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Manual material handling: A classification scheme

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Abstract

Ergonomic evaluation of Manual Material Handling (MMH) has largely been based on task analysis approach where the job are broken down into simpler tasks and studied. But there is lack of clarity in the use of terms defining various MMH activities. The challenge in classifying MMH arises because of the dependence of man-machine interaction on multiple worksystem characteristics. This paper presents a classification scheme for MMH tasks. Towards making a classification scheme the work system characteristics are examined and the important dimensions from those are identified that are able to differentiate the nature of MMH exposure. Suitable examples for each class are presented. The methods for collecting biomechanical and physiological responses, and nature of ergonomic analysis required are discussed. A qualitative judgment on exposure magnitude and measurement cost is made. Finally, critical issues and scope for research is presented.

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Keywords:

1. Introduction

Material handling is an invariable part of any manufacturing or service operation, and there is always a significant human input to those operations in terms of physical load. The physical load is the effect of force inputs during material handling operations coming from the interaction with material handling equipment or the material. Manual Material Handling (MMH) has largely been focused on single/individual task level based on a task analysis approach where the job are broken down into simpler tasks and studied. This has been exemplified in the works of Garg et al. (1978), Ciriello et al. (1999), Genaidy et al. (2006), Dempsey et. al. (2008), Garg et al. (2014), and

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Rajesh et al. (2014). There is lack of clarity in the use of terms defining various MMH activities. The challenge in classifying MMH is that man-machine interaction is dependent on multiple dimension i.e., work station and MHE, human, and task and environment (Rajesh et al., 2014). The objective of the paper is to present a classification scheme for MMH tasks. A short review of status of MMH terms is highlighted in Section 2.1. The classification is discussed in Section 3, followed by Conclusion section.

2. Method

The literature was selected from SCOPUS bibliographic database. Some of the original articles from the last ten years were selected from reputed ergonomics journals such as Ergonomics, Applied Ergonomics, International Journal of Industrial Ergonomics, Human Factors, Theoretical Issues in Ergonomics Science, Work, Scand J Work Environ Health, IIE Transactions on Occupational Ergonomics and Human Factors for the review. Towards making a classification scheme the work system characteristics are examined and the important dimensions from those are identified that are able to differentiate the nature of MMH exposure. A qualitative judgment on exposure magnitude and measurement cost is made on a scale of 1-7.

2.1. Literature Review

Single or individual MMH task are lift, lower, push, pull, carry and hold. Any MMH operation or job is composed of these elemental tasks. A combined MMH task is composed of a combination of tasks involving lifting, lowering, pushing, pulling or carrying. 'Combined MMH' (Taboun & Dutta, 1989; Straker et. al., 1997; Li et. al., 2009) or multiple-component MMH task is combination of MMH tasks in sequence. Based on literature a number of different types of CMMH has been identified. Waters et. al. (2007) defined 'Multi-task lifting' jobs as jobs in which there are significant differences in lifting tasks that are done concurrently, such as a palletizing job, where the vertical height can vary from lift to lift. This definition can be extended to other basic tasks and can be termed 'Multi-task MMH' job where there is within task variability of critical parameters. For example carry distance may vary when a worker moves concrete slurry on head during a roof concrete laying process over a period of 1-2 hours. Waters et. al. (2007) termed sequential lifting jobs where workers rotate between job elements in sequence. There are ample situations where team MMH is relevant. For example loading a log from ground to floor of truck is a team lift task. An example of multi-person MMH task is loading of boxes into truck by 4 material handlers, two handlers lifting from floor height to hip height into the hands of two handlers standing on truck in stooped posture, and those two handlers then placing in appropriate location in truck. Demsey (1999) used the term 'Multiple task MMH' job as job comprising of different types of MMH tasks over task duration. Mital & Ramakrishnan (1999) used 'Complex manual materials handling' task to designate a combination of different types of MMH tasks where non-basic task types like turning and sliding are also involved.

There is ample evidence from literature to point to the usage of different terms in MMH that cater to the need of describing the situation or scenario of that manual exertion. The MMH terms are used interchangeably and with lot of overlap. The usage of term 'multi-task' and 'multiple task' MMH creates ambiguity in their usage. Combined MMH task describes a material handling where material is moved from origin to a prescribed destination. 'Multiple component MMH' task or 'Multiple task MMH' equally means the same. 'Multiple task MMH' job considers time aspect of exposure dimension i.e., frequency and duration. In principle 'sequential lifting' can be extended to mean 'sequential carrying' or 'sequential pushing/pulling' where carry distance and sequence of those can be varied. Such interchangeable use of terms can be stream lined if a commonality of ergonomic parameters can be highlighted, and used further for better classification.

2.2. MMH classification scheme

The nature of MMH exposure is decided by the worksystem characteristics (Rajesh et. al., 2014). The task related exposure dimensions (i.e., intensity, frequency and duration), material related dimension (i.e., load and direction), and worksystem related dimension (i.e., layout, material handling equipment) has been used for the proposed