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Dynamic quality decisions of software-as-a-service providers based on customer perception

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ABSTRACT

Software-as-a-service (SaaS) allows customers to use software over the Internet by paying a subscription fee rather than by buying shrink-wrapped software and installing it on their computers. To maintain customer interests in SaaS, the provider's dynamic quality decision is important. Thus, we consider a dynamic programming model that assumes demand is quality sensitive and influenced by customer perception. In both finite and infinite planning horizons, we show that a unique optimal policy exists for the SaaS provider to set quality periodically. We demonstrate that the SaaS provider may have a constrained opportunistic behavior towards its quality decisions when considering customer perception. This behavior results in a transient fluctuating quality decision path before it converges to a steady state. We find that the software's initial quality plays a critical role in long term decisions, and that customers' expectations of quality improvement positively affect the quality, although the actual improvement may not meet their expectations.

1. Introduction

In recent years, many famous software companies such as IBM (Subramanian, 2010), HP (Eddy 2012), Intel, Dell (Rosoff 2011), salesforce.com (Babcock 2009), and NetSuite (Turner 2005) have adopted the business model termed "*Software-as-a-Service (SaaS)*." This model constitutes a change from the traditional mode of selling shrink-wrapped software to allowing a customer to use the software over the Internet for a certain period with a subscription fee. Thus, customers no longer need to purchase hard copies and install the software on their individual computers. Instead, they can simply sign up to use the applications hosted by the software providers (Dubey and Wagle 2007). Undoubtedly, this selling mode benefits customers because the risk of uncertain quality is shared by the SaaS provider and customers, and customers now make multiple purchase decisions over periods rather than making a single critical decision. According to Katzmarzik (2011), SaaS is a win–win scheme for both its providers and customers. SaaS providers can collect more profits since the demand size increases because of the lower implementation and maintenance costs for the buyers (Fan et al. 2009). In addition, customers reduce their risk of procurement, enjoy lower costs and reduced delivery time, and can more easily access new software updates (Dubey and Wagle 2007, Katzmarzik 2011). Consequently, the development space of SaaS is believed to be broad. It is forecasted that by 2015, approximately 24% of all new business purchases of software will be Internet-enabled, and approximately 13.1% of worldwide spending on software will be on SaaS (Mahowald et al. 2011). According to a business analysis report by Gartner Inc. (a leading information technology research and advisory company), the global market share of SaaS was 12 billion dollars in 2011 and will be 21 billion dollars in 2015, a compound annual growth rate of 16.3% (Columbus 2011).

For intangible products such as SaaS, quality is identified as the most important factor that influences customers' purchasing decisions (Sheetal and Harsh 2002). Previous studies have shown that high quality brings strategic benefits to the sellers by increasing their market shares and returns on investment (Lengnick-Hall 1996). Thus, numerous companies have been paying increasing attention to their quality management and improvement. Lengnick-Hall (1996) indicates that quality has become an essential part of organizational success.

However, quality is not a well-defined concept. Researchers often bypass this concept and use the unidimensional self-reporting measures (Parasuraman et al. 1985). Although some scholars define quality as zero defects, indicating that the firm should provide a service/product that conforms to requirements (Sheetal and Harsh 2002), many other researchers note that quality also depends on customers' orientations, perceptions and expectations. For example, Parasuraman et al. (1985) define quality as "the

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degree and direction of discrepancy between customer perceptions and expectations"; Dean and Bowen (1994) believe that quality is based on a system's perspective, continuous improvement, high productivity, teamwork and customer orientation, in which the last term is the most important. Recently, five dimensions of SaaS products have been identified from customers' perceptions of quality (Wilhelmsen, 2008): reliability (i.e., the provider's ability to provide the promised service), responsiveness (i.e., the provider's willingness to help customers), assurance (i.e., the provider's ability to have employees inspire customers' trust and confidence), empathy (i.e., the provider's individual care and attention), and tangibles (i.e., the provider's physical facilities and equipment).

In our context, we follow their steps and consider quality as a decision variable influenced by customer perception. In practice, SaaS providers have paid significant attention to customer feedback, and they have changed service features and functionality accordingly (Dubey and Wagle 2007). This is because customers who are paying monthly subscription fees are more likely to switch to another provider if they have bad experiences with their current provider. Wilhelmsen (2008) indicates that 70% of the failures of SaaS are related to companies' attitudes and responses to customers' perceptions and feedback. We observe that SaaS is typically process dependent, and hence, its provider has to participate in customers' long-term purchasing behavior. This results in the dynamic adjustments of service quality levels (Benlian and Hess 2011). Dynamic quality adjustment has sustained as a major property of SaaS, because it is easier to release new developments in SaaS than in the traditional shrink-wrapped software with a perpetual license (Choudhary 2007). Providers can only modify the customer-specific configurations without changing the common module stored on the providers' server (Cusumano 2010). We also consider the SaaS provider's dynamic quality decisions in both finite and infinite planning horizons. The consideration of an infinite planning horizon is included because we observe that many SaaS providers have operated and updated their services for a significant amount of time because of their responsive services (Fan et al. 2009).

In this study, we propose a stylized model by assuming customers' perceived quality in the current period depends on *both* the perceived quality from the previous period *and* on the newly observed SaaS quality. This is because a customer's perception is usually *ex-post* based on his/her experience. Previous studies have discussed firms' efforts to realize customer expectations to achieve better customer satisfaction. Here, we consider a reverse flow that customer perception indeed influences the provider's quality decisions in the long run. Customers' attitudes can be viewed as a motivation for SaaS providers to adjust their quality levels to attract customers to subscribe in the next period. When customers are well informed that the quality is high, they are very likely to purchase in the following period. By contrast, if a service provider is not capable of providing a satisfactory experience to its customers, they may discontinue their current subscriptions and switch to another service provider. Therefore, SaaS providers suffer from service inefficiency (due to the loss of economies of scale) and elusive profitability (Giurata 2008).

Motivated by the foregoing observations on SaaS, dynamic quality decisions and customer perception, our main research questions are listed as follows: (i) Is there an optimal quality decision for the SaaS provider in a dynamic environment that considers customer perception? (ii) What are the characteristics of the optimal policy, if it exists? (iii) What are the impacts of our model assumptions on the optimal policy?

Our findings are multi-fold. First, assuming that prices are exogenous and determined by the market, we show that a unique optimal quality decision exists in each period, and that a unique optimal initial quality then exists for the SaaS provider. We also find that the optimal quality levels increase with customer expectations on quality improvement. This result verifies the empirical findings by Loewenstein and Prelec (1993) and industrial observations by Chichoni (2012). The insight behind this is that the SaaS provider should cautiously measure customer expectations and consider them when making dynamic quality decisions. Otherwise, customers may complain and feel disappointed when their expectations are not met. For example, Wesabe, one of the first online personal finance management service providers, failed in 2010 because it largely ignored customers (Henderson 2010). Before that, customers had long been complaining and expecting quality improvements (Asay 2007). We find that a previous positive perception by customers has a *negative* impact on the service provider's quality decision in the current period, because the provider then sets a low quality level after observing customers' positive perception in the previous period. However, this opportunistic behavior is constrained and unsustainable. Otherwise, customers' updated perception is destroyed, which causes the SaaS provider to lose profit in the future.

In an infinite planning horizon, we prove the uniqueness of the optimal quality decision in each period and identify the conditions under which the optimal quality levels converge to a steady state. In practice, online services with very long life are frequently observed. For example, salesforce.com, which provides sales force automation tools and customer relationship management (CRM) solutions, was started by three former Oracle software developers in 1999. During the last 13 years, salesforce.com has become known for its reliable and high quality services, despite the rapid growth of its customer base (Babcock 2009). Similarly, NetSuite was launched in 1998 to provide services such as accounting, enterprise resource planning (ERP), partner relationship management (PRM), CRM, and sales force automation (SFA). Since then, NetSuite has been offering cheap and high-quality customer service, and the company is constantly improving and adding features (Turner 2005). Our findings for SaaS with an infinite planning horizon include: (i) at the steady state, customers' perceived quality is always lower than the actual quality provided by the firm, if the customers have continuous expectations on quality improvement; (ii) at the steady state, the effect of customers' learning from their experiences negatively affect the quality; (iii) the SaaS provider should raise the quality level if the depreciation on future profit is low.

We also consider several extensions of the basic model and conduct extensive numerical studies to further investigate the SaaS provider's optimal decisions. We first study the effect of the initial quality and find that it may significantly influence the firm's subsequent quality decisions. A high initial quality causes a quality degradation strategy, whereas a low initial quality is very likely to be followed by a quality improving strategy. When the initial quality is optimally decided, we observe a fluctuating quality path because of the effect of the SaaS provider's opportunistic behavior, as previously stated. We show that the resulting profit loss due to a wrongly chosen initial quality can be as high as 400%, even under a relatively long planning horizon. Thus, it is worth emphasizing that the initial quality should be appropriately determined and invested in, to avoid future profit loss. We then analyze the value of dynamic pricing and find that it is very limited when the initial quality is appropriately determined, because the ratio between total profits without and with dynamic pricing is approximately 90%. This finding justifies the assumption of exogenous prices in our basic model. Finally, we analyze the optimal policy when customers' expectations on quality improvement are uncertain. We show that the main results still hold, but that the optimal policy cannot converge to a steady state in an infinite planning horizon. Furthermore, we find that the optimal initial quality increases, but the expected total profit decreases in the degree of uncertainty.