Supply chain management model for ready mixed concrete

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ARTICLE INFO

Article History:
Accepted 3 May 2010

Keywords:
Simulation
Ready mixed concrete
Construction
System dynamics

ABSTRACT

Supplying ready mixed concrete (RMC) in both a timely and cost-effective manner has been a particular challenge for RMC suppliers. To address this issue, a dynamic simulation model is developed using system dynamics. This model represents the generic RMC operation process and can customize its structure and parameters for different operational conditions. Through model simulation, the RMC supply process is analyzed, focusing on the tradeoff between the truck mixer dispatching interval and queuing time on-site. The research findings indicate that the model-generated information helps in achieving an economical RMC supply by maintaining the number of queuing truck mixers at the desired level, while satisfying the contractor’s need. Ultimately, this dynamic model could potentially be used as an effective automated tool to assist RMC suppliers in supply planning.

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1. Introduction

With many advantages over concrete mixed on-site, ready mixed concrete (RMC) has played an important role in enhancing construction performance. However, its advantageous features are not always realized. Failure to deliver RMC on time can result in subsequent construction delays or even make delivered concrete useless if the time threshold for concrete hardening has exceeded. On the other hand, in some cases, too many truck mixers simultaneously queue up to be unloaded on-site; this results in time being wasted that could have been used to serve other construction sites.

Furthermore, supplying RMC in an efficient and economical manner depends greatly on the distance between the batch plant and the construction site. Thus, RMC suppliers have to determine how to geographically distribute their plants and what production and delivery capacity each plant should have in order to handle the potential concrete demand within the coverage area [1]. At the operational level, truck mixer scheduling and raw material logistics within the batch plant are critical to ensure timely and economical supply [2–5].

RMC supply performance is also heavily influenced by factors that are under the contractor’s control (e.g., concrete placing work). An experiment by Smith [6], for example, indicates that the contractor has an even greater influence over the RMC supply process than the supplier. Moreover, as long as smooth concrete work is ensured, contractors tend not to be as concerned about truck mixers idling on-site [3]. As a result, RMC suppliers are faced with the challenge of supplying RMC in a timely and cost-effective manner. Although previous studies have addressed this challenge together with productivity issues, automated tools that support RMC supply planning from the supplier’s perspective are rarely found in the literature.

Therefore, this paper develops a dynamic simulation model to ultimately enhance RMC supply planning at the operational level. First, previous simulation-based research on RMC operations is examined, and the generic RMC production and delivery processes are identified by observing the batching plants of a local company in Singapore. Then, the model structure is described, focusing on the tradeoff between the truck mixer dispatching interval and the average queuing time on-site. Next, in the model verification and application section, the data collected from expert surveys and various policy scenarios are simulated to examine the model’s behaviors under different conditions. The feasibility of the model is also examined through experiments deploying various construction sites and traffic conditions.

As well, this paper demonstrates how the model-generated information assists in achieving an economical RMC supply by maintaining the number of queuing truck mixers at the desired level, while satisfying the contractor’s need. Finally, it is confirmed that the developed dynamic model could be used as an automated tool to support RMC suppliers in crucial decision making pertaining to RMC supply planning.

2. Previous research

There are many simulation models that address RMC batch plant operations. Several examples follow. Bernold [2] developed a concrete placing model using CYCLONE (CYCLic Operations NEtwork; [7]). The Bernold model was used to analyze how changing conditions impact the performance of concrete placement. Paulson et al. [8] used CYCLONE to