RISK ASSESSMENT IN MANUAL MATERIAL HANDLING OF TEXTILE INDUSTRY

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Abstract — The process of moving material manually has the potential for injury to workers. He purpose of this study is to access and and analyze the injury risk level in manual material handling activity, as well as to improve the condition. The observed manual material handling activities is truck loading. This activities using different software such as NIOSH (National Institute for Occupational Safety and Health) equation, Rapid entire Body Assessment, and compression force using 3 DSSP (3D Static Strength Prediction Program) software. As well as Nordic body map questionnaire was used to identify body discomfort level. In this study, conducted on 16 male truck loading operator, they are loading boxes from stacking area to truck, using manual material handling activity. The task involved small repetative movement of action. while handling material, due to this when the load man faced work related musculoskeletal disorder. In this study make a nordic questionnaire method. which is spread among the workers in each truck loader. Afterward collecting all information make as documents. From document shortout, any one person and analysis the body parts using above software. Before modification the results show that most workers who perform activities have a high level of risk with the score of REBA exceeds points 12 score or more (risk is very high, need immediate change required to improve the task), the lifting index should not be in greater than 1 therefore the valve obtained as 7.591 Based on the suggestion and modification made to re assess risk level of the body parts and the result shows that the risk decreased up to 50%. Therefore replacing manual handling system with the conveyor system reduce the lower back pain.

I. INTRODUCTION

Manual Material handling (MMH) is one of the most physical demanding word in the industry. Back injury is one of the most common (22% of all accidents that occurred) problem reported. One cause of this injury was occurred by overload force, 60% of the overload is caused by lifting and 20% pushing or pulling. For this related manual material handling based on literature survey used to Nordic body mapping questionnaire among the workers after that collecting information about discomfort of body parts and make it as documents. Study and analysis the load man job task activity and watched every sequence of motion involved in the manual material handling. Taken photograph of different posture angle related MMH activity. After taking photos analyze during ergo-fellow software and the measurement feed into software. There are different ergonomic tools used in this study such as NIOSH equation, REBA, And 3DSSPP (3D Static strength prediction program) to find out compression force. Suggestion and modification needed to be applied to the load man and the posture is reassessed. To analysis the manual material worker system of the worker and to identify major areas causing injury of worker that related to that activity. These study was conducted in a reputed textile industry. The main purpose is to minimize the risk of workers physical and physiological disorders caused by poor MMH system.

2.METHODS AND MATERIALS ;

- review of literature
- Collecting information of body part discomfort (Nordic questionnaire body mapping method)
- Study and Analysis of job task
- Data Collection of truck loading worker
- Taken photograph of worker different posture
- Based on phtotograph find out worker body posture measurement
- Obtain result using software before modification
- suggesting better posture
- Reassessing the body posture
- Obtain result using software after modification
- Both are compared
- suggested system implemented

This research was conducted to 8 workers who perform manual handling material activity, especially the activity of lifting the pole and loading the goods. Nordic body map questionnaire was used to identify symptoms, complaints, disorder, and injuries experienced by workers. Measuring tools that used to perform data collection were the camera and the meter. Data collected included:

1. Anthropometry: height and weight, and body segment length (upper arm, forearm, and torso).
2. Joint Angles, including data related to angles of between 2 body segments or between body segment and horizontal/vertical line during work, such as legs back neck arms and wrists.
3. Material specification, including size, type, and weight of materials to be transported.
4. Hand Loads show load received by hand.
5. The intensity of labor usage, duration, working speed, and length of work per day.
6. Worker photos and videos while performing manual material handling activities. The next step is to perform data processing by Job Stain Index, REBA, and Chaffin's 2D Planer Static Model. Some variables needed to calculate the score on

Job Strain Index Method. After JSI method, processing data was continued using REBA method.

3. NIOSH Lifting Equation

- This Equation provides risk estimates to help evaluate lifting tasks and reduce the incidence of low back injuries in workers.
- Calculates the composite lifting index
- Promotes better musculoskeletal health.
- Serves as job design guidelines for manual lifting tasks
- Can Helps workers make informed decisions about the potential hazards to their musculoskeletal health
- be used as a research tool to collect manual lifting data.
- REBA (Rapid Entire Body Analysis)
- Wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees
- 3DSSPP software

3.1DATA COLLECTION

A total of 16 goods loading worker were approached for the survey. The worker was loading goods manually. During manual handling a load man lift the box having weight is 15 kg and working on 12 hr per day.
Body Segment angles, hand locations, and hand force magnitude and direction.

3.3 RESULT AND DISCUSSION :

The RWL for this activity is 1.976 at the destination. The weight to be lifted is 15 kg. If we divide the weight to be lifted (15) to Recommended Weight limit (RWL = 1.976), we got LI (Lift Index) value (LI= 7.591). Therefore LI is greater than 1, These values indicate that a man doing the job more dangerous and stressful, in future a man face longtime chronic disease.

LIFTING EQUATION	HM cm	VM cm	DM Cm	AM degree	FM Lift/min	CM	LOAD Kg	Score
LOAD MAN 1	37	75	75	83	14box/min	0.95	15	1.9
LOAD MAN 2	40	75	75	78	12box/min	0.95	15	1.7
LOAD MAN 3	39	75	75	81	13box/min	0.95	15	1.9
LOAD MAN 4	36	75	75	76	12box/min	0.95	15	1.7
LOAD MAN 5	42	75	75	80	12box/min	0.95	15	2
LOAD MAN 6	40	75	75	82	12box/min	0.95	15	1.9
LOAD MAN 7	35	75	75	84	13box/min	0.95	15	1.7
LOAD MAN 8	35	75	75	77	12box/min	0.95	15	1.7
LOAD MAN 9	42	75	75	75	12box/min	0.95	15	2
LOAD MAN 10	37	75	75	78	12box/min	0.95	15	1.8
LOAD MAN 11	35	75	75	80	13box/min	0.95	15	1.7
LOAD MAN 12	40	75	75	79	12box/min	0.95	15	1.9
LOAD MAN 13	43	75	75	81	12box/min	0.95	15	2.1
LOAD MAN 14	45	75	75	78	12box/min	0.95	15	2.1
LOAD MAN 15	40	75	75	82	14box/min	0.95	15	1.9
LOAD MAN 16	38	75	75	82	12box/min	0.95	15	1.9
AVG	38	75	75	80	12 box/min	Fair 0.95	15	1.95

Table –4. 1 worker general information

So we reduce this type of manual material handling necessary of improvement to be needed.

4. REBA (Rapid Entire Body Analysis)

This ergonomic assessment tool is uses in a systematic process to evaluate the load man whole body postural MSD and risk associated with job tasks. Using the REBA worksheet assigned the score for each of the following body regions: wrists, forearms, elbows, shoulders, neck, truck, back, legs and knees.

After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk Totally 16 load man were doing the job alternatively, Collecting data and prepared chart from load man. The load man's body posture angle average value was taken and entered in the ergo- fellow software, finally the REBA score is obtained. The REBA (Rapid Entire Body Assessment) ergonomic assessment tool uses a systematic process to evaluate whole - body postural MSD and risks associated with job tasks.

Sl no	Name	Experience	Age	Weight (kg)	Height (cm)	Arm Length (cm)	Hip height (cm)	Shoulder Length (cm)	Score
1	LOAD MAN 1	2 Years	36	62	170	58	87	43	13
2	LOAD MAN 2	6 Years	45	67	168	57	86	40	13
3	LOAD MAN 3	4 Years	37	71	164	56	92	38	12
4	LOAD MAN 4	1 Years	32	63	172	60	85	34	14
5	LOAD MAN 5	3 Years	43	58	161	54	86	36	14
6	LOAD MAN 6	8 Years	47	73	167	57	89	37	12
7	LOAD MAN 7	6 Month	28	54	165	52	85	36	15
9	LOAD MAN 8	2 Years	36	62	170	58	87	43	11
10	LOAD MAN 9	2 Month	32	67	158	45	86	40	11
11	LOAD MAN 10	1 years	28	58	167	50	82	38	12
12	LOAD MAN 11	7 Moths	6	62	165	55	90	42	9
13	LOAD MAN 12	2 Years	31	71	170	58	88	37	10
14	LOAD MAN 13	3 Month	27	64	173	54	92	40	10
15	LOAD MAN 14	5 Month	48	68	168	52	85	43	9
16	LOAD MAN 15	1 Years	29	59	158	60	90	38	11

Table 4.1 – worker general information

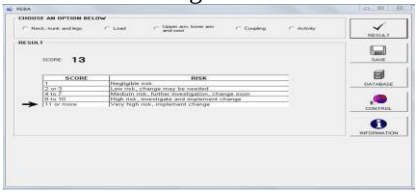


Fig 4.1Score of REBA

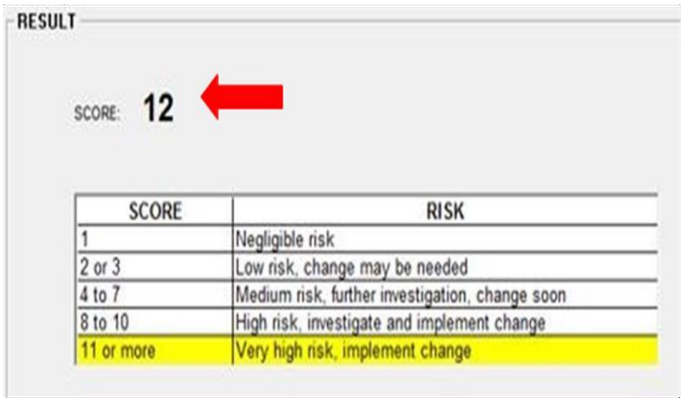


Fig 4.2 score

4.1.RESULT REBA;

After implementing new system REBA score decreased upto 50 % compared to existing system. The score of the REBA 6 , therefore the risk was medium, need further investigation to improve the task soon or engineering control.

5.Load man Nordic body mapping

1- 1-2 times last week
2- 3-4 times last week 4-
Once every day
4.- Several times every day

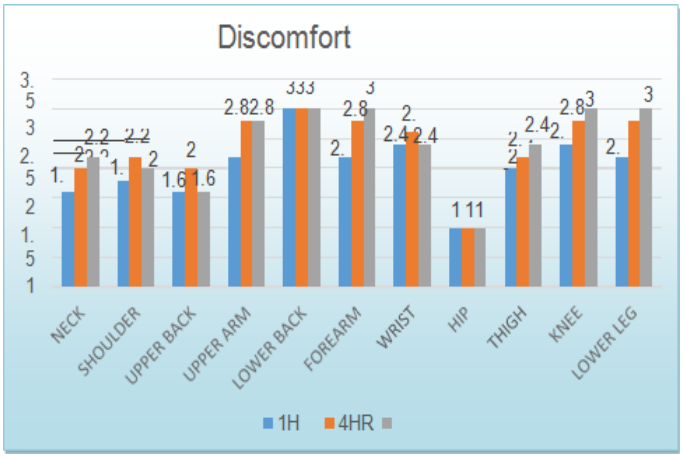
5.2DISCOMFORT ANALYSIS ;

Following activity were made for ergonomic analysis of the Truck loading worker.

Fig 5.1Discomfort score before modification

Table

	Neck	Shoulder	Upper Back	Upper Arm	Lower Back	Fore Arm	Wrist	Hip	Thigh	Knee	Lower Leg
Load Man 1	5	4	5	5	5	4	5	2	5	5	5
Load Man 2	2	3	2	4	5	4	5	1	3	4	4
Load Man 3	4	4	5	3	5	4	5	1	4	4	4
Load Man 4	4	3	3	5	5	4	4	2	3	4	3
Load Man 5	2	2	3	4	5	4	4	1	3	4	3
Load Man 6	4	2	4	4	5	4	5	1	2	3	3
Load Man 7	4	3	3	3	5	4	4	1	2	3	3
Load Man 8	2	2	2	3	5	4	4	1	2	3	5
Load Man 9	4	3	3	3	5	4	3	2	3	5	2
Load Man 10	2	2	2	5	5	4	3	1	2	2	5
Load Man 11	3	3	2	3	5	4	2	1	2	4	4
Load Man 12	2	2	4	5	5	4	2	1	2	4	2
Load Man 13	3	2	2	4	5	4	3	1	3	5	4
Load Man 14	3	3	2	4	5	4	2	1	2	5	4
Load Man 15	2	4	3	5	5	4	4	1	3	2	5
AVG	3.4	3.2	3.6	4.2	5	4	4.6	1.4	3.6	4.2	3.8



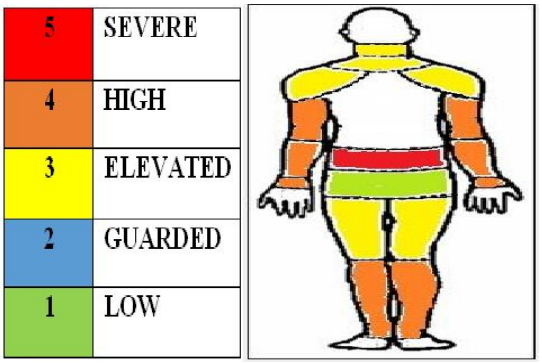


Fig 5.2 **1Discomfort score before modification**

The Checklist results showed that the **major discomfort was found in the body posture Upper Arm Lower Arm, lumber, Forearm, Wrist, Wrist, Knee.**

6.COMPRESSION FORCE :

The software of 3D SSPP is used to find out the maximum force suffered by the worker in doing such a job. If the total compression is still within the specified limit or less than 3400 N, then it can be concluded that the maximum force that has to be accepted is still acceptable for the worker's body. The truck loader posture designed in 3DSSPP software.

Fig – 6.1 working posture

A worker wants to take object and load to the truck. It can be seen that the truck is fully bent 90 degree and slightly up at neck portion. The load man was doing job continuously at this awkward position, resulting in a high score. The value of the compression force obtained exceeds 3400 N, indicating that this activity can be seen that the truck is fully bent 90 degree and slightly up at neck portion. The load man was doing job continuously at this awkward position, resulting in a high score. The value of the compression force obtained exceeds 3400 N, indicating that this activity is dangerous.

Fig 6.2 - Making material handling Anatomy posture in 3DSSPP software

Joint angle was determined using the measured angle from pictures that were is taken during activities. Angles was measured with the help of image Analysis by Ergo intelligence to perform REBA analysis. In REBA method, assessment of operator's work postures was done to know the possibility of risks due to work postures performed by the operator. If the REBA score showed '' undesired '' score, then some necessary improvements were suggested.

LOAD MAN	Sex	Feet Support	Body posture	weight Cm	height Cm	Hand load (N) Right	Hand load (N) Left	Type of load Handling
Load Man 1	Male	Both Feet	Bending	62	170	73	73	Lifting
Load Man 2	Male	Both Feet	Bending	67	168	73	73	Lifting
Load Man 3	Male	Both Feet	Bending	71	164	73	73	Lifting
Load Man 4	Male	Both Feet	Bending	63	172	73	73	Lifting
Load Man 5	Male	Both Feet	Bending	58	161	73	73	Lifting
Load Man 6	Male	Both Feet	Bending	73	167	73	73	Lifting
Load Man 7	Male	Both Feet	Bending	54	165	73	73	Lifting
Load Man 8	Male	Both Feet	Bending	62	170	73	73	Lifting
Load Man 9	Male	Both Feet	Bending	67	158	73	73	Lifting
Load Man 10	Male	Both Feet	Bending	58	167	73	73	Lifting
Load Man 11	Male	Both Feet	Bending	62	165	73	73	Lifting
Load Man 12	Male	Both Feet	Bending	71	170	73	73	Lifting
Load Man 13	Male	Both Feet	Bending	64	173	73	73	Lifting
Load Man 4	Male	Both Feet	Bending	68	168	73	73	Lifting
Load Man 15	Male	Both Feet	Bending	59	158	73	73	Lifting
Load Man 16	Male	Both Feet	Bending	62	170	73	73	Lifting
Avg	**Male**	**Both Feet**	**Bending**	**70**	**167**	**73**	**73**	**Lifting**

Table 6.1 **Data collection for compression force before modification**

The software of 3D SSPP is used to find out the maximum force suffered by the worker in doing such a job. The assessment was based on the results of Sagittal Plane Low back Analysis Compression Force on L5 / S1. If the total compression is still within the specified limit or less than 3400 N, then it can be concluded that the maximum force that has to be accepted is still acceptable for the worker's body. For every score that beyond the specified limit, work improvement was suggested, especially to improve the work posture. Moreover, further analysis was done to estimate the requirement of supporting tool. If it was necessary, a new tool design was suggested. Suggested work posture then is reassessed using the same posture analysis method.

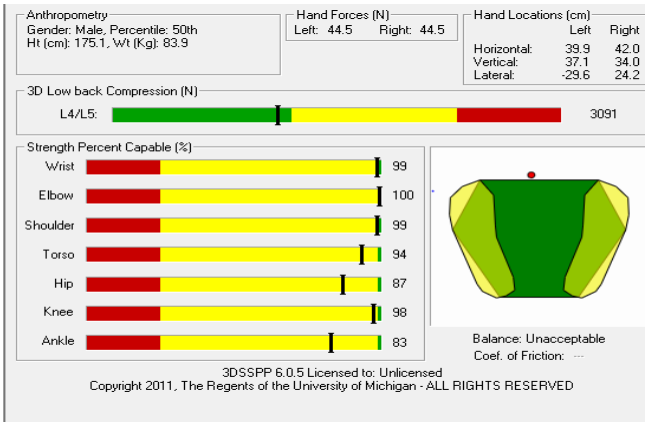


Fig 6.3 Result of Compression Force acting on body

6.2. COMPRESSION FORCE DISCUSSION ;

When the maximum compression force of lifiting 3400N, low risk, work is achieved when the score is below 3. on the other hand, an activity is determined to have high risk of injury of the score is more then 7.almost all activity have risk level of all three method activity of slot leaf removal by the workers. Workers position when he want to take leaf slot. It can be seen that the body is bend slightly spume. The body angle for each segment of the body is quit large resulting in a high score. The value of the compression force obtained exceeds 3400N, indicating that this activity is dangerous.

6.3 BASED ON THESE RESULTS, THE PROPOSED IMPROVEMENTS ;

1. Proposed improvement by engineering controls in the proposed improvement, a suggestion was made on the leaf slot packing arrangement so that the pack was easier to left by the workers. In the current situation, 2 workers are working together to lift 1 pack of leaf slats (1 pack consider of 10 slats). However, the worker has to widely stretch out his arms to lifts the edge the edge of the pack. This overextended posture cause causes risk for arms. In suggested system, using the proposed system, 5 slats were stacked together. In one lift, a pair of workers can lift 2 or 3 packs, depends on the weight of the ach slot. This arrangement is safer for worker since did not have to overextend their arms.

Fig 6.3.1 Replacing fully manual material handling to partially manual material handling

2. Proposed improvement by management controls each worker should be trained on safety working especially in manual material handling activities. The proposed lifting position was presented. In this position, legs should be opened with and bent with 1 leg was slightly toward the other. Do not forget to keep maintain back position. When the object was started to lift , put the 0bject as close to the body. If it is possible, put the object between his legs, body move towards slightly with still keeping the bank straight position and begin to lift. It is important to keep all lifting activities as smooth as possible and avoid jerk lifiting.

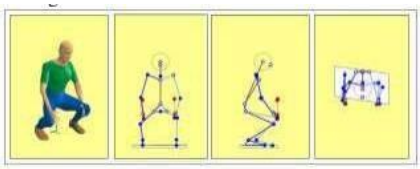


Fig 6.3.2 Modification of manual material handling

3. Proposed improvement by work practice control it also suggested making lifting guidelines posture . the posture should be put in the area where the lifiting activity, in the location that can be easily seen by workers.The proposed improvements were suggested for all activities. One improvement that implemented was tried is work posture changing like suggestion number 2. When the trials were conducted, workers have confusion when applying the new lifting method, often the position only persisted for some replication only and returns to its original position. However, after some repetition finally, the workers understand. the comparison of value between the current situation score. Proposed situation score was estimated based on trials after the workers can apply new lifting and loading posture relative persistently.

Fig 6.3.3- **Modification of manual material handling**

The results of the table show that the proposed method was able to reduce the risk of injury and shorten activity time. Figure 5,6 ,7 show the comparison between current and proposed system. In all current methods, the main flawless is the back position. Workers tend to their back instead of their leg. Therefore, maintaining straight back position has been the main improvement. Second thing, in the current system, workers tend to perform the activity individually. Similar to lifting process in figure 6, worker lifted the slat alone by putting the slat on shoulder one by one. In the proposed system, the activities should be done by two persons, lifting 2 slats at a time. Therefore the productivity is still maintained.

After the trials were conducted, an interview was conducted with the workers who had performed the proposed condition, where the results found that the worker felt awkward at the beginning of the new position but then felt more comfortable with the position. Workers give no complaint at the waist and shoulders. From the trial processes, it can be concluded that basically, the proposed method improved the work qualities. However, further training is needed to make sure workers aware about the safe lifting procedure and how to apply it in their daily working activities.

7. SUGGESTIONS FOR IMPROVEMENTS ;

Replace pulley conveyor to telescopic conveyor

Some times truck driver unconsciously hit on the pulley conveyor because of it occupy long length and also the person may injured.

Increased sheet tray height

A Load man continuously bent and take objects so he felt uncomfortable for truck load. We can increasing the sheet tray height the person bent can be reduce.

1.Lowering platform from ground level in truck loading /unloading area

Goods from warehouse more energy need to push the load other. If we lowering the platform from ground level easy to push and convey the load truck easily.

Gravity feeding

Difficult to replace the conveyor we want to use gravity.

Feeding activity. The gravity feeding goods is no power required to convey the load to other side.

Use roller conveyor

If we use roller conveyor less energy required to convey the load. This also power less material handling activity.

Provide energy drink

A loader man continuously working in a hours, afterwards he loss the energy by handling of load manually. If provide energy drink we have to reduce energy loss

Work alternation

A load man not allowed to do the same task again and again we have alternate the task.

Increasing resting duration

Aware the employee Proper training provide to the loader. It will help to load man aware of manual material handling hazards

Exercise Routine

Exercise to stay fit. Exercise is an excellent way to prevent back pain.

8.CONCLUSION

Using NIOSH, REBA, and compression force acting on the body and Nordic body mapping, those are the Manual material handling activity identify that almost all activities have high-risk levels. Body position greatly affects the occurrence of high risk, especially the back position. There are improvements applied to reduce the risk of injury to the activity, improving body posture, and making guideline postures. This above the process we can't eliminating manual material handling (MMH) instead the reducing MMH activity. If replacing mechanical material handling or automatic material handling is only possible solution of this process, but we can't replace fully automated machine because of high cost to install machines or robots as well as maintenance cost also should be consider. So best way to deal with the problems is to modify or improve the task. In this study manual handling risk was reduced up to 50% from existing process.

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	NIOSH–LI value		REBA score		Compression Force (N)	
Criteria	Current	proposed	Current	proposed	Current	Proposed
Truck Loading	7.591>1	3.696>1	12 High Risk	6 Medium Risk	3408	1747

9.AFTER MODIFICATION RESULT ;

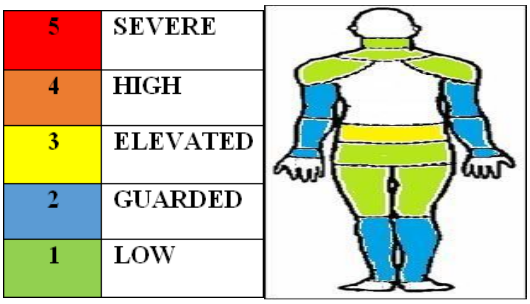

Fig 9.1 **after modification result**

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