



Vendors' incentives to invest in software quality in enterprise systems



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ABSTRACT

In the enterprise system market, software quality is often unobservable at the contracting stage between the vendor and the customer. Two factors complicate the vendor's decision to invest in software quality. First, as a required part of the transaction, services such as installation and maintenance are bundled with the product. Second, the vendor's cost of delivering these services is directly affected by quality of the software. Incorporating these factors, we develop an analytical framework to examine when vendors of enterprise systems have an incentive to invest in software quality under different market structures and market participant behaviors. We also investigate economic consequences of such quality decisions by enterprise software vendors, highlighting certain unique characteristics of these markets. We consider a duopoly setting, with simultaneous and sequential moves of the vendors. Our results show that in the duopoly market, even when customers are uninformed about quality, an investment-equilibrium exists. We find that there exist conditions under which customers might have reasons to trust that vendors would invest in high software quality.

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1. Introduction

The market for enterprise systems has unique characteristics that distinguish it from both traditional product and software markets. First, the adoption decision requires significant long-term financial and organizational commitments. Second, an enterprise system purchase consists of both a product – the system – and the associated services such as installation, customization, maintenance, and upgrade. The service component is unique compared to a non-enterprise prepackaged software product. In addition, the quality of the software not only is of concern to the adopter, but also affects the vendor's cost of delivering the services. The vendor's product-quality decision, therefore, has to be made based on the understanding of all the above factors and their interactions and can have significant economic impacts on both the customer and the vendor.

Adding to the complexity of the problem is the considerably high switching costs for customers and their inability to perfectly observe the real quality of the system at purchase time. This gives vendors additional incentives to exaggerate the quality of their software products, hoping if and when the customer does discover the low quality of the software it is too expensive and too late to switch to a competitor. Such information asymmetry between vendors and customers at the onset of the agreement raises the question: How does the information asymmetry of product quality affect the

vendors' incentives to invest in software quality? Also, should customers believe the vendor-speak about their high product quality?

In this paper, we develop an analytical model to answer these research questions. During the development process, a software vendor decides on the level of investment in the quality of packaged software. On the one hand, creating high quality software requires non-trivial investments and process quality decisions. On the other hand, these decisions might not directly influence the customer's decision as many software quality attributes are unobservable at the time of signing the contract. Thus, the vendor may have incentives not to invest in those unobservable attributes. In addition, due to the fast-changing technological environment and the presence of market uncertainties, spending extensively on the quality of solutions over alternatives such as additional marketing effort might not seem desirable to the vendors.

Nevertheless, quality investments, even on unobservable product attributes, are very likely to benefit the vendor during the customization and maintenance processes (e.g., [5]). For instance, investing in flexible and modular design choices would enable the vendor to customize the software more effectively in response to a customer's request, thus saving time and effort. Similarly, investing in a high level of reliability and security would reduce maintenance costs and prevent potential security breaches. In addition, in the long run, a high-level investment in quality is also likely to benefit the vendor through good brand reputation and high customer satisfaction. Thus, the quality of enterprise software is likely to affect the customer's utility and the software vendor's profitability in providing customization and maintenance services.

The aim of the current paper is to examine strategic behaviors of the two enterprise software vendors in the duopoly market with

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asymmetric information about software quality *ex ante*. The present study could provide software vendors with guidelines on making decisions about product quality during the development process². This research could also help organizations in the process of making strategic decisions about enterprise solutions and contracting with vendors. We intend to provide researchers with a better understanding of economic consequences of quality-related decision in the domain of enterprise systems, a rapidly growing area.

From the perspective of the customer, purchasing and adopting an enterprise system are critical decisions that may highly impact its organizational performance. However, selecting an enterprise system product is a complicated decision because information about the quality of enterprise software is privy only to the software vendor. Customer would have to make the purchase decision before they are able to systematically determine whether a vendor's enterprise systems' quality would be sufficient to meet the firm's expectations. In addition, once an organization chooses a software vendor with a specific enterprise system product, they might have to live with the choice for several years.

We find that there exists an investment-equilibrium in the duopoly market, even if customers are uninformed about the quality at the time of purchasing decision. This implies that the vendors have incentives to invest in the unobservable quality dimensions of enterprise software in the presence of competition.

2. Background and model development

Much industry and anecdotal evidence suggests that asymmetric information on the quality of enterprise software can cause tension between vendors and customers. As a case in point, a leading firm in the waste management service industry, Waste Management, sued SAP over ERP implementation seeking recovery of more than US\$100 million [10]. Waste Management's argument was that:

SAP promised that the software could be fully implemented throughout all of Waste Management within 18 months. ... From the beginning, SAP assured Waste Management that its software was an 'out-of-the-box' solution that would meet Waste Management's needs without any customization or enhancements. ... Unfortunately, Waste Management ultimately learned that these representations were not true. ... Product demonstrations by SAP prior to their deal were fake software environments, even though these demonstrations were represented to be the actual software. ... mock-up version of that software intended to deceive Waste Management...

Before the agreement was formalized between the two companies, SAP had promised to Waste Management that the solution was mature. According to Waste Management's argument, the SAP's talk turned out to be a significant exaggeration.

Details of this case suggest that the failure could be explained by lower levels of quality of the SAP's software to Waste Management along some unobservable dimensions such as flexibility, functionality and scalability. For instance, one could maintain that limited design flexibility might have affected the ability of SAP to customize the enterprise solution within the stipulated time. However, from a selling standpoint, vendors might have an inclination to exaggerate the software quality. Because it sometimes takes several months to a few years for a customer to observe the quality of enterprise software, it is not pragmatic to expect the customer to terminate the agreement before it is too late. Instead, in many cases, the customer's investment is locked in with the vendor during implementation, and the bargaining power of the customer is very little or non-existent once the contract is signed (e.g., [17]).

² In this paper, the term *software quality* refers to the quality of the packaged software, which is generally developed before the sale of the enterprise system.

In the academic literature, product quality has been studied as a strategic choice of companies in industrial organization (IO). For monopolists, the cost of improving quality is incurred as a sunk design cost that does not change with total output [16]. A monopolist's choice, then, will depend on whether quality affects demand. In the duopoly and oligopoly markets, a company's quality choice will be determined by competition as well as the cost and demand structure in the market [2]. In the traditional setting, with information asymmetry between companies and customers, it is found that a monopolist does not have any incentive to invest in product quality [6].

In this paper, we adopt the lens of product quality models in the IO approach, while taking into account of the differences between the enterprise system market and the traditional product markets studied in existing IO models. We discuss properties of enterprise systems markets in the following sections.

2.1. Characteristics of the enterprise systems market

As noted earlier, there are several unique characteristics that distinguish the enterprise system market from personal software markets as well as traditional product markets. First, sales of enterprise systems involve a combination of products and services associated with it. Customers will need to purchase both in order to generate positive value. The product sale is often in the form of licenses to install and use the packaged software and services include customization, enhancements, maintenance (repair and updates) and training. Vendors earn their revenue by selling license fees and service fees, but the combination of the two types of sales is often inseparable. Though many kinds of manufacturers of typical product markets sell warranty services with their products, such as PCs and televisions, the purchase of the service component is a consumer's option in most cases. Consumers may not buy the warranty service, and even when they purchase the warranty, the price of the service sales is often lower than that of the product. However, in the case of enterprise systems, the price of services including customization and maintenance could be higher than or at least on the same scale of the price of user licenses. Further, customers generate value from the product only in the presence of the service component.

Second, it often takes considerable time before customers can evaluate the software quality. The quality of personal and individual productivity software such as Microsoft Office™ programs can be revealed right after customers purchase the software because those programs do not need to be customized before user experiences the product fully. However, enterprise systems require significant time to be implemented and installed before they are used by organizations. Depending on the size of the adoption and the degree of customization, it could take up to a few years. What is worse from the perspective of the customer is that their bargaining power over the vendor decreases over time due to switching costs for the firm and possible holdup by the vendor.

Third, given that there are two kinds of operational costs in enterprise systems business: (1) the cost of developing packaged software and (2) the cost of delivering services including customization and maintenance, enterprise systems are characterized by the relationship between these two kinds of costs. Specifically, the first operational cost affects the cost of the second component. If the vendor invests more in the development of packaged software, then the quality of the enterprise software would be higher and the higher quality can reduce the cost of service delivery. For example, as flexibility, scalability and capability of the software increases, it will cost less to customize the enterprise system and to meet customer's needs.

2.2. The quality of enterprise systems and unobservable attributes of quality

Customers need to confirm whether the quality of an enterprise system is at least as great as the level of need on the observable

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