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NOTES

Participatory Ergonomics and an Evaluation of a Low-Cost Improvement Effect on Cleaners' Working Posture

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Cleaning is a highly physically demanding job with a high frequency of awkward postures and working environments as contributing risk factors. Participatory ergonomics is a method in which end-users take an active role in identifying risk factors and solutions. The aim of this study was to apply the participatory ergonomics method to identify cleaning problems and to evaluate the effect of a low-cost improvement on cleaners' working postures in an office environment. The results show that the cleaning problem was identified, and the low-cost ergonomics solution suggested by the cleaners was implemented. Thus an improved working environment reduced the number of awkward cleaning postures and the Ovako Working Posture Analysis System (OWAS) action category for floor mopping decreased. It can be concluded that working in an improved environment can lead to better working postures which, in turn, leads to the cleaners' better health and better cleaning results.

participatory ergonomics cleaning OWAS postural analysis low-cost improvement

1. INTRODUCTION

Cleaning is considered a high physically demanding job, resulting in high cardiovascular load [1, 2], high frequency of awkward postures [3, 4] and, as such, it is rated as a highly strenuous job [1, 2]. In several studies the relationships between a poorly designed workplace, poor working posture and diseases of the musculoskeletal system have been demonstrated [5, 6, 7].

According to Noro and Imada [8] participatory ergonomics is a method in which its end-users take an active role in the identification and analysis of risk factors, as well as in the design and implementation of ergonomics solutions. Participatory ergonomics interventions have been associated with a decrease in the incidence of musculoskeletal symptoms [9, 10], a decrease in work absenteeism [10] and an improved psychosocial work environment [11].

Amongst the various ergonomics approaches, participatory ergonomics is a popular one. In participatory ergonomics workers are involved in implementing ergonomics knowledge and principles in their workplace, supported by their supervisors and managers, in order to improve their working conditions [12]. Several studies have shown the success of problem identification and solution through participatory ergonomics intervention [10, 13, 14].

The aim of this study was to use the participatory ergonomics method to evaluate cleaning problems and to evaluate the effect of a low-cost improvement

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on cleaners' working postures in an office environment.

2. METHOD

Twenty-three motivated professional female cleaners from one university in Sweden took part in a participatory workshop (PW). Their age ranged from 24 to 54 years and the average length of their work experience was 14 years. The PW was carried out according to the following steps:

- Step 1: Definition of the framework/theme of the PW,
- Step 2: Establishment of the goal,
- Step 3: Identification of the problem,
- Step 4: Development of a possible ergonomics solution,
- Step 5: Implementation of the solution,
- Step 6: Evaluation.

The PW method is based on recommended outlines for the process of participatory ergonomics [15, 16, 17].

The theme of the PW, "Problems while cleaning", was defined in an active discussion of all the cleaners. The conditions were flexible and informal with access to refreshments and materials for visualizing the output of the PW. The cleaners sat in a U-shaped seat arrangement. The cleaners' supervisor also participated as a neutral person to guide the PW. Researchers facilitated the PW, which took about 3 hrs.

The goal of the PW was to highlight all the problems related to the present work situation or conditions, which were experienced by the cleaners and which they wanted to change. Each participant briefly described a problem she had experienced. The PW leader wrote it down verbatim on a large sheet of paper with a running number. This continued until no cleaner could come up with any problem other than what had already been expressed. This meant that the cleaners had expressed all their criticisms.

After listing all the problems, each participant ranked the three most critical problems from the list and the PW leader ranked the listed problems from the first to the last. The first ranked problem was selected for developing a possible ergonomics and economical solution.

The computer and electric cables were ranked first by the cleaners because they made mopping the floor difficult. Due to the cables on the floor, the cleaners had to squat, lift the cables with one hand, and mop the floor with the other. A possible ergonomics solution to the problem, suggested by the cleaners, was to fix the cables above the floor by attaching them to the working table in such a way that they did not lie on the floor in a scattered fashion, or hang in the air (Figure 1).

Two hundred and twenty offices in one of the university buildings were observed closely, and it was found that 65% of those rooms had cables sprawled on the floor. Out of the 220 office rooms, six were selected for the purposes of the test; all of them were used by university staff.

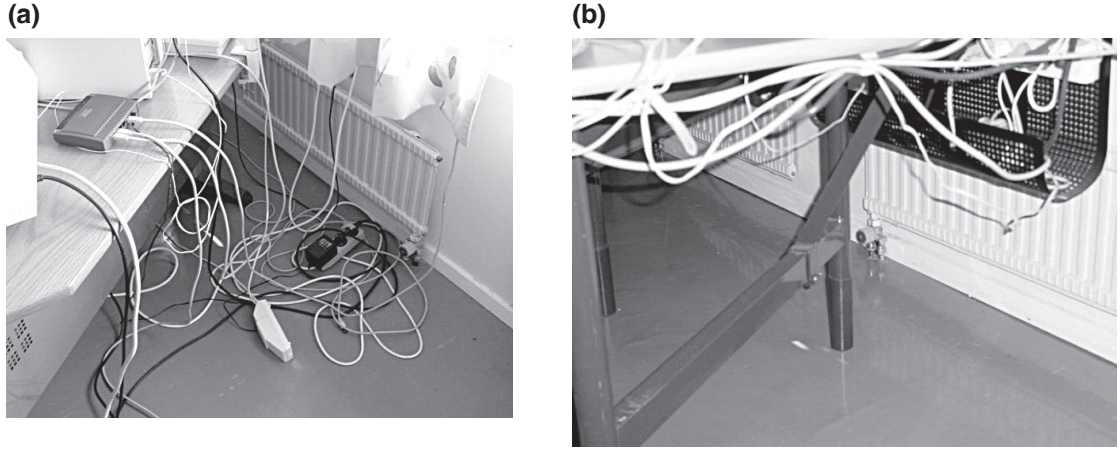

Figure 1. (a) Cables on the floor, (b) cables above the floor, attached to the working table.

Ten female cleaners, who had taken part in the PW, participated in Tests 1 and 2, each of which lasted 30 min per cleaner. In Test 1, they cleaned a room with the cables on the floor using their usual pace and style. Test 2 was carried out after all cleaners finished Test 1. In Test 2, the cables were fixed above the floor (they were attached to the working tables) and the cleaners were asked to perform the cleaning task in the same manner as in the first test. One deciliter of dry sand was used as cleaning dust on the floor in both tests so that cleaners maintained their normal pace. Both tests were recorded on videotape for task analysis and postural analysis of cleaners with the Ovako Working Posture Analysis System (OWAS) method [18].

In the OWAS method there are about 252 posture combinations: work postures for the back, arms, legs, and for carrying load, all of which are assigned action codes [19, 20]. The four action codes are defined as follows:

- Action category 1: change not required,
- Action category 2: change required in the near future,
- Action category 3: change required as soon as possible,
- Action category 4: change required immediately.

After the second test, the videotapes were analyzed with the WinOWAS computer software [21] for analyzing working postures according to the OWAS method. The random time interval for coding a cleaning posture was 10 s.

3. RESULTS

3.1. Task Analysis

Task analysis was done by analyzing the videotapes recorded while the cleaners cleaned a selected room for the purposes of the tests. The task started with pushing the cleaning cart into the office door, and ended with closing the door (Figure 2).

As a result of task analysis, nine main activities of the cleaning job were identified. Floor mopping and wet dusting were the major ones (Figure 3).

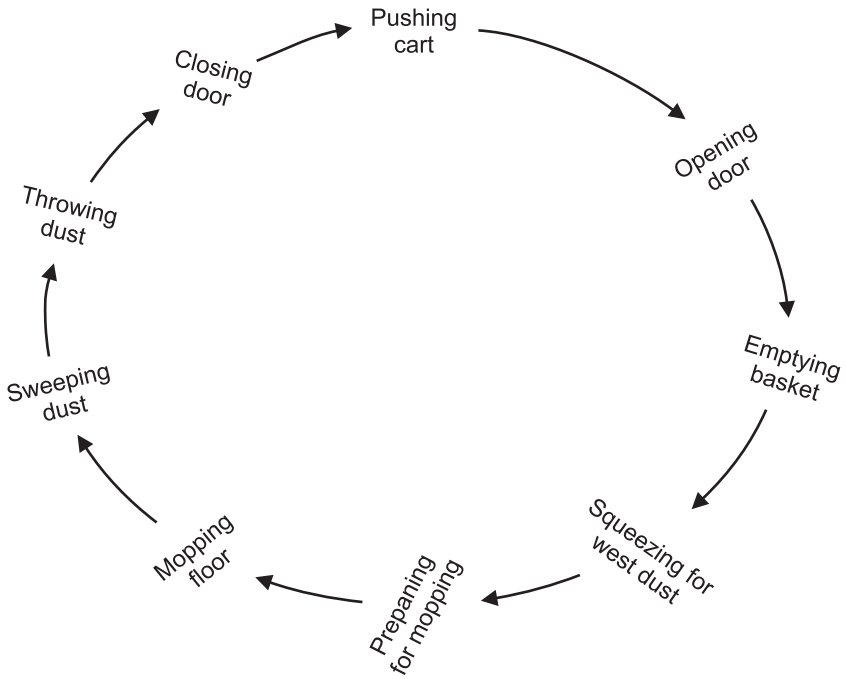

Figure 2. Cleaning activities from task analysis.

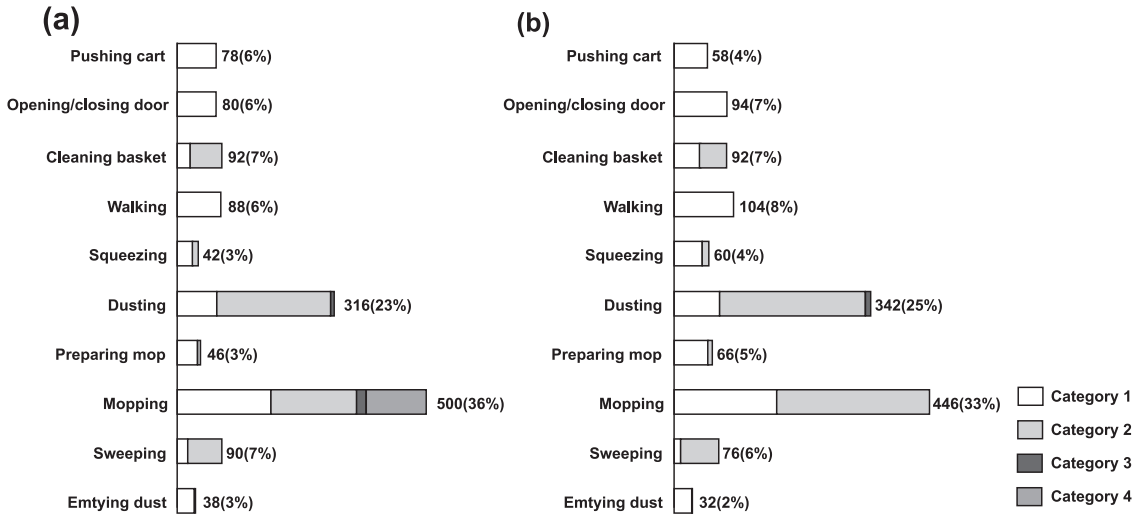

Figure 3. The proportion of cleaning activities: (a) with cables on the floor, (b) with cables above the floor.

3.2. Postural Analysis

The obtained data was analyzed according to the different work phases (corresponding with task analysis) for both tests, and the proportionate share of postures for different work phases was calculated in percentages.

The total number of OWAS observations for each test was 1,370 for the 10 participating cleaners. The proportionate share of postures of different body parts was analyzed and categorized into different action categories. After analyzing the postures in Test 1, it was found that only mopping and dusting proportions fell into categories 3 and 4. In Test 2, the floor mopping task did not fall into categories 3 or 4 (Table 1).

The number of working postures for floor mopping decreased from 36 to 33% of the total working time after the cables were fixed above the floor. The differences were found in the proportion of the back, arms, and legs postures between Tests 1 and 2 during the floor mopping task (Table 2).

It was found that fixing the cables above the floor affected the cleaners' posture in the floor mopping task only: the cleaners did not squat while cleaning under the tables (Figure 4).

TABLE 1. OWAS Category for the Mopping Task Before and After Fixing Cables

	% of Working Time		
Cleaning Task	**Cables on Floor**	**Cables Above Floor**	**OWAS Category**
Mopping	38	40	1
	35	60	2
	4	—	3
	24	—	4
Dusting	25	23	1
	73	75	2
	2	2	3

Notes. OWAS—Ovako Working Posture Analysis System.

TABLE 2. The OWAS Proportion of Back, Arms, and Legs Posture in the Floor Mopping Task in Tests 1 and 2

Posture	Test 1 (Cables on Floor, %)	Test 2 (Cables Above Floor, %)
Back		
Straight	31	31
Bent	32	37
Twisted	8	9
Bent and twisted	29	23
Arms		
Both below shoulder	74	100
One above shoulder	26	—
Both above shoulder	—	—
Legs		
Standing on two legs	36	51
Standing on one leg	5	11
Sitting on two bent knees	6	—
Sitting on one bent knee	17	—
Kneeling	6	—
Walking	30	39

Notes. OWAS—Ovako Working Posture Analysis

Figure 4. Change of working posture during the floor mopping task: (a) with cables on the floor, (b) with cables above the floor.

3.3. Quality of Floor Cleaning

It was observed that in Test 1, sand was still left under the table where there were cables on the floor. In Test 2, no sand was left on the floor after the cables had been fixed above it.

4. DISCUSSION

In this study, the participatory ergonomics method was successful in identifying ergonomics problems at the workplace and possible ergonomics solutions. The reason why workers' participation is important in problem solving is that workers know their work and workplace better than others, and they act as problem solvers [15, 22]. Further, participatory ergonomics enhances the development of a two-way information flow between a supervisor/researcher and the workers (Figure 5), which facilitates ergonomic activities for problem identification and ergonomics solutions [23].

The low-cost change was implemented in the office environment as suggested by the cleaners

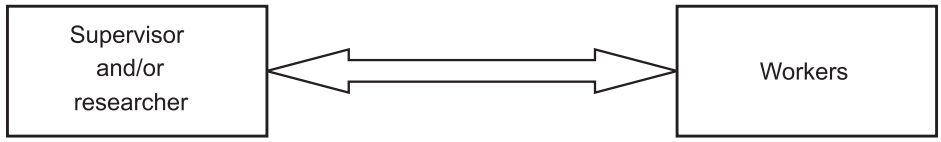

Figure 5. Two-way information flow between supervisor/researcher and worker while using the participatory ergonomics method.

and an evaluation of the effects of the change on the cleaning postures was carried out. Task analysis was done in order to classify the activities/tasks of the cleaning job, which was done in OWAS in the form of work phases, such as pushing the cart, opening/locking the door, etc. (Figure 2).

Some minutes of observation were ruled out from the video analysis because of other activities which were not related to the cleaning job, such as talking on the phone, waiting for the occupant to leave the room, etc. Therefore, the average cleaning time was shorter than the required 30 min. Although the recommended time interval for an OWAS analysis is 30 s, the researchers chose to use 10-s intervals in order to obtain more observations.

After implementing the low-cost improvement, none of the cleaning activities fell into categories 3 or 4. Further, in Test 1, we found that the cleaners' arms posture was 74% for both arms below the shoulders, and 26% for one arm above the shoulder as compared to 100% for both arms below the shoulders in Test 2 during the floor mopping task. It was also found that the cleaners' legs posture for standing on two bent knees, standing on one bent knee, and kneeling were completely eliminated after the low-cost improvement.

The reason is that after fixing the cables above the floor, none of the cleaners squatted or sat on bent knees while cleaning the floor under the table in Test 2. This was in contrast with Test 1, in which the cleaners had to bend their knees in order to hold the cables in one hand, and to mop the floor with the other hand (Figure 4).

We also found that after fixing the cables above the floor, the cleaners bent their back more than in Test 1. The reason is that while standing and cleaning the floor, the cleaners had to bend their backs in order to see under the table.

Although the quality of floor cleaning was not measured in this study, it was clear that the floor was completely cleaned when the cables were fixed above the floor. The possible explanation is that fixing the cables above the floor gave the cleaners a complete clear space to clean under the table. In contrast, cables on the floor forced the cleaners to squat and hold the cables with one hand, which limited them in cleaning the whole area properly.

It has been clearly shown that thanks to this low-cost improvement the cleaners have a better working posture for floor mopping compared to unimproved working conditions. One research study [24] made a low-cost improvement for small enterprises in the Phillipines and many low-cost improvements were shown to reduce work-related musculoskeletal disorders and discomfort. After fixing the cables above the floor, no working postures fell into categories 3 or 4. This finding indicates that an improvement in working conditions helps cleaners to maintain a safe working posture during the mopping task. In their study, Hopsu and Louhevaara [18] used the OWAS method to measure postural load in cleaners' work during an intervention study: this intervention study included educational training and ergonomic job redesign, and the results showed a decrease from 39 to 25% in the number of postures in categories 2 through 4.

The OWAS action category for the floor mopping task decreased and fell from categories 3 and 4 to category 2. However, the mopping task still requires changes in the near future.

5. CONCLUSIONS

From this study it can be concluded that participatory ergonomics is an appropriate ergonomics tool for identifying and solving ergonomics problems. A low-cost improvement improved the cleaners' working postures by eliminating the awkward ones such as sitting

on one and two bent knees, and holding an arm above the shoulder. This study also indicates that the quality of floor cleaning improved after cables were fixed above the floor. The results from this study can be used as a general means for improving cleaners' working postures.

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