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A micro-simulation model for performance evaluation of a logistics platform

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Abstract

The paper focuses on the receiving area of a logistics platform operating in the agri-food sector. The main aim of this work is to propose a "what to" approach for the resolution of problems related to the vehicles and goods receiving. The approach is based on a dynamic, stochastic, discrete-event micro-simulation model, which was properly specified and calibrated.
The work proposes the formulation of the mathematical model defining the receiving activities in the logistics platform. The aim of the objective function is to minimize the average trucks turnaround in accordance with constraints allowing to establish the optimal entry sequence of the inbound trucks. The problem formulation considers the introduction of ITS to support the receiving activities management.

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Keywords: logistics platform; receiving area; micro-simulation model; ITS; mathematical model

1. Introduction

A logistics platform, like a warehouse, "is a facility, which provides the services about material storage and management to a manufacturing firm or customer". Its efficiency depends on many factors and is important because costs affect the production or distribution accounts and ultimately fall on the consumer.

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The implementation of new management philosophies and the generalized application of new technologies and ITS give new opportunities to improve warehouse operations. Real-time process monitoring, communication with other supply chain components and automation of some features may help to improve the warehouse performance, especially in terms of efficiency (time and monetary costs).

The proposed work is part of an extensive search, in which a discrete event, stochastic, dynamic micro-simulation model has been appropriately specified, calibrated and validated to analyze the operation of a logistics platform in order to determine ITS performance in different system configurations by using appropriate efficiency indicators (Gattuso and Cassone, 2012).

The paper introduces the mathematical formulation of a trucks scheduling problem for a logistics platforms, with particular attention to the specification and calibration of the objective function.

The problem formulation considers the introduction of ITS to support the management of the receiving system through appropriate representative variables and, as a result, to increase the efficiency and effectiveness of the services provided for the goods receiving.

The model allows the performance evaluation of the receiving area of logistics platforms, already existing or to be built, by offering a support for the decisions about the planning activities at different levels.

The proposed model is a useful decision support tool for the operators of logistics platforms. As a matter of fact, based on its results, it is possible to make evaluations on the operational level that may direct the planning of tactical and strategic actions for the existing platforms. As regards the analysis of the platforms to build, the simulation allows to test the scenarios offering to the operators the opportunity to make updated choices about the provision of space and resources as well as the management approach to be taken in the planning phase.

After the characterization of the micro-simulation model, the proposed procedure can be transferred to other contexts and applied for the capacity analysis of the warehouses dealing with different types of goods.

2. Literature Review

A logistics platform, like a warehouse or a cross-docking, is a very dynamic environment, where resources are used and allocated in real time in order to meet the client's requirements.

In the literature, several studies deal with operational problems such as the trucks scheduling problem. Tsui and Chang (1992) address the problem without considering temporary storage of the incoming goods, the objective is to minimize the distance traveled by the handling means. They use a traditional formulation for the problem and a branch-and-bound algorithm for the resolution. The model is a reference point in the literature sector, in fact many authors propose an integration or an adaptation of it (Bermudez et al., 2001; Rong Zhu et al., 2009; Cohen and Karen, 2009; Guignard et al. 2012). Chen and Lee (2009) develop a polynomial approximation algorithm and a branch-and-bound algorithm to minimize the makespan for the products going through a cros-docking facility without temporary storage. In particular, the authors propose to sequence the unload/upload and degroupage/groupage operations for the inbound/outbound goods to minimize the makespan. Boysen (2008) uses a dynamic approach and heuristic methods to minimize the total time spent at node by the inbound/outbound trucks. Yu and Egbelu (2008) study the scheduling issue of the inbound and outbound trucks in cross-docking systems with temporary storage. They try to find the scheduling sequence for both inbound and outbound trucks to minimize total operation time when a storage buffer to hold items temporarily is located at the shipping stock. Boloori Arabani et al. (2011) deal with the same problem and propose an implementation of a genetic algorithm for the resolution.

Other researches concern the study of the trucks scheduling through simulation. Rohrer (1995) discusses about the modeling methods and the issues as they are applied to the cross docking systems. He describes how the simulation helps to ensure success in the logistics platform system design by determining the optimal hardware configuration and software control. A simulation model of a generic cross docking facility (Magableh et al., 2005) to examine the operational risks associates with individual cross docking facilities within a company's distribution network under a dynamic environment. McWilliams et al. (2008) cover a specific truck scheduling problem at a parcel hub. A simulation-based scheduling approach with an embedded genetic algorithm is proposed.

Only very few research papers focus on the trucks and goods management in the receiving area of the logistics platform by using the ITS (Radio Frequency Identification - RFID; Electronic Data Interchange - EDI; Enterprise Resource Planning - ERP), for instance, Ching-Long and Wu-Chen (2007) propose a hybrid multiobjective training