European Journal of Operational Research 243 (2015) 555–565

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Production, Manufacturing and Logistics

Influence of order acceptance policies on optimal capacity investment with stochastic customer required lead times

Klaus Altendorfer[a,*], Stefan Minner[b]

[a] Department of Operations Management, School of Management, Upper Austria University of Applied Sciences, Wehrgrabengasse 1-3, A-4400 Steyr, Austria
[b] TUM School of Management, Technische Universität München, 80333 Munich, Germany

A R T I C L E I N F O

Article history:
Received 14 August 2013
Accepted 3 December 2014
Available online 16 December 2014

Keywords:
Order acceptance
Stochastic customer-required lead time
Queuing theory
Service level
Tardiness
Operations management

A B S T R A C T

The influence of applying queue state dependent order acceptance policies, where either decision is with customer or with manufacturer, on optimal capacity investment is discussed. Therefore, three order acceptance policies are developed where either the customer has a certain service level threshold for each order or the manufacturer has an overall service level threshold. The third policy, modeling queue state independent order acceptance, is used to identify performance gains of including queue state knowledge into this decision. Equations for state probabilities, order acceptance rate, work-in-process, finished-goods-inventory, backorders and service level are developed for a system with stochastic customer-required lead times applying queuing methodology. An optimization problem minimizing capacity, work-in-process, finished-goods-inventory, backorder and lost sales cost (for rejected orders) in a single stage MTO production system is presented. The system is modeled as an M/M/1 queue with input rates depending on queue length and random customer required lead time. For the optimization problem, which cannot be solved explicitly, a solution heuristic is developed and a broad numerical study is conducted. The numerical study shows that allowing the customer to know the expected production lead time and—based on this knowledge—decide whether or not to place an order can have positive or negative influences on the overall costs, depending on the customer's service level target. Furthermore, the study shows that a high cost reduction potential exists for simultaneously optimizing capacity investment and order acceptance policy if the production system can decide whether or not to accept an order.

1. Introduction

In many production systems, the order acceptance decision is one of the choices influencing performance. In the available literature, this order acceptance decision is either treated in combination with lead time quotation (e.g. Savaşaneril, Griffin, & Keskinocak, 2010), pricing (e.g. Ray & Jewkes, 2004) or customer class decisions (e.g. Modarres & Sharifyazdi, 2009). Most models trade off the expected cost of accepting an order with the cost of lost sales. However, none of the models treats the situation where customers can state a required lead time which is not to be quoted. In many real production systems, customers state orders with a predefined due date and the manufacturer has to decide whether to accept them or not (decision with the manufacturer). Alternatively, if the decision is with the customer, the customer knows the required lead time and gets some queue state dependent production lead time information from the manufacturer based on which she decides whether to place the order or not. In such environments, the customer required lead time can be assumed to be independent of the order processing time and a detailed scheduling of orders is not applicable at the point in time of order acceptance. Both possibilities are modeled in this paper. Order acceptance policies in such systems may intuitively focus on how many orders are already in the production system (see also Chatterjee, Slotnick, & Sobel, 2002; Gordon, Proth, & Chu, 2002; Savaşaneril, Griffin, & Keskinocak, 2010; Slotnick, 2011) and on what the customer-required lead time of an order is, i.e. the question: what is the longest possible production lead time if the delivery still needs to be on time? Relevant questions in such production systems are the performance of the order acceptance policy and the optimal capacity to invest. In addition, a third policy ignoring the current queue state for the order acceptance decision is developed to identify the benefits of including this information.

The production system is approximated by an adapted M/M/1 queue where orders are accepted based on queue length and customer required lead time. An optimization problem balancing the optimal capacity investment, the costs for inventory and backorders, and the lost sales cost for the predefined policies is set up. Three different order acceptance policies are applied for each of which the optimization problem is either solved with predefined service level

* Corresponding author. Tel.: +43 50804 33150; fax: +43 50804 33199.
E-mail address: klaus.altendorfer@fh-steyr.at (K. Altendorfer).

http://dx.doi.org/10.1016/j.ejor.2014.12.003
0377-2217/