garment industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
11. VT garment Co.	Sewing section 1	Sewing machine 1(C1)	sew1 mc 1(c1)
		Sewing machine 5(C1)	sew1 mc 5(c1)
		Sewing machine 28(C2)	sew1 mc 28(c2)
		Sewing machine 30(C2)	sew1 mc 30(c2)
		Sewing machine 45(C3)	sew1 mc 45(c3)
	Sewing section 3	Sewing machine 107(C3)	sew3 mc 107(c3)
		Sewing machine 130(C3)	sew3 mc 130(c3)
		Sewing machine 132(C3)	sew3 mc 132(c3)
		Sewing machine 145(C3)	sew3 mc 145(c3)
		Sewing machine 150(C3)	sew3 mc 150(c3)
	Sewing section 2 (C7-8)	Sewing machine 53(C7)	sew2 mc 53(c7)
		Sewing machine 75(C7)	sew2 mc 75(c7)
		Sewing machine 78(C8)	sew2 mc 78(c8)
		Sewing machine 92(C8)	sew2 mc 92(c8)
		Sewing machine 98(C8)	sew2 mc 98(c8)
	Iron section	Ironing table 3U	iron tab 3u
		Ironing table 12U	iron tab 12u
		Ironing table 15U	iron tab 15u
		Ironing table 22U	iron tab 22u
		Ironing table 29U	iron tab 29u
	Cutting department	Cutting table 1C	cut tab 1c
		Cutting table 3C	cut tab 3c
		Cutting table 4C	cut tab 4c
		Cutting table 5C	cut tab 5c
		Cutting table 6C	cut tab 6c
12. HT garment Co.	Sewing section 1	Sewing machine 4(C7-8)	sew1 mc 4(c7-8)
		Sewing machine 21(C7-8)	sew1 mc 21(c7-8)
		Sewing machine 38(C7-8)	sew1 mc 38(c7-8)
		Sewing machine 42(C7-8)	sew1 mc 42(c7-8)
		Sewing machine 80(C7-8)	sew1 mc 80(c7-8)
	Sewing section 2	Sewing machine 85(C5-6)	sew2 mc 85(c5-6)
		Sewing machine 105(C5-6)	sew2 mc 105(c5-6)
		Sewing machine 116(C5-6)	sew2 mc 116(c5-6)
		Sewing machine 122(C5-6)	sew2 mc 122(c5-6)
		Sewing machine 158(C5-6)	sew2 mc 158(c5-6)
	Sewing section 3 (C1-2)	Sewing machine 164(C1-2)	sew3 mc 164(c1-2)
		Sewing machine 173(C1-2)	sew3 mc 173(c1-2)
		Sewing machine 181(C1-2)	sew3 mc 181(c1-2)
		Sewing machine 185(C1-2)	sew3 mc 185(c1-2)
		Sewing machine 201(C1-2)	sew3 mc 201(c1-2)
	Finished product section	Table 2	finish tab 2
		Table 16	finish tab 16
		Table 32	finish tab 32
		Table 58	finish tab 58
		Table 65	finish tab 65
	Cutting department	Cutting table A1	cut tab a1
		Cutting table A2	cut tab a3
		Cutting table A5	cut tab a5
		Cutting table B5	cut tab b5
		Cutting table B1	cut tab b1

[a] *At each spot one sample were collected*

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
13. MMK Co.	Sewing section 2.1	Sewing machine 6	sew2.1 mc 6
		Sewing machine 38	sew2.1 mc 38
		Sewing machine 45	sew2.1 mc 45
		Sewing machine 65	sew2.1 mc 65
		Sewing machine 118	sew2.1 mc 118
	Sewing section 2.2	Sewing machine 124	sew2.2 mc 124
		Sewing machine 151	sew2.2 mc 151
		Sewing machine 172	sew2.2 mc 172
		Sewing machine 183	sew2.2 mc 183
		Sewing machine 236	sew2.2 mc 236
	Sewing section 2.3	Sewing machine 244	sew2.3 mc 244
		Sewing machine 253	sew2.3 mc 253
		Sewing machine 278	sew2.3 mc 278
		Sewing machine 288	sew2.3 mc 288
		Sewing machine 294	sew2.3 mc 294
	Cutting department B	Cutting table 6	cutB tab 6
		Cutting table 7	cutB tab 7
		Cutting table 8	cutB tab 8
		Cutting table 9	cutB tab 9
		Cutting table 10	cutB tab 10
	Ironing and Quality control department B	Checking table B2	ironB tab b2
		Checking table B15	ironB tab b15
		Checking table B21	ironB tab b21
		Checking table B28	ironB tab b28
		Checking table B35	ironB tab b35
14. MTD garment Co.	Ironing and Quality control section F1	Ironing table 2	iron tab 2
		Ironing table 15	iron tab 15
		Ironing table 35	iron tab 35
		Ironing table 63	iron tab 63
		Ironing table 73	iron tab 73
	Sewing section F2	Sewing machine 8(F2)	sewf2 mc 8(f2)
		Sewing machine 18(F2)	sewf2 mc 18(f2)
		Sewing machine 67(F2)	sewf2 mc 67(f2)
		Sewing machine 85(F2)	sewf2 mc 85(f2)
		Sewing machine 101(F2)	sewf2 mc 101(f2)
	Sewing section F4	Sewing machine 105(F4)	sewf4 mc 105(f4)
		Sewing machine 122(F4)	sewf4 mc 122(f4)
		Sewing machine 151(F4)	sewf4 mc 151(f4)
		Sewing machine 178(F4)	sewf4 mc 178(f4)
		Sewing machine 196(F4)	sewf4 mc 196(f4)
	Sewing section F5	Sewing machine 203(F5)	sewf5 mc 203(f5)
		Sewing machine 220(F5)	sewf5 mc 220(f5)
		Sewing machine 238(F5)	sewf5 mc 238(f5)
		Sewing machine 270(F5)	sewf5 mc 270(f5)
		Sewing machine 287(F5)	sewf5 mc 287(f5)
	Cutting department A (F1)	Cutting table 2A	cutA(f1) tab 2a
		Cutting table 6A	cutA(f1) tab 6a
		Cutting table 8A	cutA(f1) tab 8a
		Cutting table 10A	cutA(f1) tab 10a
		Cutting table 12A	cutA(f1) tab 12a

[a] *At each spot one sample were collected*

Appendix 24. Description of data collection for lighting samples -Rice mill industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
15. CP NSTP CR rice mill Co.	Polishing rice department B	Machine number 1B	polishB mc 1b
		Machine number 3B	polishB mc 3b
		Machine number 4B	polishB mc 4b
		Machine number 6B	polishB mc 6b
		Machine number 7B	polishB mc 7b
	Polishing rice department A	Machine number 1A	polishA mc 1a
		Machine number 3A	polishA mc 3a
		Machine number 4A	polishA mc 4a
		Machine number 6A	polishA mc 6a
		Machine number 7A	polishA mc 7a
	Rice packing department C	Machine number 2C	packC mc 2c
		Machine number 3C	packC mc 3c
		Machine number 4C	packC mc 4c
		Machine number 5C	packC mc 5c
		Machine number 6C	packC mc 6c
	Bran collecting section D	Cyclone number 1D	bran cyclo 1d
		Cyclone number 2D	bran cyclo 2d
		Cyclone number 3D	bran cyclo 3d
		Cyclone number 4D	bran cyclo 4d
		Centre of department	bran cen
16. MP rice mill Co.	Polishing rice section 1	Machine number BVN 1	polish1 mc bvn1
		Machine number BVN 3	polish1 mc bvn3
		Machine number BVN 4	polish1 mc bvn4
		Machine number BVN 5	polish1 mc bvn5
		Machine number BVN 6	polish1 mc bvn6
	Polishing rice section 2	Machine number BVN 7	polish2 mc bvn7
		Machine number BVN 9	polish2 mc bvn9
		Machine number BVN 10	polish2 mc bvn10
		Machine number BVN 11	polish2 mc bvn11
		Machine number BVN 10	polish2 mc bvn12
	Rice packing section	Machine HG-13	pack mc hg13
		Machine HG-14	pack mc hg14
		Machine HG-15	pack mc hg15
		Machine HG-16	pack mc hg16
		Machine HG-17	pack mc hg17
	Bran collecting section	Fine grain cyclone 1	bran cyclo 1
		Large cyclone number 2	bran cyclo 2
		Large cyclone number 3	bran cyclo 3
		Large cyclone number 4	bran cyclo 4
		Between cyclone 2&3	bran cen
17. TT CD CD rice mill Co.	Polishing rice department 1	Machine number DB-2	polish1 mc db2
		Machine number DB-3	polish1 mc db3
		Machine number DB-4	polish1 mc db4
		Machine number DB-6	polish1 mc db6
		Machine number DB-7	polish1 mc db7
	Polishing rice department 2	Machine number DB-9	polish2 mc db9
		Machine number DB-10	polish2 mc db10
		Machine number DB-11	polish2 mc db11
		Machine number DB-12	polish2 mc db12
		Machine number DB-13	polish2 mc db13
	Storage	Spot 1	storage spot 1
		Spot 2	storage spot 2
		Spot 3	storage spot 3
		Spot 4	storage spot 4
		Centre of department	storage cen
	Final polish department	Machine number DBX-15	finalpoli mc dbx15
		Machine number DBX-17	finalpoli mc dbx17
		Machine number DBX-18	finalpoli mc dbx18
		Machine number DBX-19	finalpoli mc dbx19
		Machine number DBX-21	finalpoli mc dbx21

Factory	*Department*[a]	*Sampling spots/ job title*	*Shorthand description*[a]
18. MK rice mill Co.	Polishing department 1	Machine number LB-1	polish1 mc lb1
		Machine number LB-3	polish1 mc lb3
		Machine LB number LB-4	polish1 mc lb4
		Machine number LB-5	polish1 mc lb5
		Machine LB number LB-6	polish1 mc lb6
	Polishing department 2	Machine number LB-8	polish2 mc lb8
		Machine number LB-10	polish2 mc lb10
		Machine LB number LB-11	polish2 mc lb11
		Machine number LB-12	polish2 mc lb12
		Machine LB number LB-14	polish2 mc lb14
	Rice packing department	Rice packing number 15	pack mc 15
		Rice packing number 17	pack mc 17
		Rice packing number 18	pack mc 18
		Rice packing number 19	pack mc 19
		Rice packing number 20	pack mc 20
	Bran collecting section	Cyclone number CT 1	bran cyclo ct1
		Cyclone number CT 2	bran cyclo ct2
		Cyclone number CT 3	bran cyclo ct3
		Cyclone number CM 4	bran cyclo cm4
		Centre of department	bran cen
19. NSTP CR rice mill Co.	Rice packing department zone 1	Machine number 1-1	pack1 mc 1-1
		Machine number 3-1	pack1 mc 3-1
		Machine number 4-1	pack1 mc 4-1
		Machine number 5-1	pack1 mc 5-1
		Machine number 6-1	pack1 mc 6-1
	Bran collecting section zone 1	Old cyclone number 7-1	bran1 cyclo 7-1
		Cyclone number 8-1	bran1 cyclo 8-1
		Large cyclone number 9-1	bran1 cyclo 9-1
		Large cyclone number 10-1	bran1 cyclo 10-1
		Centre of department	bran1 cen
	Rice drying section zone 1	Spot 1	dry1 spot 1
		Spot 2	dry1 spot 2
		Spot 3	dry1 spot 3
		Spot 4	dry1 spot 4
		Spot 5	dry1 spot 5
	Rice input section zone 1	Rice input door A-1	input1 door a1
		Rice input door C-1	input1 door c1
		Rice input door D-1	input1 door d1
		Rice input door E-1	input1 door e1
		Rice input door F-1	input1 door f1
20. DNTN TT rice mill Co.	Polishing rice zone A	Machine number BVN1	polishA mc bvn1
		Machine number BVN2	polishA mc bvn2
		Machine number BVN3	polishA mc bvn3
		Machine number BVN4	polishA mc bvn4
		Machine number BVN6	polishA mc bvn6
	Polishing rice zone B	Machine number BVN7	polishB mc bvn7
		Machine number BVN8	polishB mc bvn8
		Machine number BVN9	polishB mc bvn9
		Machine number BVN10	polishB mc bvn10
		Machine number BVN12	polishB mc bvn12
	Rice packing zone	Machine number HG 1	pack mc hg1
		Machine number HG 3	pack mc hg3
		Machine number HG 4	pack mc hg4
		Machine number HG 5	pack mc hg5
		Machine number HG 6	pack mc hg6
	Bran collecting zone	Large cyclone number 1	bran cyclo 1
		Large cyclone number 2	bran cyclo 2
		Cyclone number 3	bran cyclo 3
		Cyclone number 4	bran cyclo 4
		Centre of department	bran cen

[a] *At each spot one sample were collected*

Appendix 25. Description of data collection for noise samples -Printing -paper industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
1. HL printing Co.	Shutting boxes department	Large machine number 1	shut mc 1
		Large machine number 3	shut mc 3
		Small machine number 5	shut mc 5
	Pressing paper department	Pressing machine number 6	press mc 6
		Pressing machine number 8	press mc 8
		Small machine number 10	press mc 10
	Printing department	-Machine O1	print mc O1
		-Machine O2	print mc O2
		-Machine O3	print mc O3
	Label pasting department	Team A, job number 2	label team a2
		Team C, job number 4	label team c4
		Team E, job number 3	label team e3
	Gas furnace	Spot 1	furnace spot1
		Spot 2	furnace spot2
		Spot 3	furnace spot3
2. TH printing Co.	Printing and Shutting box department 1	Machine number 2	print1 mc 2
		Machine number 4	print1 mc 4
		Machine number 6	print1 mc 6
	Printing and Shutting box department 2	Machine number 7	print2 mc 7
		Machine number 9	print2 mc 9
		Machine number 11	print2 mc 11
	Label pasting department	Job number 1	label job 1
		Job number 2	label job 2
		Job number 4	label job 4
	Making paper department	Machine SG1	make pap mc sg1
		Machine SG2	make pap mc sg2
		Machine SG3	make pap mc sg3
	Waving paper department	Job number 1	wave pap job1
		Job number 2	wave pap job2
		Job number 3	wave pap job3

[a] One ten minute sample at each spot

Appendix 26. Description of data collection for noise samples -Civil engineer industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
3. CK TA civil engineering Co.	Welding section	Job welding pipe HO1	weld job ho1
		Job welding bar HT2	weld job ht2
		Job welding box HH3	weld job hh3
	Adaptor department	Machine 1	adapt mc1
		Machine 3	adap mc 3
		Machine 4	adapt mc 4
	Machinery department	Screw-Lathe machine 2	machry mc 2
		Auto-Lathe machine PC4	machry mc pc4
		Large-Lathe machine 7	machry mc 7
	Metal cutting department	Small machine N1	cut mc N1
		Small machine L2	cut mc L2
		Small machine N3	cut mc N3
	Assembling department	Job frame, group 2	assemb frame gr2
		Job machinery, group 3	assemb machry gr3
		Job operation, group 1	assemb operat gr1
4. CD TH civil engineering Co.	Machinery department A	Lathe machine 1A	machryA mc 1a
		Lathe machine 4A	machryA mc 4a
		Large lathe machine 5A	machryA mc 5a
	Machinery department B	Lathe machine 8B	machryB mc 8b
		Lathe machine 10B	machryB mc 10b
		Auto-Lathe machine 12B	machryB mc12b
	Assembling department	Team 1	assemb team 1
		Team 3	assemb team 3
		Team 4	assemb team 4
	Adaptor department	Machine 2	adap mc 2
		Machine 3	adap mc 3
		Machine 4	adap mc 4
	Welding section	Team 1, job number 1	weld team 1-1
		Team 3, job number 3	weld team 3-3
		Team box, job number 2B	weld team 2b
5. CD CT civil engineering Co.	Metal cutting department	Large machine CSL22	cut mc csl22
		Machine CS11	cut mc cs11
		Small machine number CS41	cut mc cs41
	Welding section	Welding box, job 2B	weldbox job2b
		Welding column 1, job 2C	weldcolum1 job2c
		Welding column 2, job 3C	weldcolum2 job3c
	Winding adaptor department	Auto-Winding machine TD1	wind mc td1
		Winding adaptor job QD2	wind mc qd2
		Large machine number L33	wind mc L33
	Adaptor department	Team 1	adapt team 1
		Team 2	adapt team 2
		Team 4	adapt team 4
6. DN CN civil engineering Co.	Machinery department 1	Lathe machine 1	machry1 mc 1
		Lathe machine 2	machry1 mc 2
		Cutting machine 4	machry1 mc 4
	Machinery department 2	Lathe machine T5	machry2 mc t5
		Lathe machine T7	machry2 mc t7
		Cutting machine C9	machry2 mc c9
	Winding adaptor department	Machine number 1	wind mc 1
		Auto-machine 2	wind mc 2
		Manual machine 4	wind mc 4
	Adaptor department 4	Team 1	adapt4 team 1
		Team 2	adapt4 team 2
		Team 3	adapt4 team 3

[a] One ten minute sample at each spot

Appendix 27. Description of data collection for noise samples -Metal casting industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
7. DT metal casting Co.	Aluminous smelting furnace	Job Smelter 1	smelt smelter job1
		Job Pouring worker 2	smelt pour job2
		Job Moulding worker 4	smelt mould job4
	Drilling department	Machine 6	drill mc 6
		Machine 8	drill mc 8
		Machine 9	drill mc 9
	Grinding department	Large machine number 1L	grind mc 1L
		Large machine number 3L	grind mc 3L
		Small machine number 5N	grind mc 5N
	Polishing department	Sitting machine 01	polish mc 01
		Machine number 03	polish mc 03
		Machine 05	polish mc 05
8. NCT metal casting Co.	Cutting department	Round machine 1T	cut mc 1t
		Small machine number 2N	cut mc 2n
		Large machine number 4L	cut mc 4L
	Pressing material department	Machine number 5N	press mc 5n
		Machine number 6N	press mc 6n
		Machine number 7L	press mc 7L
	Forging department	Machine number 10L	forge mc 10L
		Small machine number 12L	forge mc 12L
		Large machine number 14L	forge mc 14L
	Pressing bowl department	Machine 17E	press bowl mc 17e
		Machine 18E	press bowl mc 18e
		Machine 19E	press bowl mc 19e
9. CKSH metal casting Co.	Lathe department	Machine T7	lathe mc t7
		Machine T9	lathe mc t9
		Machine T11	lathe mc t11
	Moulding department	Change mould job 1TK	mould chang job 1tk
		Remove mould job 4TK	mould remo job 4tk
		Carry semi product job 3	mould carry job 3
	Making mould section	Making mould job K1	make mould job k1
		Making mould job K4	make mould job k4
		Drying mould job PK3	make mould job pk3
	Smelting furnace	Smelter 1	smelt smelter job 1
		Smelter 2	smelt smelter job 2
		Pouring worker job 2	smelt pour job 2
	Machinery department	Machine T1	machry mc t1
		Machine T3	machry mc t3
		Machine TTD4	machry mc ttd4
10. TTC metal casting Co.	Machinery department 1	Machine 2	machry1 mc 2
		Machine 3	machry1 mc 3
		Machine 4	machry1 mc 4
	Machinery department 2	Machine 5	machry2 mc 5
		Machine 6	machry2 mc 6
		Machine 7	machry2 mc 7
	Making moulding section	Making mould job 3	make mould job 3
		Making mould job 1	make mould job 1
		Drying mould job 5	make drymould job5
	Grinding department	Old machine 1	grind mc 1
		New machine number 3	grind mc 3
		New machine number 6	grind mc 6
	Copper smelting furnace	Smelter 1	smelt smelter job 1
		Pouring worker 2	smelt pour job 2
		Moulding worker 3	smelt mould job 3

[a] One ten minute sample at each spot

Appendix 28. Description of data collection for noise samples -Garment industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
11. VT garment Co.	Sewing section 1	Sewing machine 5 (C1)	sew1 mc 5(c1)
		Sewing machine 30 (C2)	sew1 mc 30(c2)
		Sewing machine 45 (C3)	sew1 mc 45(c3)
	Sewing section 3	Sewing machine 107 (C3)	sew3 mc 107(c3)
		Sewing machine 130 (C3)	sew3 mc 130(c3)
		Sewing machine 150 (C3)	sew3 mc 150(c3)
	Sewing section 2 (C7-8)	Sewing machine 53 (C7)	sew2 mc 53(c7)
		Sewing machine 75 (C7)	sew2 mc 75(c7)
		Sewing machine 98 (C8)	sew2 mc 98(c8)
	Iron section	Ironing table 3U	iron tab 3u
		Ironing table 12U	iron tab 12u
		Ironing table 29U	iron tab 29u
	Cutting department	Cutting table 1C	cut tab 1c
		Cutting table 3C	cut tab 3c
		Cutting table 6C	cut tab 6c
12. HT garment Co.	Sewing section 1	Sewing machine 4(C7-8)	sew1 mc 4(c7-8)
		Sewing machine 38(C7-8)	sew1 mc 38(c7-8)
		Sewing machine 63(C7-8)	sew1 mc 63(c7-8)
	Sewing section 2	Sewing machine 85(C5-6)	sew2 mc 85(c5-6)
		Sewing machine 116(C5-6)	sew2 mc 116(c5-6)
		Sewing machine 143(C5-6)	sew2 mc 143(c5-6)
	Sewing section 3 (C1-2)	Sewing machine 164(C1-2)	sew3 mc 164(c1-2)
		Sewing machine 181(C1-2)	sew3 mc 181(c1-2)
		Sewing machine 192(C1-2)	sew3 mc 192(c1-2)
	Finished product section	Table 2	finish tab 2
		Table 32	finish tab 32
		Table 65	finish tab 65
	Cutting department	Cutting table A2	cut tab a2
		Cutting table A5	cut tab a5
		Cutting table B3	cut tab b3
13.MK Co.	Sewing section 2.1	Sewing machine 6	sew2.1 mc 6
		Sewing machine 45	sew2.1 mc 45
		Sewing machine 103	sew2.1 mc 103
	Sewing section 2.2	Sewing machine 124	sew2.2 mc 124
		Sewing machine 151	sew2.2 mc 151
		Sewing machine 236	sew2.2 mc 236
	Sewing section 2.3	Sewing machine 244	sew2.3 mc 244
		Sewing machine 278	sew2.3 mc 278
		Sewing machine 294	sew2.3 mc 294
	Cutting department B	Cutting table 7	cutB tab 7
		Cutting table 9	cutB tab 9
		Cutting table 11	cutB tab 11
	Ironing and Quality control department B	Checking table B2	iron b tab b2
		Checking table B21	iron b tab b21
		Checking table B35	iron b tab b35
14. MTD garment Co.	Ironing and Quality control section F1	Ironing table 2	iron tab 2
		Ironing table 35	iron tab 35
		Ironing table 73	iron tab 73
	Sewing section F2	Sewing machine 8(F2)	sewf2 mc 8(f2)
		Sewing machine 63(F2)	sewf2 mc 63(f2)
		Sewing machine 101(F2)	sewf2 mc 101(f2)
	Sewing section F4	Sewing machine 105(f4)	sewf4 mc 105(f4)
		Sewing machine 147(f4)	sewf4 mc 147(f4)
		Sewing machine 196(f4)	sewf4 mc 196(f4)
	Sewing section F5	Sewing machine 203(f5)	sewf5 mc 203(f5)
		Sewing machine 241(f5)	sewf5 mc 241(f5)
		Sewing machine 287(f5)	sewf5 mc 287(f5)
	Cutting department A (F1)	Cutting table 2A	cut A(f1) tab 2a
		Cutting table 6A	cut A(f1) tab 6a
		Cutting table 9A	cut A(f1) tab 9a

[a] One ten minute sample at each spot

Appendix 29. Description of data collection for noise samples -Rice mill industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
15. CP NSTP CR rice mill Co.	Polishing rice department B	Machine number 1B	polishB mc 1b
		Machine number 4B	polishB mc 4b
		Machine number 6B	polishB mc 6b
	Polishing rice department A	Machine number 1A	polishA mc 1a
		Machine number 3A	polishA mc 3a
		Machine number 6A	polishA mc 6a
	Rice packing department C	Machine number 2C	packC mc 2c
		Machine number 4C	packC mc 4c
		Machine number 6C	packC mc 6c
	Bran collecting section D	Cyclone number 1D	branD cyclo 1d
		Cyclone number 2D	branD cyclo 2d
		Cyclone number 3D	brand cyclo 3d
16. MP rice mill Co.	Polishing rice section 1	Machine BVN-1	polish1 mc bvn1
		Machine BVN-3	polish1 mc bvn3
		Machine BVN-5	polish1 mc bvn5
	Polishing rice section 2	Machine BVN number 7	polish2 mc bvn7
		Machine BVN number 9	polish2 mc bvn9
		Machine BVN number 12	polish2 mc bvn12
	Rice packing section	Machine HG-13	pack mc hg13
		Machine HG-15	pack mc hg15
		Machine HG-17	pack mc hg17
	Bran collecting section	Fine grain cyclone 1	bran cyclo1
		Large cyclone number 2	bran cyclo2
		Large cyclone number 4	bran cyclo4
17. TT CD rice mill Co.	Polishing rice department 1	Machine number DB-2	polish1 mc db2
		Machine number DB-4	polish1 mc db4
		Machine number DB-6	polish1 mc db6
	Polishing rice department 2	Machine number DB-9	polish2 mc db9
		Machine number DB-11	polish2 mc db11
		Machine number DB-13	polish2 mc db13
	Storage	Spot 1	storage spot1
		Spot 3	storage spot3
		Spot 5	storage spot5
	Final Polishing department	Machine number DBX-15	finalpolish mc dbx15
		Machine number DBX-19	finalpolish mc dbx19
		Machine number DBX-21	finalpolish mc dbx21
18. MK rice mill Co.	Polishing department 1	Machine number LB-1	polish1 mc lb1
		Machine number LB-4	polish1 mc lb4
		Machine number LB-6	polish1 mc lb6
	Polishing department 2	Machine number LB-8	polish2 mc lb8
		Machine number LB-10	polish2 mc lb10
		Machine number LB-14	polish2 mc lb14
	Rice packing department	Rice packing number 15	pack mc 15
		Rice packing number 17	pack mc 17
		Rice packing number 20	pack mc 20
	Bran collecting section	Cyclone number CT 1	bran cyclo ct1
		Cyclone number CT 3	bran cyclo ct3
		Cyclone number CM 4	bran cyclo cm4

[a] One ten minute sample at each spot

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
19. TP rice mill Co.	Rice packing department zone 1	Machine number 1-1	pack1 mc 1-1
		Machine number 4-1	pack1 mc 4-1
		Machine number 6-1	pack1 mc 6-1
	Bran collecting section zone 1	Old cyclone number 7-1	bran1 cyclo 7-1
		Large cyclone number 9-1	bran1 cyclo 9-1
		Large cyclone number 10-1	bran1 cyclo 10-1
	Rice drying section zone 1	Spot 1	dry sec1 spot 1
		Spot 2	dry sec1 spot 2
		Spot 3	dry sec1 spot 3
	Rice input section zone 1	Rice input door A-1	input1 door a1
		Rice input door D-1	input1 door d1
		Rice input door F-1	input1 door f1
20. DNTN TT CD rice mill Co.	Polishing rice zone A	Machine number BVN 1	polishA mc bvn1
		Machine number BVN 3	polishA mc bvn3
		Machine number BVN 6	polishA mc bvn6
	Polishing rice zone B	Machine number BVN 7	polishB mc bvn7
		Machine number BVN 9	polishB mc bvn9
		Machine number BVN 12	polishB mc bvn12
	Rice packing zone	Machine number HG 1	pack mc hg1
		Machine number HG 4	pack mc hg4
		Machine number HG 6	pack mc hg6
	Bran collecting zone	Large cyclone number 1	bran mc cyclo 1
		Large cyclone number 2	bran mc cyclo 2
		Cyclone number 3	bran cyclo 3

[a] One ten minute sample at each spot

Appendix 30. Description of data collection for static dust samples –Printing -paper industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
1. HL printing Co.	Shutting boxes department	Large machine number 4	shut mc4 m shut mc4 a
	Pressing paper department	Centre of Pressing paper department	press cen m press cen a
	Printing department	Centre of Printing department	print cen m print cen a
	Label pasting department	Centre of Label pasting department	label cen m label cen a
	Gas furnace	Centre of Gas furnace	furnace cen m furnace cen a
2. TH printing Co.	Printing and Shutting box department 1	Centre of Printing and Shutting box department 1	print1 cen m print1 cen a
	Printing and Shutting box department 2	Centre of Printing and Shutting box department 2	print2 cen m print2 cen a
	Label pasting department	Centre of Label pasting department	label cen m label cen a
	Making paper department	Centre of Making paper department	make pap cen m make pap cen a
	Waving paper department	Centre of Waving paper department	wave pap cen m wave pap cen a

[a] Two samples were collected in the centre of each department, one in the morning (m) and the other in the afternoon (a).

Appendix 31. Description of data collection for static dust samples-Civil engineer industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
3. CK TA civil engineering Co.	Welding section	Centre of Welding section	weld cen m weld cen a
	Adaptor department	Centre of Adaptor department	adap cen m adap cen a
	Machinery department	Centre of Machinery department	machry cen m machry cen a
	Metal cutting department	Centre of Metal cutting department	cut cen m cut cen a
	Assembling department	Centre of Assembling department	assemb cen m assemb cen a
4. CD TH civil engineering Co.	Machinery department A	Centre of Machinery department A	machryA cen m machryA cen a
	Machinery department B	Centre of Machinery department B	machryB cen m machryB cen a
	Assembling department	Centre of Assembling department	assemb cen m assemb cen a
	Adaptor department	Centre of Adaptor department	adap cen m adap cen a
	Welding section	Centre of Welding section	weld cen m weld cen a
5. CD CT civil engineering Co.	Metal cutting department	Centre of Metal cutting department	cut cen m cut cen a
	Welding section	Centre of Welding section	weld cen m weld cen a
	Winding adaptor department	Centre of Winding adaptor department	wind cen m wind cen a
	Adaptor department	Centre of Adaptor department	adap cen m adap cen a
6. DN CN civil engineering Co.	Machinery department 1	Centre of Machinery department 1	machry1 cen m machry1 cen a
	Machinery department 2	Centre of Machinery department 2	machry2 cen m machry2 cen a
	Winding adaptor department	Centre of Winding adaptor department	wind cen m wind cen a
	Adaptor department	Centre of Adaptor department	adap cen m adap cen a

[a] Two samples were collected in the centre of each department, one in the morning (m) and the other in the afternoon (a).

Appendix 32. Description of data collection for static dust samples -Metal casting industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
7. DT metal casting Co.	Aluminous smelting furnace	Centre of Aluminous smelting furnace	smelt cen m smelt cen a
	Drilling department	Drilling machine number 7	drill mc 7 m drill mc 7 a
	Grinding department	Centre of Grinding department	grind cen m grind cen a
	Polishing department	Polishing machine number 3	polish mc 3 m polish mc 3 a
8. NCT metal casting Co.	Cutting department	Centre of Cutting department	cut cen m cut cen a
	Pressing material department	Centre of Pressing material department	press cen m press cen a
	Forging department	Centre of Forging department	forge cen m forge cen a
	Pressing bowl department	Centre of Pressing bowl department	press bowl cen m press bowl cen a
9. CKSH metal casting Co.	Lathe department	Centre of Lathe department	lathe cen m lathe cen a
	Moulding department	Centre of Moulding department	mould cen m mould cen a
	Making mould section	Centre of Making mould section	makemould cen m makemould cen a
	Smelting furnace	Centre of Smelting furnace	smelt cen m smelt cen a
	Machinery department	Centre of Machinery department	machry cen m machry cen a
10. TTC metal casting Co.	Machinery department 1	Centre of Machinery department 1	machry1 cen m machry1 cen a
	Machinery department 2	Centre of Machinery department 2	machry2 cen m machry2 cen a
	Making moulding section	Centre of Making moulding section	makemould cen m makemould cen a
	Grinding department	Centre of Grinding department	grind cen m grind cen a
	Copper smelting furnace	Centre of Copper smelting furnace	smelt cen m smelt cen a

[a] Two samples were collected in the centre of each department, one in the morning (m) and the other in the afternoon (a).

Appendix 33. Description of data collection for static dust samples -Garment industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
11. VT garment Co.	Sewing section 1	Sewing machine 28(c2)	sew1 mc 28(c2)m sew1 mc 28(c2)a
	Sewing section 3	Sewing machine 132(c3)	sew3 mc132(c3)m sew3 mc132(c3)a
	Sewing section 2 (C7-8)	Sewing machine 78(c7)	sew2 mc 78(c7)m sew2 mc 78(c7)a
	Iron section	Table number 15U	iron tab 15u m iron tab 15u a
	Cutting department	Table number 4C	cut tab 4c m cut tab 4c a
12. HT garment Co.	Sewing section 1	Sewing machine 21(C7-8)	sew1 mc 21(c7-8)m sew1 mc 21(c7-8)a
	Sewing section 2	Sewing machine 105(C5-6)	sew2 mc 105(c5-6)m sew2 mc 105(c5-6)a
	Sewing section 3 (C1-2)	Sewing machine 173(C1-2)	sew3 mc 173(c1-2)m sew3 mc 173(c1-2)a
	Finished product section	Table number 34	finish tab 34 m finish tab 34 a
	Cutting department	Centre of Cutting department	cut cen m cut cen a
13.MK Co.	Sewing section 2.1	Sewing machine 38	sew2.1 mc 38 m sew2.1 mc 38 a
	Sewing section 2.2	Sewing machine 150	sew2.2 mc 150 m sew2.2 mc 150 a
	Sewing section 2.3	Sewing machine 271	sew2.3 mc 271 m sew2.3 mc 271 a
	Cutting department B	Centre of Cutting department	cut b cen m cut b cen a
	Ironing and Quality control department B	Checking table B20	iron b tab b20 m iron b tab b20 a
14. MTD garment Co.	Ironing and Quality control section F1	Ironing table 36	iron f1 tab 36 m iron f1 tab 36 a
	Sewing section F2	Sewing machine 67(F2)	sewf2 mc 67(f2) m sewf2 mc 67(f2) a
	Sewing section F4	Sewing machine 151(F4)	sewf4 mc 151(f4) m sewf4 mc 151(f4) a
	Sewing section F5	Sewing machine 238(F5)	sewf5 mc 238(f5) m sewf5 mc 238(f5) a
	Cutting department A (F1)	Centre of Cutting department A (F1)	cutA(f1) cen m cutA(f1) cen a

[a] Two samples were collected in the centre of each department, one in the morning (m) and the other in the afternoon (a).

Appendix 34. Description of data collection for static dust samples -Rice mill industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
15. CP NSTP Cai rang rice mill Co.	Polishing rice department B	Machine number 3B	polishB mc 3b m polishB mc 3b a
	Polishing rice department A	Machine number 4A	polishA mc 4a m polishA mc 4a a
	Rice packing department C	Machine number 3C	packC mc 3c m packC mc 3c a
	Bran collecting section D	Cyclone number 2D	bran cyclo2d m bran cyclo2d a
16. MP rice mill Co.	Polishing rice section 1	Machine number BVN4	polish1 mc bvn4 m polish1 mc bvn4 a
	Polishing rice section 2	Machine BVN number 10	polish2 mc bvn10 m polish2 mc bvn10 a
	Rice packing section	Machine HG-15	pack mc hg15 m pack mc hg15 a
	Bran collecting section	Large cyclone number 3	bran cyclo3 m bran cyclo3 a
17. TT CD CD rice mill Co.	Polishing rice department 1	Machine number DB-3	polish1 mc db3 m polish1 mc db3 a
	Polishing rice department 2	Machine number DB-10	polish2 mc db10 m polish2 mc db10 a
	Storage	Rice spot number 3G	stora rice spot 3g m stora rice spot 3g a
	Final Polishing department	Machine number DBX-18	finalpoli mc dbx18m finalpoli mc dbx18a
18. MK rice mill Co.	Polishing department 1	Machine number LB-3	polish1 mc lb3 m polish1 mc lb3 a
	Polishing department 2	Machine number LB-11	polish2 mc lb11 m polish2 mc lb11 a
	Rice packing department	Rice packing machine number 18	pack mc 18 m pack mc 18 a
	Bran collecting section	Cyclone number CT 2	bran cyclo ct2 m bran cyclo ct2 a
19. TP rice mill Co.	Rice packing department zone 1	Machine number 3-1	pack1 mc 3-1 m pack1 mc 3-1 a
	Bran collecting section zone 1	Old cyclone number 8-1	bran1 cyclo 8-1 m bran1 cyclo 8-1 a
	Rice drying section zone 1	Drying spot number 5	drying1 spot 5 m drying1 spot 5 a
	Rice input section zone 1	Rice input door C-1	input1 door c1 m input1 door c1 a
20. DNTN TT CD rice mill Co.	Polishing rice zone A	Machine number BVN4	polishA mc bvn4 m polishA mc bvn4 a
	Polishing rice zone B	Machine number BVN10	polishB mc bvn10 m polishB mc bvn10 a
	Rice packing zone	Machine number HG 3	pack mc hg3 m pack mc hg3 a
	Bran collecting zone	Large cyclone number 4	bran cyclo 4 m bran cyclo 4 a

[a] Two samples were collected in the centre of each department, one in the morning (m) and the other in the afternoon (a).

Appendix 35. Description of data collection for personal dust samples -Printing -paper industry

Factory	*Department* [a]	*Sampling spots/ job title*	*Shorthand description* [a]
1. HL printing Co.	Shutting boxes department	Large machine number 1	shut mc 1
		Large machine number 3	shut mc 3
		Small machine number 5	shut mc 5
	Pressing paper department	Pressing machine number 6	press mc 6
		Pressing machine number 8	press mc 8
		Small machine number 10	press mc 10
	Label pasting department	Team A, job number 2	label team a2
		Team C, job number 4	label team c4
		Team E, job number 3	label team e3
2. TH printing Co.	Printing and Shutting box department 1	Machine number 2	print1 mc 2
		Machine number 4	print1 mc 4
		Machine number 6	print1 mc 6
	Printing and Shutting box department 2	Machine number 7	print2 mc 7
		Machine number 9	print2 mc 9
		Machine number 11	print2 mc 11
	Label pasting department	Job number 1	label job 1
		Job number 2	label job 2
		Job number 4	label job 4

[a] One sample was collected from a worker at each position

Appendix 36. Description of data collection for personal a dust samples-Civil engineering industry

Factory	*Department*	*Sampling spots/ job title* [a]	*Shorthand description*
3. CK TA civil engineering Co.	Welding section	Job welding pipe HO1	weld job ho1
		Job welding bar HT2	weld job ht2
		Job welding box HH3	weld job hh3
	Machinery department	Screw-Lathe machine 2	machry mc 2
		Auto-Lathe machine PC4	machry mc 4
		Large-Lathe machine 7	machry mc 7
	Assembling department	Job frame, group 2	assemb frame gr2
		Job machinery, group 3	assemb machry gr3
		Job operation, group 1	assemb operat gr1
4. CD TH civil engineering Co.	Machinery department A	Lathe machine 1A	machryA mc 1a
		Lathe machine 4A	machryA mc 4a
		Large lathe machine 5A	machryA mc 5a
	Machinery department B	Lathe machine 8B	machryB mc 8b
		Lathe machine 10B	machryB mc 10b
		Auto-Lathe machine 12B	machryB mc 12b
	Welding section	Team 1, job number 1	weld team1 job1
		Team 3, job number 3	weld team3 job3
		Team box, job number 2B	weld box job2b
5. CD CT civil engineering Co.	Metal cutting department	Large machine CSL22	cut mc csl22
		Machine CS11	cut mc cs11
		Small machine number CS41	cut mc cs41
	Welding section	Welding box, job 2B	weld box job2b
		Welding column 1, job 2C	weld colum job2c
		Welding column 2, job 3C	weld colum job3c
	Winding adaptor department	Auto-Winding machine TD1	wind mc td1
		Winding adaptor job QD2	wind mc qd2
		Large machine number L33	wind mc L33
6. DN CN civil engineering Co.	Machinery department 1	Lathe machine T1	machry1 mc t1
		Lathe machine T2	machry1 mc t2
		Cutting machine C4	machry1 mc c4
	Machinery department 2	Lathe machine T5	machry2 mc t5
		Lathe machine T7	machry2 mc t7
		Cutting machine C9	machry2 mc t9
	Winding adaptor department	Machine number 1	wind mc 1
		Auto-machine 2	wind mc 2
		Manual machine 4	wind mc 4

[a] One sample was collected from a worker at each position

Appendix 37. Description of data collection for personal a dust samples-Metal casting industry

Factory	*Department*	*Sampling spots/ job title* [a]	*Shorthand description*
7. DT metal casting Co.	Aluminous smelting furnace	Smelter job 1	smelt smelter job1
		Pouring job 2	smelt pour job2
		Moulding job 4	smelt mould job4
	Grinding department	Large machine number 1L	grind mc 1L
		Large machine number 3L	grind mc 3L
		Small machine number 5N	grind mc 5n
	Polishing department	Sitting machine 01	polish mc 01
		Machine number 03	polish mc 03
		Machine 05	polish mc 05
8. NCT metal casting Co.	Cutting department	Round machine 1T	cut mc 1t
		Small machine number 2N	cut mc 2n
		Large machine number 4L	4L
	Pressing material department	Machine number 5N	press mc 5n
		Machine number 6N	press mc 6n
		Machine number 7L	press mc 7L
	Forging department	Machine number 10L	forge mc 10L
		Small machine number 12L	forge mc 12L
		Large machine number 14L	forge mc 14L
9. CKSH metal casting Co.	Moulding department	Changing mould job 1TK	mould chang job 1tk
		Remove mould job 4TK	mould remo job 4tk
		Carrying semi product job 3	mould carry job 3
	Making mould section	Making mould job K1	make mould job k1
		Making mould job K4	make mould job k4
		Drying mould job PK3	make mould job pk3
	Smelting furnace	Smelter 1	smelt smelter job 1
		Smelter 2	smelt smelter job 2
		Pouring worker job 2	smelt pour job 2
10. TTC metal casting Co.	Making moulding section	Making mould job 3	make mould job 3
		Making mould job 1	make mould job 1
		Drying mould job 5	make drymould job5
	Grinding department	Old machine 1	grind mc 1
		New machine number 3	grind mc 3
		New machine number 6	grind mc 6
	Copper smelting furnace	Smelter 1	smelt smelter job1
		Pouring worker 2	smelt pour job2
		Moulding worker 3	smelt mould job3

[a] One sample was collected from a worker at each position

Appendix 38. Description of data collection for personal a dust samples -Garment industry

Factory	*Department*	*Sampling spots/ job title* [a]	*Shorthand description*
11. VT garment Co.	Sewing section 1	Sewing machine 5(C1)	sew1 mc 5(c1)
		Sewing machine 30(C2)	sew1 mc 30(c2)
		Sewing machine 45(C3)	sew1 mc 45(c3)
	Iron section	Ironing table 3U	iron tab 3u
		Ironing table 12U	iron tab 12u
		Ironing table 29U	iron tab 29u
	Cutting department	Cutting table 1C	cut tab 1c
		Cutting table 3C	cut tab 3c
		Cutting table 6C	cut tab 6c
12. HT garment Co.	Sewing section 1	Sewing machine 4(C7-8)	sew1 mc 4(c7-8)
		Sewing machine 38(C7-8)	sew1 mc 38(c7-8)
		Sewing machine 63(C7-8)	sew1 mc 63(c7-8)
	Sewing section 2	Sewing machine 85(C5-6)	sew2 mc 85(c5-6)
		Sewing machine 116(C5-6)	sew2 mc 116(c5-6)
		Sewing machine 143(C5-6)	sew2 mc 143(c5-6)
	Cutting department	Cutting table A2	cut tab a2
		Cutting table A5	cut tab a5
		Cutting table B3	cut tab a3
13.MK garment Co.	Sewing section 2.2	Sewing machine 124	sew2.2 mc 124
		Sewing machine 151	sew2.2 mc 151
		Sewing machine 236	sew2.2 mc 236
	Cutting department B	Cutting table 7	cutB tab 7
		Cutting table 9	cutB tab 9
		Cutting table 11	cutB tab 11
	Ironing and Quality control department B	Checking table B2	iron B tab b2
		Checking table B21	iron B tab b21
		Checking table B35	iron B tab b35
14. MTD garment Co.	Ironing and Quality control section F1	Ironing table 2	iron tab 2
		Ironing table 35	iron tab 35
		Ironing table 73	iron tab 73
	Sewing section F2	Sewing machine 8(F2)	Sew f2 mc 8(f2)
		Sewing machine 63(F2)	sew f2 mc 63(f2)
		Sewing machine 101(F2)	sew f2 mc 101(f2)
	Cutting department A (F1)	Cutting table 2A	cut A(f1) tab 2a
		Cutting table 6A	cut A(f1) tab 6a
		Cutting table 9A	cut A(f1) tab 9a

[a] One sample was collected from a worker at each position

Appendix 39. Description of data collection for personal a dust samples -Rice mill industry

Factory	*Department*	*Sampling spots/ job title a*	*Shorthand description*
15. CP NSTP CR rice mill Co.	Polishing rice department B	Machine number 1B	polishB mc 1b
		Machine number 4B	polishB mc 4b
		Machine number 6B	polishB mc 6b
	Rice packing department C	Machine number 2C	packC mc 2c
		Machine number 4C	packC mc 4c
		Machine number 6C	packC mc 6c
	Bran collecting section D	Cyclone number 1D	bran cyclo 1d
		Cyclone number 2D	bran cyclo 2d
		Cyclone number 3D	bran cyclo 3d
16. MP rice mill Co.	Polishing rice section 2	Machine BVN number 7	polish2 mc bvn7
		Machine BVN number 9	polish2 mc bvn9
		Machine BVN number 12	polish2 mc bvn12
	Rice packing section	Machine HG-13	pack mc hg13
		Machine HG-15	pack mc hg15
		Machine HG-17	pack mc hg17
	Bran collecting section	Fine grain cyclone 1	bran cyclo 1
		Large cyclone number 2	bran cyclo 2
		Large cyclone number 4	bran cyclo 4
17. TT CD rice mill Co.	Polishing rice department 1	Machine number DB-2	polish1 mc db2
		Machine number DB-4	polish1 mc db4
		Machine number DB-6	polish1 mc db6
	Polishing rice department 2	Machine number DB-9	polish2 mc db9
		Machine number DB-11	polish2 mc db11
		Machine number DB-13	polish2 mc db13
	Final Polishing department	Machine number DBX-15	finalpolish mc dbx15
		Machine number DBX-19	finalpolish mc dbx19
		Machine number DBX-21	finalpolish mc dbx21
18. MK rice mill Co.	Polishing department 1	Machine number LB-1	polish1 mc lb1
		Machine LB number LB-4	polish1 mc lb4
		Machine LB number LB-6	polish1 mc lb6
	Rice packing department	Rice packing number 15	pack mc 15
		Rice packing number 17	pack mc 17
		Rice packing number 20	pack mc 20
	Bran collecting section	Cyclone number CT 1	bran cyclo ct1
		Cyclone number CT 3	bran cyclo ct3
		Cyclone number CM 4	bran cycly cm4
19. TP rice mill Co.	Rice packing department zone 1	Machine number 1-1	pack1 mc 1-1
		Machine number 4-1	pack1 mc 4-1
		Machine number 6-1	pack1 mc 6-1
	Bran collecting section zone 1	Old cyclone number 7-1	bran1 cyclo 7-1
		Large cyclone number 9-1	bran1 cyclo 9-1
		Large cyclone number 10-1	bran1 cyclo 10-1
	Rice input section zone 1	Rice input door A-1	input1 door a1
		Rice input door D-1	input1 door d1
		Rice input door F-1	input1 door f1
20. DNTN TT CD rice mill Co.	Polishing rice zone A	Machine number BVN1	polishA mc bvn1
		Machine number BVN3	polishA mc bvn3
		Machine number BVN6	polishA mc bvn6
	Rice packing zone	Machine number HG 1	pack mc hg1
		Machine number HG 4	pack mc hg4
		Machine number HG 6	pack mc hg6
	Bran collecting zone	Large cyclone number 1	bran cyclo 1
		Large cyclone number 2	bran cyclo 2
		Cyclone number 3	bran cyclo 3

[a] One sample was collected from a worker at each position

Appendix 40. Description of data collection for carbon monoxide samples -Metal casting industry

Factory	*Department*	*Sampling spots/ job title* [a]	*Shorthand description*
1. HL printing Co.	Furnace department	Centre of furnace department	furnace cen 1 furnace cen 2
2. TH printing Co.	Making paper department	Centre of furnace unit	furnace cen 1 furnace cen 2
7. DT metal casting Co.	Aluminous smelting furnace department	Centre of smelting department	smelt cen 1 smelt cen 2
8. NCT metal casting Co.	Forging department	Centre of smelting unit	smelt cen 1 smelt cen 2
9. CKSH metal casting Co.	Smelting furnace department	Centre of smelting department	smelt cen 1 smelt cen 2
10. TTC metal casting Co.	Copper smelting furnace department	Centre of smelting department	smelt cen 1 smelt cen 2

[a] One sample was collected at each position

Appendix 41. Description of data collection for carbon dioxide samples -Garment industry

Factory	*Department*	*Sampling spots/ job title* [a]	*Shorthand description*
1. HL printing Co.	Furnace department	Centre of furnace department	furnace cen 1 furnace cen 2
2. TH printing Co.	Making paper department	Centre of furnace unit	furnace cen 1 furnace cen 2
7. DT metal casting Co.	Aluminous smelting furnace department	Centre of smelting department	smelt cen 1 smelt cen 2
8. NCT metal casting Co.	Forging department	Centre of smelting unit	smelt cen 1 smelt cen 2
9. CKSH metal casting Co.	Smelting furnace department	Centre of department	smelt cen 1 smelt cen 2
10. TTC metal casting Co.	Copper smelting furnace department	Centre of department	smelt cen 1 smelt cen 2
11. VT garment Co.	Sewing section 1	Sewing machine 28(C2)	sew1 machine 28(c2) s1 sew1 machine 28(c2) s2
	Sewing section 3	Sewing machine 132(C3)	sew3 machine 132(c3) s1 sew3 machine 132(c3) s2
12. HT garment Co.	Sewing section 1	Sewing machine 21(C7-8)	sew1 mc 21(c7-8) s1 sew1 mc 21(c7-8) s2
	Sewing section 2	Sewing machine 105(C5-6)	sew2 mc 105(c5-6) s1 sew2 mc 105(c5-6) s2
13.MK garment Co.	Sewing section 2.1	Sewing machine 38	sew2.1 mc 38 s1 sew2.1 mc 38 s2
	Sewing section 2.2	Sewing machine 150	sew2.2 mc 150 s1 sew2.2 mc 150 s2
14. MTD garment Co.	Sewing section F2	Sewing machine 67(F2)	sew f2 mc 67 s1 sew f2 mc 67 s2
	Sewing section F4	Sewing machine 151(F4)	sew f4 mc 151 s1 sew f4 mc 151 s2

[a] One sample was collected at each position

Appendix 42. Dust Monitoring – sampling equipment, measurement technique and calibration

Equipments

The universal sampling pump model PCXR4 (SKC, USA) is a constant flow air sampler operating in the range of 1000 to 5000 mL/min. The pump weighed 964 grams, dimensions of 13cm x 11.9cm x 4.9cm. It was used for both static and personal sampling. The pump displays flow rate, run time (minutes), battery check and any fault conditions. A built-in rotameter provided a visible check of flow rate during the sampling period. The NiCad rechargeable 6V battery packs provided up to 12 hours continuous run time. Two types of filter holder were used: the conductive plastic cyclone with 25 mm cassette model SKC-225-69-25 (SKC, USA) for collection of the respirable dust fraction (features in MDHS 14/3) and the IOM filter holder (SKC-225-70A) personal sampler used for collecting cotton dust samples at the garment factories. Polyvinyl chloride filters 25 mm pore size 5μm type GLA-5000 were used for all particulate samples. An analytical electric balance model SM50, (Scientech, USA) capable of weighing to 0.01mg was used to weigh the filters. Other accessories included a rotameter range 300 – 3000 mL/min, model 392-0330 (SKC, USA), harness for personal sampling, a tripod stand for static sampling, petri-slides, replacement cassette, transport clips, forceps and plastic tubing.

Calibration

One month before each cross-sectional survey, the sampling pumps were sent to the SKC company agency in Hanoi, Vietnam for calibration and servicing. The pump flow meter was also checked before and after sampling using a rotameter.

Measurement techniques

Filters were pre-conditioned by placing in a Petri-slide or cassette for at least 24 hours before sampling in the laboratory where they were weighed. The pre-weighed field filters included 6-10 blank filters, the latter were used as control filter for each day of sampling.

The pre-weighted filters were carefully placed in the sampling head using forceps to avoid contamination and the sampling head casing screwed but not over tightened.

The sampling train was set up and included the sampling head (with filter) tubing and air pump. For personal respirable samples, equipment was attached to the worker's body with a harness and the sampling head was clipped to a worker's collar or placed as close to the breathing zone as possible; the flow rate was set at 1.9 litres per minute for 8 hours work shift for 5 μm 50% cut-point, according to British medical research convention (BMRC curve and ISO/CEN curve). For static sampling the same sampling train was placed on tripod at the pre-determined sampling points for 2 hours during the shift. The cotton dust personal and static samples collected same duration by IOM filter holder had flow rate 2 litres per minute according to ACGIH convention for inhalable sampling (OSHA, 2006). For each sample the pump flow rate was adjusted at the start of sampling period and re-checked at the end and sampling position and duration recorded. During the sampling period, the flow rate displayed on the pump was visually checked and noted every hour. Typically, two static samples were taken at the central location of each department, one in the morning and one in the afternoon, and personal measurements from three workers in each of the three dustiest departments. For the detail of actual sampling position on each site, only three dusty departments could be considered due to time constraints and equipment shortages. All sampling positions were recorded which served as reference sampling points for the post intervention evaluation phase.

Measurement calculation:

Minimum air sampling time was calculated from the expression:

$$Minimum\,volume\,(m^3) = \frac{10\,X\ sensitivity\ of\ the\,balance\,(mg)}{suitable\,hygiene\,standard\ (mg.m^{-3})}$$

The Vietnam standard of 1 mg.m^{-3} dust (Ministry of Health, 2003) was used as the hygiene standard.

$$\text{Minimum volume (m}^3\text{)} = \frac{10\,\text{x}\ 0.01\,\text{(mg)}}{1\,\text{mg.m}^3} = 0.10\ \text{m}^3$$

The dust concentrations were calculated using the following formula:

$$\text{Dust concentration (mg.m}^{-3}\text{)} = \frac{(\text{x}_2 - \text{x}_1) - (\text{z}_2 - \text{z}_1)}{\text{sampling volume}\,(\text{m}^3)}$$

Where:

Weight of filter before exposure = x_1 (mg)
Weight of filter after exposure = x_2 (mg)
Weight of blank filter before = z_1 (mg)
Weight of blank filter after = z_2 (mg)

Appendix 43. Equipment, measurement technique and calibration for toxic gases monitoring

Equipment

The short term colorimetric tubes were used to estimate static exposure level for Carbon monoxide (CO) and Carbon dioxide (CO_2). The tubes were connected to a hand held pump model AP-20S (Kitagawa, Japan) which delivers up to 100 millilitres per pump stroke. The short term CO_2 tubes (Kitagawa, type. 126SF) have a measurement range of 100 - 4,000 ppm. The short term CO tubes (Kitagawa type 106SC) have measure range of 1 - 50 ppm. A barometer and thermometer were also used to measure air pressure and air temperature at the scene. A hot air probe was used for air temperatures over 40^{o}C. All colorimetric tubes were stored below 25^{o}C and were less than two years old.

Calibration

One month before each survey, the pumps and barometer were sent to the Kitagawa representative office in Hanoi, Vietnam, for calibration and servicing. On each working day of the surveys, the pump was checked to leaks using an unbroken tube.

Measurement techniques

For both CO_2 and CO, the concentration was obtained as a mean of three samples taken at 30 minutes intervals. The pumps were at the breathing zone of the workers, taking account of typical working postures in each department. To start the measurement, the investigator broke off both ends of the tubes and connected to the pump with the arrows on the tube pointed toward the pump. For sampling CO_2 half (50ml) or full (100ml) pump strokes were used depending on the ambient concentrations. For sampling carbon monoxide the pump stroke was pulled and locked at 100 ml. The tube readings were adjusted for ambient air pressure and air temperature. In cases where half pump stroke were used the reading on the tube was multiplied by a factor of two. In addition, both measurements were adjusted with atmospheric pressure by following formula:

$$True\,concentration = tube\,reading\ X\ \frac{1013}{Atmospheric\ \ pressure\,(hPa)}$$

The results were converted from ppm to $mg.m^{-3}$ for local common uses, by the formula:

$$\mathrm{mg.m}^{-3} = \frac{\mathrm{P\,x\,MW\,x\,(ppm)}}{62.4\,\mathrm{x}\,(273.15 + {}^{\circ}\mathrm{C})}$$

where:

mg/m^3 = milligrams of gaseous pollutant per cubic meter of ambient air

ppm = ppm by volume (i.e., volume of gaseous pollutant per 10^6 volumes of ambient air)

MW = molecular weight of the gas

°C = ambient air temperature in degrees Centigrade

P = air pressure in mmHg

R = 62.4 is the volume ideal gas constant (litre) when the temperature is Kelvins

K = (273.16 + ^{o}C) is the temperature in Kelvins

Two carbon monoxide samples were taken at the centre of the melting department in metal casting and in the furnace department of printing and paper factories. Four carbon dioxide samples were taken at the centre of two sewing departments in the garment factories and two samples were taken at the centre of the melting department of metal casting factories. The sampling points were identified in terms of nearby machines.

Appendix 44. Equipment, measurement technique and calibration for noise monitoring

Equipment

A type 1, handheld Rion NL-20 (Japan) integrating sound level meter (SLM) was used with a measuring range from 28 to 138 dBA and frequency range from 20 Hz to 8 KHz. The following were recorded: sound level (Lp), equivalent continuous sound pressure level (Leq), and maximum (Lmax). The SLM was calibrated using The NC-74 external calibrator at 94 dB and 1000 Hz.

Calibration

One month before each cross-sectional survey, the SLM and the external calibrator were sent to the RION agency office in Hanoi, Vietnam for calibrating and servicing. On each working day of the surveys, the SLM was checked to ensure correct settings and battery fully charged. At the beginning of each factory visit, the investigators calibrated the SLM by attaching the microphone of the sound meter to the NC-74 external sound calibrator and the reading was adjusted to 94 dB and 1000 Hz frequency.

Measurement techniques

After calibration the SLM setting were checked together with battery status. The meter was switched to “fast” response and held at arm’s length away from the body at least one meter above the floor level. The meter was changed to a “slow” response if recording showed extreme fluctuation. When recording noise levels in areas with high air velocity or outdoors, a microphone windshield was used avoiding overestimating of readings.

Three samples were taken at along the central axis for each department, at the front, middle and the rear of each department. Each sampling point was one metre from the closest machine.

Appendix 45. Equipment, measurement technique and calibration for lighting monitoring

Equipment

The light meter model T-10 (Konica Minolta, Japan) had a measuring range from 0.01 to 299,900 Lux. This meter is compact, light-weight and easy to use, and measurement ranges can be set automatically or manually. Measurement results are shown on a screen with LCD back-light that can be seen clearly in dark areas.

Calibration

One month before each monitoring survey, the light meters were sent to the LMS Technologies Pte Ltd in Hanoi, Vietnam for calibration and servicing. Before each measurement, the investigators calibrated the light meter by obtaining an automatic zero value after covering the cell with a cap and turning the meter on.

Measurement techniques

Measurements were made by placing the cell on the surface of work stations that were measured. Five samples were taken from five different work stations in each department, one sample in the centre and the others at four corners of the department. The points were identified in terms of nearby machines and recorded.

Appendix 46. Equipment, measurement technique and calibration for air temperature, air humidity and air speed monitoring

Equipment

The multi-function thermal anemometer model Climomaster A531 (Kanomax, Japan) was used to measure simultaneously air temperature (range 0.0 ^{o}C to 60.0^{o}C), air velocity (range 0.10 m/s to 30.0m/s) and relative humidity (range 2.0% to 98.0% RH). In addition, an aspirated psychrometer model Assmann, type 430101A (Fischer, Germany) was used to measure air temperature (range -35 ^{o}C to 50 ^{o}C) and relative humidity (range 0% to 100%) when the Kanomax Climomaster did not perform well to changing conditions.

Calibration

One month before each cross-sectional survey, the instrument and probe were sent to Dou Yee Enterprise Pte Ltd, Hanoi, Vietnam, for checking and servicing.

Measurement techniques

On each working day of the surveys, investigators checked that the equipment worked properly and that batteries had sufficient power. The probe was connected directly to the main body or via an extension cable. When the equipment was turned on, the display showed current date and time, air velocity, air temperature, relative humidity, battery level and time constant of 1 (data results were updated every second).

For measuring air velocity, the probe was aligned with wind direction. If the investigator was not sure of wind direction, the probe was rotated slowly and air velocity was measured at the point where the investigator obtained the highest reading. It was necessary to leave the probe for 30 seconds until the display became stable. Reading ready showed on screen including air temperature (^{o}C, ^{o}F), air relative humidity (%) and air velocity (m/s).

When measuring rapidly changing environments, the Climomaster took a long time to show stable reading and the psychrometer was used instead. The investigator wetted the wick of the wet thermometer with distilled water, and a clockwork mechanism ran the fan inside the instrument. The psychrometer was placed at about of 1.5 metres for those standing during work activities and at 1 metre for those seated. After the fan was turned on 30 seconds, the reading of the wet bulb was checked and then every l0 seconds as it descends. When the wet bulb temperature appeared constant, equilibrium had been achieved (normally after 2 minutes). The psychrometer was then turned off and readings from both thermometers were taken, wet bulb first. Care had to be taken that the psychrometer was not allowed to run too long, as this would cause the wick to dry out and resulting in an erroneous relative humidity reading. The relative humidity was obtained using a psychrometer chart provided with the instrument.

Four samples were taken at the centre of each department, two in the morning and two in the afternoon for each of the three variables. Two samples were also taken outside the workplaces, one in the morning and the other in the afternoon, for comparing the effects of outside conditions.

Appendix 47. Checklist exercise for PAOT (WIPE) training course

Work Improvement for Protection of Environment WIPE Programme

WORKPLACE CHECKLIST

HOW TO USE THE CHECKLIST

1- Define the work area to be checked. In the case of a small enterprise, the whole production area can be checked. In the case of a larger enterprise, particular work areas can be defined for separate checking.

2- Read through the checklist and spend a few minutes walking around the work area before starting to check.

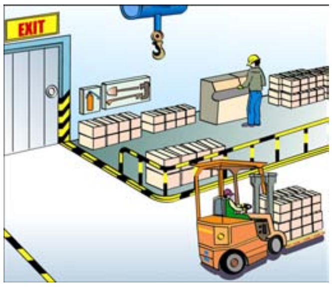
3- Read each item carefully. Look for a way to apply the measure. If necessary ask some questions to the manager or workers. If the measure has been applied or it is not needed, mark **NO** under " Do you propose action?". If you think the measure is worthwhile, mark **YES**. Use the space under **REMARKS** to put a description of your suggestion or its location.

4- After you have gone through the whole items, look again at the items you have marked **YES**. Choose a few items where the benefits seem likely to be the most important. Mark **PRIORITY** for these items.

5- Before finishing, make sure that for each item you have marked **NO** or **YES**, and that for some items marked **YES** your have marked **PRIORITY**.

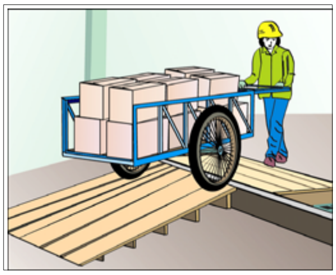
I- MATERIALS STORAGE AND HANDLING

1- Clear and mark transport routes.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
…………………………………………………

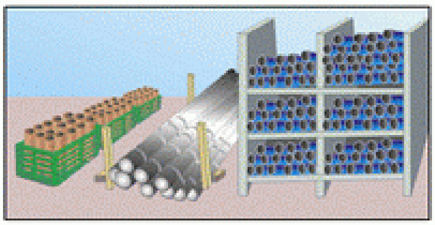
2- Provide ramps with small inclination instead of stairways within the workplace.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
…………………………………………………

1

3-Avoid placing materials on the floor but on a special storage.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
……………………………………………

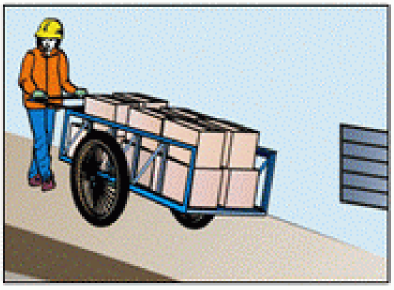
4- Save space by introducing multi-level shelves or racks near the work area.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
……………………………………………

5- Use mobile storage racks.

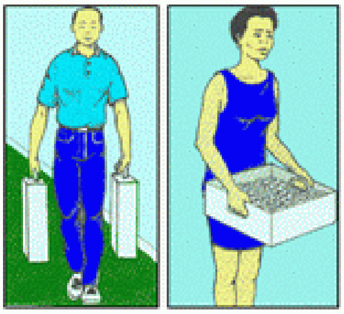
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
……………………………………………

6- Use carts, hand-trucks or other wheeled devices or rollers when moving materials.



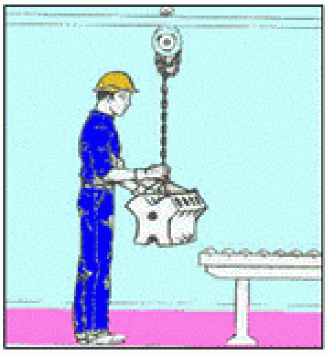
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
……………………………………………

7- Provide good handholds, grips or holding points for all packages and containers.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
…………………………………………………

8- Reduce manual handling of materials by using conveyers, hoists and other mechanical means of transport.



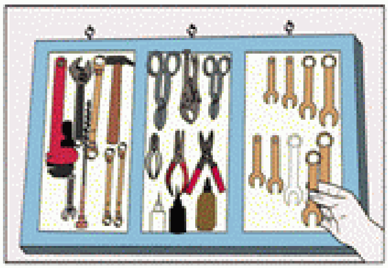
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
…………………………………………………

II- WORK STATION

9- Place frequently used materials, tools and controls within easy reach.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
…………………………………………………

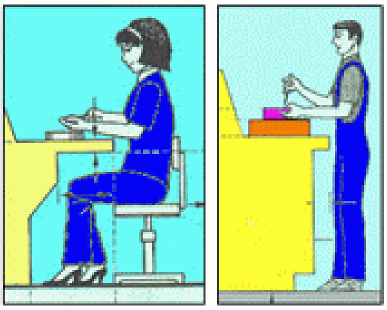
10- Provide "home" for tools.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
…………………………………………………

11- Adjust the working height for each worker at elbow level or slightly below it.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:...
....

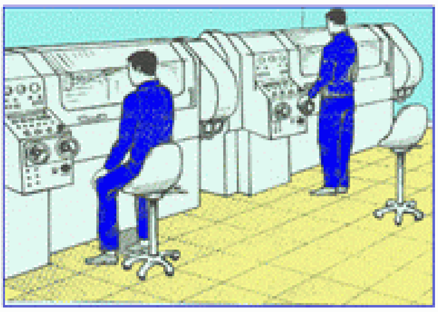


12- Provide sitting workers with good adjustable chairs with a backrest.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:...
....

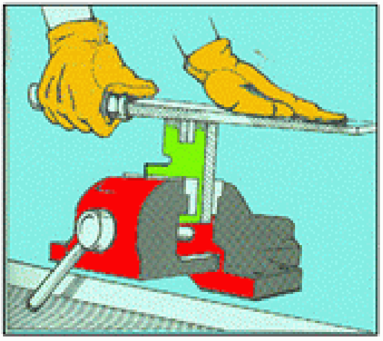
13- Allow workers to alternate standing and sitting at work as much as possible.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:...
....



14- Use jigs, vices and clamps to hold materials.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:...
....



15- Use markings, colors or attach simple worded labels in the local language on displays to help workers understand what to do.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
……………………………………………

16- Make emergency controls and switches clearly visible.

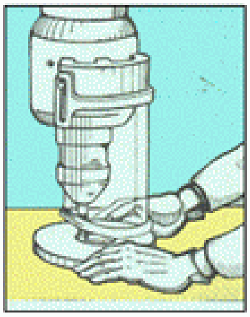
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
……………………………………………

III- PRODUCTIVE MACHINE SAFETY

17- Use safe feeding and ejection devices to keep the hands away from dangerous parts of machinery.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
……………………………………………

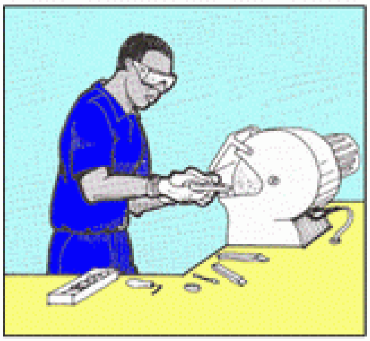
18- Use properly fixed guards or barriers to prevent contact with moving parts of machines.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
……………………………………………

19- Inspect, clean and maintain machines regularly including electric wiring.

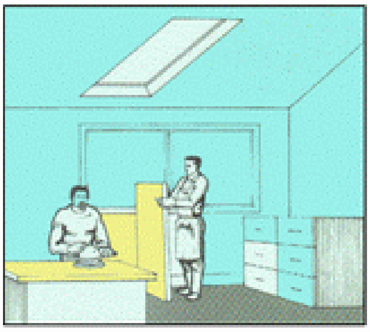
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:......................................
....



IV. PHYSICAL ENVIRONMENT

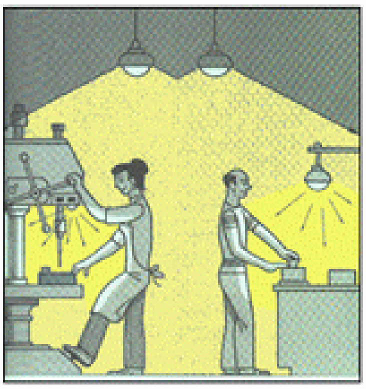
20- Increase the use of daylight and use light colors for walls and ceilings.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:......................................
....



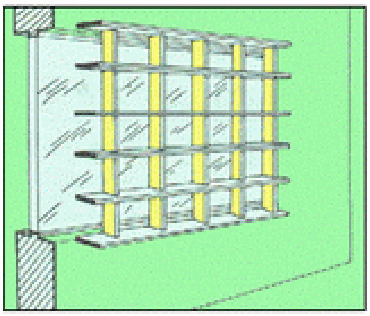
21- Relocate light sources and provide local lights for precision or inspection work.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:......................................
....



22- Increase the use of natural ventilation.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:......................................
....



23- Protect the workplace from excessive outside heat

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:..................................
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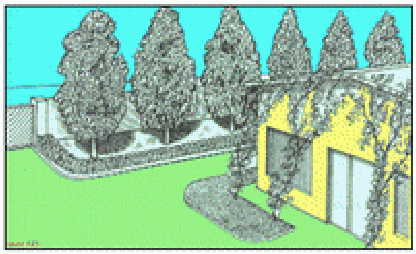

24- Move heat, noise, dust and chemical sources from general work area.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:..................................
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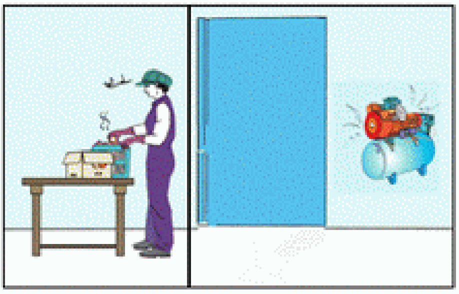

25- Use partitions to screen heat, noise, dust and chemical sources.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:..................................
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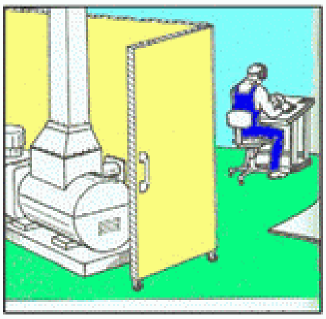
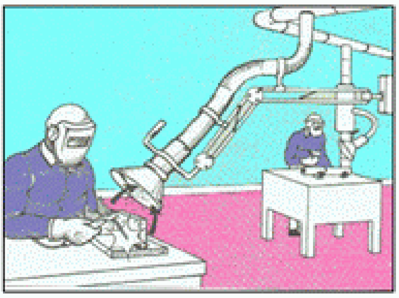


26- Use local exhaust ventilation systems against heat, dust and chemicals.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:..................................
....



27- Provide enough fire extinguishers near the work area and be sure that workers know how to use them.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
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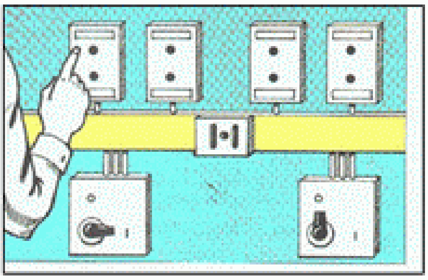
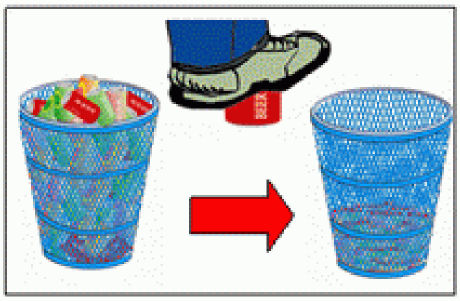
28- Ensure electrical circuits are enclosed, insulated and properly fused.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
………………………………………………

V. ENVIRONMENT PROTECTION

29. Select raw materials using minimal necessary packages.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
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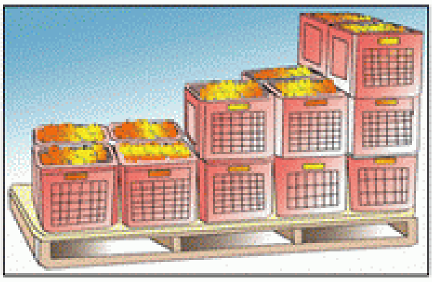
30- Substitute reusable containers for disposable containers.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
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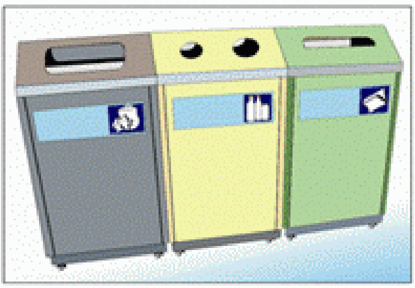
31- Place separate waste containers in the workplace for different types of waste such as metals, bottles, cans and plastics.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
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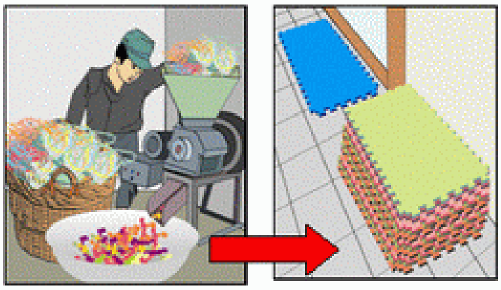
32- Develop a mechanism to recycle and reuse collected separate waste.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
……………………………………………

33- Adopt batch washing when washing materials and minimize continuous rinsing.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
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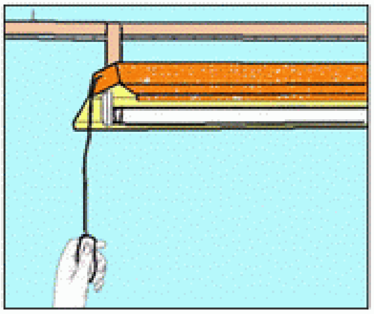
34- Provide separate switches for lights to save electricity and reduce heat.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:……………………………………
……………………………………………

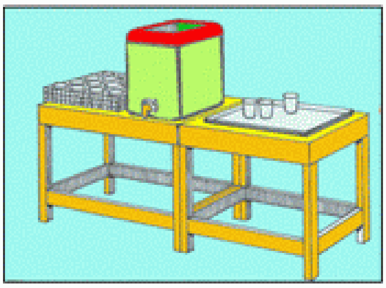
35- Prepare special containers having clear signs and instructions for collecting hazardous waste.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
………………………………………………

VI. WELFARE FACILITIES

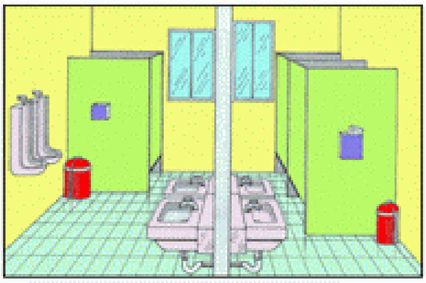
36- Provide drinking facilities, eating areas and rest rooms to ensure good performance and well being.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
………………………………………………



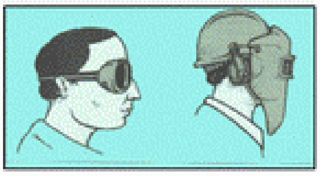
37- Provide and maintain good changing, washing and sanitary facilities to ensure good hygiene and tidiness.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
………………………………………………

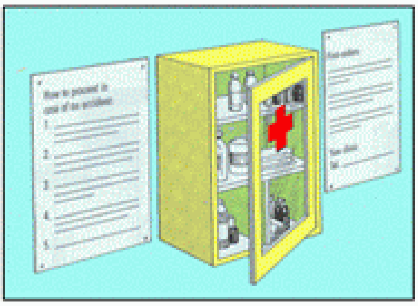


38- Provide personal protective equipment that gives adequate protection.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:………………………………
………………………………………………



39- Provide first aid equipment and train a qualified first-aider.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:.....................................
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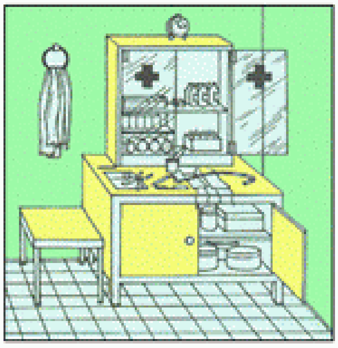
40- Establish health promotion program to prevent professional diseases and provide good health services.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:.....................................
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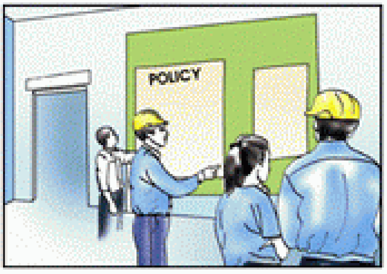
VII. WORK ORGANIZATION

41- Provide opportunities to take frequent short breaks for strenuous work requiring continuous attention.

Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:.....................................
....

42- Establish an OSH policy and provide adequate safety and health training to all workers.



Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks:.....................................
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Appendix 48. Examples of improvements in the factories under study

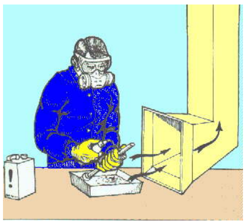
A. Example of improvement in work environment

1. **Local exhaust ventilation (LEV) at the CKSH metal casting factory**

a. Before the intervention

A grinder emitted metal dust, smoke and heat. It can cause pulmonary diseases and also cause serious eyes injuries from hot and sharp debris shooting out.

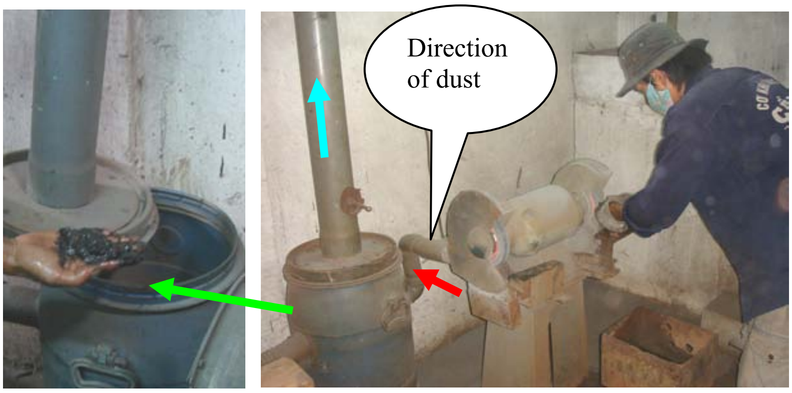
b. Illustration and ideas from PAOT training may be applied



"Install local exhaust ventilation"

c. Solution after the intervention

Dusty air was pumped away by LEV to an airtight watering container, where the dust was filtered by water and clean air went out through hard PVC pipes. The improvement caught dust from grinder (showed in photo). This improvement cost £210 to buy a second hand air pump and PVC tubes. However, this system was connected to four other machines (that were controlled by valves), so average cost per improvement was £52.50.

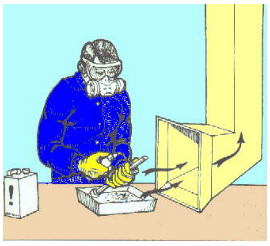


2. A local exhaust ventilation (LEV) at the CKSH metal casting factory

a. Before the intervention

A lathe machine emitted metal dust, oil mist and heat. It could also cause serious eyes and skin injuries in case of hot and sharp debris shooting out.

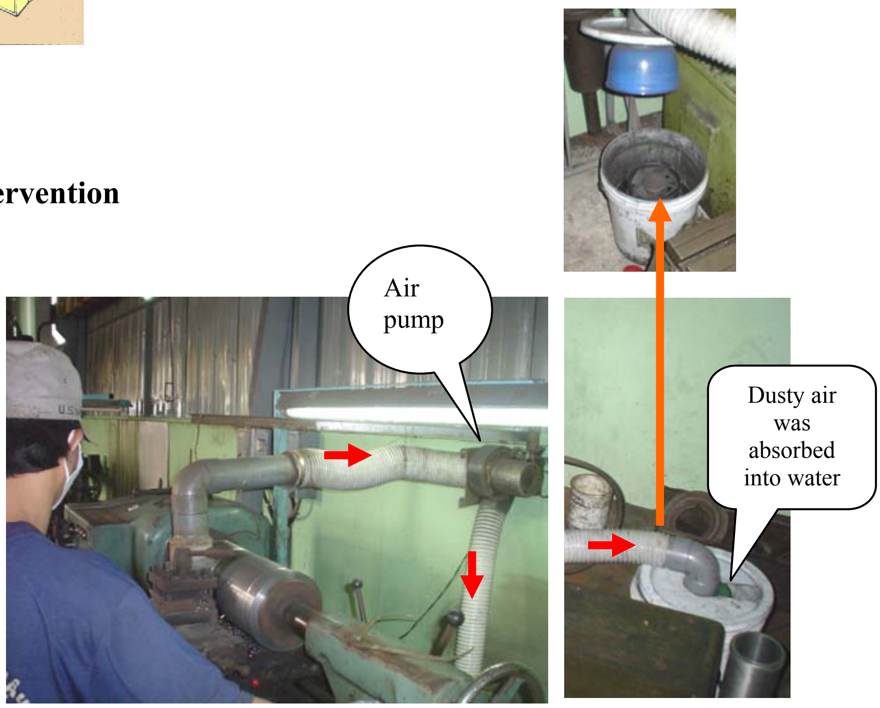
b. Illustration and ideas from PAOT training may be applied



"Install local exhaust ventilation"

c. Solution after the intervention

A mini LEV was installed with an air pump connected to a small container by plastic tubes. Dusty air was pulled out and dust was absorbed into water in a container. This improvement cost £10 to buy a second hand air pump and plastic tubes.

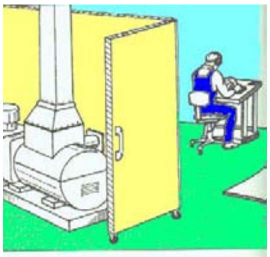


3. Noise isolation for an air compressor at the CKSH metal casting factory

a. Before the intervention

An air compressor made high noise to surrounding workplaces and residential areas. Moving the machine far away from the workplace may cause reduced air pressure in the system, and annoyance to neighbours. A safer machine, however, is quite expensive.

b. Illustration and ideas from PAOT training may be applied



"Isolating hazardous factors from workplaces"

c. Solution after the intervention

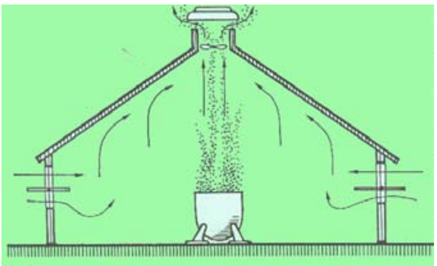
The machine was isolated in a concrete soundproof cabinet with the interior wall full of holes. An electric fan provided cool air to the machine. This improvement cost £30 to build the cabinet and bought the electric fan.

4. Typical roof doors at the CBLT CR rice mill factory

a. Before the intervention

Micro-climate in a rice mill factory is typically hot, humid, dark and dusty. However, many rice firms have no windows or roof doors because managers wanted to preserve rice grains from tropical rain-falls.

b. Illustration and ideas from PAOT training may be applied



"Use natural upward flow of hot air"

c. Solution after the intervention

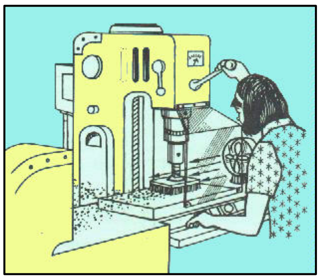
Sliding windows were broken through the roof of workshop to extract hot, humid and dusty air inside the firm. Fresh air and day-lighting changed work environment without electricity cost to managers. The windows moved upon ball-bearings and rails easily. One window cost £120 and one rice firm needed four windows (total from £480).

5. Typical water spraying at the CKSH civil engineering factory

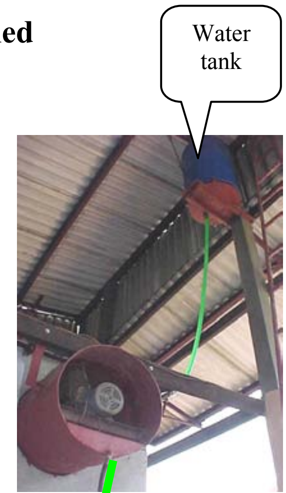
a. Before the intervention

Air temperature at the casting furnace was very hot and dusty. Two workers shared rotations every 30 minutes. They were dehydrated and felt tired at the end of the working day. An electric fan blew fresh air in. However, this fan caused the loss of thermal energy from the furnace.

b. Illustration and ideas from PAOT training may be applied

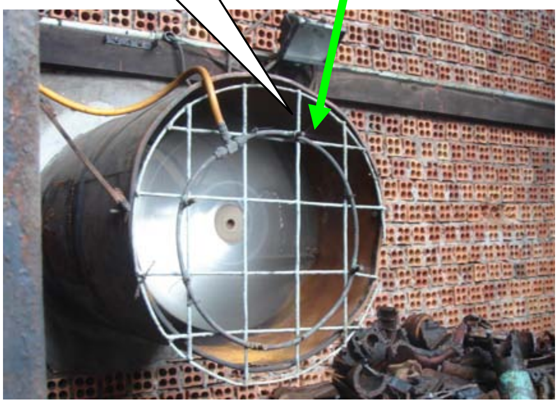


"Reduce heat, dust from workplaces"



c. Solution after the intervention

A combination of a water spray and a smaller fan provided a light drizzling rain to the worker's body. The solution offered a cooling effect to the worker but did not effect the furnace. The improvement cost £20 for an electric fan, eight buzzles and pipes.



6. Waste bin at the MK garment factory

a. Before the intervention

Cutting workers threw away superfluous cloths on the floor. Dust was discharged from this rubbish by walking, sweeping, or removing them out of the workplaces.

b. Illustration and ideas from PAOT training may be applied

"Place different waste containers in the workplace"

c. Solution after the intervention

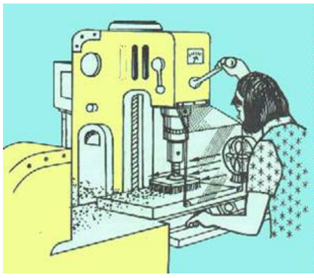
Setting a bin near each working station collected all rubbish at once until it full and was moved out. The solution not only cut down dust concentration in the work places but also stopped hazard exposure from cleaning tasks. The bins cost £10 each but can be used for a long time.

7. A feather input box at the MK garment factory

a. Before the intervention

Jackets were stuffed with feathers. Workers sat on the floor working with opened containers. Workers wore thin masks. Dusty work conditions may cause respiratory diseases, there was also a loss of expensive feathers.

b. Illustration and ideas from PAOT training may be applied



"Isolate and set local exhaust ventilation to control hazard"

c. Solution after the intervention

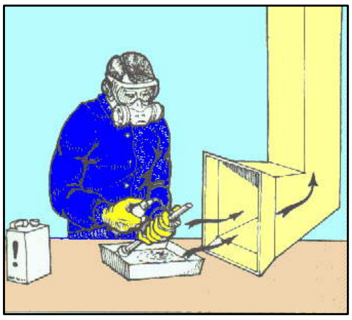
Feathers were stored in tight transparent boxes with some chinks (holes) that allowed workers to collect feathers for stuffing the jackets. The solution not only reduced dust concentration but also saved significant amount of feathers. The box cost only £10 for two workers.

8. A dust collector room at the DT metal casting factory

a. Before the intervention

Four grinders were used to smooth semi-finished products in a metal casting department. They discharged metal dust and fractions (large particles) around the workplace. The manager eliminated dust with a simple partition behind each machine.

b. Illustration and ideas from PAOT training may be applied



"Use local exhaust ventilation systems against heat, dust and chemicals.

c. Solution after the intervention

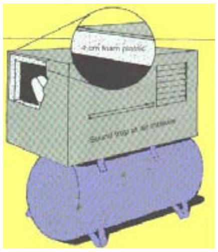
Openings were made behind the grinders and were connected to a tight pipe. An electric fan pulled dusty air from grinders through the pipe and filtered it by a large cloth sleeve. Fractions were deposited on the ground whereas dust was caught by filter at end of the pipe. The improvement cost £22 for 4 grinders.

9. A CO_2 welding application at the TA civil engineering factory

a. Before the intervention

Welding by electric arc was one of the most hazardous tasks in the TA factory. The task discharged dust, toxic gases, caused burning and electric shocks. Unfortunately, it was one of the main tasks workers had to do.

b. Illustration and ideas from PAOT training may be applied



"Purchase safe and productive machine"

c. Solution after the intervention

Thinking of workers health and better work environment, the manager and workers decided to change to a safer carbon dioxide welding machine. It not only improved work environment but also produced high quality products. The improvement cost £880 with benefits to workers and potential customers.

B. Example of improvement in work station design

1. A typical side table for a winding machine at CD CT civil engineering factory

a. Before the intervention

A rudimentary winding machine forced worker to adopt an adverse posture. After many hours working, the worker felt tired and there was decreased productivity.

b. Illustration and ideas from PAOT training may be applied

"Use side table to provide extra work station"

c. Solution after the intervention

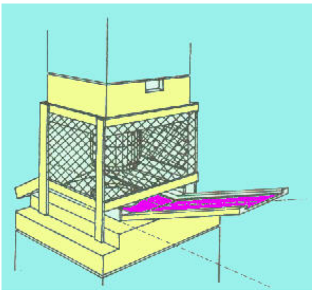
A side table made from recycled materials provided a place for tools and materials in an easy reach zone. It saved worker time, prevented fatigue symptoms and increased productivity. The improvement used recycled materials available in the factory.

2. A chute for increasing productivity at the VT garment factory

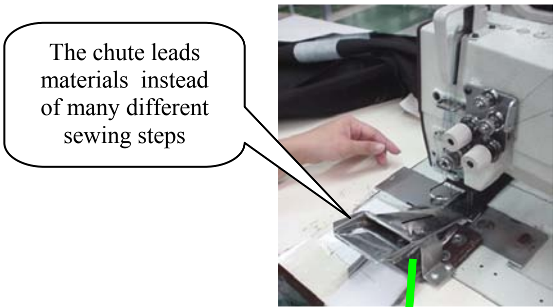
a. Before the intervention

Most of garment factories in Can Tho involved semiautomatic and handmade manufacturing. Workers produced a semi-finished product by several steps. The meticulous processes were quite complicated and took a lot of workers' time and energy.

b. Illustration and ideas from PAOT training may be applied



"Use simple devices to support manual operations"



c. Solution after the intervention

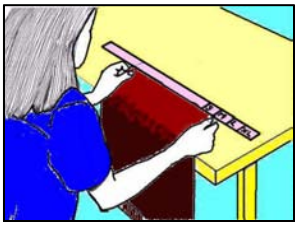
A simple device attached to the sewing machine could combine different materials from several steps at once. It could save time and manipulations. The devices not only increased productivity but also produced better quality products compared to traditional techniques. The improvement was made by factory technicians with cheap materials just £5.

3. Typical sewing frame at the MK garment factory

a. Before the intervention

Many steps in sewing are semiautomatic. Workers connect 2 to 5 single pieces of cloth and sew them into semi-finished products. They spend much time on monotonous activities and these meticulous processes use up workers' energy.

b. Illustration and ideas from PAOT training may be applied



"Use simple devices to support manual operations"

c. Solution after the intervention

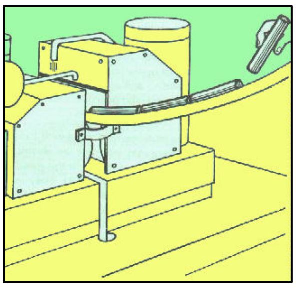
A plastic frame grasps cloths firmly and allows worker to sew easily and quickly. Depending on type of products, the technician designs different frames by sizes, shapes, and structures. The workers not only obtain higher productivity, better quality but also prevent finger injuries. The devices are made by factory technicians and cost as little as 30 pence each.

4. A multi feeding device at the MK garment factory

a. Before the intervention

Waistband production requires several steps. The meticulous process involves sewing different layers by separate phases before combining them together.

b. Illustration and ideas from PAOT training may be applied



"Use feeding devices to support manual operations"

c. Solution after the intervention

A combined device attached to sewing machines could feed different materials from several steps at once. The devices not only increased productivity but also produced better quality products compared to traditional technique. The devices were made by factory technicians for just £3.

5. Typical iron supportive device at the VT garment factory

a. Before the intervention

Ironing workers in garment industry carry out difficult work involving many movements of the iron and materials. These are heavy tasks in a hot environment, pay is low because the work is time-consuming to accomplish a single product.

b. Illustration and ideas from PAOT training may be applied

"Use support devices for multi steps tasks"

c. Solution after the intervention

A wooden frame kept the leg of trousers straight and the ironing became quicker and easier. The solution not only reduced workers' workload but also increased productivity and perhaps their incomes. The frame cost only £6.

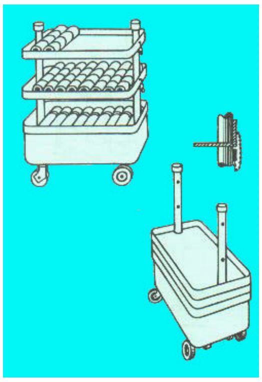
C. Example of improvement in Materials Handling

1. A convenient pushcart at the CKSH metal casting factory

a. Before the intervention

Push carts are needed to carry heavy materials at metal casting factories. There are different push carts depending on the shape of products. However, manual handling materials from too high or too low levels can cause musculo-skeletal disorder to workers.

b. Illustration and ideas from PAOT training may be applied



"Use suitable push cart for material handling"

c. Solution after the intervention

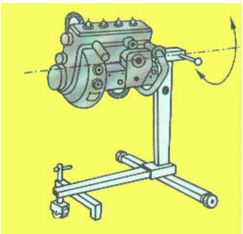
Because heavy semi-finished products were stored on shelves at high levels, a "combined 2-in-1 push cart and ladder" was created to simplify working procedures and reduce gap of material lifting. The improvement cost £15 for steel bars and wheels.

2. An injection moulding process at the CKSH metal casting factory

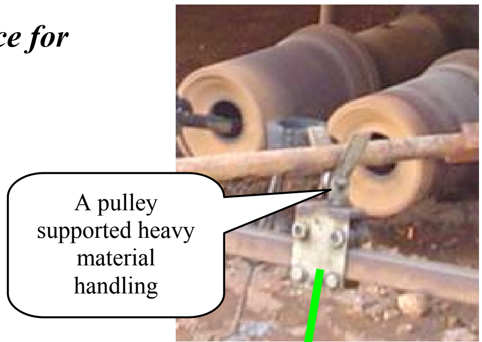
a. Before the intervention

Moulders had to carry heavy, melted metal containers and to cast with adverse working postures. The working conditions were hot, dark and risky. Shift rotation took place every 60 minutes and workers felt exhausted after working time.

b. Illustration and ideas from PAOT training may be applied



"Use a rotary device for heavy object"



c. Solution after the intervention

A strong mobile frame with a roller was introduced, made of 2 ball-bearings and a V handle. It supported founders to cut down their work load from heavy materials. The workplace environment was also improved with stronger daylight and natural ventilation. The founders could save their energy and, perhaps, gain higher productivity comparing to previous conditions. This improvement cost £7 to buy the ball-bearings and 3 metres steel pipe.

D. Example of improvement in Machine Safety

1. A sewing machine guard at the VT garment factory

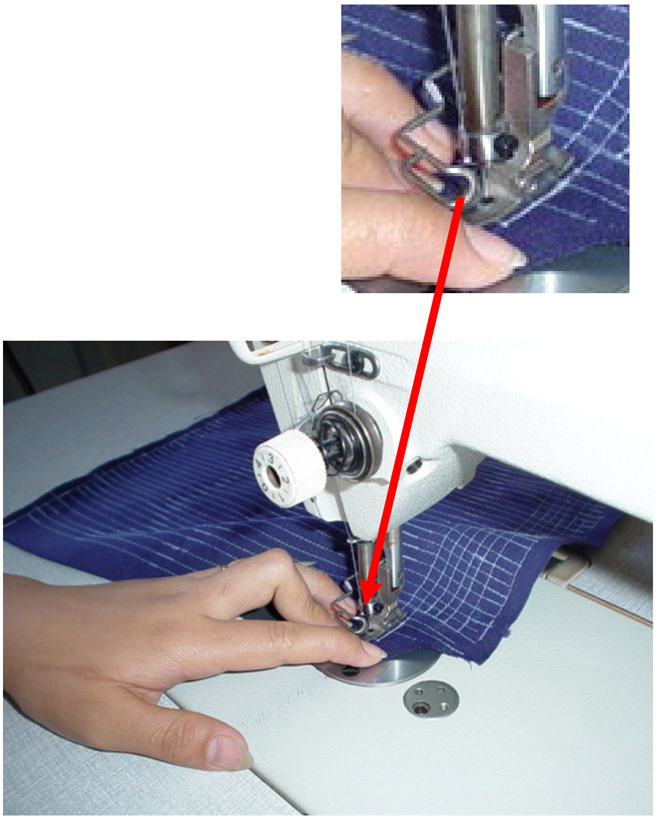
a. Before the intervention

A common accident in the garment industry was needle thrusting, because small factories bought second hand sewing machines without needle guards. Some workers sought higher productivity by removing safety guard from machines.

b. Illustration and ideas from PAOT training may be applied

"Use fixed guards or barriers around danger parts"

c. Solution after the intervention



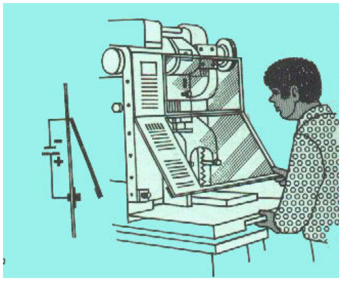
Needle guards made of steel wire and attached to all sewing machines could reduce the number of finger injuries sharply. The solutions cost only 1 penny for each machine but saved factory health costs and worker absence.

2. A safe cutting machine at the HL printing factory

a. Before the intervention

The cutting machine in the printing and paper industry is one of high risk in terms of accidents to hands. The second hand cutting machine lacked inter-lock guards for safe operation, but workers did not recognise this.

b. Illustration and ideas from PAOT training may be applied



"Use inter-lock guards"

c. Solution after the intervention

An inter-lock guard was designed by technicians that switched the machine off when workers' hands were unintentionally at risk. The improvement cost £15 but prevented dangerous accidents.

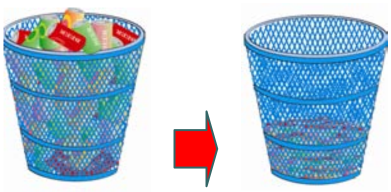
E. Example of improvement in Environment Protection

1. Washing materials machine at the CKSH metal casting factory

a. Before the intervention

The metal casting SMEs in Can Tho City have been using recycled materials to produce new products. Such materials were quite unclean because they were oxidised and come from different sources. After classifying, materials were burnt with charcoal and metal was melted. The ashes that came out of the chimney depended on the proportion of impurity in the raw materials.

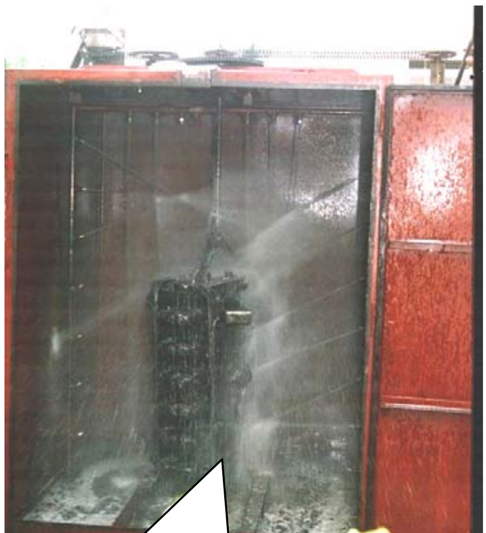
b. Illustration and ideas from PAOT training may be applied



"Examine raw materials if they have damages or decays when selecting them"

c. Solution after the intervention

The raw materials were washed inside a self-propelled cabinet with an electric motor, a pump, and rotary accessories. This reduced impurities. Cleaner materials produced lower ash concentration discharged from smoke and manufacturing production was improved. The washing liquid was recycled, the improvement cost £400.



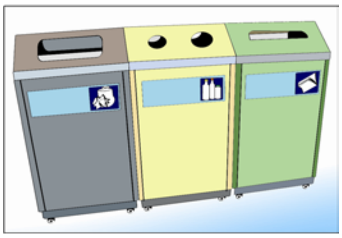
Raw material in a basket turned round and round while washing liquid was sprayed at high pressure (door must be closed when working)

2. Simple waste oil collection at the CKSH metal casting factory

a. Before the intervention

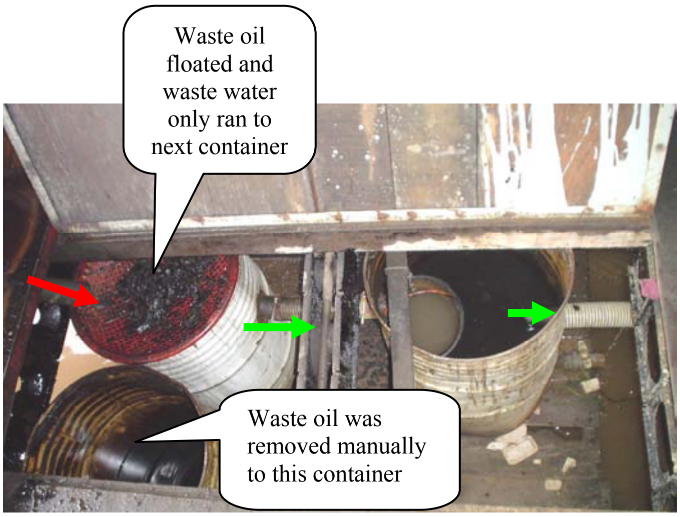
Waste water mixing with oil can cause environmental pollution and biological disorder. A waste water treatment system was unaffordable for any SMEs.

b. Illustration and ideas from PAOT training may be applied



"Place separate waste containers in the workplace for different types of waste"

c. Solution after the intervention



Waste water mixed with oil was collected into a container. Oil floated on surface and water only run into next container through a lower level pipe. Floating oil was removed to another container. The uninterrupted containers with controlled water levels let system run automatically and workers removed waste oil as needed. The improvement cost £30 for containers and one metre metal pipe.

3. A waste materials were recycled at the VT garment factory

a. Before the intervention

Every month a garment factory threw away huge amount of superfluous cloths mixed with other waste. This rubbish was transported at a cost to a dumping ground and became long lasting pollution.

b. Illustration and ideas from PAOT training may be applied

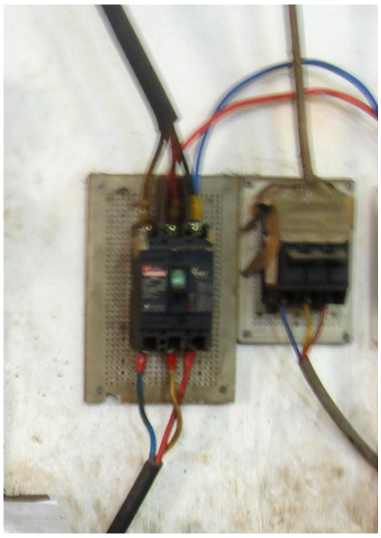
"Recycle and reuse collected separate waste"

c. Solution after the intervention

Wastes were collected, classified and sold for recycling. The solution saved costs for transporting wastes, and prevented environmental pollution. The improvement did not require any cost but manager earned budgets for environment protection activities.

F. Some typical zero cost improvements

1. A safety tag at the TA civil engineering factory



a. Before the intervention

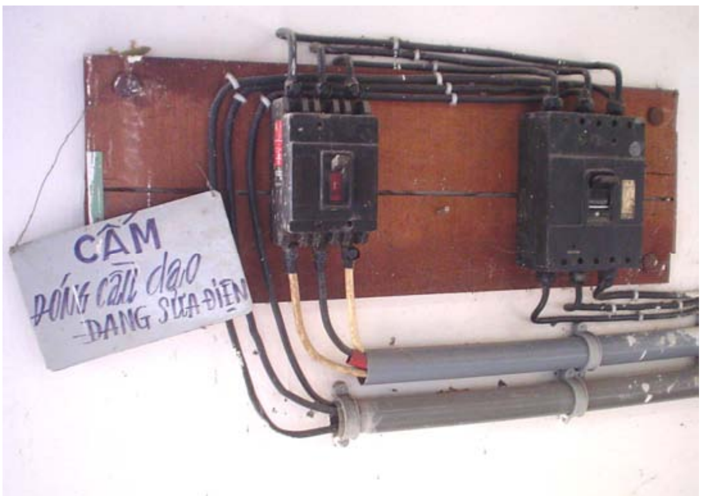
Electric shocks cause fatal accidents among SMEs in Vietnam. Some of them are caused by improper operations or poor maintenance of electric wire supply.

b. Illustration and ideas from PAOT training may be applied

"To lock control mechanisms of machines with a safety tag when maintaining or preparing machines".

c. Solution after the intervention

A tag with clear information ***"Danger, do not operate"*** at the electric switches prevented such fatal mistakes. The improvement was at zero cost.

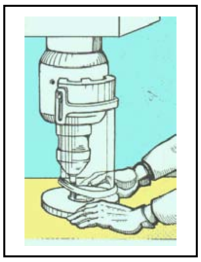


2. A metal cutting machine at the CD CT civil engineering factory

a. Before the intervention

A cutting machine discharged metal dust, noise, and smoke. It also caused risk of a fire and eyes and skin injuries from its hot and sharp debris.

b. Illustration and ideas from PAOT training may be applied



"Isolating hazardous sources to health"

c. Solution after the intervention

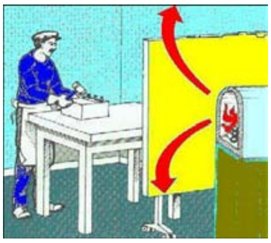
A metal pipe was designed and attached a manhole to direct dust flow toward a dish where the mouth of the pipe was dipped into water. The solution caught a part of dust from cutting task. This improvement took worker one hour to make a pipe, without any cost.

3. Heat isolation at the VT garment factory

a. Before the intervention

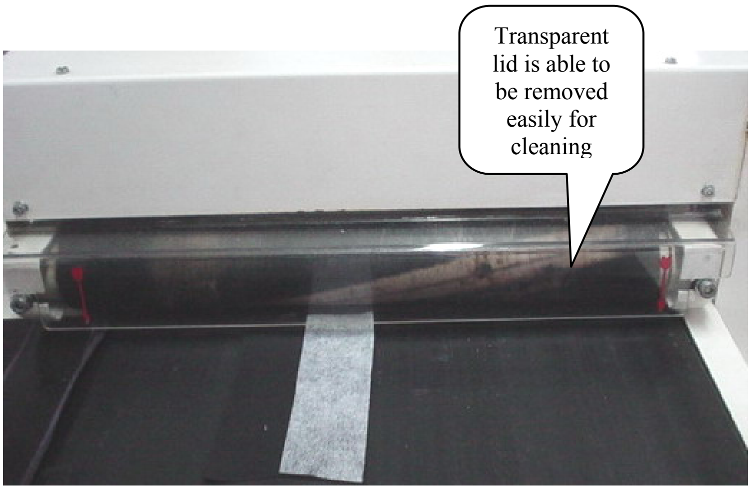
A thermal pressing machine radiated heat and burning smell surround working area. Chemical burning also irritated the respiratory tract of many workers in the unit. An LEV could not work because it caused heat loss.

b. Illustration and ideas from PAOT training may be applied



"Isolating hazardous sources to health"

c. Solution after the intervention



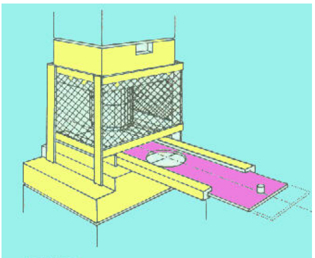
A mica lid was fixed to the hot cylinder. The solution decreased heat and also minimised the bad chemical evaporation. The improvement used recycled materials that were available in the factory.

4. A holding device at the VT garment factory

a. Before the intervention

Another thermal pressing machine also radiated heat and unpleasant smells in the surrounding work area. However, feeding process required workers to stand close to the hot machine. There were complaints of health effects and burning accidents.

b. Illustration and ideas from PAOT training may be applied



"Use safe feeding devices"

c. Solution after the intervention

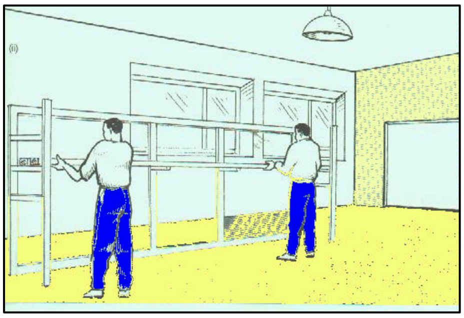
A simple feeder held and led materials to machine instead of workers' hands. The solution allowed workers to stand far from the pollutants. The improvement used recycled materials that were available in the factory.

5. Day light and natural ventilation at the TA civil engineering factory

a. Before the intervention

Workers in the lathe department complained of low lighting and poor ventilation.

b. Illustration and ideas from PAOT training may be applied



"Make full use of daylight and natural ventilation"

Windows on the walls provide more fresh air and lighting

c. Solution after the intervention

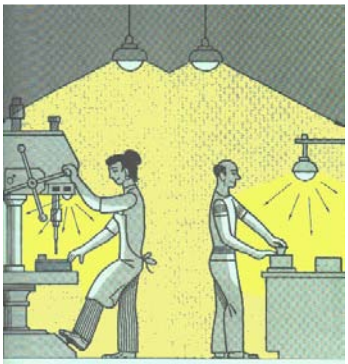
Workers broke through the wall to create more windows. The workplace got more natural lighting and fresh air without cost of new equipment and electricity.

6. Local lighting at the TA civil engineering factory

a. Before the intervention

An old drilling machine lacked local light. It prevented workers wearing eye protection because they could not see objects clearly. A new light was set but it caused uncomfortable glare to eyes.

b. Illustration and ideas from PAOT training may be applied



"Use local lights for precision work and avoid glare"

c. Solution after the intervention

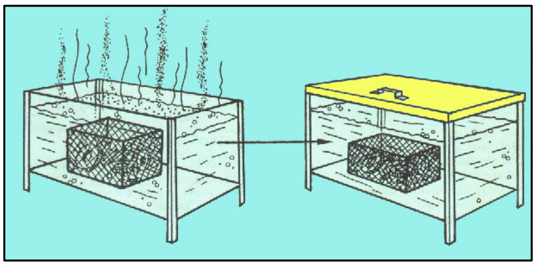
A lampshade was made from aluminium paper to prevent glare. Light could change from general lighting to local lighting by moving the lampshade. The improvement used recycled material only.

7. A dust cover at the TT CD rice mill factory

a. Before the intervention

Dust was discharged from an opened surface where workers regularly checked quality of products.

b. Illustration and ideas from PAOT training may be applied



"Use partitions to screen heat, noise, dust and chemical sources"

c. Solution after the intervention

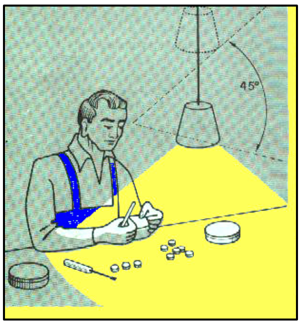
An airtight dust cover made by metal sheet to prevent dust from the machine. The lids were able to open easily for quality checks. The improvement used recycled materials.

8. A relocation of lights at the TT CD rice mill factory

a. Before the intervention

Lights hang at high level and dust adheres on light bulbs causing inefficient lighting. Checking rice quality in the rice mill industry requires good lighting.

b. Illustration and ideas from PAOT training may be applied



"Relocate light sources for better lighting conditions at the workplace"

c. Solution after the intervention

All light bulbs were relocated downwards near to the checking points to obtain the best lighting efficiency and to enable convenient cleaning. The improvement was carried out at no cost to the firm.

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