

EXPLORING THE MEDIATING AND MODERATING EFFECTS OF INFORMATION QUALITY ON FIRMS' ENDEAVOR ON INFORMATION SYSTEMS

(Research-in-Progress Paper)

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Abstract Information quality has been largely neglected by many business firms and firms are losing or wasting big money because of the poor information quality in their information systems. This paper will theoretically examine where and how information quality influences a firm's performance. The mediating and moderating effects of information quality on information systems' impact toward business operations and consumer behaviors are identified and analyzed. The managerial implication of information quality is also emphasized. Top management team is called to pay close attention to the information quality in their information systems.

Key Words: Data Quality, Information Quality, Consumer Behaviors, Information Technology Investment, Firm Performance

More and more companies are recognizing that data is a key organizational resource [13]. All kinds of business data are used increasingly in strategic information systems, such as executive- or decision-support systems. Practices such as Business Process Reengineering (BPR), e-commerce and e-business have been generating a large amount of data every day. The emerging popularity of Customer Relationship Management (CRM) and many other e-commerce initiatives are creating requirements for large, integrated data repositories and advanced analytical capabilities [37]. Consequently, the quality of information or data in those data repositories has become a greater concern for firms and their IT divisions. Watson and Haley [34] indicate that providing high-quality data to decision makers is the fundamental reason for building a data warehouse. Unfortunately, data or information quality issues have not been dealt with seriously [38]. For example, when interest rates changed drastically, a financial company lost more than \$250 million because of the poor data quality in its database [16]. In 1990, US General Accounting Office reported that at a single agency more than \$2 billion in federal loan money had been lost due to the poor data quality [13]. Many business managers had not known that the poor quality of the data or information flowing in their information systems was hurting their business performance until it was too late.

There is strong evidence that information quality issues have become increasingly prevalent in today's business practices [4, 13, 27, 31]. When firms rely more and more information systems to operate their business, information quality has become an extremely important factor for firms to achieve competitive advantages or at least survive in today's fierce competition. This paper attempts to theoretically justify the importance of information quality in firms' increasing endeavor on their information systems. Mainly, the

mediating and moderating effects of information quality on firms' information systems are identified and examined.

1. BACKGROUND ON INFORMATION QUALITY RESEARCH

Information or data needs to be accurate in order to meet the quality requirements. But accuracy is not the only requirement for data quality. Data quality is synonymous with 'fitness for use', which means the data needs to be appropriate to a specific application or use, not just accurate. This implies that the concept of data quality is relative [33]. A set of data appropriate for one use may not be viewed as having sufficient quality for another use. Ballou and Pazer [2] identified four dimensions of data quality: accuracy, completeness, consistency and timeliness. Wang and Strong [36] believe that data consumers have a broader view of data quality than information technology (IT) professionals. They developed a conceptual framework of data quality from the perspective of the data consumer. The framework consists of fifteen dimensions, grouped into four categories. The multiple dimensions of data quality from various researches suggest that data quality is far more than being accurate, and it is a fairly complicated issue.

As data travels from collectors to different databases, data marts and data warehouses, it may lose its meaning apparent in the initial context but not in the followings [13]. A piece of five-year old stock price data may be appropriate for researchers doing a longitudinal study on that stock, but it is not fit for a stock day trader's use because it does not meet the requirement of "timely" for the stock day trader. A database that is satisfactorily used by one division might be regarded as a problematic database by another division if the two divisions have incompatible data formats or one division has a lot of difficulties in accessing the database. Also, different people see data differently. Although the value of a particular data item is accurate, it can be interpreted differently by different people.

Data stored in computer systems, especially transactional information systems, is usually hard data, which inherently is verifiable. But managers and executives also need their information systems to support soft data, such as the moving trend of the market, competitor's intentions, etc., which are not inherently verifiable. Today, management uses soft data more often than hard data in strategic thinking, and the requirements for overall data quality have been raised to a much higher level.

The high quality of data cannot be simply achieved via investing in IT alone. Instead, there needs to be a formal, official mechanism in place within the organization to ensure it [3,13]. Like Total Quality Management (TQM) in physical product manufacturing or services, there are many factors affecting the quality of the data or information product, such as top management commitment, continuous improvement, etc. Different studies look at this issue from different perspectives. Besides the research in defining data quality, measurement, analysis and improvement, several other studies regarding how to develop tools, methods and processes to manage and improve data quality and how data quality affect job satisfaction, etc. have been done [3,11, 12, 35]. For example, by adapting the Deming cycle of Plan, Do, Check and Act in physical product manufacturing [8], Wang developed the TDQM cycle: Define, Measure, Analyze, and Improve [35]. Redman discussed the impact of data quality in firms on different levels, e.g., the operational level, tactical level and strategic level [27].

2. INFORMATION QUALITY AS A WHOLE

The data flowing in a firm's information systems is used to conduct business, such as processing transactions, servicing customers, and helping make business decisions. For example, the data in Enterprise Resources Planning (ERP) or Supply Chain Management (SCM) systems is used to plan

enterprise resources to better fulfill production or services. The data in a CRM system is mainly used for customer service and to analyze customers' consuming patterns or preferences; the results are then used to guide customer-oriented product design, conduct more specific marketing campaigns, and so on [13, 30]. The data in an executive support system is often used to analyze overall industry environment, a firm's and its competitors' strength and weakness, economic situations, market movement, etc.

In general, the wide use of IT in business operations generates more data than ever and the use of data is seen everywhere inside an organization. The purpose of implementing information systems is to gather data, process it and then generate high quality information from the data. Its ultimate goal is to "improve operation and decision making at the back end and marketing and service at the real-time front end for increased revenues and a competitive advantage in the new, global, wired economy" [1]. The cost of collecting data has been lowered drastically because of the use of Internet and the Intranets. Today, massive amounts of data are available to firms, and they have sufficient resources to do data analyses and conduct their business in a more scientific, data-based style. The emergence of the CRM systems to analyze customer's purchasing patterns or behaviors is a good example [30]. When the data a firm possesses grows exponentially and the quantity of the data is no longer a problem, the quality of the data becomes a much more important issue.

Poor information quality impacts a typical firm in many ways on the operational, tactical and strategic level. These impacts include customer dissatisfaction, increased operational costs, less effective or wrong decision-making, and a reduced ability to make and execute strategies; poor information quality reduces the employees' trust in the data, the employees' enthusiasm to use the data, and makes it more difficult to align the firm [27]. Poor information quality and its underlying causes are potent contributors to an "information ecology" inappropriate for the Information Age [9]. Redman pointed out that although it was very difficult to estimate the total cost of poor data quality, three proprietary studies that he knew of yielded an estimate in the 8% -12% of revenue range. More informally, 40% - 60% of a service organization's expenses may be consumed as a result of poor data [27]. A system possessing high information quality and system quality can lead to net benefits for various stakeholders, including individuals, groups of individuals and organizations [29]. Proposition A is based on the assumption that better information quality leads to better business operations and strategic positioning, which then lead to better firm performance.

Proposition A: Information quality of a firm is positively related to the firm's performance.

Quality of information could affect a firm's operations and performance through many ways. It increases the use of information [22] and improves the effectiveness of the information systems a firm deploys [24]; it also influences online customers' purchasing decisions [17, 19] and improves customer satisfaction [6, 24], etc. This paper focuses on the impact of information quality on business operations and consumer behaviors.

3. INFORMATION QUALITY ON BUSINESS OPERATIONS

Information quality often serves as a moderator and mediator between the information systems a firm deploys and its business operations, as showed in Figure 1. Firms are increasingly using data in their daily operations and strategy formulation. IT-based business initiatives like ERP, CRM, SCM, etc. fully operate on a data-driven platform. Good data quality in these information systems could help firms run business smoothly and precisely. It has been long recognized that data problems can cause computer-based systems to perform poorly [3]. Managers need information that encourages insights and helps them

make day-to-day decisions that enhance profitability, increase value for customers and differentiate the firm's products and services from others. Many firms have realized that erroneous data in their information systems negatively impacts their business operations and can be extremely costly [32, 39]. In 2001, the Data Warehouse Institute estimated that dirty data cost U.S. business \$600 billion per year [40]. Successful implementation of relationship-based marketing strategies, such as CRM, demands the integration of timely and accurate market, consumer and product information [13]. Without good data quality, strategies such as TQM and CRM may be difficult to implement [10, 13, 26]. Designated goals of these systems would be comprised and business operations and performance would less likely be improved. The impact of these information systems on business operations and performance is thus moderated by data or information quality, as shown by the solid arrows in Figure 1.

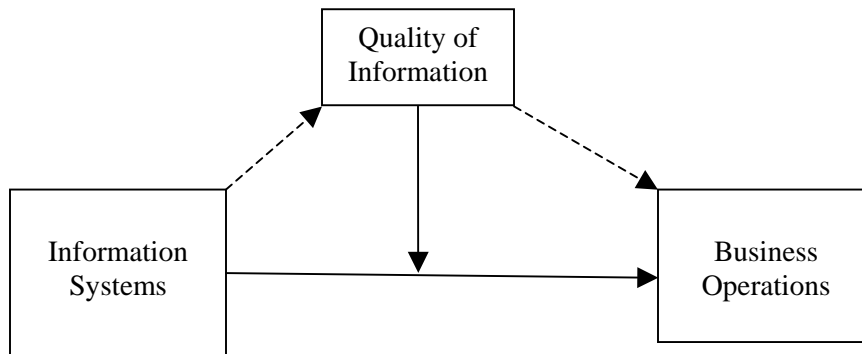


Figure 1: Moderating (solid arrows) and Mediating (dotted arrows) Effect of Information Quality on Information Systems toward Firm's Business Operations

In many other cases, information quality acts as an intermediary between a firm's information system and its business operations and performance, as illustrated by the dotted arrows in Figure 1. For example, web-based customer support system has been widely used in today's world of e-business. Because of the richness of the information provided by websites, customer can get much higher quality of information from a firm's website than from regular phone support. Abundant text, along with vivid illustrations, sound and video clips, are put up on websites for customer support purpose. On Dell Computers' technical support website¹, customers can learn how to install, configure, troubleshoot computers, find parts, read technical articles, download software updates, etc. Cisco Systems Inc. invested in a web-based system to alleviate the customer service problems occurring with its exponential growth in the 1990s; it was reported that the system had saved Cisco at least \$30 millions annually and the sales force had been on average about 15 percent more productive [7]. Because of a web-based customer support system handling over 100, 000 unique customer visits every day, Microsoft was able to maintain a constant level of phone support when its sales grew. The success of these systems helped these firms to achieve better performance, such as improved customer services, reduced cost, etc. The higher the information quality, in terms of richer information format, higher availability, and more structured form provided by the web-based systems, serves as the intermediary between a firm's information systems and its business operations and performance. The information systems, particularly the web servers here, increase the quality of the information conveyed to customers; it then in turn improves business operations and performance, such as reducing cost of customer services and producing higher customer satisfaction. Without the higher quality of information made available to customers through the web systems and

¹ <http://support.dell.com/>

related back office information systems, the benefit of a firm's information systems would be largely discounted.

The success of information systems, e.g. the web-based customer support system, largely relies on the quality of the information, for instance, the accuracy of the information, presented on the websites. If the accuracy of the information on the websites was lower than expected, customers could not get appropriate support and the support system would eventually be abandoned. In such case, the information quality of websites mediates the influence of a web-based customer support system on a firm's business operations and performance. Without high quality of information, a firm's information system, e.g. the web-based customer support system here, could not contribute much to a firm's customer service because the web system might be perceived useless by the firm's customers. Empirical studies have revealed that information quality, among many factors affecting the success of a web-based customer support system, was found to be positively related to the success of such systems [24]. Information quality was also found to be the only significant predicting factor of end-user's perception on usefulness of a website which led to the adoption of the World Wide Web according to the Technology Acceptance Model (TAM) [20]. The high quality of information on web sites positively contributes to the customers' satisfaction of using the web-based support systems and the effectiveness of the systems, which in turn leads to improved business operations and firm performance [5, 7, 24]. Proposition *B* and *C* examine the moderating and mediating function of information quality on information systems' impact toward a firm's business operation and performance.

Proposition B: Information quality has a moderating effect on information systems' impact toward a firm's business operations and performance.

Proposition C: Information quality has a mediating effect on information systems' impact toward a firm's business operations and performance.

4. INFORMATION QUALITY ON CONSUMER BEHAVIORS

The quality of the information of a product and service has been long recognized to have influence on consumers' purchasing decisions toward that product and service [17, 28]. Online e-commerce websites brought by the commercialization of the Internet in the 1990s have been a great channel to convey product or service information to consumers. The rich information format and virtually unlimited capacity for storing information provided by websites give firms a great deal of freedom to organize product information on the website. Furthermore, the interactive functionality of the websites offers a two-way communication channel between firms and their online customers. Customers are able to demand more information with richer format on products or services of interest. Firms are able to know and manager their customers better through their web-based systems such as electronic customer relationship management [30]. E-commerce websites deliver higher quality product or service information, in terms of richer information format, higher availability, and more structured form, etc., to customers so that the customers will be able to make their decisions based on better and more complete information. The influence of an e-commerce website on consumer's purchasing behaviors is partially realized through higher information quality conveyed to consumers via web than via regular channels such as TV or radio ads.

In the e-commerce domain, the quality of information of a company's offerings is crucial to create a positive image of the company and build an ongoing relationship with the customers [15] and to determine customers' purchasing decisions [17]. When customers perceive that the information meets their needs and requirements, they are willing to examine the product or service based on their purchasing decision criteria [25]. In other words, when the information quality of the offered product or service is

perceived not good, customers will not even take the product or service into consideration. Good information quality is a necessary prerequisite for the setting-up of an active partnership between suppliers and consumers [28]. For example, of four constructs of information quality, perceived usefulness was found to be a significant indicator to predict customer's purchasing behaviors using lodging websites [17]. Customers also have been found to prefer websites having high information quality assurance seal [19]. E-commerce websites with high information quality are more attractive to consumers and would generate more sales revenues than the websites with low information quality. The impact of e-commerce website toward consumer behaviors is moderated by the information quality of the websites too. Proposition *D* and *E* look at the moderating and mediating effects of information quality on e-commerce websites' impact toward consumer purchasing behaviors, as illustrated by Figure 2.

Proposition D: Information quality has a moderating effect on e-commerce websites' impact toward consumer behaviors.

Proposition E: Information quality has a mediating effect on e-commerce websites' impact toward consumer behaviors.

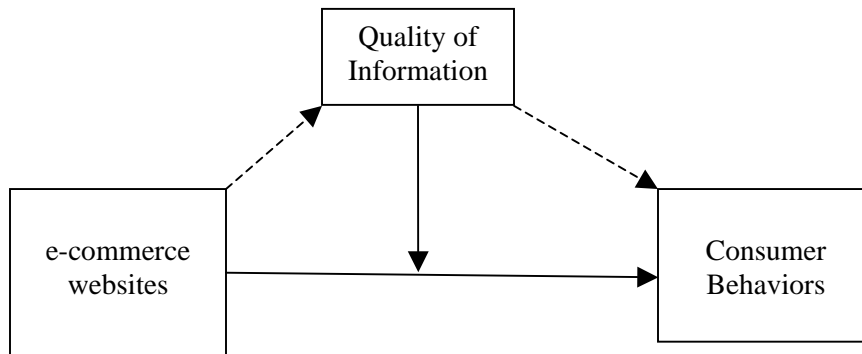


Figure 2: Moderating (solid arrows) and Mediating (dotted arrows) Effect of Information Quality on e-Commerce Websites toward Consumer Behaviors

5. CONCLUSIONS AND DISCUSSIONS

This paper seeks to understand the importance of information quality in the adoption and implementation of information systems by firms. By identifying the moderating and mediating effects of information quality on information systems' impact toward business operations and consumer behaviors, this paper partially reveals where and how information quality influences the outcome of firms' information systems.

Information quality has been largely neglected in organizations, which partially contributes the discounted return from firms' investment on their information systems. In order to fully reap the benefits from a firm's deployed information systems, top management team of the firm should pay more attention to the quality of the information their information systems generate. Information quality can serve as a measure to the effectiveness and efficiency of the deployed information systems. It can tell if the information systems are doing what they are supposed to do --- generating high quality information.

This paper also contributes to the literatures on IT investment and firm performance. As a matter of fact, the results in this research field are mixed. Some found IT investment is positively associated with firm performance while others found opposite relationship or no relationship [31]. This paper suggests why IT systems need to be carefully used and managed. The information quality from a well-managed IT system

could be greatly different from the information quality from mismanaged IT systems. The different information quality could influence the quality of services, products, business operations and strategic decisions of a firm, etc. These then will impact the firm's performance later on. Mata et al. [23] did a resource-based analysis on information technology and sustained competitive advantages and they concluded that the managerial IT skill, as compared to capital requirement, proprietary technology and technical IT skills, is the only one that can provide sustained competitive advantages. Superior firm performance cannot be achieved by just simply investing in technology alone. Instead, firms should manage and organize their information systems to produce high quality data output to support business activities. The information technology should be evaluated in light of the business model and strategy prior to the adoption and deployment, and then carefully managed to achieve its pre-determined goals after deployment. The management skills here do not only mean the skills for understanding and managing business, but also the skills of understanding and managing information technology. While the information system itself can be easily replicated by competitors, the managerial skills and the understanding of information technology are not replicable; this is where firm gains sustained competitive advantages through IT.

The moderating effect of information quality could also help explain the high standard errors of estimates reported in Hitt and Brynjolfsson [14], which found that some firms were obtaining significant competitive advantages while others were not. The reason firms did not obtain competitive advantages could be because their information systems did not work effectively and efficiently to produce high quality information to help their business operations or influence consumer behaviors in a positive way. In other words, their information systems were not as well managed and utilized as they should be, or maybe their expensive information systems were processing and producing the data with high rates of errors so that there was not much useful output from which the firm could benefit.

6. FUTURE WORK

Empirical validation of the models presented in Figure 1 and Figure 2 is certainly needed. Constructors measuring the impact of information quality on business operations and consumer behaviors need to be developed and validated. A firm's total dollar amount of IT investment can be a measure of the firm's endeavor on their information systems. There are several sources for firms' IT investment data, such as IDG group's annual survey, InformationWeek 500, etc. Firm performance data, such as return on investment, return on asset, etc. can be obtained from the Compustat database. Data on a firm's information quality can be obtained through questionnaire survey. The questionnaire used in studies [41] and [11] can be used in this study. The subjects of the survey will be the major data users within firms, such as marketing directors, executive managers, etc. The success of the firm business operations can be accessed through surveys sent to these subjects too. To test Proposition *D* and *E*, questionnaires to evaluate consumers' behaviors and consumers' perceived data quality toward firms' e-commerce website should be sent to the firms' online consumers. As for statistical methods, the relationship between a firm's information quality and its performance can be measured by using the Pearson's correlation. To test the moderating effect of information quality, ordinary least square regression with an interaction item can be used. Path analysis can be used to test the mediating effect of information quality.

The information quality issue is gaining attention in corporations. Corporations are getting more and more data every day. How to manage this data and utilize this data could be a key contributor to the firm performance, either financial or managerial. This paper looks at a part of the contribution from data or information quality. In fact, information quality could have its impact everywhere within a firm. For example, Joshi and Rai [11] empirically studied the impact of quality of information products on information system users' job satisfaction. They found that the quality of the information product has a

positive correlation with job satisfaction of the users of the information systems, and the correlation is fully mediated by role conflict and role ambiguity. Research to identify other business areas which can be significantly affected by information quality is needed very much and is very valuable in today's information era.

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