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A revised EMQ/JIT production-run model: An examination of inventory and production costs

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Abstract

Production-runs are an important cost minimizing scheduling and production planning activity. Commonly used classic lot-sizing models (i.e., economic manufacturing quantity or EMQ models) do not reflect current just-in-time (JIT) lot-sizing cost realities. The purpose of this paper is to present a cost comparison of the classic EMQ model and a revised EMQ/JIT model to show efficacy of a more cost inclusive model.

Keywords: Inventory cost; JIT; EMQ; Cost comparison

1. Introduction

The classic economic manufacturing quantity (EMQ) model seeks to determine the optimal production-run lot-size in manufacturing. EMQ modeling originated with the work of Harris (1915) and has become one of the most researched topics in the field of inventory management. More recent research has expanded the classic EMQ model to include cost and resource factors that may dominate a particular application setting. For instance, Chang and Hong (1994) developed an extended EMQ model to take failure prone equipment into consideration in the lot-sizing decision.

Unfortunately inventory models such as the EMQ model do not always include all of the relevant holding costs because they are either too complex of a cost component to represent in a simple quantity-based model or simply assumed away in the model development (Wacker, 1986). As observed by Heizer and Render (2001, p. 480) inventory holding costs, examples such as housing costs, building rent, and depreciation are often understated or just left out in cost data for inventory models, yet they often represents up to 40% of the total value of the inventory. Clearly there is a need to bring additional relevant holding costs into EMQ models that have not previously included.

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The EMQ and JIT cost-related models that currently appear in the literature focus on two types of costs: holding costs and setup (or run) costs. Studies by Grout and Seastrand (1987), Golhar and Sarker (1992), Jamal and Sarker (1993), Gunasekaran et al. (1993) presented lot-sizing formulas that provided a theoretical foundation for EMQ lot-sizing in a JIT environment. The variables in these models were all focused on the determination of lot-size, as a determining factor for total cost minimization. These models did not consider annual demand as a variable or that this variable could be used to make a choice between a JIT or an EMQ inventory system.

Hong et al. (1992) and Corbey and Jansen (1993) also analyzed the economic lot-size and setup costs and concluded that applying the EMQ-based models as lot-sizing rules was not correct because opportunity costs were neglected. Opportunity costs that were not fully considered in EMQ models included a differing variety of cost savings (i.e., physical facilities, setup costs, cost of capital, etc.) generated by smaller lot-sizes. In other words, the EMQ models for JIT environments did not fully take advantage of unique cost savings such as physical facility space reduction that normally occurs as JIT is implemented over a period of time.

Despite the prior research, Wolsey (1995) in a literature review research study found little of JIT cost elements being considered in most models. At the time, other researchers found that difficulties in estimating holding costs in EMQ models inhibited successful modeling. For example, Toelle (1996) suggested that estimating relevant holding costs in classic lot-sizing models might be inappropriate if the parameters could not be accurately estimated. Yet other researchers have proven that relevant factors in lot-sizing models unique to JIT systems must be considered in any modeling process. For example, Dave et al. (1996) developed an EMQ model, which takes into account the effect of varying marketing conditions on demand. Their results show that the inclusion of unique cost factors, such as advertising play a crucial role in determining lot-size and total costs. This study also illustrates how a single unique cost factor (i.e., advertising) can have a substantial impact on the variables (i.e., lot-size) sought in the model.

As the prior research reveals, one particular JIT cost element that is lacking in the EMQ models for JIT environments is the facility space reduction created when a firm adopts JIT. Yet other previous research on JIT suggests that cost savings of facility space reduction is one of the key benefits of the JIT system (Schonberger, 1982; Voss, 1990). Schonberger and Schniederjans (1984) observed many years ago that opportunity costs, including material control costs, uneven workload costs, work improvement (benefits foregone), and physical storage space costs are often omitted in the lot-sizing models based on classic economic order quantity (EOQ) models. They found that even when North American companies did include storage costs in inventory models they were likely to understate or omit relevant cost elements.

Why facility space reduction under a JIT system is so important is due to its potential size of impact in the cost considerations of any problem and that it is seen as an inevitable outcome of using JIT. There is long history of research connected to this particular cost component of JIT. According to Schonberger (1982) and Voss (1990), the reduction in facility space in a JIT environment is caused by the elimination of the space required to store incoming inventory, work-in-process inventory, and finished goods inventory. Many predominant JIT authors, such as Schonberger (1982) and Wantuck (1989), have long cited examples that prove conversion to JIT will reduce space in plants and factories. One example of a company that initiated a JIT operation saved the company 100,000 ft^2 (roughly 30% of the total facility space) of facility inventory storage and production area from their previous large-lot type of system (Chase et al., 1998). In the process of restructuring their layout to accommodate the JIT principles, they ended up renting the space to another company turning what would be a cost into a rental income. Other examples of the magnitude of impact of facility space reduction under a JIT system reported in the literature includes reducing floor space by 30% (Voss, 1990, p. 330), by 40% (Stasey and McNair, 1990, Chapter 13), and even 50% or more (Jones, 1991). Hay (1988, pp. 22–23) reported space reductions of up to 80%. These studies also revealed that the facility cost component was easily observed in JIT applications and could be accurately measured as a cost factor.