Information Quality and Online B2B Relationships After the Purchase

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Abstract

Much has been written about both the theory and the practical importance of developing enduring buyer-seller relationships. While most commentary has addressed business relationships in bricks-and-mortar settings, attention has shifted to the impact of Web-based relational exchanges. There is a growing need to consider how Web-based information systems influence relationship growth between organizational buyers and sellers. We are particularly interested in how trust, commitment, and communications in relationships develop when the quality of information carried by electronic information systems is taken into account.

We draw upon theory found in the information management literature—specifically, the information-quality constructs of accuracy, completeness, consistency, and timeliness. These constructs provide useful insights into business-to-business (B2B) relationships that either take place on a Web site or are supported by Web based information system tools. We briefly set the stage with a discussion of relationship development theory. Then we define information quality and illustrate how quality considerations may be applied to analysis of B2B relationships.

While our examples concern relationships after a sale has taken place, we mention other applications of information quality concepts to relationship development. We cover aspects of customer service that takes place online, such as: contract tracking, application assistance, and inventory management. Various information quality trade-offs are identified and discussed.

Background and Overview

Relationships make possible long-term exchange between businesses in environments where change requires business adaptation (Hallen and Johanson 1991). Even legal contracts cannot replace the benefits derived from trust and mutual understanding that accompany–in fact, characterize–a healthy business relationship. Various information technologies in recent decades

offered means for augmenting communication in business relationships. Electronic data interchange—EDI, for instance, enabled efficient coordination of information flow, but cost and lack of flexibility limited this application to large companies. In the 1990's, browser technology and the Web overcame these limitations and introduced a new medium for information exchange between buyers and sellers, even between small businesses.

Early Web use was fairly limited (Kennedy and Deeter-Schmelz 2001). Simple, new purchases and routine reorders accounted for the majority of online activity, with complex new purchases accounting for 12.9% of online activity. By 2002 the integration of supply chains online has become a strong trend, with firms such as IBM, General Electric, and Cisco leading the curve.

As electronically coordinated buyer-seller information flows expand, relational communications that once took place directly between purchasing agents, salespeople, and engineers now take place online (e.g., Rosson 2001). Significantly, changing the medium of communication can change the results, perhaps affecting both economic and other values that business relationships are supposed to create (Mandják and Durrieu 2001, Phillips and Meeker 2000).

Our objective and intended contribution is to introduce a framework that applies information quality considerations to understanding relationship development. To illustrate our framework, we focus on what takes place in a business relationship after the purchase, when many important aspects of a relationship can be coordinated over the Web. The domain of investigation, for example, would include:

- Gaining and maintaining trust that enables exchange of proprietary, strategic information.
- Increasing commitment, as indicated by the integration of information systems.
- Increasing the frequency and quality of communication for planning as well as problem solving.

There are important information-quality design tradeoffs when structuring Web communications. Among other things, supply chain managers want information that is timely, accurate, complete, and consistent. However, such characteristics are rarely easy to achieve simultaneously, and business relationships can be enhanced or degraded by an information system that provides the wrong mix of information quality. For example, Cisco's vaunted real-time supply information-system was implicated in a $2.3 billion dollar charge against earnings when management tried to compensate for the poor accuracy of forecasts in its supply chain (VanScoy 2001). Essentially, Cisco managers created a safety stock that was never needed.

Amazon was not confident that the quality of customer service and customer service information could be maintained if it relied on a virtual supply chain, so it undertook the enormously expensive fixed-cost investment of building its own warehousing system—in short, Amazon could not trust its suppliers. Today, Amazon's inventory management is a case-study in bricks and mortar efficiency (Sandoval 2002). However, Amazon's warehouse system now seems less essential to an online business. Specifically, Target and Bluelight.com have adopted an effective drop-ship virtual-inventory information system managed by Frank Poore's Commerce Hub software (Frontline Solutions 2001). The Commerce Hub system seems to offer a tangible example indicating that when important characteristics of information quality are addressed effectively, an information system makes networks of relationships possible in ways that could not otherwise exist.

Our premise is that as online information systems grow in importance, we need to take into account information quality if we are to understand how moving the buying process online will affect buyer-seller relationships. From simple matching sites to supply chain management systems, the trade-offs associated with information quality will increasingly draw attention. The business importance of information-system supported exchange is conveyed by IBM's experience. In 2001 IBM spent $40.3 billion on online procurement with 32,000 suppliers using its proprietary system. IBM attributes online procurement with over $400 million in savings attributable to a variety of online tools (Purchasing, 2002). Next, we will give substance to our framework by defining the information quality constructs.

Information Quality Constructs

Information used by managers varies in quality. A variety of different constructs have been proposed for describing information quality. We will use four constructs: accuracy, completeness, consistency, and timeliness (Ballou and Pazer 1985, 1995, 2002; Chengalur-Smith, Ballou, and Pazer 1999).

Accuracy refers to the degree of conformity between the value actually used and the correct value. For example, if a report provides stock levels for 80 products, only 40 of which are correct, then the accuracy of the communication would be 50 percent.

Completeness has two components: structural completeness and content completeness. Structural completeness refers to presence of data in each cell. For example, information gathered by means of an online form is structurally complete if all the blanks have been filled. Content completeness refers to the use of the most informative metric for information. For example, if a report converts supplier evaluations based on a 10-point scale into a simple ranking of suppliers, the latter information is less complete.

Timeliness is the age when information is actually communicated to a user viewed in the context of the data's shelf life. Timeliness relates the age of data to the age sensitivity of the data. The age of the data is calculated by summing the time when it is collected, plus the time it has spent in processing and storage, plus the time required to communicate it to a user. For example, three month old information concerning a supplier's location may be quite acceptable, while three month old information concerning "current" inventory levels is nearly useless.

Consistency refers to the underlying formats or processes used to communicate data. A simple example would be distance measurements in English versus metric measuring systems. In an actual example, one of the authors ordered online four wheels, four tires, and four hubcaps for a car. However, the supplier shipped four tires, four wheels, and 16 hubcaps—that is, four sets of hubcaps. The buyer and seller had a different understanding of product-ordering language, an information consistency problem. (Interestingly, a human sales agent dealing with the problem for the company wondered why the author ordered online in the first place.) Of course, one of the most challenging obstacles in the exchange of information between businesses is the inconsistency present in legacy computer systems.

These four information quality constructs are especially interesting in the context of management decision making because of trade-offs among them. For example, greater timeliness might be possible if data were less complete. Greater accuracy might be possible if timeliness were sacrificed. (In the previous example concerning Cisco, if managers had waited six months for more accurate forecasts before ordering the slack inventory, they would have saved billions.) A simpler system might achieve higher completeness and timeliness, but sacrifice the accuracy of details and the system's ultimate usefulness. Each trade-off may have implications for planning and coordination in a supply chain network and, ultimately, an impact on serving the end customer.

Business Relationships

When considering the nature of online business relationships, it is useful to start with the two ends of the spectrum: transactions and relational exchange (Dwyer, Schurr, and Oh 1987).

Online *transactions* are brief compared to *relational exchange*. For instance, an overstock site or an electronics supply vendor offers purchase of standardized, often branded, products, perhaps with payment by credit card, and shipment reported and tracked by Federal Express. While situations like this are often referred to as transactions, relationship certainly creeps into such transactions because of branding, use of credit, and exchange of unique identities during the brief activity of filling out an online purchase request and receiving confirmations, purchase tracking numbers, and assurances. Further, such transactions may be sequential, though each purchase episode is isolated. In fact, there may be no expectation of future interaction and no personal relationship to plan such exchanges. Note, however, all the opportunities for variation in information quality in the context of ordering and shipping.

Even before the transaction itself, there are information-quality issues concerning information about alternative suppliers, supplier performance, product availability, projected delivery, and appropriate product applications. For example, an industrial supplier of wheel chocks (wedges that hold industrial vehicles motionless) received an order for what seemed to be a sample. The customer later lodged a complaint against the supplier that was posted at a public online business exchange for small businesses. It turns out that the part did not work very well as a stand for a bonsai plant, a totally inappropriate application. The supplier is unable to correct this negative performance mark at the online site. (The exchange ought to reevaluate the content completeness of supplier ratings.) The supplier now makes more effort to collect accurate information about a buyer's intended use of a product before committing to a transaction.

Expectations of future interaction elevate the importance of a relational exchange as a guarantor of supply stability, lower risk, and effective problem solving. Ongoing relationships must navigate through the unpredictable storms of the future, making inflexible legal contracts less effective than the trust, commitment, and good communication that accompany a relationship. The importance of long-term relationships in B2B situations and the variety of issues worth investigating and discussing have received increased attention in recent years (e.g., Nevin 1995, Weitz and Bradford 1999, Wilson 2000). Further, relational exchange can involve coordination among multiple partners in a supply chain, which has led to discussion about relationships in networks.

Table 1 shows relationship growth phases. For each phase, characteristics and examples of relationship-related information issues are indicated (cf. Ganesan 2000; Mohr and Spekman 1994; Morgan and Hunt 1994; Robinson, Faris, and Wind 1967). Relational exchange involves a number of people in two or more organizations engaging in a series of activities over an extended period of time. As more value accrues to the exchange process, partners are more likely to make non-transferable commitments of assets, as suggested in Table 1. From the standpoint of marketing, it is both desirable and profitable to gain increased customer commitment and deepen the relationship overtime. Likewise, industrial buyers see important cost savings by reducing the number of suppliers for individual parts while coordinating more effectively in planning and control processes.

Table 1: Relationships and Information Issues

Relationship Phase	Activities	Examples of Relational Information Issues
Awareness	Identifying potential exchange partners.	Partner characteristics and performance record.
Exploration	Evaluating the transactional or relational values available.	Availability of benefits from association. Suitability of product and service solutions. Data contributing to conclusions about trust. Effectiveness of trial commitments.
Expansion	Trial interactions that reveal the benefits of a relationship through experience and extend the range of relational activities.	Problem solving. Trial purchases. Exchange of proprietary information. Trial integration of selected systems.
Commitment	Mutual dedication of non-transferable assets.	Integration of strategically critical systems. Linkage of legacy data. Joint efforts at process improvement. Broader coordination with a supply chain network.
Dissolution	Withdrawing from a relationship that does not satisfy criteria for desired business performance.	Customer ratings. Supplier ratings. Relationship performance tracking.

Two decades ago Levitt (1983) drew attention to the importance of what takes place after a sale. Today, supply chain management has achieved a distinct position in the strategy of the firm. We propose that information quality investigations will make the greatest contributions when partners increase commitment during relationship growth. Consider, for example, how business customers prioritize their suppliers according to strategic importance. Top concerns include (Tan 2002):

- Determining future needs,
- Reducing response time across the supply chain,
- Improving on time delivery at the points of use, and
- Improving the integration of activities.

In addition to these task-related concerns, there are important relationship and business development concerns: stimulating trust, communicating strategic priorities, accomplishing more

frequent contact, increasing information sharing, and involving supply chain partners in planning. Tan (2002) reports that achieving supply chain coherence—reconciling both task and relational information system issues—rates highest among supply chain managers. Each of these supply chain concerns invites investigation from the standpoint of information quality effects.

Business Relationships and Information Quality

Both task and relational information can be exchanged through information systems. For example, suppose the implementation of a purchase contract involves a number of smaller purchases against a comprehensive supply contract involving dispersed order locations and a variety of products. Systematic ordering procedures and inventory reporting systems integrated between a buyer and seller facilitates the supply process, while introducing opportunities for information quality problems. Also, relational information, such as that affecting trust, norm development, and problem solving is a byproduct of task-focused activity. For example, error reports show the frequency of late deliveries, defective products, and incorrect products shipped, which enables managers to form opinions of supplier reliability and the degree of trust warranted. This section gives an example of how information quality affects business relationships and suggests additional avenues for using this framework.

Contract Fulfillment (Structural Completeness) and Loss of Supplier Good Will

Of the many performance characteristics supply chain managers try to optimize, supplier good will can be among the most strategic, because it contributes to a supplier's commitment to a relationship. Inevitably, periods of excess supply turn to scarcity, and a supplier will prioritize customers so that the best customers get what they need on time—clearly, a strategic issue from a buyer's standpoint. A customer cannot afford to lose supplier good will by, for instance, purchasing less than a contract amount or inadvertently breaking exclusive-supply agreements.

For example, IBM surveyed suppliers and found that suppliers criticized IBM's all too frequent failure to uphold negotiated contracts (Purchasing 2002). Further, IBM discovered that business with core suppliers—those of strategic value to IBM—were losing business to nonstrategic suppliers. In other words, information about purchases-against-contracts was structurally incomplete. IBM was ineffective at obtaining in one place the necessary information about each purchase that matched a long-term purchase agreement. Such completeness problems can arise from the difficulty in controlling activities at globally dispersed operations. Sometimes completeness problems are related to trade-offs involving timeliness.

More generally, failures of information quality can arise in various ways, as suggested by Table 2. These information quality issues may appear in manual systems, of course, but also in partially automated and fully automated ERP and EDI systems. In the latter, problems arise because ERP and EDI systems are never as flexible as Web based systems that can handle large and small enterprises as well as multinational supply chain systems.

Table 2: Information Quality Constructs and Relational Decisions

Quality Characteristics	Examples of Possible Problems	Examples of the Impact on Relational Decisions
Accuracy	Contract purchase figures in error due to incorrect data entry, compilation methods, and transmission errors. Also, estimates (projections) may be used when actual figures are too difficult or costly to obtain.	Inaccurate data fails to trigger optimal decisions.
Completeness	Reports fail to include information in all categories. May occur, for example, when a global operation experiences delays getting supply reports necessary for comprehensive reports.	Errors in evaluating suppliers and managing contracts vary by geographical locations.
Timeliness	Accurate and complete reports are provided, but too late for contracting shortfalls to be remedied.	Data accumulates about problems that have already had negative consequences.
Consistency	Variations in the way contract execution is reported results in errors in contract execution.	Uneven approach to supplier relationships.

Even with Web based systems, some aspects of information quality are problematic. Both accuracy and completeness interact with timeliness. That is, systems that are not truly real-time will present decision makers with a trade-off. The timeliest information may suffer more completeness errors. Forcing timely information by means of policy instead of successful system redesign invites data estimation to avoid delays in timeliness. Even Cisco's famed real-time supply chain information system suffered from such problems and eventually led to billions of dollars of inventory being written off—not to mention the impact on supplier relationships.

A key insight is that supply chain managers are not primarily driven by using the Web as another tool for price negotiation that plays one supplier against another. To the contrary, buying strategy requires stable relationships with suppliers in which commitments are carefully negotiated, precisely tracked, and faithfully executed. Such strategy relies on a wide variety of information system tools. For example, Table 3 identifies some of the practices employed by IBM to address information quality issues of the kind identified in Table 2.

Table 3: IBM Web-Based Information System Supply Chain Management Tools

Application	Description
Business data warehouse	Procurement information warehouse fed by ERP, contract and material information systems.
Supply portal	A single point of entry for suppliers and internal IBM personnel to access procurement applications.
Contracts online tool	Worldwide repository to generate new contracts and manage current contracting activity.

Outsourced supply chain	Application to process parts orders from contract manufacturers.
Worldwide accounts payable	A single organization on an SAP platform and consolidated supplier master file that receives more than 96% of all invoices electronically.
Replenishment and supply collaboration	Common Web tool for direct materials replenishment from IBM suppliers and supply/demand planning.
Web ordering and invoicing	Converts SAP and EDI Pos into Web-based e-forms for suppliers.
Technology qualification application	Checklist qualification data repository tool for automatic notification of product engineer and review capability.
Supplier problem log	Collaboration tool that allows for the sharing of quality problem data among engineers, commodity chairs, and management.
Quality information network.	Repository for IBM audit activity results, schedules and action items.

Source: Adapted from Purchasing 2002, p. 36S4

To illustrate, consider the supply portal entry in Table 3: the problem concerns globally dispersed company operations and perhaps a globally dispersed supply chain. Information quality problems may involve structural consistency (e.g., different terminology used by different locales and industries) and content consistency (some locations not reporting data). Also, the poor timeliness of communications plagues some global systems. One solution used by IBM is the common supply chain portal. By directing buying and selling activity through a common gateway, managers more effectively capture data, promote structural consistency, and provide timely communications.

Future Research

Our brief discussion of the information quality and relationships framework offers only an introduction to the possibilities for research. For example, after the sale there are various tasks that must be performed. Each task is associated with information quality issues that might impact how a relationship develops, as suggested in Table 4. One approach to investigation would be to identify for each exchange task the characteristics of required information. Then the quality trade-offs may be considered and the possible effects on relationship development hypothesized. In this way researchers will uncover opportunities for increasing the effectiveness of buyer-seller relationships. Also, Web interface developers will gain insights to the software tools or human intervention necessary for moving ever more complex supply chain relationships online.

Table 4: Purchase Tasks and the Impact of Information Quality

Purchase Task	Example of an Information Quality Issue	Impact on Relationship
Shipment Reporting	Completeness versus Timeliness (Multiple shipping points require coordination of data accumulation.)	Expectations are established against which the reliability of a supplier is evaluated and perceptions of trust are formed.
Drop Shipments	Convergence of order, inventory, picking, and shipment information depends on information consistency, timeliness, completeness, and accuracy.	Networked relationships benefit when partners specialize. The ephemeral goal of virtual retailers avoiding inventory is achieved today by virtue of third party software. A network can become a seamless alliance.
Application Assistance and Technical Support	Completeness of strategic information and timeliness of entries to a common knowledge base.	Information sharing always requires trust when the information is strategic and proprietary. Microsoft has persistently undermined its customer relationships through poor information management. Cisco has thrived by achieving high quality information for application assistance and technical support.

An alternative approach is to draw upon the literature of relationships (e.g., Dwyer et al. 1987; Ganesan 2000; Hallen and Johanson 1991; Mohr and Spekman 1994; Morgan and Hunt 1994; Nevin 1995; Robinson, Faris, and Wind 1967). By starting with the critical incidents of relationship development, investigators can study how the trade-offs necessary for planning information quality impact relationship development.

Certainly, the impact of information quality on trust, commitment, and communications in relationships deserves early attention. Today's supply chain partners seek stability in relationships but also the ability to adapt, evolve, and grow. Clearly the Web will play an increasing role in buyer-seller relationships. However, some activities of relationships in the online age still require human interaction. We have yet to develop a model that articulates what aspects of relationships belong online and what aspects are optimized by face-to-face interaction. Perhaps an understanding of information quality will contribute to this model.

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