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A discrete simulation analysis of a logistics supply system

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Abstract

An important aspect of logistics supply systems in agro industries is to manage the processes of harvesting and transporting raw materials, from the rural fields to the processing plants. The truck waiting times in the various queues of the plant reception area are of particular concern. This paper applies discrete simulation techniques to study the reception area processes of a sugarcane plant, analyzing the performance of the system and investigating alternative configurations and policies for its operations. The analysis is also useful for other agro industries with similar supply systems, such as orange and wood industries.

Keywords: Discrete simulation; Logistics supply system; Agro industries; Sugarcane

1. Introduction

In the last few decades agro industries, especially commodity producers, have carried out research and development in an effort to assure prominence and competitiveness in their sectors. For agro industries with continuous processing such as sugarcane, orange and wood industries, the logistics supply systems represent relevant sources of opportunities to increase their efficiency, integrating agricultural and industrial operations. A problem inherent in such systems is to manage the processes of harvesting and transporting raw materials, from the rural fields to the

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processing plants. Several studies have pointed out the importance of inbound logistics systems to assure a continuous and uniform feeding of sugarcane, orange and wood to the processing facilities, such as Hansen et al. (1998), Neves et al. (1998), Martin et al. (2002), Higgins and Muchow (2003), Bradley and Winsauer (2004), Neves (2004), Raicu and Taylor (2004), Bredstrom et al. (2004) and Carlsson and Ronnqvist (2005). For these agro industries, the supply operations can comprise a large percent of the overall production costs, as discussed in Seixas (1992), Caixeta Filho et al. (1998), Sousa (2000), Martin et al. (2002), Neves (2004) and the aforementioned references.

The reception operations in the processing plant yard include the processes from the initial weighing of the vehicles loaded with raw materials to their unloading in the processor's cranes and conveyors. Therefore, trucks, upon arriving at a processing plant, go through several operations such as net weighing on a scale, sampling tests to determine content quality, unloading on intermediary storage areas and/or on the processor's cranes and conveyors. The truck waiting times in the various queues of the reception area are of special concern because of the possible interruptions in the production process due to shortages of raw material (since longer waiting times delay the return of the trucks to the rural fields, thereby reducing their availability to transport raw material to the processing plant, as well as causing machine and worker idleness in the fields). The costs of idle drivers and wasted fuel of the trucks while waiting in the lines are also important, but in second place if compared to the shortage costs. Another concern of the sugarcane and orange agro industry, which process perishable products, is that the quality of the raw materials deteriorates the longer the period between harvesting and grinding. According to Semenzato (1995), Arjona et al. (2001) and Neves (2004), sugarcane and orange should be milled within a certain time period after it is harvested to preserve its weight, sucrose content and juice quality. Therefore, primary concerns of logistics managers are to assure a continuous and uniform feeding of raw material at the mills, maximize the unloading rates and minimize the amount of raw material waiting in the unloading lines.

The purpose of this paper is to analyze the performance of the reception area processes and investigate alternative configurations and policies for their operations. Due to several sources of uncertainty and the operational complexity inherent in these systems, the method of analysis is based on discrete simulation techniques. The simulations were completed using Arena software (SMC, 1994). An analytical queuing network approach could also be employed, but it is disregarded due to the complexity of the dispatching policies involved. We used the case study of a large Brazilian sugarcane plant located in Sao Paulo State, which has a daily grinding capacity of approximately 36,000 tons of sugarcane. Brazil is the largest sugarcane producer in the world, followed by India and Australia. The typical amount of sugar produced annually in Brazil is approximately 18 million tons and 60% is produced in Sao Paulo State (Unica, 2004). Based on this case study, it is shown how the simulation of a logistics supply system can detect efficiencies to be gained from such a system.

The main performance measures are related to the average waiting times of trucks, average unloading rates of sugarcane at the mills, and the mill's workloads. There are few studies similar to this in the literature that focus on the supply system of the processing plant's reception area, especially related to a sugarcane plant which has a large capacity and it is as operationally complexity as the present case. The analysis of the present study has wider applicability than just to sugarcane plants, such as orange and wood plants with similar inbound logistics systems. Related