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Review

Cross-docking operations: Current research versus industry practice ☆

Anne-Laure Ladier [a,*], Gülgün Alpan [b]

[a] Université de Lyon, INSA Lyon, DISP laboratory EA 4570, Bât. Léonard de Vinci, 21 av. Jean Capelle, 69621 Villeurbanne, France
[b] Univ. Grenoble Alpes, G-SCOP, F-38000 Grenoble, France; CNRS, G-SCOP, F-38000 Grenoble, France

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ABSTRACT

The technique of cross-docking, which consists in unloading trucks, sorting the items they contain and reloading them directly into outbound trucks in order to minimize temporary storage, has attracted researchers' attention in the past few years. The number of articles on the subject has been growing very fast, but largely detached from industry practice. In order to see whether the current state-of-the-art matches the industry practice, we propose a common framework that helps comparing the literature review regarding cross-docking operations with on-field observations and platform managers' interviews. Analyzing the gaps between the state-of-the-art and the industry practice helps drawing future research directions, in relation to industrial needs.

Contents

1. Introduction

In a very competitive environment where customers are highly impatient, the supply chain must be reactive and fast while keeping the prices low. Cross-docking is one of the logistic

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* Corresponding author.
E-mail addresses: anne-laure.ladier@insa-lyon.fr (A.-L. Ladier), gulgun.alpan@g-scop.fr (G. Alpan).

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techniques which can help cutting inventory costs while increasing the goods flow and shortening the shipping cycle.

In a cross-docking platform (also called cross-dock facility, cross-dock terminal or cross-dock), the goods are unloaded from the incoming trucks, sorted, dispatched and directly reloaded in outbound trucks. The inventory is kept to a minimum, since typically the goods do not spend more than 24 h inside the cross-dock.

Cross-docks raise numerous optimization questions, either strategic, tactical or operational. Several authors have attempted to review articles dealing with part or all of these questions. Agustina et al. [3] propose a review of cross-docking mathematical models on the three decision levels. In a similar way, Stephan and Boysen [118] propose a classification of cross-docking settings and list the important decision problems related to cross-docking, from long-term strategic to short-term operational. Boysen and Fliedner [27] propose a classification of truck scheduling problems.

In 2012, Van Belle et al. [128] published a state-of-the art of cross-docking which addresses a large range of cross-docking problems. Their review article also covers the articles studied in Agustina et al. [3], Boysen and Fliedner [27] and Stephan and Boysen [118]. Because of the important increase in the number of articles published about cross-docking recently, it has become necessary to complete Van Belle et al.'s work. This has been done in three articles which focus their reviews on a subset of the problems addressed by Van Belle et al.: Shuib and Fatthi [114] review specifically the mathematical models used to assign trucks to doors when operating cross-docks, Walha et al. [133] review cross-docking models dealing with uncertainty, while Buijs et al. [31] review and classify synchronization problems in cross-docking networks. Because they conceptualize synchronization as the "coordination of the local and network-wide operations," their review also covers operational issues. Our article focuses only on the operations at the cross-dock, raised by the day-to-day management of cross-docking operations, and therefore covers a narrower scope compared to the reviews by Van Belle et al. [128] and Buijs et al. [31].

Cross-docking is not a scholar's invention: it actually finds its roots in industry. Wal-Mart is often cited as the first retailer to implement it, in the late 1980s. In an analysis of Wal-Mart's success published in 1992, Stalk et al. [117] note that running 85% of its goods through its cross-docks enabled Wal-Mart to lower its costs of sales by 2–3% compared to the industry average in 1992 – and to become the highest profit retailer in the world at that time. Office Depot also achieved major gains with an early adoption of cross-docking techniques [102], and many other examples of cross-docking implementations can be found in Ertek [45]. But the cross-docking optimization literature evoked earlier seems somewhat disconnected from the actual industrial implementations of cross-docking. Because of the computational complexity of the optimization problems, the models proposed are often simplified and do not match industrial requirements. Thus very few articles mention an implementation of their work in a cross-dock, while articles giving advice on cross-docking implementation (see *e.g.* Napolitano [96], Apte and Viswanathan [11], Gue [56], Vogt [132], Su [120]) do not mention optimization as a key success factor.

In such a context, can we make sure that the work carried out on cross-docking optimization models is not disconnected from the industrial needs? The paper at hand answers this question by comparing industrial practices with the existing cross-docking operations literature. Firstly, we provide an accurate overview of the literature related to cross-docking operations by building upon the sections addressing this topic in the literature reviews by Van Belle et al. [128] and Buijs et al. [31]. Secondly, we conduct a field-based qualitative research, based on 8 cross-dock visits and interviews with their managers, in order to capture the main issues and challenges met in cross-docking operations in practice. The comparison between industrial and academic practices then helps drawing new research perspectives regarding cross-docking operations, with the goal of closing the existing gap between research and industry.

The article is organized as follows. Section 2 proposes a common framework which will be used to compare the articles found in the literature, analyzed in Section 3, with the observations made when visiting the cross-docking platforms and interviewing their managers. These observations are detailed in Section 4. In Section 5, we discuss the similarities and differences highlighted by the comparison. This analysis leads to the conclusions and directions for future research described in Section 6.

2. Comparison framework

This section describes the different elements that characterize a cross-dock and its performance indicators. They are used in the following sections to classify the problems treated in the literature as well as the real platforms visited.

This framework is used to compare industry practices with current research. The key decisions (used in Van Belle et al. [128] and Buijs et al.'s [31] frameworks) are not covered in this section but are addressed in Section 3, where the decisions addressed in the literature are reviewed with regards to our comparison framework.

2.1. Cross-dock settings

Our focus in this article is on the decisions made on a daily or weekly basis about the internal operations of the cross-dock. However, decisions made earlier on a mid-term or long-term time scale have a key impact on the operations. Therefore, we need to take strategic (long term) and tactical (mid-term) levels into account as well; in this comparison framework, they are comparison elements to identify the type of cross-dock under consideration. They consist in constraints imposed by either the physical features of the platform, tactical decisions that will not be questioned at this point, or external stakeholders.

Most of the elements listed as cross-dock settings are introduced by Boysen and Fliedner [27] in their classification of truck scheduling problems, and re-used by Van Belle et al. [128] to categorize the articles of their review. Unless indicated otherwise, the cross-dock settings given here come from Van Belle et al.'s framework. Note that Van Belle et al. [128] organize the description of the cross-dock characteristics into physical, operational and flow characteristics. This classification is not very common. Therefore we classify these characteristics based on the classical division between strategic, tactical and operational levels. The words in italics correspond to the possible values for each criterion.

2.1.1. Strategic level

We consider situations where the physical characteristics of the platform are fixed, and use the physical characteristics described by Van Belle et al. [128] to characterize a cross-dock:

Shape: The shape is usually described by a letter (I, L, U, T, H, E, X, etc.).[1] Sometimes the layout is simply determined by external constraints – for example the shape of the lot where the building stands, or landscape integrity regulations enforcing all doors to be on a single side.

Number of doors: The number of doors (or "dock doors" [128]) is an important physical characteristic of a cross-dock. It can be

[1] This notation was popularized by Bartholdi and Gue [14].