Ergonomic Assessment

Trailer Unload / Load

Concern Details

Task Description:

In the courier industry, packages are transferred between hubs and terminals via semi trailers. Packages are sorted into trailers and are then unloaded once at their destination. Packages are commonly stacked into trailers by loose loading them into the trailer (see Figure 1 a and b). Loose loading refers to stacking as many packages as possible into the trailer from floor to ceiling. Multiple MSD risk factors have been identified while loading and unloading the semi trailers placing the workers at increased risk of injury.

Often one worker is responsible for unloading all packages from a semi trailer onto an automated conveyor. To load the trailer, the opposite is done, where packages are lifted from the conveyor and stacked into the trailer. The worker transfers an average of 1350 packages in an hour and a half, which equates to a lifting frequency of 18 lifts per minute. The vertical height of the packages in the trailer ranges from the floor to 180 cm. The vertical and horizontal hand height when placing or retrieving packages from the conveyer was 103 cm and 40 cm respectively. The packages range in weight from 1-35 kg, with the majority of the packages ranging from 1-9 kg. Occasionally, a second worker may assist with the loading and unloading, however, that is not standard at the terminals analyzed.

Figure 1 a: worker unloading freight from with automated conveyer

Figure 1 b: worker loading freight into semi trailer semi trailer with automated conveyer

Evaluation:

This job is cause for concern for the following reasons:

(1) Some of the population may not be able to perform because it exceeds tabulated strength capabilities.
(2) High back loads that that increase risk of injury.
(3) The weights exceed value outlined by Snook thus resulting in increased risk of injury.
(4) The packages are outside the recommended lifting zones.
(5) The high lifting frequency may induce fatigue.

These concerns are discussed in further detail below. Overall, the concerns on this job expose workers to increased risk of injury.

Ergonomic Assessment

(1) Some of the population may not be able to perform because it exceeds strength capabilities.

Based on the biomechanical assessment of this job, less than 90 percent of the population has sufficient strength to lose load the trailers due the awkward postures and heavy loads. The workforce has strength limitations at the shoulder and elbows for lifts over 18 kg at vertical heights over 95 cm and back strength limitations when lifting 35 kg packages [1]. When forces exceed strength capabilities, it hinders an individual's ability to perform the task, and the higher the portion of the population not capable of performing a task, the greater the risk of overexertion injury.

(2) High back loads that exceed acceptable levels of which risk of injury increases.

The biomechanical human model revealed concern with high spinal loading for workers performing this job (1). Retrieving or placing packages from the trailer results in high spine loads that increase the risk of injury for some of the population, specifically when lifting all package weights (1-35 kg) from off the floor as the shear force exceeds the MPL as well as when lifting packages over 26 kg at a vertical height of 50 cm and 35 kg packages at a vertical height of 50 cm as the back compression exceeds the AL. The combined low back pain reporting index score for (un)loading the trailer indicates 56% of workers have increased chance of reporting low back pain from this job.

(3) The weights exceed maximum acceptable weight limits.

According to well accepted manual handling guide (Liberty Mutual Tables, i.e. Snook Tables) (2), the package weights exceed the maximum acceptable weight of lift (MAWL). Due to the high frequency and awkward postures, the maximum acceptable weight of lift for this job is 5 kg for packages over shoulder height, 6 kg for packages between knuckle and shoulder height, and 7 kg for packages below knuckle height. Workers are three times more susceptible to injury if the job exceeds the MAWL.

(4) The packages are outside the accepted lifting zones.

This job results in poor lifting conditions which are cause for concern as the location of the packages are outside the preferred lifting zone of 75 cm to 110 cm vertical height and horizontal reach of 40 cm (5^{th} percentile female reach distance with elbow at side of body) (3).

(5) The high lifting frequency may induce fatigue.

Furthermore, high frequency lifting tasks (≥ 15 lifts/min) result in fatigue if there is inadequate recovery time between lifts or lifting bouts (4, 5) as well as repetitive, awkward shoulder and back postures which are cause for concern (6)

Using a method proposed by the National Institute of Occupational Safety and Health in the USA to create a composite lifting index, unloading or loading the packages from the trailer at a frequency of 18 lifts per minutes results in a frequency multiplier of 0, which results in a composite lifting index score of infinity. A score of infinity suggests the work demands of the job exceeds physiological demands, and puts most of the workforce at increased risk of fatigue increasing the risk of injury. Note that at a lifting frequency of 11.7 lifts a minute, which is 65% of the actual frequency, the CLI is 6.5. A score above 1.0 indicates the job poses risk of injury for some of the workforce, and a score over 3.0 indicates high risk of injury to the majority of the population (7).

Overall, this job is cause for concern as it may not be possible for some of the population to perform because it exceeds strength capabilities, the weights exceed maximum acceptable weight limits, the packages are outside the accepted lifting zones, the high lifting frequency may induce fatigue and loads lifted create high spinal loads. Therefore, countermeasures are recommended to reduce the risk of developing musculoskeletal disorders when unloading and loading packages to and from the trailer.

Countermeasures

Countermeasures were investigated to determine which interventions would be effective at reducing the risk of injury. The following countermeasures were investigated however on their own they did not reduce the risk of injury to an acceptable level as the composite lifting index was still over 1.5 or they were not deemed feasible: reduce the lifting frequency by adding additional three workers to load and unload the trailers, use a step to reach higher levels (figure 2), team lifting packages over 9.5 kg, stop loading packages over 122 cm high, do not put packages on the floor of the trailer by adding shelves in the trailer.

A combination of countermeasures is required to reduce the risk of injury on this job due the awkward postures, high lifting frequency and heavy loads (Table 1). To improve the poor lifting conditions and awkward postures, eliminating the loose loading is required. This would involve loading the packages into crates / bins on lift tables (see figure 3 a and b). The carts and cages should be redesigned to the minimum vertical lifting height is 45 cm, maximum vertical height is 140 cm and maximum horizontal forward reach distance is 50 cm [1, 2]. This can be achieved by designing crates that are no more than 95 cm high and 45 cm deep and then stacking the crate on a raised table so the bottom is at 45 cm from the ground. The depth of the crate can be increased if the crates can be opened from both sides and then the crate must then be stacked on a lift and rotate table. The full crates would be moved with forklifts and would be stacked in the trailer to optimise truck capacity.

In addition to improving the vertical heights of the packages, the lifting frequency is unacceptable and needs to be reduced to a quarter of the current frequency by slowing the conveyor and adding additional workers. Slowing the conveyor belt speed will reduce the speed at which the packages can be loaded onto it and thus not as many additional workers would be required. If the conveyor speed is not altered, four additional workers are required.

Even with the above modifications, the package weights still exceed the maximum acceptable weight of 9 kg at a frequency and improved vertical heights (2). Since the majority of the packages exceed that weight, the use of a hoist or team lifting boxes over 9 kg is required to reduce the risk of injury. However, if the above countermeasures are not implemented, a hoist or team lift would be required for packages over 6 kg.

Furthermore, by having 4 workers load as well as implementing a vacuum hoist to lift packages over 9 kg (2) reduces the risk. Implementing these combined countermeasures reduces the demands on the job to acceptable levels and thus reduces risk of injury (1, 2, 7).

Table 1: Countermeasure summary

Risk Factors	Countermeasures
Lifting packages are outside the accepted lifting zones	Eliminating the loose loading is required. This would involve loading the packages into crates / bins on lift tables (see illusions). The full crates would be moved with forklifts and would be stacked in the trailer to optimise truck capacity.
High lifting frequency	Reduce conveyor speed by half and add additional workers.
Heavy loads	Vacuum hoist or team lifting boxes over 9 kg

Figure 2: step

Figure 3 a: bin

Figure 3 b: bin raised on rotate stand

Figure 4: vacuum hoist

References

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