A Field Assessment of Ergonomic Risk: a Case Study

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Abstract. Musculoskeletal injuries are common at work. Ergonomic risk assessments at workplaces are essential for the safety & health for workers. A factory, producing air-bag inflators and metal bottles, in Taiwan was visit for ergonomic risk assessments. Three workstations were selected. The first one was about the welding of air-bag inflator using an automatic machine. The second workstation was about testing of electric resistance of the finished air-bag inflators. The third was about visual inspection of metal bottles. The worker at each of the workstations was interviewed and their operations were videotaped. The Key Indicator Method (KIM), developed by the Federal Institute for Occupational Safety and Health (BAuA) and the Committee of the German states for Occupational Safety and Health (LASI), was employed to determine the worker's risk of suffering musculoskeletal disorders. In addition, pathological exam of these workers were performed by a physician. The Manual Handling Operation (MHO) scores of KIM for the three workers were13.5, 31.5, and 40.5, indicating medium, medium-high, and medium-high risk conditions. Positive results were obtained for the worker performing the visual inspection. This was consistent with those in the scoring of the KIM MHO analyses. Redesign of the visual inspection task was recommended and discussed.

Keywords: manual task, musculoskeletal disorders, job design, KIM

1. INTRODUCTION

Musculoskeletal injuries are common at workplaces. Workers exposed to risky working conditions & environments are suffering risk of musculoskeletal injuries. Heavy, repetitive and forceful work, adoption of awkward and uncomfortable postures, carrying of excessive loads, vibration, low temperature, and so on are common risky job and environmental conditions (Ayoub et al., 1978; Chaffin and Andersson, 1984; Armstrong and Radwin, 1986; Putz-Ansderson, 1988; Ayoub and Mital 1989). These conditions impose stress on muscles and joints, affecting the soft tissues in body parts jointly or individually. Chronic musculoskeletal injuries are likely to develop cumulatively in a period of time and could lead to temporary or permanent disability. These problems are found at work-sites in including sectors in manufacturing, dining, agricultural, health care, construction, and so on (Schneider and Susi, 1994).

An official safety & health statistics in Taiwan (IOSH, 2010) indicated that 58.7% of the employees reported pains or discomfort in at least one of the body parts within the past 12 months. Shoulder (37.7%), neck (28.3%), and low back (30.5%) were the top three body parts complained most. Lee et al. (2007) had investigated 386 employees in six companies. Most subjects reported that prolonged use of computer (92%), wrist/hand repetitive movement (84.2%) and prolonged sitting (87%) were required. Self-reported discomforts in shoulder (78.9%), neck (70%) and low back (62.7%) were common. They concluded that the musculoskeletal injuries are correlated with work environment and job design significantly. Similar results have been reported in the literature (Li and Hsu, 1998; Li et al., 2002).

Ergonomic risks resulting in musculoskeletal injuries may be assessed via direct observation and measurements. Many techniques and tools have been developed for such purposes. The “Key Indicator Methods” (KIM) were one of those methods developed (Klussmann et al., 2010). Two different KIM Worksheets, one for Lifting, Holding, Carrying of loads (KIM-LHC) and one for Pulling and Pushing of loads (KIM-PP), are available. In addition, the Manual Handling Operations (KIM-MHO) has also been developed to study manual tasks. The KIM determines the risk of musculoskeletal injuries based on the load handling, exposure time, posture, and working conditions. A rating score may be calculated by adding the ratings of the loading/physical efforts, posture, and job/working condition and then times the rating of time or frequency. The levels of ergonomic risk may then be determined as low (total score less than 10), median, (score between 10 and 25), median-high, (score between 25 and 50), and high (score of 50 or higher). A high risk condition requires urgent intervention to remedy job design and conditions (Steinberg et al., 2006). In KIM, posture, force exertion, frequency, and duration are assessed and a score is calculated to indicate the risk of musculoskeletal injuries. The objective of this study was to assess the ergonomic risk for workers in a factory producing automobile airbag inflation activator.

2. METHOD

A field study in an automobile airbag inflation activator factory was conducted. The research personnel visited the factory in a one-day trip and had a panel discussion with the managers of safety & health and the division to discuss the working conditions that involving employee complains of musculoskeletal discomfort. Three work stations were selected for direct observation & measures. The KIM MHO, PP, and LHC were adopted for ergonomic risk assessments.

3. WORKSTATION ASSESSMENTS

3.1 Workstation 1

Workstation is the welding station for the work in process of the parts. The layout of workstation 1 is shown in Figure 1. There were six same workstations in this unit.

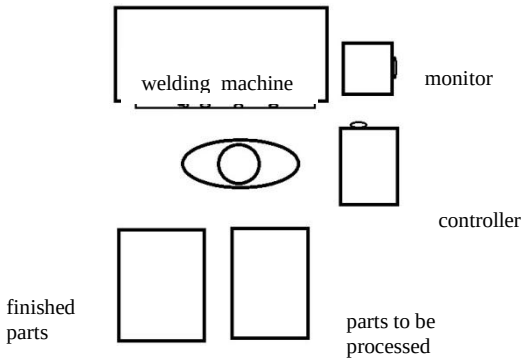

Figure 1: Layout of workstation 1.

There was one male worker in the station selected for assessment. The operating procedure in this workstation was in the following:

1. Pick up one part using left hand from the parts to b processed tray,
2. Holding the part using both hand and inspect the par visually (see Figure 2),

3. Turn 180 degree around,
4. Unload the part on the machine using left hand,
5. Upload the part onto the machine using left hand,
6. Push the power button in the front using right hand to start welding,
7. Watching the monitor on the right to check positioning of the part (see Figure 3),
8. Adjust the position of the part using right hand by rotating a hand-wheel under the monitor if necessary,
9. Turn around for 180 degree to inspect the finished part,
10. Put the finished part on to the tray.

Figure 2 Visual inspection of the part.

Figure 3 Positioning of the part.

The cycle time for this task was short. It was approximately 20 seconds without positioning adjustment. The cycle time was approximately 26 seconds with positioning adjustment. The operator held (using right, left or both hands) the part most of the time. The process time for each unit was approximately 45 seconds. The weight of each unit was 180 gram. The KIM MHO was adopted to assessment the ergonomic risk. The results were shown in Table 1.

Table 1 KIM MHO assessment results for welding

	rating	condition
time	4.5	Standing for 8 hrs
force exertion	2	Averaged holding time was 60~31 second/min
grasp	0	Easy
Hand/arm position	0	Good
Job coordination	1	seldom change
posture	0	Body can move freely
total	13.5	4.5×(2+0+0+1+0+0)

The rating score of this operation was 13.5. The job was classified was medium exposure.

3.2 Workstation 2

Workstation 2 was one of the workstations in the final assembly line. There was one female worker in this station. This station was responsible for part electrical resistance testing. The workbench was 92 cm above ground level. The operating procedure for the worker was:

1. Extending the right arm to pick up the part to be tested (see Figure 4),
2. Moving the part and handed it to left hand,
3. Scan the part,
4. Moving the part using left hand and insert it into the testing slot in the front, connect a wire to the top on the part using right hand,
5. Both hands move to the left and right buttons in the front and push the buttons to start testing,
6. Waiting
7. Push left button using left hand and adjust wire on the top of the part using right hand, watching the monitor on the right,
8. Push left button using left hand,
9. Remove the wire using right hand,
10. Move the finished part to the tray on the left

The cycle time of the testing was approximately 15 to 18 seconds. The operator was standing. Whenever the operator finished processing the parts on one tray on the right, she moved the empty tray to the location underneath the workbench. Whenever the tray containing the finished parts

on the left, the operator picked up an empty tray under workbench and put it on the top on the left. The operator lifting the trays for finished parts and putting the trays onto the cart on her back whenever there were two full loaded trays (9 kg). This lifting was performed approximately once every 8 minutes.

Figure 4 picking up a part to be processed.

Figure 5 part testing.

The KIM MHO was adopted. The rating score was 31.5 (see Table 2). This implied Medium-high exposure. It was recommended that work time be reduced to 6 hours per day. The operator may be assigned other job for the remaining time of the day. This could reduce the rating of time to 3.5 and the total rating score reduces to 24.5 (3.5×7).

As the operator needed to lift every 8 minutes, the number of lift per day was 60 (8*60/8). The KIM LHC was adopted to assess the lifting tasks. The results were shown in Table 3.

Table 2 KIM MHO assessment results for electrical resistance testing

	rating	condition
time	4.5	Standing for 8 hours
force exertion	1	Holding time 15-4 sec/min；Frequency of move5~15/min
grasp	0	easy
Hand/arm position	2	Right arm overreach when picking up
Job coordination	1	Seldom change
working condition	0	Good
posture	3	Standing at the same location
total	31.5	4.5×(1+0+2+1+0+3)

Table 3 KIM LHC assessment results

	Rating	condition
lifting	4	40~200 per day
Weight handled	2	5~10 kg (female)
posture	2	twist of trunk
working condition	0	
total	4×(2+2+0)= 16	

3.3 Workstation 3

Workstation 3 involves visual inspection of in-coming products. The products were purchased from outside vendors. The operator was inspecting the appearance of the product piece by piece to screen out those with rust.

The inspection involved the following steps:

1. Open the box, reach to pick up the product (see Figure 6),
2. Remove the plastic bag,
3. Inspect outside of the product,
4. Using a hand light to beam the inside of the product for internal inspection (see Figure 7),
5. Wrap the finished product using the same plastic bag,
6. Put the product in the box
   i. on the right hand side in the back if the product passed,
   ii. on the left hand side in the back if the product had minor rust, and
   iii. on the left hand side in the front on the workbench if the product had serious rust,
7. After finished inspecting one box, the operator sealed the box and lifting and lowering the box onto a cart,

8. The operator push the cart to the storage area with another worker whenever there were four boxes on the cart, and then they lifting and lowering the boxes on a pallet,
9. Go to step one.

Figure 6 Reach to grasp.

Figure 7 Internal inspection

On each day, an operator inspects approximately 1500 pieces. This amount comprises 50 boxes. The frequency of inspection was approximately one box for every 10 minutes, or alternatively one piece per 20 seconds. The weight of each unit was 0.5 kg. The weight of an empty box was 0.65 kg.

As the operator needed to lift every 4 boxes. The KIM LHC was adopted to assess the lifting tasks. The results were shown in Table4.

Table 4 KIM LHC assessment results for visual inspection of in-coming products

	Rating	condition
lifting	4	40~200 per day
Weight handled	2	5~10 kg (female)
posture	2	Trunk inclined forward
working condition	0	
total	4×(2+2+0)= 16	

The KIM MHO was adopted to assessment the ergonomic risk. The results were shown in Table 5.

Table 5 KIM MHO assessment results for visual inspection of in-coming products

	rating	condition
time	4.5	Sitting for 8 hours
force exertion	3	Holding time 30-16 sec/min；(Moderate forces) Frequency of move5~15/min (Moderate forces)
grasp	1	No shaped grips
Hand/arm position	2	Without hand-arm support
Job coordination	1	Seldom change
working condition	0	Good
posture	2	Trunk inclined forward
total	40.5	4.5×(3+1+2+1+0+2)

4. DISCUSSION

The welding operation in workstation1 was mainly uploading and downloading parts onto a machine. The weight handled was 0.18 kg. The operator could move freely while the machine was running. The rating score was 13.5. The exposure was medium.

The KIM LHC assessment for workstation 2 was 16 points. This implies medium exposure. The KIM MHO assessment results for this station was 31.5 points. This implies medium-high exposure. As the operator was confined in front of the workbench most of the time and was performed a prolonged standing tasks, a stand-seat design was recommended. This design supports portions of the body weight of the operator and reduces the load of the lower extremities. The exposure may be reduced to medium if this design is introduced.

For workstation 3, the KIM LHC assessment rating was 16 points. This implies medium exposure. The KIM MHO rating was 40.5 points, implying medium-high exposure. A tilt workbench was recommended. On such a workbench, the neck flexion and arm reach of the operator may be reduced.

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