Simulation analysis of models for estimation of empty travel time of vehicles in non-automated material handling systems

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Abstract

In designing a new facility like manufacturing plant or warehouse, an integral part is a proper selection of material handling system. Despite large alternatives, including automated material handling systems with conveyors or automated guided vehicles, most facilities will use for material handling one or more man-driving vehicles (non-automated discrete material handling system). Proper design of such systems requires determination of required number of vehicles. Even redesign of existing facilities, like improvement of layout design, requires analysis of proposed new solution including required number of vehicles or determination of their utilisation. In existing facilities today we can find in most cases man-driving, non-automated vehicles used for material handling, used for loading, transport and unloading loads between departments and/or machines (workplaces). For determination of required number of vehicles or for calculation of vehicle's utilisation in proposed redesign, a proper method of calculation of total transport time is required. Based on data of trips between locations (from-to matrix), distances between locations based on layout (distance matrix) and speed of travel, loading and unloading times, it is quite easy to calculate total time required for loading, unloading and transport of loads. However, determination of empty vehicle travel time is based on either time consuming simulation or non-simulation approach using estimation.

Searching for methods to estimate empty vehicle travel time leads to plenty papers dedicated to automated guided vehicle systems, in which there exist control system with various dispatching rules that are mostly not applicable to systems without computer control, like in smaller job shops, workshops or smaller warehouses. Proposed algorithms also usually assume larger fleets where proper scheduling and routing of automated vehicles is required due to the congestions and deadlocks. In smaller facilities only one or few vehicles is employed, with sometimes law utilisation.

The main goal of this paper is to review and analyse some proposed methods for empty travel time estimation of non-automated discrete material handling systems. For selected example of production process, varying throughput (production volume) and layout, results obtained by estimation methods are compared with simulation results in order to get insights on estimation errors, possible influence of vehicle's utilisation on estimation error as well as possible influence of layout design (increased full travel time) on total empty travel time and estimation error.

Keywords: Discrete non-automated material handling system, empty travel time estimation methods

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