

Prevalence of Bullwhip Effect in Hospitals

Kannan Sethuraman

Melbourne Business School, Australia

Devanath Tirupati

Indian Institute of Management, India

INTRODUCTION

Growing concern about health care costs in developed countries in the past two decades has spawned extensive research on the industry and, in particular, hospital management. The literature on the subject is extensive and covers a wide range of themes that include application of operational research-based tools, redesign/re-engineering of delivery systems and clinical procedures, and so forth. However, in our case studies, we found that hospitals in Australia are in early stages of adoption of emerging paradigms in operations management (e.g., coordination, lean principles) that have significant potential for enhanced performance. The purpose of this chapter is to describe one of the consequences of poor coordination—*bullwhip effect* in hospitals—and its impact on performance and to discuss initiatives to mitigate and manage it.

In their widely cited papers, Lee, Padmanabhan, and Whang (1997a, 1997b) define *bullwhip effect* as “the phenomenon where orders to the supplier tend to have larger variance than sales to the buyer (i.e., demand distortion), and the distortion propagates upstream in an amplified form (i.e., variance amplification).” The bullwhip phenomenon has been observed by many firms across a number of diverse industries.

Lee, et al. (1997b) state the impact of increased volatility as, “Distorted information from one end of the supply chain to the other can lead to excessive inventory investment, poor customer service, lost revenues, ineffective transportation, and missed production schedules.” Although there is a growing body of research on managing the bullwhip effect in manufacturing-based supply chains (Baganha & Cohen, 1998; Chen, Drezner, Ryan & Simchi-Levi, 2000; Chen, Ryan & Simchi-Levi, 1997; Metter, 1997), little research exists on its presence in service chains, and we are unaware of any reported research on this subject. In this chapter, we present several examples of distorted information

in hospitals resulting in variability amplification and causing inefficiencies similar to the bullwhip effect. We highlight the underlying causes for this phenomenon and propose actions that can mitigate the detrimental impact of this distortion.

BACKGROUND

The analysis of the bullwhip effect was originally initiated by Forrester (1958, 1961), who was also the first to simulate the demand amplification characteristic through the “beer distribution game.” Taking a behavioral perspective, Sterman (1989) and Senge and Sterman (1992) attribute the amplified order variability observed in the game to players’ systematic irrational behaviors or misconceptions about inventory and demand information and lack of “systems thinking” by management.

Unlike Sterman (1989), Lee, Padmanabhan, and Whang (1997a) demonstrated that even rational decision-making by individuals can result in the bullwhip effect. They identified four main factors as contributors and offered prescriptions based on four complementary themes: (a) data transparency and information sharing; (b) coordination and synchronization (e.g., demand and supply planning); (c) efficiencies at the operational level; and (d) inventory management for the entire supply chain.

A conspicuous characteristic of the literature on bullwhip effect is its focus on manufactured goods and the role of inventory. Comprehensive approaches for managing supply chain do involve service elements (e.g., interface between retailers and customers). However, consistent with its focus on manufactured products, the emphasis in bullwhip effect literature is on inventory-related service measures such as product availability, fill rate, and so forth.

Relatively very little or no research has been reported to highlight the existence of this phenomenon in service context. There are at least three reasons why research in this area has been relatively sparse. First, simultaneity in production and consumption of services often precludes use of inventory strategies, and thus, many of the results of bullwhip effect literature do not extend readily to services. Second, higher levels of demand variability in services due to seasonality and uncertainty are well recognized, and there exists extensive literature on demand and supply strategies for managing this variability. This literature, which predates emergence of supply chain management, includes research related to price and related incentives for demand and capacity adjustments for supply management. In contrast, service chains typically do not have inventory but only have backlogs that are managed indirectly through service capacity adjustments. Further, in many services, production and consumption happen simultaneously; the service chain comprises only one level, and the issue of amplitude propagation up the chain becomes irrelevant. However, it may be noted that materials and supplies required for the provision of services may exhibit variability amplification, and related results may have direct application.

The aforementioned suggests that the bullwhip effect phenomenon may not be as pronounced and relevant for managing services. However, in our study of institutions in the health care industry in Australia, we have observed several examples of variability amplification similar to the bullwhip effect. The purpose of this chapter is to highlight the existence of bullwhip effect in hospital operations, identify its causes, and prescribe ways to mitigate its detrimental impact.

RESEARCH METHODS

A case-study-based approach was employed to conduct the research. Our findings are based on in-depth case studies of three hospitals—two public and one private not-for-profit. Data were gathered through interviews, observations, and archival sources. Interviews with doctors, nurses, administrators, and other hospital staff were conducted in person. We used an informal, minimally structured, nondirective interview approach to minimize the influence of our assumptions.

Saint Mary's Hospital's Service Value Chain for Elective Surgeries²

In this section, we describe briefly the service value chain for elective surgeries at St. Mary's Hospital (SM), one of the hospitals in our case studies, to provide the necessary background for our presentation. It will become clear that other services such as emergencies and outpatients will only make the system more complex and accentuate the bullwhip effect.

SM, a private not-for-profit hospital, essentially provides facilities comprising of operating rooms (ORs) with state-of-the-art equipment, wards for in-patients, rehabilitation unit for recovery of acute cases beyond normal postoperative care, and related ancillary services. The wards are organized by specialty and considered to be departments, as is the OR management. Hospital administration is decentralized with autonomy for the departments at the operational level. Thus, departments are responsible for nurse staffing and allocation of other resources. Regulatory requirements specifying threshold levels for nurse-patient ratios impose constraints in both ward and OR schedules.

SM does not employ any specialists/surgeons but has only a small group of physicians for overall supervision of the wards. Instead, it has arrangements with a large group of consultant surgeons who hold privileges to avail of the hospital facilities for treatment of their patients. SM derives its revenues from the fees charged for the use of its facilities. In most cases, these are borne by patients' medical insurance providers.

Figure 1 provides a schematic of SM's service value chain. The process begins with a consultation with the patient's primary care physician. If necessary, the patient will visit a specialist for further assessment. This stage may involve several visits to the specialist and diagnostic tests. The patient is added to the doctor's surgery list, if needed. Typically, specialist doctors have privileges at several hospitals in the area, and the choice of hospital is determined by several factors that include cost, patient preference, complexity, wait, facilities, and other services provided by the hospital. Following the choice of hospital, the patient is scheduled for surgery by being assigned a slot in one of the doctor's theater sessions at the hospital.

Surgery represents the third stage of the value chain, and the hospital is responsible for providing required support services, including pre- and postoperative care. Insufficient capacity and/or poor management

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