CSWIM 2007

PROCEEDINGS

The First China Summer Workshop on Information Management

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Edited by

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FOREWORD

Welcome to the First China Workshop on Information Management (CSWIM 2007) being held in Shanghai, China, on July 22-23, 2007. As China has become a major player in the world’s economy and various technological fields, information systems and management research opportunities are abundant for scholars around the globe. The purpose of this workshop was to create a new bridge for promoting exchanges between scholars in China and overseas in the area of information systems and management. In particular, CSWIM 2007 focused on creating a unique experience for MIS researchers around the world who would like to communicate and collaborate with China-based scholars.

The call-for-papers solicited original research papers addressing issues concerning the theory, design, development, evaluation, and application of information systems and management. As a research workshop, CSWIM encouraged submissions of research-in-progress that were innovative and thought-provoking. Research articles particularly sought after were those driven by business problems and validated with proper research methodologies.

In total, we received 55 paper submissions, of which 33 papers were presented at the workshop. CSWIM 2007 was indeed an international conference with 1/3 of the papers from the US, 1/3 from China, and 1/3 from other parts of the world.

CSWIM Featured (1) two keynote speeches: “The Emerging Role of Chief Information Officers and Implications to Information Systems Research” (Dr. Michael Shaw, Hoeft Endowed Chair in Information Technology Management, the University of Illinois at Urbana-Champaign) and “Strategies and Tools for Success in Developing, Integrating and Running Enterprise Applications” (Dr. Shang-Ling Jui, President of SAP Labs China) and (2) two panels: “The Ins and Outs of MIS Research Outlets” (Panelists: Yong Tan (Chair), Ming Fan, Bernard C.Y. Tan, James Y. L. Thong and Daniel Zeng) and “Building Productive and Lasting Research Collaborations Across National Boundaries” (Panelists: Ting-Peng Liang (Chair), Lihua Huang, Zhangxi Lin, Yufei Yuan and Han Zhang).

We thank the members of Internal Advisory Committee, Prabuddha De (Purdue University), Alan Hevner (University of South Florida), Stuart Madnick (MIT), Jay F. Nunamaker (University of Arizona), Andrew B. Whinston (University of Texas at Austin) and Huacheng Xue (Fudan University), who gave us advices and encouragements throughout the workshop preparation. We own a debt of gratitude to the PC members for their diligent work during the short review cycle allowed for us to complete all reviews. By the review deadline, 100% of the reviews were completed. The importance of the Best Paper Award Committee, Ting-Peng Liang (Chair), Zhangxi Lin and Daniel Zeng cannot be overemphasized; the collective insight, experience, and fairness enabled CSWIM 2007 to nominate the best candidates and final winner of the Best Paper Award in reference to the original reviews.

Special thanks are due to the sponsors of CSWIM 2007, including Eller College of Management, University of Arizona; College of Management, Georgia Institute of Technology; School of Management, Fudan University; INFORMS; and China Association for Information Systems.
Furthermore, we would like to thank our webmaster Harry Wang, currently an assistant professor at University of Delaware, for his diligent work in customizing and maintaining the conference system. We also thank our review coordinator Manlu Liu, currently a doctoral student at University of Arizona, for her great support during the paper review process.

Last, but not the least, we also want to acknowledge the superb service of the local arrangement chairs Dr. Hong Ling and Dr. Bo Xu of Fudan University, China, whose tireless work made it possible to have a successful workshop in Shanghai.

We hope that you enjoyed CSWIM 2007 and will get involved with future CSWIM conferences. Information about CSWIM 2007 is at http://cswim2007.ecom.arizona.edu.

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The Impact of Animation Characteristics and Task Conditions on Online User Behavior

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Abstract
Research on online animation has generated mixed results. Due to the different types of animation used and the task conditions, it is difficult to consolidate the results of these studies. This paper reports on a study which provides a more comprehensive understanding of the effects of animation on online users’ behavior by systematically varying three characteristics of animation (i.e., motion, enlargement, new object) under two common task conditions (i.e., searching and browsing).

Keywords: Animation characteristics, searching tasks, browsing tasks, eye-tracking

1. Introduction

Animation technologies are widely adopted in the design of advertisements on commercial websites, including web portals (e.g., yahoo), news agencies (e.g., CNN), retail businesses (e.g., Dell), virtual communities (e.g., MySpace), etc. (see Figures 1a and 1b). While it is generally assumed that animation can help to attract users’ attention to advertisements (Cho et al., 2001; Li and Bukovack, 1999), it is also recognized that animation can be “annoying”, “irritating”, and even “evil” (McGalliard, 1998; Nielsen, 1996, 1997; Spool et al., 1999). Despite the criticism, animation continues to be used on commercial websites with new enhancements, such as adopting prime locations of webpages for animated advertisements, designing more visually appealing and subtle animation, and automatically stopping the animation after an elapsed period.

Figure 1a. Screenshot of www.yahoo.com (as of Feb. 25, 2007)
Figure 1b. Screenshot of www.cnn.com (as of Feb. 25, 2007)

Given the prevalence of animation technologies and their mixed advantages and disadvantages, animation has gained significant attention from researchers in various disciplines, including

1 Acknowledgment: This research was funded by grant number HKUST6444/05H.
information systems (e.g., Hong et al., 2004), computer-human interaction (e.g., Diaper and Waelend, 2000), marketing (e.g., Cho et al., 2003), communication (e.g., Diao and Sundar, 2004), etc. Despite the amount of research conducted on animation, few unequivocal findings have emerged from these studies. While some studies show that animation attracts attention and results in higher click-through rate and recall of animated contents (Li and Bukovack, 1999; Lohtia et al., 2003), other studies show that animation hinders visual search and is often ignored (Burke et al., 2004; 2005). More importantly, the results of these studies are very difficult to consolidate for two reasons. First, there are many different types of animation that have been studied, including simple flashing (Hong et al., 2004), moving texts (Bayles, 2002), and cartoon animation (Zhang, 2000). Second, there are various task conditions that are studied in prior research, ranging from aimless browsing to goal-directed searching (Pagendarm and Schaumbury, 2001), from information retrieval to online shopping (Diaper and Waelend, 2000; Hong et al., 2004). Therefore, there is a pressing need for research to systematically vary animation characteristics and examine them across different task conditions to gain a more complete understanding.

This research uses three approaches. First, based on cognitive psychology theories, we identify three main characteristics of animation (motion, enlargement, and new object), and systematically vary these characteristics to build different visual effects. Second, we examine each type of animation across two task conditions that are common in online environment, i.e., searching and browsing. Lastly, we utilize an eye-tracking machine to record subjects’ viewing patterns while performing online tasks. Few existing research has used eye-tracking machines in the study of animation, probably due to limited accessibility of this expensive equipment, as well as the difficulty of collecting data (one subject at a time) and analyzing data (high volume of eye-tracking data). Nevertheless, by combining the eye-tracking data with the subjects’ recall performance, we can gain significant insights into how animation affects online users’ visual search as well as their memories.

2. Theories and Literature Review

Types of animation

Following Zhang (2000), we define animation as motion of any kind. In particular, we are interested in studying animation that is applied on websites in the form of flash-enabled advertisements. In an effort to classify the types of animation, we will first review the cognitive psychology theories that describe how different forms of motions are perceived by humans. Specifically, we classify animation in terms of whether they involve motion, enlargement, and new object.

Motion. Motion is unique in the way it can be registered effortlessly by the human visual system (James, 1950). For example, a natural way to draw someone’s attention is to wave one’s arms. There is also neuroanatomical evidence that motion information tends to be segregated from color and orientation information in the visual system, making it more powerful in attracting attention (Girelli and Luck, 1997). In this study, we limit the definition of motion to physical movement of information elements (texts and graphics) on the screen. For example, rolling texts would be an example of motion, but flashing texts through changing of colors is not considered as motion in our study. We hypothesize that moving objects capture more attention on websites than static objects.

H1: Moving objects capture more attention than static objects.
Enlargement. Aside from motion, animation effects can be induced by changing the size of an object, through either receding or enlarging an object. Franconeri and Simons (2003) proposed the “behavioral urgency hypothesis”, which argues that attention capture is limited to dynamic events that signal the need for immediate action. Through thousands of years of evolution, humans have learned that an enlarging object in the visual field typically indicates that it is approaching, which needs immediate actions (e.g., a predator is running towards you). Therefore, enlarging objects attract our attention due to their behavioral urgency. In an online environment, we expect this effect to continue to be true because of the slow physiological evolution of the human visual perception systems. Hence, we hypothesize that enlarging objects capture more attention on websites than objects remaining the same size.

H2: Enlarging objects capture more attention than objects remaining the same size.

New object. Cognitive psychologists also find that abrupt onset has a unique ability to attract visual attention as compared to other salient features, such as color and texture (Jonides and Yantis, 1988). Abrupt onset means a sudden appearance of a new object in an originally blank visual field. Abrupt onset can direct attention to an item that has no higher probability of being the target than any other item in a display, because it activates visual channels that are particularly sensitive to abrupt changes. Hillstrom and Yantis (1994) proposed the “new object hypothesis”, which argues that the introduction of new objects in the visual field attracts special attention in a stimulus-driven fashion. An abrupt onset in a previously unoccupied location is clearly an instance of a new perceptual object, and therefore, has a unique ability to attract attention. This is also consistent with the “behavioral urgency hypothesis”, because any new object in the visual field could mean something potentially harmful, and therefore needs immediate attention. Hence, we hypothesize that objects introduced on a website after a delay (and therefore appear as new objects) will capture more attention than objects that are displayed on the website from the beginning.

H3: Objects introduced after a delay capture more attention than objects introduced from the beginning.

Task conditions

There are two ways in which humans allocate their attention in a visual field, either through goal-directed attentional guidance or through stimulus-driven attentional capture (Hillstrom and Yantis, 1994). Goal-directed attention capture operates in a top-down fashion, where humans would look for salient features that identify the search target. For example, if a subject knows that the search target, letter “T”, is displayed in green among red letters, then any green object will capture attention. Stimulus-driven attention capture, in contrast, operates in a bottom-up fashion. It occurs when attention is drawn to a salient feature that is independent or irrelevant to the subjects’ task. For example, an abrupt onset may attract attention regardless of what the subject was searching for. Humans hardly use a pure top-down or bottom-up approach. Instead, both mechanisms usually work together in guiding humans’ visual attention allocation.

In this paper, we study the two most popular types of online tasks, i.e., searching and browsing (Bodoff, 2006; Hong et al., 2005; McDonald and Chen, 2006). We define searching tasks as tasks in which users are searching for particular information on a website; and define browsing tasks as tasks in which users are browsing for general information on a website without
specific search targets. We expect that goal-driven attention capture will dominate in searching tasks, and stimulus-driven attention capture is more prominent in browsing conditions. As a consequence, the effects of animation, operating mainly through stimulus-driven attention capture, will be stronger in browsing conditions than in searching conditions.

\textit{H4: The effects of animation on online user behavior are stronger in browsing conditions than in searching conditions.}

3. Research Methodology

An online experiment will be conducted to test the hypotheses. We will use a mixed between-subject and within-subject design, with task conditions as between-subject factor (2 task conditions: searching vs. browsing) and animation characteristics as within-subject factor (8 types of animation). Therefore, subjects will be randomly assigned into either searching or browsing conditions. Then, they will see a series of 8 (2 motion × 2 enlarging × 2 new object) web pages, each page with a flash advertisement at the upper left corner of the main text area.

Following the definitions of the searching task and the browsing task, we will design two experiment tasks accordingly. We will prepare an online article whose topic is of general interest to the subjects. The article will be divided into 8 sections, with each section presented on one Web page. Subjects in the searching condition will be given a search question before they start reading the article. Subjects in the browsing condition will be asked to read the article at their own pace without any given question. Eight flash advertisements, each designed with a specific animation effect, will be provided together with the article.

Monetary incentive will be provided to recruit college students as subjects for this study. Due to the limitation of the eye-tracking machine, we can only use one subject at a time. We will first explain the experiment task to the subject. Next, we will calibrate the eye-tracking machine to accurately track the subject’s eyes movement. If the subject passes the calibration process, she can then proceed to the experimental website. After performing the experiment task, the subject will complete a questionnaire about unaided recall and aided recall of the advertisements, the search question, additional questions about the article, demographic information, and manipulation check questions.

4. Conclusions and Potential Contributions

The results of this paper will help to consolidate prior research findings on animation. It will also allow researchers to gain a more comprehensive understanding of the effects of different characteristics of animation under different task conditions. Finally, it will reveal the relationship between users’ viewing pattern and their memories of online components.

References


James, W. *The Principles of Psychology (Vol. 1).* New York: Dover, 1950. (original work published 1890)


Information Consumption on the Web: How Users Judge Web Credibility
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Abstract
This research-in-progress paper investigates factors that influence web users’ judgment of web credibility of informational web sites. We integrate “Web as Medium” and “Web as Social Actor” perspectives and derive hypotheses informed by theory of social response and theories of persuasion. We propose that trust in the organization that build the web site and trust in the subconsciously perceived social actor induced by the social cues on the web site are both factors in users’ judgment formation of web credibility. Trust beliefs in a subconsciously perceived social actor can be built through social cues that convey expertise and trustworthiness. Familiarity and topic relevance moderate relationship between trust in organization and web credibility. These two factors also moderate the relationship between trust in the perceived social actor and web credibility, however, the second moderation effect differs from the first. Our results will inform further areas for implementing trust-building measures.

Keywords: Web credibility, Theory of social response, Trust, Social cues, Research-in-progress

1. Introduction
In ecommerce environment, it is widely acknowledged that trust is an important factor affecting intention to shop online. In this literature, trust captures the belief that the trusted party, that is, the e-vendor, will not behave opportunistically (Gefen, Karahanna, & Straub, 2003). For informational web sites such as news and medical information sites, the main concern to a consumer is not whether the site would deliver the goods or services as promised, but whether the information provided by the site is believable. In this paper, we study perceived credibility of information presented on a web site, or web credibility (Fogg, 2003). We ask, “When information is delivered through a web site, does credibility building process follow the theories developed for human communicators who present information? Does the delivery medium (i.e., online) has an impact on perceived credibility of information delivered?”

Studies of media effect in the media richness and other literature have been in the context of interpersonal communications (Daft and Lengel, 1986; Dennis & Kinney, 1998), trust in online shopping (Qiu & Benbasat, 2005; Komiak, Wang, and Benbasat, 2005), and task performance (Zhang, 2006). Although the results are somewhat inconclusive, in general, researchers have found that medium has an impact on the dependent variables studied. To our knowledge, limited studies of media effect are available in the context of online information consumption, especially credibility of online information, or web credibility.

Web credibility is perceived expertise and trustworthiness of a web site (Fogg, 2003). There is some research of media effect on web credibility in the fields of information sciences and library sciences. In this literature, two qualities of a web site are thought to contribute to web credibility: cognitive qualities and technical qualities (Olaisen, 1990, as cited in Wathern & Burkell, 2002). Cognitive qualities are determined by factors such as trustworthiness and expertise. Technical qualities are determined by factors related to site design features such as novelty, accessibility, and form. These technical factors have been studied extensively in web quality literature (e.g., Aladwania & Palvia, 2002; Barnes & Vidgen, 2006; Kang & Kim, 2006;
van Iwaardena et al. 2004). Factors that affect cognitive qualities on the web are less extensively studied. This paper is an attempt in this direction.

2. Theoretical Background
We build our hypotheses on social response theory advanced by Nass and others (Nass & Moon, 2000; Sundar & Nass, 2000) and theories of persuasion developed in communications and psychology (O’Keefe, 2002).

2.1 Theory of Social Response
Nass and colleagues, through a series of experiments, advanced the theory that human-computer interactions are essentially social, that is, humans subconsciously perceive computers as social actors (see e.g., Nass & Moon, 2000; Sundar & Nass, 2000). They established this proposition by demonstrating in experiments that humans follow social interaction rules when communicating with computers. For example, participants of an experiment perceived a computer who was praised by another computer more competent than they did a computer that praised itself (Reeves & Nass, 1996); participants disclosed more information when the computer disclosed information about itself than when it did not (Moon, 2000); merely labeling a television set as a specialist was found to have induced higher perception of credibility than labeling it as a generalist (Nass & Moon, 2000). These social responses are induced through social cues such as interactivity, voice, and animation (Dennis & Kinney, 1998; Fortin & Dholakia, 2005).

2.2 Theories of Persuasion
Theories of persuasion are concerned with factors that influence the persuasiveness of messages on the message receiver and with models that reflect receivers’ judgment process concerning messages. Three types of factors have been investigated extensively: source factors, message factors, and receiver and context factors. The most important source factor is communicator credibility, which is considered to consist of two dimensions: expertise and trustworthiness. Communicator credibility judgment is influenced by communicator’s education, occupation, and experience. Other source factors include liking for the communicator, similarity with communicator, and physical attractiveness of the communicator. (For a full treatment of theories of persuasion, see O’Keefe, 2002.)

When communications are done through web sites, such as the case in news delivery and health web sites, it is unclear what the source of the message is. If we take “web as medium” view inferred from media richness theory and other theories, then the source of a message on a web site is the organization that built the web site, or e-information provider. According to social response theory of Nass and others, using minimum social cues, a web site can be perceived subconsciously as a social actor. So if we take “web as a social actor” view, a web site, even a web page, can be considered as a social actor independent of e-information provider, which means that the subconsciously perceived social actor can be considered as the source of the messages on the web site. If “web as a social actor” perspective applies to how users form judgment about web credibility, then a natural question to ask is “can social cues be used to induce a different sense of credibility perception aside from credentials of the e-information provider?” If the answer is affirmative, then the next question follows: Does “web as medium” perspective or “web as a social actor” perspective explain more of how users form web credibility judgment?
3. Hypothesis Development

According to persuasion theory, education, occupation, and experience affect how receivers perceive the credibility of the message source. If “web as medium” perspective holds, then users will perceive high web credibility if they have more trust in the e-information provider. This conclusion follows naturally from the vast trust literature where trust in a party such as a e-vendor is found to influence users’ willingness to engage in transactions or interactions with the party (e.g., Gefen, 2004; Gefen & Straub, 2003). If users have more trust in the e-information provider, they are more willing to consider the information given by e-information provider as true and of high quality and they are more willing to rely on the information given by such a provider. Many health information web sites have implemented trust-building measures following this premise (Luo & Najdawi, 2004). We therefore propose the following hypothesis:

Hypothesis 1: Trust in the e-information provider is positively related to web credibility of its web site.

If theory of social response plays a role in user’s judgment of web credibility, then the web pages themselves can be considered subconsciously as a social actors independent from the e-information provider, that is, users may subconsciously perceive the web site or web page as the source of the message. Since the perception of a social actor is induced by social cues embedded in the messages (Dennis & Kinney, 1998; Fortin & Dholakia, 2005), it follows that the richer the presentation format, the more likely it is to induce a perception of a social actor independent of the e-information provider. Informed by media richness theory, in experiments later on, we will use cartoons as social cues to induce the perception of a social actor and use text to suppress this subconscious perception. A cartoon character can be designed so it conveys the image of an educated (e.g., wearing glasses), experienced (e.g., older looking), and professional (e.g., in a doctor’s gown) individual. Since education, occupation, and experience contribute to the expertise and trustworthiness dimensions of trust, if a web site can be considered as a social actor in itself independent of the e-information provider, then users will trust more a web site whose subconsciously perceived social actor is portrayed as more expert and trustworthy. We therefore have the following hypothesis:

Hypothesis 2: A subconsciously perceived social actor portrayed on the web site as better educated, more experienced, and in the more trustworthy occupation can induce more trust than a subconsciously perceived social actor portrayed otherwise.

Trust in subconsciously perceived social actors should have similar effect on users’ attitudes and intention as trust in software artifacts such as virtual salespersons and online recommendation agents. Since trust in these software artifacts are found to influence users’ attitudes and intentions (Qiu & Benbasat, 2005; Komiak, Wang, & Benbasat, 2005; Wang & Benbasat, 2005; Komiak & Benbasat, 2006), we put forth the following hypothesis:

Hypothesis 3: Trust in a subconsciously perceived social actor associated with a web site is positively related to perceived web credibility.

Although a web site can stimulate the perception of a social actor independent of the e-information provider and as such users can form trust beliefs about the social actor, these perceptions are more at a subconscious level. The social actor that built the web site, that is, the e-information provider, is perceived at the conscious level; the trust beliefs about the
e-information provider are therefore also at the conscious level. Concerning the strength of effect of trust on web credibility, we propose the following:

Hypothesis 4: Trust in the e-information provider will be a stronger predictor of web credibility than trust in the subconsciously perceived social actor independent of the e-information provider.

Since the web as a social actor is perceived at the subconscious level, we expect that users who are familiar with the web site and its owner (the e-information provider) are likely to have weaker subconscious perception of a social actor than users who are not familiar with the web site and its owner. Further, the effect of the subconsciously perceived social actor will have less effect on them. We test the following hypothesis:

Hypothesis 5: The relationship between trust in subconsciously perceived social actor and web credibility is stronger when the user is less familiar with the web site.

Informed by theories of persuasion, we argue that when the topic of the web site is more relevant to the user, she is more likely to seek out information about the source and is more likely to exert conscious effort to evaluate the expertise and trustworthiness of the source. In these situations, the object of evaluation will be the e-information provider, not the subconsciously perceived social actor. This means that trust in the e-information provider will be a more dominant factor than trust in the subconsciously perceived social actor. On the other hand, when the topic of the web site is less relevant, she is more likely to let peripheral cues influence her judgment of web credibility.

Hypothesis 6: The relationship between trust in the e-information provider and web credibility is stronger when the topic is more relevant to the user than when it is less relevant.

Hypothesis 7: The relationship between trust in the subconsciously perceived social actor and web credibility is stronger when the topic is less relevant to the user than when it is more relevant.

4. Research Method

We propose to conduct a $2 \times 3$ experiment to test our hypotheses. We will construct web sites that deliver health-related information. Two factors will be manipulated: trust in the e-information provider and trustworthiness of the subconsciously perceived social actor independent of the e-information provider. For the first factor, two levels of trust will be manipulated by stating different facts about the e-information provider, portraying one as trustworthy and experienced and the other as less so. For the second factor, three levels will be manipulated: plain text only, cartoon image of a male, middle-aged doctor, in doctor’s gown, wearing glasses and a stethoscope, and cartoon image of a young male in a T-shirt and jeans. The plain text condition induces minimum perception of a social actor for the web page. In this case, trust in the organization alone influences the judgment of web credibility. Cartoon image of a doctor induces the perception of a social actor that is well-educated, experienced, and in a trustworthy profession relevant to the information given. The cartoon image of a young male in casual clothing induces the perception of a social actor that is less educated and less experienced. Familiarity and topic relevance will be measured using a pretest instrument.

5. Expected Contributions

Our research differs from existing literature in three ways. First, we study subconsciously perceived social actors that users do not interact with directly. In the existing literature of virtual
agents, recommendation agents, or animation, users interact with these software artifacts directly. So it is not surprising that users form trust beliefs about these artifacts. In our scenario, users do not interact with the software artifacts. These artifacts are social cues that engender subconscious perception of a social actor. Whether users will form trust beliefs about a subconsciously perceived social actor is still a question the answer to which can further inform web design. Second, our context of study is web sites that mainly deliver information, such as health information sites and news sites. The existing literature is mostly about e-vendor sites. In these studies, concerns about expertise and trustworthiness center on the e-vendor. For informational sites, not only the expertise and trustworthiness of the e-information provider but also the credibility of each information piece is important. Third, existing research focuses on the trust beliefs about one party – the organization; we compare the trust beliefs about the organization and with those about the perceived social actors independent of the organization.

Our integration of “web as medium” and “web as social actor” perspectives offers a better understanding of web credibility judgment formation. If our hypotheses are supported in later experiments, our results will identify further areas where trust-building and credibility-building are important.

References

2 Full references are available through the author upon request.
Duopoly Quality Competition of Online Services with IT Advancement

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Abstract

This paper is intended to investigate the phenomenon of quality competition in online service provision market. With game-theoretic modeling, we find that even when the optimal profit for each individual online service provider (OSP) suggests a lower level of IT quality investment, OSPs still have the incentive to invest at a higher quality equilibrium level. This phenomenon in turn promotes the continued advancement of online information technology.

Keywords: Online service, electronic commerce, information technology, quality, competition

1. Introduction

In the last decade, we have witnessed an explosion in the number and types of services provided on the Internet, often free or very inexpensive to subscribers, by online service providers (OSPs). This expansion of OSP services has coincided with an advancement of information technology (IT) capabilities, both in increased functionality and lower costs. The quality/cost ratio of computing and networking hardware is constantly increasing, instantiating Moore’s Law that each new microchip contains about twice the capacity as its predecessor, with a new chip being released about every 18-24 months. These advances have enabled the realization of innovative business concepts, such as new e-business models, and also coincided with rapid user acceptance of services offered over the Internet. Still, the question remains why a profitable OSP already having a high number of subscribers, would continue to roll out new (often free) features requiring substantial investment on the part of the OSP, even without any charge of use.

The early research on market competition referring to the product quality was typically focused on the monopolistic competition with differentiated products. In a market with differentiated products, any of the rivals is not able to totally dominate the market with the price complying with certain quality level. Hall and Porteus (2000) develop a model of interfirm competition in the context of ISP, in which the service quality is the main factor causing customers’ switching to a better service. Gans (2002) studies the Nash equilibrium for quality competition under different scenarios: 1) competitors are symmetric, 2) costs are asymmetric, and, 3) multiple competitors. The market share is the key issue in the study. Dewan et al. (2000) investigate the competition in Internet-based product customization using the game theoretic method. In general Dewan et al.’s model follows the traditional approach in differentiated product price competition. We notice that these studies, although all provide some good insights in quality competition, do not take into account the effect from the rapidly advancing IT. Current research outcomes lack the capability to explain the quality competition when price is no long an input variable. We need to establish a new model in which the quality level, which has a constantly decreasing cost, is the choice for the competitors.

In this study, we revealed that as the cost of IT declines, competing OSP providers have the incentive to continue investing in quality, in order to keep their status in the market. The equilibrium profit is a moving target that must be continually chased. We find that these incentives driving OSPs to continually improve are in place, whether or not competitors collude, and whether or not competitors’ actions are symmetric or asymmetric. Given certain assumptions,
continual improvement through IT advancement is advantageous for both OSP providers and their subscribers.

2. Duopoly Quality Optimization

Assumptions:

1) All consumers in the online service market are homogeneous in quality evaluation.

2) All consumers in the online service market are heterogeneous in utility evaluation with regard to price and quality.

Based on the above assumptions, we define a consumer composite quality evaluation vector \( B = (b_1, \ldots, b_n) \) for the product with \( n \) attributes \( a = (a_1, \ldots, a_n) \). The composite quality with a given set of quality attributes for product \( g_k \) is \( x(a_k) = B a_k^T \). When there is more than one combination of \((a_1, a_2, \ldots, a_n)\), such that \( a_1^{(1)} \neq a_1^{(2)} \) and \( x(a_1^{(1)}) = x(a_1^{(2)}) \), two online services can still be referred to as differentiated even if the quality levels are the same. In addition, we assume there exist an optimum \( a^* \) that minimizes the cost of the online service with a given composite quality level \( x(a^*) = Q(a) \). In default, we will use \( x(a) \) to denote the \( x(a^*) \) without extra explanation.

Consider that two OSPs labeled 1 and 2 compete in an online information service market. They offer their services free of charge to Internet users but earn revenue indirectly from other sources that are positively related to the size of the user population. The OSPs choose a quality level \( x_1 \) and \( x_2 \) respectively to maximize its revenue, and \( x_1 \geq 0 \) and \( x_2 \geq 0 \). There is no direct effect of service quality on the price of other chargeable services that are underpinned by the free online services. Typically, the prices for those services are fixed. Two OSPs are competing in the service user population that is aware of and responsive to changes in the service quality level.

We assume that the revenue function for an OSP is linear with regard to quality and proportional to the demand. So we have the following revenue function:

\[
R_i(x_i, x_j) = d_{i1} + d_{i2}x_i - d_{i3}x_j, \quad i, j = 1, 2, \quad i \neq j
\]

where \( d_{i1} \) is the intrinsic demand potential for OSP \( i \), \( d_{i2} \) is the revenue responsiveness to the OSP’s own quality, and \( d_{i3} \) is the revenue responsiveness to the competitor’s quality. So, \( d_{i2} > d_{i3} \) must hold, meaning the benefit from increase of quality is higher than that by the OSP’s competitor. The cost function of OSP \( i \) is generally given by

\[
\Phi_i(x_i, x_j) = c_{i0} + c_{i1}x_i + c_{i2}x_i^2 + [c_{i3} + c_{i4}x_j] R_i(x_i, x_j), \quad \text{where} \quad c_{i3} < 1.
\]

Similar to the approach in Banker et al (1998), we allow the investment in quality to impact the total cost in two ways. However, in an IT advancement environment the impacts are exactly the opposite of those proposed by Banker et al (1998):

1) Total fixed cost \( c_{i0} \) may be subject to change with regard to the impact of IT advancement, but is not relevant to the upgrade of service quality.

2) The operational cost, \( c_{i1}x_i + c_{i2}x_i^2 \), is relevant to the service quality, as a higher level of service quality requires more input. In the context of this article we consider operational cost as the amount paid as rent to a third party for using its services.
Marginal cost related to an investment in a particular level of quality, \( c_{i3} + c_{i4}x_i \), also decreases over time. Specifically, \( c_{i3} \) represents the variable production cost per unit not including the quality related costs.

The profit function of the OSP \( i \) is given by
\[
\pi_i = R(x_i, x_j) - \Phi_i(x_i, x_j)
\]
\[
= [1 - c_{i1} - c_{i4}x_i] (d_{i1} + d_{i2}x_i - d_{i3}x_j) - c_{i0} - c_{i1}x_i - c_{i2}x_i^2
\]
\[
= [d_{i2} - c_{i1} - d_{i2} c_{i3} - d_{i3} c_{i4}] x_i - [c_{i2} + d_{i2} c_{i4}] x_i^2 + d_{i3} c_{i4} x_i x_j - [1 - c_{i3}] d_{i3} x_j + (d_{i1} - c_{i0}) \tag{3}
\]
Let \( A_i = d_{i2} - c_{i1} - d_{i2} c_{i3} - d_{i3} c_{i4}, B_i = c_{i2} + d_{i2} c_{i4}, C_i = d_{i3} c_{i4}, D_i = [1 - c_{i3}] d_{i3}, E_i = d_{i1} - c_{i0} \).

Profit function (3) can be expressed in a more general form:
\[
\pi_i(x_i, x_j) = A_i x_i - B_i x_i^2 + C_i x_i x_j - D_i x_j + E_i, \quad i, j = 1, 2, \quad i \neq j
\]
where, by intuition, \( A_i, B_i, C_i, D_i > 0 \), and \( E_i < 0 \). \tag{4}

The profit function contains a constant term, linear terms regarding \( x_i \) and \( x_j \), and all quadratic terms related to \( x_i \). Obviously, it is concave with regard to \( x_i \).

Case 1: The competition between two OSPs with differentiated attributes

If the number of users could be held constant over time, an OSP’s profit keeps on increasing because of the reduction in prices of third party services due to IT advancement. The OSP has an opportunity to further increase its profit by investing in better quality (which is available because of IT advancements). The first order condition that an OSP picks up an optimum level of quality without collusion is:
\[
\frac{\partial \pi_i}{\partial x_i} = A_i - 2B_i x_i + C_i x_j = 0, \quad i, j = 1, 2, \quad i \neq j
\]
So, \( x_i = \frac{A_i + C_i x_j}{2B_i} \) \tag{5}

We obtain the equilibrium quality for OSP \( i \) as: \( x_i^* = \frac{A_j [2B_j + C_j]}{4B_j B_j - C_j C_j} \), \( i, j = 1, 2, \quad i \neq j \) \tag{6}

Case 2: The competition between two identical OSPs with the differentiated services

We define two OSPs that are identical by assuming that the cost structures and the effects of quality change are the same. Base on this, we have: \( x_i = x_j = x, A_i = A_j = A, B_i = B_j = B, C_i = C_j = C, D_i = D_j = D, \) and \( E_i = E_j = E \). Then the profit function becomes:
\[
\pi_i = Ax_i - B x_i^2 + C x_i x_j - D x_j + E
\]
The optimum quality level is: \( x_i^* = x_j^* = x^* = \frac{A}{2B - C} \) \tag{7}

The profit is: \( \pi_i^* = \pi_j^* = \pi^* = \frac{A(AB - 2BD + CD)}{(2B - C)^2} + E \) \tag{8}

We call \( x^* \) as competitive quality level and \( \pi^* \) as competitive equilibrium profit.
Case 3: Two identical OSPs collude for the monopolist profit.

If the two identical OSPs coordinate to optimize their profit, they will choose a quality level that optimizes the total profit. This is the monopoly situation.

The first order condition of the profit function becomes:

$$\frac{\partial \pi}{\partial x} = A - 2Bx + 2Cx - D = 0$$

The monopoly quality level: $x^{**} = \frac{A - D}{2(B - C)}$ (9)

Note that, in general, if two OSPs are not identical, $x_{ij}^{**} = \frac{2B_j(A_i - D_i) + (C_i + C_j)(A_j - D_j)}{4B_iB_j - (C_i + C_j)^2}$, $i, j = 1, 2, i \neq j$. The form of the profit will be too complicated to be presented here.

The profit is: $\pi^{**} = \frac{(A - D)^2}{2(B - C)} + E \geq \pi^*$ (10)

We call $x^{**}$ collusive quality level and $\pi^{**}$ monopolist profit.

The second-order condition:

$$\frac{\partial^2 \pi}{\partial x^2} = -2B + 2C = 2(d_{i3}c_{i4} - d_{i2}c_{i4} - c_{i2}) \text{. Since } d_{i3} < d_{i2}, \frac{\partial^2 \pi}{\partial x^2} < 0.$$ 

So, $\pi$ is concave in $x$, provided both OSPs choose the same level of quality $x$.

The concavity of profit in $x$ implies that we must have $x^{**} < x^*$, i.e. $\frac{A - D}{2(B - C)} < \frac{A}{2B - C}$. The condition for $x^{**} = x^*$ is $(A + D) C = 2BD$. In a general situation, it will not hold.

3. Duopoly Quality Competition over Time with the Decreasing Quality Cost over Time

**Assumption:** The cost of maintaining a certain level of service quality is constantly decreasing because of IT advancement. Therefore, two OSPs can upgrade their service quality from time to time in order to keep up the size of their user populations.

This assumption results in the following time-variable cost function:

$$\Phi(x_i, x_j, t) = c_{i0} + c_{i1}(t)x_i + c_{i2}(t)x_i^2 + [c_{i3}(t) + c_{i4}(t)x_i]R_i(x_i, x_j)$$ (11)

The cost function (11) implies:

1) Even if an OSP does not invest in quality, the operational costs that it incurs decrease with time, hence reducing the total cost over time. For instance, the rent for a leased Internet connection, which is one of the most important third party services for the online information service, is getting lower. That is $\frac{\partial c_{i1}}{\partial t} < 0, \frac{\partial c_{i2}}{\partial t} < 0$

2) Marginal cost related to an investment in a particular level of quality, $c_{i3}(t) + c_{i4}(t)x_i$, also decreases over time. Specifically, $c_{i3}(t)$ represents the variable production cost per unit
not including the quality related costs. That is \( \frac{\partial c_{i3}}{\partial t} < 0, \frac{\partial c_{i4}}{\partial t} < 0 \). Although it is commonly assumed that the marginal cost of information provision is zero, it does incur when larger user population imposes more resource demands.

From the above points we can deduce that cost is decreasing over time, i.e.

\[
\frac{\partial \Phi_i(x_i, x_j, t)}{\partial t} < 0.
\]

The profit function becomes:

\[
\pi = A(t)x_i - B(t)x_i^2 + C(t)x_i x_j - D(t)x_j + E(t)
\] (12)

The coefficients in the expression (12) are time-variable following their definitions.

**Proposition 1:** Because of IT advancements the collusive quality level of online information services is increasing over time.

**Proposition 2:** There exists a pure strategy subgame perfect Nash equilibrium of the OSPs.

(The proof of the above two propositions are available up request.)

### 4. Conclusions

Price, quantity and quality are three main properties of a commodity. In studying competition, traditional models are basically classified into quantity competition (e.g. Cournot competition), price competition (e.g. Bertrand competition), and differentiated competition – vertical or horizontal. In previous research, quality is considered as a predetermined factor. That is, once the level of quality is decided it will be kept as a constant. Our model shows that quality can play the same role in market competition as quantity and price in the economic environment that is empowered by rapidly improved IT. In our model, the constantly decreased cost for quality makes it dynamic while the price remains stable and the competitor are competing to gain more market share. This situation, which is characteristic in the markets for OSP providers, sets the stage for a quality war in the market, which is refueled by the advancing IT. The spillover from the quality competition in online services markets also exerts positive externalities to IT innovators. Therefore, quality competition keeps stimulating the demand for the IT market, include the new technology, knowledgeable IT personnel, and innovative IT application ideas.

### References

The Adaptive Technology Innovation Mechanism: a Perspective of the Agent’s Cognition and Utility

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Abstract

The agent’s cognition is a reflection of different emphases about the different things’ different aspects. His different emphases depend on the factors of agent’s goals and the environment etc. For the same aspect of one thing, different agent’s utility puts different emphasis, which depends on the content degree of the agent’s demand purpose. This paper starts from the construct of the agent’s cognition about the object and the utility emphasis, using the relatively matured theory of the neural network to find out the inherent mechanism on technology innovation. This paper puts forward an idea that the agent should connect the technology development inherent law and the environment including the agent’s cognition and utility to take the adaptive technology innovation.

Keywords: Simulation, Cognition, Utility, Technology Innovation, Artificial Neural Network

1. The Agent Characteristic of Technology Innovation

Technology innovation has a strong agent characteristic (Navi Radjou, 2006). The mess of information generated by technological innovations conflicts with the bounded rationality of economic agents, who are forced to operate some simplification in order to make sense of it. The mastery of a technology depends on the agent’s cognition degree about the technology and the scope of his cognition. And a technology development relies on the agent’s cognition to meet his need about the technology. When the agent perceives that the technology could content his demands, he would input resource to achieve its development. The agent’s cognition about the technology itself reflects his different understanding degree of the technology’s different aspects. Finally the degree of the agent’s cognition depends on the reflection depths of the object’s different aspects and the agent’s cognition ability. The degree that the object’s every aspect contents the agent’s demand impacts on the agent’s utility. The different emphasis degrees of the object’s different aspects of the agent reflect the different agent’s utilities that depend on the object’s useful value itself and the important need of the agent (Satish Nambisan, 2005; Cynthia LeRouge, Harold W Webb, 2004; Don E Kash, Robert W Rycroft, 2003). Technology’s ultimate purpose is to be applied to achieve the goal of the agent. Although technology itself has an inherent development law, its development orientation and emphases mainly depend on the agent’s cognitive ability and utility emphases.

Human beings simplify the enormous amount of information that they receive by classifying it into a manageable number of mental categories. Mental categories are continuously constructed and modified according to the similarity of a just-received piece of information to the pieces of information that have already been stored in existing categories (Barsalou, 1987). Neural networks are able to reproduce this feature of human cognition. Thus, they are able to model bounded rationality in terms of information categorization (Sgroi, 2003).
2. The Inherent Mechanism of Agent’s Cognition

For the same agent, the emphases in the perceiving reflection process about the perceived things’ different aspects are different. The perceived thing $O$ includes different aspects $F = \{ f_1, f_2 \in O, i = 1, 2, 3 \}$. Because of the difference of experience, tendency and ability, the agent will pay different attentions on the perceived thing’s different aspects. So these will lead to the different cognition emphases about the object. The different emphases can be calculated by using the weight $w_i, i = 1, 2, 3 \ldots$. To determine the weight, we can use the relatively matured theory of the neural network——Self-Organizing Feature Maps (SOFM) model (George K. Knopf, Archana Sangole, 2004) to simulate the mechanism and the result.

The research of the brain neurology indicates that the people’s brain comprises a large number of nerve cells. The interaction of information between different nerve cells has a common characteristic: the nerve cells which are adjacent will motive each other and the far will restrain each other, but the further will motive faintly each other.

The SOFM network structure simulates the structure of the brain’s nerve cells that have a structure of two-dimensional special lattice. The SOFM network’s function simulates the function of the brain’s information process which has the functions of clustering, self-organizing and self-learning through the interaction and inter-competition of the network’s nerve cells each other. The SOFM neural network adjusts the weight as

$$W(k) = \alpha a^2[p(k) - W(k - 1)]$$

$$a^2(i, q) = \begin{cases} 
1, a^i(i, q) = 1 \\
0.5, a^i(i, q) = 1, D(i, j) \leq d \\
0, \text{else} 
\end{cases}$$

Where $a$ is the learning rate, $a^i$ is the network output vector, $a^2$ is middle variable, $D(i, j)$ is the distance of the $i$th nerve cell and $j$th nerve cell, $d$ is the contiguity distance. In this arithmetic process, we only adjust the weight of the winning nerve cells and the neighbor nerve cells.

The agent observes the object’s different aspects. With the number of the observed things increasing, the special characteristics in the model of the perceiving agent neural network can basically improve a relatively fixed construct. Supposed there are two aspects to be observed of 100 observed objects, we will compose a SOFM system, which includes 30 nerve cells to be trained and to be simulated.

Firstly, randomly create 100 input data to form the input vectors, which are shown in the figure 1. Then design a two-dimensional SOFM, which comprises 30 nerve cells deputing the categories of the input vectors. As shown in figure 2, the two-dimensional feature nerve cells array in the form of 5x6, and the untrained network nerve cells weights all locate in the center of the vector space. After having been trained, network weights decrease the neighbour ranges step by step through ranking. Finally through the regulation, the competing nerve cells all delegate an input area. The orientation of the adjacent nerve cells weight vectors shows the topological structure? Figure 3 shows the result after having been trained 10 steps. After 100 steps trained, the network weights are shown in the Figure 4. From the figures, after 10 steps trained, the nerve cells distribute through self-organizing, and every nerve cell begins to distinguish the different area of the input space. With the increasing of the trained steps, such as 100 steps, the weights will distribute more rational.
3. The Inherent Mechanism of the Agent’s Effect

Considering one aspect of the object, the degree that it meets the demand of the agent is different. The agent’s different utility demands \( U, U = \{ U_i, U_j \in S, i=1,2,3 \ldots \} \) reflect the object’s different aspects’ useful value to satisfy in different degree which depend on the value function of the object’s this aspect and the special characteristics of the utility purpose of the agent’s this aspect. These different emphases can be reflected by the weight \( W_{i,j} \). To determine the weight, we can use the knowledge of neural network——Learning Vector Quantization (LVQ) model (Michael Biehl, Anarta Ghosh, et al, 2006) to simulate the mechanism and the result.

In the process of measuring the utility, we should consider the agent’s value and the goal’s relative certainty. So when measuring the object’s some aspect’s utility, nerve cells network is a utility appraisal model under the condition of thinking the value aim of agent.

In the network model of learning vector quantization (LVQ), the agent appoints the goal’s category results. So the network can gain the input vector mode’s accurate category through supervising learning.

LVQ neural network adjust the input weight vector \( W^1 \)’s \( i \) th row according to the goal vector. When the input vector \( p \) is classed accurately, so as
\[
d_k^2 = t_k = 1 \quad (3)
\]
$\textbf{w}^1$'s $i$th row can modify as

$$iW^1(q) = iW^1(q-1) + a[p(q) - iW^1(q-1)]$$  \hspace{1cm} (4)

to make this row's data to close the vector $p$.

When the input vector $p$ is not classed accurately, so as

$$d_k^2 = 1, t_k = 0, a_k^2 \neq t_k$$  \hspace{1cm} (5)

$\textbf{w}^1$'s $i$th row can modify as

$$iW^1(q) = iW^1(q-1) - a[p(q) - iW^1(q-1)]$$  \hspace{1cm} (6)

To make this row's data away from the vector $p$, the practice agent measures the object's utility value from every aspect. With the increasing of the number of observes, the practice agent nerve cells network mode forms a relatively stable construct in the object’s different aspect’s characteristic. Supposed to observe two aspects of 10 observed objects, we build a LVQ network to train and simulate which contains 10 competing nerve cells. Figure 5 shows the distribution of the two-dimension input vectors. After having been trained, the weight vectors of the competing nerve cells have the function of mode category, seen in figure 6.

**Fig. 5.** The distribution of input vectors

**Fig. 6.** The weight distribution of input vectors and trained vectors

### 4. The Adaptive Technology Innovation System

We can connect the agent’s cognition about the object’s different aspects and the content of the agent’s different demand from the object’s different aspects to research the technology innovation system’s inherent mechanism using a system perspective. The emphasis is the mechanism of agent about the technology cognition and technology mastery and use. So in the process of technology innovation, based on the technology development law, we should pay more attention to the environment including the agent and the agent’s cognition and the emphases of utility demand and to take the adaptive technology innovation.

### References


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Abstract
In this paper, we analyze market dynamics and online price dispersion in a heterogeneous market structure. According to our model, if the market structure remains heterogeneous, price dispersion will exist. The magnitude of the price dispersion depends on the portion of security-conscious consumers and the perceived security level. We then empirically test the theoretical model through examining online book market. The empirical results show support for our theoretical predictions.

Keywords: Market dynamics, Price dispersion, Trust assurance seals

1. Introduction
The advent of a ubiquitous information infrastructure has made significant impacts on the market. As a result of this, electronic markets are expected to become more efficient than conventional markets (Malone et al. 1987; Benjamin and Wigand 1995). It was expected that lower search costs and the absence of spatial product differentiation would promote competitive pricing, causing all online retailers to charge the same price for a mass produced physical good. However, numerous empirical studies led to a different conclusion. Brynjolfsson and Smith (2000), for example, analyze two categories of homogeneous products, books and CDs, and find considerable price dispersion across Internet retailers. Clay et al. (2001) find that prices are significantly differentiated at online bookstores.

Many factors have been identified as potential causes of price dispersion across Internet stores through an empirical approach (Smith and Brynjolfsson 2001; Clay et al. 2001), but there has been little theoretical attempt to explain market dynamics, price, and their interactions on the Internet, where search cost is so small. This paper theoretically investigates market dynamics and pricing strategies in B2C electronic markets. With the help of two year data in 2001 and 2006, we then empirically test the model by studying online book industry. By examining the impacts of seals on price premium, this paper also contributes to the literature on trust assurance seals.

2. Theoretical Model
We assume that there exists a heterogeneous market structure, where there are store $A$ of stronger security and store $B$ of less security that compete in equilibrium. Both stores’ unit holding costs of the good are $c$. Consider a Hotelling (1929) spatial linear city with consumers indexed with $x$ and uniformly distributed on the interval $[0, 1]$ according to increasing preference of store $B$. Let $t > 0$ be the store differentiation parameter. Each consumer consumes one or zero units of the good. The maximum value of the good is $V$. Consumers are divided into two portions (Miyazaki and Fernandez 2001). A portion of consumers, $m$, value the security and privacy protection provided by the store $A$ and therefore will bear a loss of $f(s)$ if they buy the product at store $B$, where $s$ represents the relatively stronger security of store $A$. It is reasonable to assume that $f(s)$ is positive and $f'(s)$ is non-negative: consumers value stronger online security and privacy protection. A fixed cost, $g(s)$, is incurred by store $A$ for its security efforts. Another portion of consumers, $1-m$, have a natural propensity to trust retailers, and care less about online security. For ease of exposition, we label the first segment of consumers “type I” and the second segment “type II”. Assume that $f(s) \in (0, 1)$, so that at least some type I consumers’ preferences for the lower price charged by store $B$ will outweigh the loss associated with less security. The delivery times for stores $A$ and $B$ are
denoted as $t_A$ and $t_B$. Both types of consumers value shorter delivery time. Let $p_A$ and $p_B$ denote the prices of the stores $A$ and $B$. The utilities of type I and type II consumers from purchasing the product are

\[
\begin{align*}
&\begin{cases}
V - \tau x - p_A - t_A & \text{buying from store A} \\
V - \tau (1 - x) - p_B - f(s) - t_B & \text{buying from store B}
\end{cases} \\
(1)
\end{align*}
\]

\[
\begin{align*}
&\begin{cases}
V - \tau x - p_A - t_A & \text{buying from store A} \\
V - \tau (1 - x) - p_B - t_B & \text{buying from store B}
\end{cases} \\
(2)
\end{align*}
\]

Define $\tilde{x}_1$ and $\tilde{x}_2$ the type I and II marginal consumers. Then the utility functions (1) and (2) imply that $\tilde{x}_1 = (p_B + f(s) - p_A + t + \tau)/2\tau$ and $\tilde{x}_2 = (p_B - p_A + t + \tau)/2\tau$, where $t = t_B - t_A$ and is denoted as the delivery advantage of store $A$. The distribution of the two types of consumers is illustrated in Figure 1, with stores $A$ and $B$ at 0 and 1 respectively. It is quite intuitive that $\tilde{x}_1 > \tilde{x}_2$, i.e., type I consumers are more likely to purchase the good from store $A$.

![Figure 1. The distribution of consumers between the two online stores](image)

The firms' profit functions are

\[
\begin{align*}
&\begin{cases}
\frac{sgtp - mfpc}{A} - p_A - t_A & \text{buying from store A} \\
\frac{sgtp - mfpc}{B} - p_B - t_B & \text{buying from store B}
\end{cases} \\
&\begin{cases}
\frac{sgtp - mfpc}{B} - p_B & \text{buying from store B}
\end{cases}
\end{align*}
\]

Maximizing $p^*$ yields that $3/\tau(\frac{2mf}{3}) = 2mf(s)/3 > 0$. The following proposition is immediate.

**Proposition:**

(i) $\frac{dp^*_A}{ds} > 0$ and $\frac{dp^*_B}{ds} < 0$

(ii) $p^*_A - p^*_B = 2mf(s)/3 > 0$

(iii) $\frac{dp^*_A}{ds} = mf'(s) \geq 0$ if $f'(s) \geq 0$

(iv) $\frac{dp^*_B}{dm} = \frac{f(s)}{3} > 0$

The first part of the proposition states that in equilibrium stores can charge a higher price for shorter delivery time. The second and third parts of the proposition reveal that as long as the market structure remains heterogeneous, price dispersion will exist. The magnitude of price dispersion, in this setting, depends on the portion of type I consumers and the perceived security strength. Stores with stronger security can charge a higher price and still attract a profitable number of consumers, especially type I consumers; and stores with less security will have to lower their price in order to allure type I consumers to buy from their shops. The last part depicts the dynamics of price dispersion over time. The price dispersion gets larger as the portion of type I consumers becomes larger. The above four parts of the proposition form hypotheses (1), (2), (3), and (4) for the empirical work in the following sections.

**3. Data**

Two-period data was collected. We first randomly selected 10 books from Yahoo!Shopping and searched 20 different online book stores that were available at that time for prices and shipping and handling fees in November 2001. Later in May 2006, we randomly selected 106 books and searched 22
different stores for the same information. Stores selling only second-hand books were dropped. Unit price is the list price of each book displayed on the webpage, and total price is measured as the list price plus handling fee and charge of standard shipping.

A striking feature of book prices across online book retailers is the large variation of prices found through examining the price range of each book: the highest price can be more than three times higher than the lowest price. The price dispersion in 2006, measured as the difference between the maximum and minimum price of each book, seems to have grown larger than it was in 2001. Table 1 provides some descriptive statistics for the price dispersion. Dispersions of the unit price in both 2001 and 2006 are significantly different from zero. Moreover, the price dispersion in 2006 is statistically larger than that in 2001 at the 5% significant level. Total price exhibits the same pattern. We normalize maximal and minimal price by list price and calculate the percentage difference. There results, shown in Column 3 of Table 1, are consistent with those of nominal value.

Table 1. Price difference of online book retailers

<table>
<thead>
<tr>
<th>Price dispersions</th>
<th>Mean of Nominal Value (SD)</th>
<th>Mean of Normalized Value (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Price</td>
<td>11.06*** (2.03)</td>
<td>0.61*** (0.04)</td>
</tr>
<tr>
<td>Total Price</td>
<td>11.55*** (1.84)</td>
<td>0.49*** (0.03)</td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Price</td>
<td>17.55*** (2.16)</td>
<td>0.76*** (0.03)</td>
</tr>
<tr>
<td>Total Price</td>
<td>19.29*** (2.17)</td>
<td>0.68*** (0.02)</td>
</tr>
</tbody>
</table>

We use trust assurance seals as a proxy for online security. We browsed each bookstore’s website and recorded the seals displayed on their site. In total there were 4 distinct seals in 2001 and 9 distinct seals in 2006. In our 2001 sample, about 25% of online retailers had seals, of which about 15% had more than one seal. These numbers increased to 59% and 37% in 2006, respectively. A dummy named “Seal” was constructed, which equals 1 for the store with any seal and 0 otherwise. We also included the number of seals, “NSeal”, to study the impact on price of having more than one seal.

For each book we collected data on “Acquisition time”, “Shipping time”, and “In stock”. “Acquisition time” is the time from placing an order until shipping, while “Shipping time” is the time from shipping to delivery. “In stock” notifies consumers of the availability of the book. We calculated the percentage of books that are in stock and named the new variable “Product variety”. A number of control variables were included to control for store-specific factors. We added a dummy variable “Channel” with 0 denoting “pure e-commerce” stores and 1 for “brick-and-click” stores and a dummy variable of “Public” with 1 for websites owned by public companies, and 0 otherwise. For the 2001 sample we constructed a dummy variable “BName” with 1 equal to brand-name stores and 0 otherwise. For the 2006 sample, firm characteristics, such as “Web traffic”, “Online age”, “Web presence”, and “Web loading speed” were gathered from Alexa.com. In particular, web traffic is measured as the three-month average of “Reach per million,” which measures how many unique Web users had visited the retailer’s website daily on average in the previous three months. We used the date when the store first opened its website to calculate the “online age”. Web presence is measured by the number of other sites that link to the site. The web speed statistic is a measurement of the time it takes for the pages on a site to load.

4. Empirical Results

A one-way fixed effects model with robust standard errors cluster by the books was estimated. Models I and II report the results of the 2006 sample, while Model III provides the results of the 2001 sample. The results show support for hypotheses (1), (2), (3), and (4). As shown in model I of Table 2, after controlling for other factors, online bookstores with seals can charge an approximately 12% higher price than other stores. Evaluated at the mean of $24.46, consumers are willing to pay a price premium of about $3 per book for the presence of seals. The significant result on the variable NSeal provides support of hypothesis (3), i.e., websites displaying more seals charge a higher price. Interestingly, the existence of seals did not seem to have significant effects on pricing in 2001 but has significantly positive impact on pricing in 2006 (Models III and I). In 2001 online retailers with seals generally did not charge a
premium for having seals, even though the purchasing of these seals costs additional money or efforts. It may well be that most consumers didn’t recognize the value of these online seals, which makes it difficult to charge a premium. With the proliferation of viruses, phishing attacks and other maliciousness online, more consumers have become security conscious. According to an IBM survey (January 25, 2006), more Americans anticipate falling victim to a cyber attack than a physical crime. The increased anxiety about the possibility of a cyber attack leads to this change in consumer behavior. For example, 70 percent of Americans only use Internet shopping sites that display a security protection seal. The impact of displaying trust assurance seals materialized in 2006 as more consumers have become security conscious. These results show strong support for hypothesis (4).

Table 2. Estimation Results

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Specifications I</th>
<th>Specifications II</th>
<th>Specifications III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal</td>
<td>0.12***</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSeal</td>
<td>-</td>
<td>0.03***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>Acquisition Time</td>
<td>-0.0002</td>
<td>0.000</td>
<td>0.01**</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Shipping Time</td>
<td>-0.04***</td>
<td>-0.18***</td>
<td>0.05*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.005)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Shipping Charge</td>
<td>-0.02*</td>
<td>0.001</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.008)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>In stock</td>
<td>-0.05*</td>
<td>-0.04*</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Product Variety</td>
<td>0.001*</td>
<td>0.004***</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.0007)</td>
<td>(0.0004)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Public</td>
<td>-0.09***</td>
<td>-0.05***</td>
<td>0.11***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Channel</td>
<td>0.06***</td>
<td>0.03***</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Web Traffic</td>
<td>0.004</td>
<td>0.02**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>Web Links</td>
<td>-0.06***</td>
<td>-0.13***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
<td></td>
</tr>
<tr>
<td>Web Speed</td>
<td>-0.004***</td>
<td>-0.006***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.0005)</td>
<td></td>
</tr>
<tr>
<td>Online Age</td>
<td>-0.05***</td>
<td>-0.03***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>Online Age Square</td>
<td>0.006***</td>
<td>0.006***</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.0006)</td>
<td></td>
</tr>
<tr>
<td>BName</td>
<td>-</td>
<td>-</td>
<td>-0.09**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
</tr>
<tr>
<td>No. of observations</td>
<td>1254</td>
<td>1254</td>
<td>139</td>
</tr>
<tr>
<td>R-square (within)</td>
<td>0.31</td>
<td>0.31</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Note: *, **, *** = significant at 10%, 5% and 1% level. Standard errors are reported in parentheses.

To our surprise, model III shows that acquisition time has a positive and significant effect on price for the 2001 sample. In particular, an additional day of acquisition time increases the price by about 1.2%. Shipping time is also significantly positive at 10% level, with the coefficient being 0.05. It seems that online book retailers generally passed the additional costs of the faster acquisition times to the price of the book. From the consumer’s point of view, additional waiting time to get the book should be offset by a discounted price. Such a pricing strategy as suggested by the empirical results does not seem to favor the consumer. It is reasonable to question whether the online book markets had reached equilibrium at that
time. The Internet is now attracting more and more people to shop online, and as a result the demographics of online shoppers have begun to more closely mirror those of America in general. Compared with the Web-shopping pioneers of the late 1990s — typically young, well-off and male — the newcomers to the market are less affluent and less tech-savvy. According to one article in the Wall Street Journal, these new comers care more about low prices and are likely to recognize and trust the names of stores they know well, such as Gap or Wal-Mart, over online merchants like Amazon or eBay. It is to be expected that the e-commerce industry has become more competitive and more mainstream. Indeed, the list price no longer responds to an additional day of acquisition; however, the shipping time has a negative effect on price as expected. Online retailers are competing to ship items more quickly than rivals, yet they pass fewer or no costs onto consumers, suggesting a more competitive online book market.

The results regarding most of the control variables are generally consistent with expectation, although some may not always be statistically significant. For example, e-commerce sites with personalization options will generally take longer to load the images and other non-text content, according to Alex.com. Therefore, a negative coefficient of the Web speed indicates that stores with more personalization options and rich contents are able to charge higher price.

5. Conclusion
In this paper, we analyze online price dispersion on the Internet where search costs are much smaller than in a physical setting. According to our model, if the market structure remains heterogeneous, price dispersion will exist. The magnitude of the price dispersion depends on the portion of security-conscious consumers as well as the perceived security level. As the portion of security-conscious consumers becomes larger, the price dispersion will also become larger. Our model predicts that the effect of seals will strengthen over the years as consumers become more security conscious. In fact, the empirical results show support for our theoretical predictions. Price dispersion has increased over the period of 2001-2006, partly because more consumers have become security conscious and partly because the effect of seals on the product price has materialized. The e-commerce industry has become more competitive and mainstream. Currently, online retailers are competing to ship items quicker than rivals and are passing fewer or no costs onto consumers, while in 2001 online book retailers generally passed the additional costs of acquiring and shipping the book onto the price.

Reference:
Abstract

Interactive Digital Entertainment (IDE) includes Internet-based gaming, wireless gaming and any other forms of consumer-oriented entertainment via data networks. Inducing repeated plays from users is crucial to IDE providers as more plays lead to improved profitability. To date, however, little research exists on how an IDE provider can induce repeated plays among gamers. Our work fills in this gap by studying when gamers will (not) stop playing using detailed game log from the mobile gaming industry. This study reveals how players’ experiences with IDE, especially in terms of the sequence of performance feedbacks they receive, affect their decisions of whether to stay in the game. Our findings have a number of implications on game designs. First, helping players to achieve their initial success with a game is very important in inducing repeated plays. Second, providing players with increasing challenge is a good way to keep them going. Third, the motivating effect of prizes may be limited to high-skilled players. Our results strongly suggest that IDE design should customize players’ experiences based on their past achievement instead of following a one-size-fits-all approach.

Keywords: Interactive Digital Entertainment, Wireless, Empirical study

1. Introduction

Interactive Digital Entertainment (IDE) includes Internet-based gaming, wireless gaming, online discussion forums for sports or music fans, and any other forms of consumer-oriented entertainment that involves human-computer or human-human interactions via the Internet or wireless networks. In a time when corporate IT spending stagnates (Foremski et al. 2003), IDE, which targets consumers instead of corporations, enjoys strong growth (AGC 2006). For instance, merely two years into its launch, Blizzard Entertainment’s popular online game, World of Warcraft, has already amassed 6 million subscribers and is reaping hundreds of millions of dollars in revenue annually.

Inducing repeated plays from users is crucial to IDE providers as their business model is built around users’ repeated interactions via network. Repeated plays benefit the IDE providers in two ways: first, the more repetitions, the more usage a user generates, thus more usage fees; second, the longer a user stays, the more subscription fees she pays. To date, however, little research exists on how an IDE provider can induce repeated play.

Our work fills in this gap by studying when gamers will (not) stop playing using detailed game log from the mobile gaming industry. Our dataset contains rich information about a player’s game performance throughout time, which enables us to assess various mechanisms that cause a player to stop or to continue playing a game. Past research in economics and psychology has identified three interrelated driving forces in gaming-like activities. First is intrinsic motivation, i.e., what makes an activity fun or intrinsically motivating (Csikszentmihalyi 1975, 1990).
This literature suggests the balance between skill and challenge is crucial for players to have fun. Second is performance feedback, which provides an information value for players who seek to identify their own abilities (Trope 1975). Third is extrinsic motivation, such as prizes or status (Veblen 1899, Frank 1985, Loch et al. 2003, Liu et al. 2007). Economics literature on contests has made various predictions on how players behave when they compete for relative performance. These three drive forces provide theoretical foundations for understanding the patterns we observe in our datasets.

2. Data from the Mobile Millionaire Game
We collected data from a cell-phone-based trivia game called Mobile Millionaire, which resembles the TV hit “Who Wants To Be a Millionaire?” except played via SMS (short-message service) or WAP (wireless application protocol) or Java, depending on which carrier offers it and what cell phones consumers have. Data used in this paper is from a European carrier that uses SMS where each message costs players a constant fee. The dataset contains detailed logs of 50,050 games from February 2003 to August 2003. Similar to the TV hit, in this cell-phone game a player is presented sequentially with 15 trivia questions with increasing difficulty, and failure in answering any of them will immediately end the game. Players who obtain the highest scores using the shortest time during a time period (e.g., a month) are declared winners and, in most cases, awarded with monetary prizes. All trivia questions are communicated via SMS messages.

Players play Mobile Millionaire in an intermittent fashion, that is, they locate this game on their cell phones, play one or more repetitions of this game within a short period of time (usually minutes), then shelve the game for a longer while (usually hours or days) until next sequence of plays. We call the consecutive plays with short intervals a sequence. The question of when a player stops playing can have two variations: in the short-term, the question is when a player ends a sequence (but may come back again later); in the long-term, the question is when a player stops playing the game forever.

Both short- and long-term stopping decisions are of crucial business importance to the mobile game providers whose revenue depends on the total number of SMS message generated – ideally, the provider would hope a player to play many sequences and many repetitions within any sequence. This distinction between short- and long-term stopping decisions is important as we will show later that the motivations for playing another game in a row can be significantly different than the motivations for playing another sequence of games some time later.

3. Model and Results
Our first model, the short-term model, focuses on the impact of performance feedbacks on a player’s decision to continue (or end) the current sequence. One major measure of a player’s performance is his score in the last game, which takes value (0, 1, 2, 3, 4) if he has answered (0, 1-4, 5-9, 10-14, 15) questions correctly. Another major measure is the trend, which takes value (1, -1, 0) if a player gets a (higher, lower, even) score in this game than in the last one. The probit model is as follows.

\[
\text{Continue} = \Phi(\alpha_0 + \sum_{i=1}^{4} \alpha_i \text{Score}_i + \alpha_5 \text{Trend} + \alpha_6 \text{GameNumber} + \alpha_7 \text{SequenceNumber} + \alpha_8 \text{Sophisticated} + \epsilon) \]

continue indicates whether a player continues playing within the current sequence. GameNumber is the (time-order) index of the game within the sequence, and SequenceNumber is the index of the current sequence among the player’s history of all sequences. One dummy, Sophisticated,
indicates whether a player has taken any sophisticated moves, such as using lifelines or strategically walking away (same as the ones in the TV hit), in a game. The value of this dummy will become clear when we compare short- and long-term models.

Our second model, the long-term model, focuses on the impact of performance feedbacks on a player’s decision to (not) play a new sequence at some later time.

\[ \text{Continue}_L = \Phi(\beta_0 + \sum_{i=0}^4 \beta_i \text{Score}_L + \beta_5 \text{Trend}_L + \beta_6 \text{GameCount} + \beta_7 \text{SequenceNumber} + \beta_8 \text{Sophisticated} + \epsilon) \]

suffix “L” stands for long-term measures. ScoreL is defined as the highest score within a sequence. Regression results for both models are shown in Tables 1 and 2, respectively, followed by a summary of our findings and analysis.

### Table 1. Results for the Short-Term Model (* P<0.1, ** P<0.05, *** P< 0.01)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Lower bound</th>
<th>Upper bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.987***</td>
<td>0.0117</td>
<td>0.9641</td>
<td>1.0099</td>
</tr>
<tr>
<td>Dummy for score=0</td>
<td>-0.4982****</td>
<td>0.0241</td>
<td>-0.5453</td>
<td>-0.451</td>
</tr>
<tr>
<td>Dummy for score=2</td>
<td>0.1253****</td>
<td>0.015</td>
<td>0.0958</td>
<td>0.1548</td>
</tr>
<tr>
<td>Dummy for score=3</td>
<td>0.0489*</td>
<td>0.0272</td>
<td>-0.0044</td>
<td>0.1023</td>
</tr>
<tr>
<td>Dummy for score=4</td>
<td>0.0005</td>
<td>0.0687</td>
<td>-0.1342</td>
<td>0.1351</td>
</tr>
<tr>
<td>Trend within a sequence</td>
<td>0.1441****</td>
<td>0.0104</td>
<td>0.1238</td>
<td>0.1644</td>
</tr>
<tr>
<td>Game number within a sequence</td>
<td>-0.1967****</td>
<td>0.0045</td>
<td>-0.2055</td>
<td>-0.1878</td>
</tr>
<tr>
<td>Sequence number</td>
<td>-0.0126***</td>
<td>0.0006</td>
<td>-0.0138</td>
<td>-0.0114</td>
</tr>
<tr>
<td>Sophisticated player</td>
<td>0.1515***</td>
<td>0.0152</td>
<td>0.1217</td>
<td>0.1813</td>
</tr>
</tbody>
</table>

### Table 2. Results for the Long-Term Model (* P<0.1, ** P<0.05, *** P< 0.01)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Lower bound</th>
<th>Upper bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.0034***</td>
<td>0.0174</td>
<td>0.9692</td>
<td>1.0376</td>
</tr>
<tr>
<td>Dummy for scoreL=0</td>
<td>-0.0774**</td>
<td>0.0349</td>
<td>-0.1458</td>
<td>-0.0089</td>
</tr>
<tr>
<td>Dummy for scoreL=2</td>
<td>-0.0398**</td>
<td>0.017</td>
<td>-0.0732</td>
<td>-0.0064</td>
</tr>
<tr>
<td>Dummy for scoreL=3</td>
<td>-0.0988***</td>
<td>0.0307</td>
<td>-0.159</td>
<td>-0.0387</td>
</tr>
<tr>
<td>Dummy for scoreL=4</td>
<td>0.1756*</td>
<td>0.1</td>
<td>-0.0205</td>
<td>0.3716</td>
</tr>
<tr>
<td>Trend among sequences</td>
<td>0.0348**</td>
<td>0.0149</td>
<td>0.0056</td>
<td>0.064</td>
</tr>
<tr>
<td>Game counts within a sequence</td>
<td>-0.2495****</td>
<td>0.0098</td>
<td>-0.2688</td>
<td>-0.2302</td>
</tr>
<tr>
<td>Sequence number</td>
<td>-0.1444****</td>
<td>0.0031</td>
<td>-0.1505</td>
<td>-0.1383</td>
</tr>
<tr>
<td>Sophisticated player</td>
<td>-0.0784***</td>
<td>0.0171</td>
<td>-0.1118</td>
<td>-0.045</td>
</tr>
</tbody>
</table>

**A Tough Beginning Is a Bad Beginning**

Table 1 shows that a player who fails at the very first trivia question (i.e. score=0) is less likely to continue a sequence than if he succeeds initially. Moreover, Table 2 shows that if a player indeed stops a sequence after failing to answer the first question, he is also more likely to stop playing permanently (except for the case of scoreL=3 where the likelihood is uncertain). Therefore, helping players to achieve their initial success with the game (by, for instance, making the first trivia question easy) is very important in inducing further plays. This can be
explained with the argument in the intrinsic motivation literature that individuals have the most fun when tasks suit their skill levels (Csikszentmihalyi’s 1975). When challenge is too high, one experiences anxiety (Csikzentmihalyi and LeFevre 1989).

**Improvement Is Motivating**
Both short- and long-term results suggest that, even after controlling for the performance effect (i.e. score), a player is more likely to continue playing if his score improves. In other words, being able to answer some questions is exciting, but being able to answer *more* questions than previously is even more motivating.

**Extrinsic Incentives are More Sound among the Skilled**
One surprising result is that, in the long-term, players who get the high score of 4 are more likely to start new sequences than ones getting lower scores. One possible explanation is that these players are more motivated by extrinsic incentives as top performers in a month are awarded with monetary prizes and/or fame. This is also consistent with work by Liu et al. (2006), where the incentive effect of monetary prizes is much larger for high-level performers.

Note that monetary prizes come at a price for game providers. Further research is needed in order to understand whether investments in prizes can generate enough additional game plays that cover cost of prizes. Another intriguing finding is that Table 1 does not provide a definitive answer on the short-term impact of high scores – whether a player who just obtains a high score will play more or less within a sequence remains an open question.

**More Game Plays, Less Likely to Continue**
Tables 1 and 2 show that, the more sequences a player already played, or the more games he already played within the current sequence, the less likely he will continue the current sequence or to start a new sequence thereafter. This result is also surprising since it is widely believed in the gaming industry that an excessive play history often signals addiction, which in turn implies a higher likelihood to continue playing. One possible reason of the lack of evidence of addiction is the simplicity of mobile games: addiction requires a game environment that provides endless new challenges, yet mobile games have very limited variety or levels of challenges.

This finding may also be explained by the theory of information feedback. Some players play Mobile Millionaire just to find out how knowledgeable they are. After playing a while, they find out this information and thus lose motivations to continue (Trope 1975).

**Sophisticated Players Are Hard to Satisfy in the Long-Term**
One interesting finding is that sophisticated players – ones who do not simply punching answers to questions but also utilize lifelines or strategically walk away – are more likely to continue in a sequence, yet less likely to start a new sequence. One plausible explanation is that, out of curiosity, they try to quickly figure out everything about a game. Once they figure things out, they quickly get bored.

**4. Concluding Remarks**
This study reveals how players’ experiences with IDE, especially in terms of the sequence of performance feedbacks they receive, affect their decisions of whether to stay in the game. Our findings have a number of implications on game designs. First, helping players to achieve their initial success with a game is very important: our result shows those who fail in the first question
has significantly lower probability of playing another game. Second, providing players with increasing challenge is a good way to keep them going. Our regression shows that even after controlling for the performance effect, simply playing better than the last game can motivate a player to play another game. Third, the motivating effect of prizes may be limited to those high-skilled players. All of the above strongly suggest that IDE designers should customize players’ experiences based on their past achievement instead of following a one-size-fits-all approach to game design.

References
1. AGC (Austin Game Conference) 2006. “Austin Game Conference Reports Online Game Market To Grow To $4.4 Billion,” http://www.vfxworld.com/?sa=adv&code=3631a5a1&atype=news&id=17875
Why Blogging? An Emerging Social interaction Approach in Virtual World

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Abstract

Today more and more people are writing blog online. They keep personal diaries in public places. Why would they like disclosing traditional privacy to other people, even to strangers? Few prior studies have been addressed such motivation of blogging behavior empirically. This study will try to incorporate social interactionism in analyzing online blog usage from a new perspective, by exploring how social interaction process affects blogger’s perceived rewards. Empirical research is under way to confirm our hypotheses. Based on prospect conclusion, we hope to find out some new change in mind and behavior that reshape the process of social interaction, the shared value among online users, and even the social structure.

Keywords: Blogging, Social Interaction, Esteem, Social risk, Network Effects

1. Introduction

Blog, short for “Web Log”, is not only a personal journal maintained on the web, but also a form of personal communication and expression (Nardi et al. 2004, Kim et al. 2006). Thanks to web 2.0 technology, blog becomes an emerging online social fashion that occurs between many and many, different from former ones that most occur between one and one or one and many (iResearch 2005).

In recent years, a lot of people are engaged in keeping blogs. As of July 2006, the number of bloggers in the world reached about 50 million which was over 100 times bigger than it was just 3 years ago. About 175,000 new blogs were created each day, which means that on average, there are more than 2 blogs created each second (Xinhuanet 2006). From 2003 to 2006, the number of bloggers who use Chinese rose from 200,000 (iResearch 2005) to 19.87 million (iResearch 2006). Tremendous diversity in blog content has also been found (Nardi et al. 2004, CNNIC 2006).

Traditionally, diary is regarded as privacy. People usually keep diaries to document their personal lives and private emotions. Most of them tend to protect personal diaries from being exposed publicly. Now, however, with the emergence of blog, a lot of people change their mind, like keeping diaries online, and disclose privacy voluntarily. CNNIC showed that in China, only 17.8% of bloggers did not care about having many readers; however, 30% cared about readers very much (CNNIC 2006). Here come the most interesting questions: What motivations drive individuals to maintain their blogs and disclose private things to a wider range? Does this new change in mind and behavior reshape the process of social interaction, the shared value among online users, and even the social structure? If does, how?

Researchers have conducted some ethnographic investigation on explaining blogging motivation (e.g. life documentation, commentary, catharsis, and community form, see Nardi et al. 2004), descriptive case study on blog’s effect on online community (Blood 2004), and empirical studies on the factors affecting satisfaction of blogs (e.g. blog quality and presentation, see Kim et al. 2006). However, few prior studies have been addressed the motivation of blogging
behavior empirically. The purpose of this paper is to incorporate social interactionism in analyzing online blog usage from a new perspective.

2. Theoretical Background
In this section, we present the theoretical foundations for this study. We incorporate social interaction theory in exploring blog motivation because several blog studies have indicated that blog is a social communication tool among bloggers rather than merely a personal media (Nardi et al. 2004). Self-identify and self-verification may play important roles in keeping blogs.

According to social interaction theory, interaction between human is “symbolic” that actors respond to others’ behaviours for the significance imputed to them by the actors (Singelmann 1972, Turner 1998). Individual sets his role and looks after role-support from others (McCall and Simmons 1978). In this sense, keeping blogs is a particular kind of role-setting and role-support conduct, and can be accounted for by social interaction theory, e.g., writing blogs can be seen as setting roles, and others’ comments can be seen as role-support. Therefore, this study uses social interaction theory as its theoretical base.

Furthermore, social interaction theory also takes reward-cost paradigm (McCall and Simmons 1978), and finds out vital invisible rewards for human’s “unrewarding” behavior (Turner 1998). In all interaction process, people are always seeking for rewards. If the rewards are less than the costs they pay out, they would be driven to adjust their future behavior to get more rewards or pay fewer costs (McCall and Simmons 1978). In this study, we follow this reward-cost framework to explain why people keep blogs.

During social interaction, people are motivated by three distinctive rewards: external reward, internal reward, and role-support reward (McCall and Simmons 1978, Turner 1998). External reward, which refers to money or other visible stimuli, is not seen markedly in blog behavior and thus ignored in this study. Internal reward, which refers to inside invisible stimuli such as satisfaction or enjoyment, can be represented in the form of perceived enjoyment in keeping blogs. Role-support reward, which refers to outside invisible stimuli, is even considered more important than the other two rewards. Positive role-support will reinforce individual’s conduct (Cast and Burke 2002, Gecas 1982).

During social interaction, costs can be incurred in the form of role-setting efforts (Turner 1998). Individual usually makes efforts to set himself a role by signalling self-meanings to others and verifying the role via others’ feedback. In keeping blogs, people set roles mostly through editing their web pages, such as writing diaries or presenting pictures. Such maintenance efforts will be investigated in this study as main cost. Besides actual efforts, social risk should be taken into account according to some studies in IT adoption (Featherman and Pavlou 2003) because some potential risk would impede people interacting via online blogs. Social risk is defined as the embarrassment, loss of face, and revelation of incompetence (Xu 2006) associated with uncomfortable feedbacks on blogs and potential loss of control over personal information (Featherman and Pavlou 2003). These two cost factors will be investigated in this study.

3. Research Model
Based on the theoretical review in the previous section, we developed a research model, as Figure 1 shows. Most independent variables come from social interaction theory, while dependent variable comes from technology acceptance literature.
3.1 Role support reward
In social interaction, people identify their roles and seek feedback from the environment to help them verify their roles. This process is called self-verification (Burke 1997, Cast and Burke 2002), the degree of which is regarded as the role-support reward. It has been suggested that greater self-verification produces feelings of efficacy and worth, increasing self-esteem (Cast and Burke 2002). Particularly, Cast and Burke stated that the self-esteem consists of efficacy-based esteem and worth-based esteem. The former refers to the degree to which people see themselves as capable and efficacious, and the latter refers to the degree to which people feel they are persons of value (Cast and Burke 2002). Therefore we propose Hypotheses 1(a,b):

\[ H1a: \text{Self-verification is positively related to efficacy-based esteem.} \]

\[ H1b: \text{Self-verification is positively related to worth-based esteem.} \]

Furthermore, as many prior studies stated, self-esteem is a major source of motivation of human conduct (Cast and Burke 2002, Gecas 1982). A person with high self-esteem is more likely to express and communicate. Both kinds of self-esteem are positively related to online blog usage. Since usage dimensions can be defined in terms of frequency of usage, daily usage and diversity of usage (Teo et al. 1999), Hypotheses 2(a,b,c) and 3(a,b,c) are stated as follows:

\[ H2a, b, c: \text{Efficacy-based esteem is positively related to frequency of blog usage, daily blog usage, and diversity of blog usage.} \]

\[ H3a, b, c: \text{Worth-based esteem is positively related to frequency of blog usage, daily blog usage, and diversity of blog usage.} \]

3.2 Internal reward
People will also be driven by internal reward, the perceived enjoyment, to adopt technology. The effect of perceived enjoyment on technology usage has been tested a lot in an individual’s adoption of information technology (Davis et al. 1992, Teo et al. 1999, Venkatesh and Brown 2001, Hong and Tam 2006). Therefore, we propose Hypotheses 4(a,b,c):

\[ H4a, b, c: \text{Perceived enjoyment is positively related to frequency of blog usage, daily blog usage, and diversity of blog usage.} \]

3.3 Maintenance effort
Keeping blogs involves codifying words, editing pictures, updating news, and other maintaining acts. Previous researches suggested that maintenance acts can entail costs to individuals as an expense of time and effort, and the maintenance efforts can impede technology adoption (Kankanhalli et al. 2005). Therefore, we propose Hypotheses 5(a,b,c):

\[ H5a, b, c: \text{Maintenance effort is negatively related to frequency of blog usage, daily blog usage, and diversity of blog usage.} \]
3.4 Social risk
For personal blogs, an important factor that might affect blogging behavior is the social risk the bloggers might take (Featherman and Pavlou 2003). For example, visitors might diffuse your articles or pictures via the internet, and you would take the risk of disclosing personal information. When you write something not so good, others may think you incompetent. If you present some ideas that would irritate others, unexpected conflict may occur. Thus, aware of others’ presence, people can perceive some potential social risk that would reduce their motivation to write blogs. Therefore, we propose Hypotheses 6(a,b,c):

H6a, b, c: Social risk is negatively related to frequency of blog usage, daily blog usage, and diversity of blog usage.

3.5 Network effect
Many previous studies showed that network effect is an exogenous factor that indicates people’s subjective perception of the number of current users with some particular communications service and affects people’s adoption behavior (Li et al. 2005, ). A network with more users would bring every user more rewards (Karz and Shapiro 1985). This rule also works in blog usage. Particularly, when individual perceives a large network with a lot bloggers or readers, he will be more willing to be motivated by rewards and less willing to incur social risk. For example, he must be aware that what he presents would be read by more people and may think that he is able to do things as well as most other people, thus enhancing the effect of his esteem on keeping blogs. The influence of perceived enjoyment on blog usage also would be intensified (Li et al. 2005). With the presence of more people, the negative impact of social risk on blog behavior can be highlighted. Therefore, Hypotheses 7(a,b,c)-10(a,b,c) are stated as follows:

H7a,b,c: When bloggers perceive stronger network effects, the positive impacts of efficacy-based esteem on (a) frequency of blog usage, (b) daily blog usage, and (c) diversity of blog usage are more significant than when they perceive weaker network effects.

H8a,b,c: When bloggers perceive stronger network effects, the positive impacts of worth-based esteem on (a) frequency of blog usage, (b) daily blog usage, and (c) diversity of blog usage are more significant than when they perceive weaker network effects.

H9a,b,c: When bloggers perceive stronger network effects, the positive impacts of perceived enjoyment on (a) frequency of blog usage, (b) daily blog usage, and (c) diversity of blog usage are more significant than when they perceive weaker network effects.

H10a,b,c: When bloggers perceive stronger network effects, the negative impacts of social risk on (a) frequency of blog usage, (b) daily blog usage, and (c) diversity of blog usage are more significant than when they perceive weaker network effects.

4. Future Works
This study tries to address why people keep blogs online. We explore the motivations from social interaction perspective. We will further conduct empirical study to draw results. The questionnaire has been sent out and preliminary findings will be available in one month. We anticipate positive evidence for supporting the ten hypotheses.

5. References


Interactions in E-Learning: Impacts of Social Presence

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Abstract
This research in progress paper investigates the impacts of social presence on interactions in e-learning systems, specifically addressing how social presence affects user satisfaction with the interaction and the learning outcomes. It is hypothesized that interaction methods with higher social presence will be associated with higher user satisfaction and better learning outcomes. Two types of interaction: “virtual interaction” and email-based interaction are compared from the perspective of social presence. Related research about interactions in e-learning and social presence concepts are reviewed and a proposed field experiment is described.

Keywords: e-learning, social presence, virtual interaction, email, interaction

1. Introduction
Interaction has been identified to be the key to effective learning by many recent studies (Bernard et al. 2004). Researchers have found that interaction with instructors and other students, either face-to-face or through mediation, is a consistent and reliable predictor of positive learning outcomes (both achievement and satisfaction) in distance education programs (Bernard et al. 2004). In e-learning systems, interaction with instructors can be implemented synchronously through telephone, videoconferencing, and online chats, or asynchronously through email or discussion forums. However, all these interaction methods rely on the availability of human instructors. A recent research study proposed a new concept, “virtual interaction”, to address this problem (Cao et al. 2005). By pre-recording an instructor’s instructions (e.g. lectures) in digital video format and using automated question answering (QA) technologies, the human questioning and answering process can be simulated by a process of finding the specific video segment(s) that are most relevant to a learner’s question. This process is called virtual interaction, and it can provide learners immediate feedback without relying on human instructors. It was found that virtual interactions positively impacted learner behaviors by encouraging learners to interact more and increasing learner satisfaction with the learning process. However, even though it was believed that the use of video in virtual interactions would provide a higher degree of media richness that facilitates communication and understanding (Daft et al. 1984), both quantitative and qualitative results showed that learner satisfaction with the interaction and learning process is limited due to the possible lack of social presence in virtual interaction (Cao 2005). Particularly, many learners still regarded virtual interaction as one way communication between them and a computer, which was less social and personal than the dynamic dialogues among live people (e.g. via email or online discussion).

Consequently, the objective of this paper is to investigate how social presence affects the interactions in e-learning. In particular, how do different interaction methods in e-learning differ in their level of social presence, and how do different levels of social presence affect the learning satisfaction and effectiveness? To study these research questions, we compare virtual interaction to email-based interaction in a multimedia-based e-learning system. A field experiment is proposed and described later in this paper.
2. Research Hypotheses

In this section, we first illustrate the concept of virtual interaction in more detail, and then review the theories about social presence in order to present the research hypotheses.

2.1 Virtual Interaction

Virtual interaction is a special type of interaction between a learner and a rich media representation of an instructor. A Web-based prototype named Learning with Virtual Instructor (LVI) has been developed to illustrate the idea of virtual interaction (Cao et al. 2005). In the LVI prototype, learners may initiate interaction with the LVI system (the “virtual instructor”) by typing in questions in a textbox on the user interface. Once a question is submitted, a video segment determined to be the “best answer” will be automatically played with its associated slide and text notes. Therefore, learners may feel that an instructor immediately responds to their question in a video. Other “close fit” video segments are also listed as alternative answers. So if learners are not satisfied with the first answer, they can click on the links in the alternative answer list to view the other video answers. Besides the interactions initiated by learners, the virtual instructor (the system) uses pop-up quizzes to initiate interaction with learners. The use of multiple media makes the virtual interaction a rich medium of communication that can carry multiple verbal and nonverbal cues (Daft et al. 1984). However, previous research found that virtual interaction could not provide personalized messages from the virtual instructor (the video is pre-recorded and pre-segmented) and the multiple cues carried in the video were not adaptive to individual learners. This drawback of virtual interaction significantly affected the learners’ satisfaction with the interaction and the entire learning process (Cao 2005). We think this phenomenon can be explained by the social presence theory.

2.2 Social Presence

Social presence was introduced by Short, Williams, and Christie (Short et al. 1976) as “the salience of the other in a mediated communication and the consequent salience of their interpersonal interactions” (p. 65). It is not a clearly defined concept but generally implies the degree to which individuals perceive a sense of each other within the context of their mediated interactions/communications. Social presence is closely related to two social psychology factors: intimacy, such as physical distance, eye contact, smiling, and personal topics of conversation (Argyle et al. 1965) and immediacy, referring to the psychological distance a speaker puts between himself and the listener (Wiener et al. 1968). Short et al. (1976) determined that social presence was a subjective quality of the communication medium. That is, the fewer communication channels or cues available within a medium, the less the intimacy and immediacy behaviors can be supported, and thus the lower the social presence (the less the user will feel the presence of other communication participants). Face-to-face meetings, for example, are capable of passing on nonverbal cues (e.g. facial expression, direction of gaze, posture, dress) and social context cues (e.g. spatial features, artifacts, and actors’ dynamic nonverbal behaviors that defines their relative social status), and therefore are considered to have higher social presence than computer-mediated communication media and written documents because they lack nonverbal feedback cues (King et al. 1999). From this point of view, one would expect that virtual interaction may provide high social presence because it is able to carry nonverbal cues in video. Similarly, text-based computer-mediated communication (CMC) such as emails may have low social presence because it filters out the communication cues found in face-to-face interaction.
However, Walther (1994) challenges this “cues-filtered-out” perspective by pointing out unexplainable research findings that indicate that experienced CMC users rated email or computer conferencing “as rich” or “richer” than telephone conversations and face-to-face conversations. He argues that social presence is not an inherent, constant, context-invariant feature of a medium. Instead, social presence should be considered with the appropriate social processes, settings, and purposes within CMC use (Walther et al. 1992). This point of view is also supported by studies in educational settings. That is, courses conducted through text-based CMC had a comparable amount of socio-emotional content to traditional face-to-face courses (Gunawardena et al. 1997; McDonald 1998).

We agree with Walther’s view that social context is very important in determining a communication medium’s level of social presence. Therefore, although the video in virtual interaction can carry nonverbal cues, it cannot improve social presence because these cues are not specific to the current communication context since the video is pre-recorded (e.g. the instructor may be smiling in the answer video, but the student does not feel that the instructor is smiling at him or her). In other words, the nonverbal cues in virtual interaction are not customized to each individual learner and therefore do not reflect the real social status between the specific learner and the virtual instructor. Since there is no dynamic message exchange and dynamic nonverbal behaviors associated with virtual interaction, virtual interaction should actually have low social presence.

On the other hand, text-based CMC such as email, is able to support rapid and dynamic message exchange with social context cues, and can successfully develop social relationships over time (Walther et al. 1992). Therefore although it lacks nonverbal cues, it would have higher social presence than virtual interaction. This is summarized in hypothesis 1.

**Hypothesis 1:** Email-based interaction has higher social presence than virtual interaction.

In addition, similar to the findings about how social presence affects users’ satisfaction with interaction in general settings (Walther et al. 1992), Gunawardena (1997) suggested that in online teaching and learning, learners consider the social presence of the communication media an important predictor of satisfaction. Previous research also found that when social presence is lack in online learning, there will be a high level of frustration, a critical attitude toward the instructor’s effectiveness, and a lower level of affective learning (Hample et al. 1995). This leads to hypotheses 2 and 3.

**Hypothesis 2:** Learners who use email-based interaction will be more satisfied with (a) the interaction and (b) the learning process than those who use virtual interaction.

**Hypothesis 3:** Learners who use email-based interaction will have better (a) perceived learning effectiveness and (b) actual learning performance than those who use virtual interaction.

### 3. Research Methodology

A field experiment is proposed to be conducted in a real educational setting to test the three hypotheses. Undergraduate college students will be recruited as participants. They will take this study as an alternative of an assignment in an Information Systems course. Participants will be randomly assigned to two treatment groups, the LVI group and the Email group. In both groups, participants will first be asked to complete a pre-test with 10 multiple-choice questions about
computer security concepts. Participants will then be asked to watch an online video lecture on “Essentials of Computer Security” and complete an assignment with eight open-ended questions on the information in the lecture. All participants will be given a two-day period for this learning task and they will be encouraged to ask questions of the (virtual) instructor to help them complete the assignment. In the LVI group, the video lecture is part of the LVI system and participants will be able to interact with the “virtual instructor” through virtual interactions. In the Email group, the video lecture will be provided in a separate link and participants will be encouraged to ask the instructor questions directly through email. Finally, participants will be asked to complete a posttest that has similar questions to those in the pretest, and a post-lecture questionnaire including measurements about social presence, perceived learning effectiveness and other factors. Repeated measures analysis using SPSS will be conducted for data analysis.

In this study, social presence will be measured by three scales consisting of a total sixteen items adapted from (Tu 2004). Satisfaction with interaction is measured by four self-developed items. Satisfaction with the learning process will be measured by five items adapted from (Alavi 1994). Perceived learning effectiveness will be measured by three items adapted from (Alavi 1994). All the above mentioned items are ranked on a five-point Likert type scale ranging from strongly disagree (1) through neutral (3) to strongly agree (5). Finally learning performance will be measured by the participant’s percentage accuracy score on the post-tests, as compared to the score on the pre-tests.

4. Conclusion and Implications
This research is important for understanding the role of social presence in interactions in e-learning, especially in a new type of interaction: virtual interaction. We expect to find that although nonverbal cues can be provided through video, virtual interaction still has lower social presence than the email-based interaction, because the latter can provide more social context cues through dynamic two-way message exchange, and therefore virtual interaction may be associated with lower user satisfaction and learning effectiveness than email-based interaction.

If these expectations are supported by our study results, e-learning practitioners should be advised that social presence is a critical factor for improving interactions in e-learning. Therefore, although virtual interaction may resolve in long term savings by reducing the need for human instructors in e-learning, it should be added with caution and careful consideration of students’ different requirements for social presence. For example, an ideal solution of adding interactions in e-learning may be providing the following three levels of interactions. On the first level are task-oriented situations in which social feelings are not the most important issue (e.g. reviewing for an exam of a concept-based course), and virtual interaction may be used to save cost and reduce response time. On the second level when some clarification and discussion are needed, but not critical (e.g. an advanced, hands-on class), computer-mediated communication as simple as text-based email may be used to provide moderate social presence. On the third level where social context exchange is the most important thing (e.g. a debate session or a case discussion), face-to-face interaction should be used to provide the highest social presence and the most effective interaction. Integrating the three levels in the design and implementation of e-learning systems should provide the most cost-efficient and satisfying interactions in a variety of circumstances.

References


Instruction for Interactions in OSS Projects: An Exploratory Multiple-Case Study

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Abstract

Open source software (OSS) has gained great popularity in recent years. While the extant literature provides insights into drivers for OSS project success, in-depth investigation on how participants interact to transform individuals’ effort and inputs into collective outputs helps us understand how inner dynamics of OSS project teams lead to OSS success and therefore complements our current understanding of OSS phenomenon. Drawing upon theories in team process and software development, we derive our research model. In particular, we submit that task and team attributes affect team processes in OSS software development, which in turn affect task outcomes in terms of task performance and team satisfaction. The research model will be tested with data collected with multiple OSS projects.

Keywords: open source software, interaction, team process model, task performance, team satisfaction

1. Introduction

Open source software (OSS) projects, such as Linux and Apache, have achieved remarkable success and thus have interested researchers and practitioners (von Krogh and von Hippel, 2003; von Krogh and von Hippel, 2006). These projects are often initiated by an individual or a group that wants to develop a software product to meet their own needs (Lakhani and von Hippel, 2003; von Krogh and von Hippel, 2006). The OSS participants write, test, commend, enhance and/or distribute the communities’ software by communicating through discussion forums and mailing lists via the Internet (Lee and Cole, 2003). This constant improvement of software allows an OSS project to provide value for its stakeholders (Chesbrough 2003) and such improvement relies on the interactions among the project’s participants. Therefore, it is imperative to investigate what factors and how these salient factors affect these interactions, and how interactions affect the collaboration outcomes (Kuk, 2006).

However, there is a dearth of research on the detailed, inner-workings of OSS projects in general and participants’ interactions in particular. The extant OSS literature has largely focused on three areas, namely participants’ motivations for contributions to open source software projects (Franke and von Hippel, 2003; Hars and Ou, 2002; Hertel, et al., 2003; Kuk, 2006; Lakhani, et al., 2002; Lerner and Tirole, 2002); the governance, organization, and innovation process in OSS projects (Kuk, 2006; Lee and Cole, 2003; MacCormack, et al., 2006; Mockus, et al., 2002; O'Mahony, 2003); and the competitive dynamics of OSS (Bonaccorsi, et al., 2006; Bonaccorsi and Rossi, 2003; Economides and Katsamakas, 2006; West, 2003). These many studies have provided great insights into OSS phenomenon. In particular, they have contributed to our understanding of the difference between OSS and proprietary software development, and
what leads to OSS projects’ success. Yet, these studies are mainly based on projects or communities (e.g., Koch and Schneider 2002; Lee and Cole 2003). A closer, in-depth examination of interactions among OSS participants at a more micro-level will complement our current understanding of the drivers of OSS innovation success (Kuk 2006). Towards this end, we conduct the research reported in this paper.

In this research, we intend to examine how salient factors affect interactions and investigate how interactions among different types of participants (i.e., users, developers and core team members) affect collaboration outcomes (i.e., task performance and group satisfaction). Drawing on theories in team process and software development, we derive our research model. This model will be tested with data embedded in discussion threads of OSS projects and data collected with relevant OSS participants through both survey and interviews.

2. Theoretical Background

2.1 Participants, Development Process and Architecture of OSS

In OSS communities, there are three types of participants, i.e., users, co-developers and core team members (AlMarzouq, et al., 2005). Core team members are responsible for the majority of code development and effort contribution (Crowston and Howison 2005), maintaining the control on what features should be in the product and how it should be designed (Lee and Cole 2003); co-developers contribute occasionally by modifying or reviewing code and submitting bug fixes; and users download the software without cost, use the software, report and document bugs, and contribute ideas about new features. Participants of OSS projects are geographically dispersed and they communicate, coordinate and collaborate by using mailing lists and discussion forums via the Internet. Given the nature of low proximity among and different backgrounds of members, how participants work as a team is critical for the success of an OSS project.

While there is no globally accepted framework that defines OSS development (Scacchi 2002), many OSS projects display a high degree of similarity (AlMarzouq et al. 2005). Projects begin with a prototype that meets the requirements developed by the core team or embedded in an existing old product (Scacchi 2002). This prototype, as the early version of an OSS, constantly evolves through the collaboration among project participants. In this process, there are two major categories of development tasks namely the core and periphery (Lee and Cole 2003). The core includes the tasks of selecting and retaining code for the official product release, while the periphery tasks include reporting bugs, fixing bugs and submitting code. The newly distributed code and fixed bugs are tested and reviewed by users and developers, who also provide suggestions for further improvement based on their evaluation of the source code. To sum, the periphery brings new requirements and the core gathers and prioritizes these requirements. At the same time, the periphery provides inputs and applies pressure on the core to shape its decisions (AlMarzouq et al. 2005). Hence, the continuous redesign of OSS is the process of transforming a vast number of individual inputs into collective outputs and thus, whether participant interact with each other constructively determines whether the project will be a success or simply die out.

In addition, OSS’ concurrent, independent development and testing is feasible due to their modular architecture (MacCormack et al. 2006). A product’s architecture is defined as the arrangement of functional requirements, the allocation of functional requirements to specific modules, and the design of interfaces between these modules (Ulrich 1995). It is theoretically argued and empirically found that greater architecture helps alleviate the effect of volatility and
Modularity refers to the manner in which a design is decomposed into different modules. In essence, modularity is about the notion of interdependence within modules and independence between modules (Baldwin and Clark 2000). The modularity of OSS allows work on a module to be carried out without affecting other modules (i.e., “loose coupling”) and requires well-designed interfaces between various modules. Therefore, OSS’ modular design provides the foundation for the parallel development process and creates challenges for the OSS final product, an integration of constantly changed modules (MacCormack et al. 2006).

2.2 Team Process Theory
While the diverse composition of an OSS community, the flexible development process and modular architecture enable OSS developments, transforming individuals’ independent efforts and inputs into collective outputs is the key to OSS project success and whether this transformation can succeed greatly relies on the team’s interactions and endeavor. Therefore, to best understand the underlying process of such team success, we apply Marks and colleagues’ episodic team process theory (Marks, et al., 2001). Marks et al. (2001) posit that team work is best viewed with I-P-O (Input-Process-Output) models and these I-P-O models are attached to episodes and sub-episodes, rather than the entire life cycle of the team. In addition, outcomes from a previous episode often are inputs for a next cycle and the importance of processes vary across episodes and sub-episodes.

In episodic team process theory, teams are regarded as being actively engaged in different types of task work at different phases of task accomplishment. Based on their different emphases, team process theory categorizes team processes into three types: (1) transition processes, which are focused on interpreting feedback and environmental information, setting goals, and planning future actions; (2) action processes, which are those involved in the execution of task work; and (3) interpersonal processes, which concern the social-psychological aspects of teamwork (Mathieu and Schulze, 2006). In addition, these processes are of multi-facet. In particular, transition process consists of mission analysis, formulation and planning; goal specification and strategy formulation. Action process includes monitoring progress toward goals, systems monitoring, team monitoring and backup behavior, and coordination. Interpersonal process consists of conflict management, motivation and confidence building, and affect management.

Furthermore, Marks and colleagues (2001) also suggest that team compositional variables and contextual factors affect team processes, which in turn affect team performance. Indeed, it is well established theoretically and empirically that team processes are affected by attributes of environment, team and technology (e.g., Polzer et al. 2002; Saavedra et al. 1995; Mathieu and Schulze 2006; Hoegl and Proserpio 2004). Similarly, the effect of team process on performance is well supported by the extant literature (e.g., Balkundi and Harrison 2006; Mathieu and Schulze 2006; Hoegl and Gemuenden 2001).

3. Research Model
Drawing upon episodic team process and software development theories, we derive our research model. Given that OSS development is divided into multiple tasks due to its modular architecture design, we examine how task attributes (i.e., locus of requirements), together with team characteristics (i.e., team competence and team tenure), affect the team’s interactions in different team processes. In addition, we investigate how interactions influence task outcomes, namely task performance and team’s satisfaction. Figure 1 depicts our research model.
4. **Research Plan**

We intend to finalize our research model by interviewing OSS participants and test our hypothesis by collecting data with multiple OSS projects. By the time of CSWIM'07, we should have finished our data collection and therefore we will present at least part of our research findings at the workshop.

**References**


Volunteer’s Involvement in Online Community Based Software Development

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Abstract

Open source software is developed by voluntary participants in online communities. The participants’ involvement in software development is critical to the success of an open source software project. In this paper, we investigate the effects of involvement on volunteers’ performance in open source software development, and study the antecedents to the generation of involvement, including individual motivations and characteristics of online project community.

Keywords: online community, open source software, involvement.

1. Introduction

Open source software comprises a revolutionary new model of software development and distribution. Open source software contrasts with the traditional software distribution model, in which computer software is sold only with a license to use precompiled binary code without giving users access to the developer’s source code. Open source software, on the other hand, is licensed to guarantee free access to the source code, so users who are technically inclined can fix bugs or make modifications by themselves (Bretthauer 2002). Open source software is usually developed by a community of voluntary participants that are geographically dispersed and communicate through the Internet (Lee and Cole 2003, Ljungberg 2000). The widespread diffusion of Internet access in the early 1990s led to a dramatic acceleration of open source activity, and today, open source software is significantly influencing the software industry and society (Ljungberg 2000).

The developers’ knowledge contribution is critical to the success of open source software development (von Hippel and von Krogh 2003). Involvement, which is “a subjective psychological state, reflecting the importance and personal relevance of an object or event” (Barki and Hartwick 1989), plays a very important role in promoting an individual to participate in a certain activity, especially if the participation is voluntary instead of mandatory. In the context of open source software development, developer’s involvement is expected to be very important since the participation is voluntary.

The purpose of this study is to understand the role of involvement in promoting open source software developer’s performance. This paper, for the first time, introduces the concept of involvement into the open source software research, and investigates the factors that affect the generation of involvement in open source projects by voluntary developers.

2. Theory and Research Model
Open source software development is significantly different from traditional software development in both organization and process (Ljungberg 2000). Members in an open source software project community play different roles: the project leaders, the core developers, the peripheral developers, and the passive end users (Crowston and Howison 2005). The core developers offer most of the contribution and perform most of the development work (O’Reilly 1999), so their activities are critical to the final outcome of the software development. This study chooses core developers as the target for study, and focuses on their involvement. The research model is shown in Figure 1.

Involvement
In this study, developer’s involvement is defined as the degree to which the person is engaged with a certain open source project. Increased involvement can lead to greater effort, particularly when the effort is voluntary rather than mandatory. In the context of open source software projects, the voluntary developer’s involvement in a certain project is very important to his performance in the project, which is defined as his level of knowledge contribution in the project.

Hypothesis 1: A voluntary developer’s involvement in an open source project is positively related to his performance.

Figure 1 Research Model

Involvement is believed to come from two broad sources: (1) intrinsic or stable sources due to individual differences and (2) situational sources, those that may be manipulated within the environment (Celsi and Olson 1988). To examine the antecedents of developer’s involvement, both intrinsic and situational factors are studied. The individual motivational factors, including software needs, skill learning, reputation and enjoyment, are expected to affect the intrinsic form of involvement. Open source software development takes online community as its organizational
form. The factors related to open source project community, including leadership, interpersonal relationship, and community ideology, are expected to affect the situational form of involvement.

**Individual Motivations**

**Software Needs**
Many volunteers participate in an open source project because they personally need the software being developed (Hars and Ou 2002, Roberts et al. 2006). This personal software need becomes the motivation for a volunteer to become a member of an open source project. It is expected to influence the generation of involvement into the project because a developer who personally needs the software will consider the project as more important to himself.

Hypothesis 2: A voluntary developer’s personal software needs is positively related to his involvement in the open source software project. The more the developer needs the software, the more he is involved.

**Skill Learning**
Many volunteers participate in open source projects because they want to learn software development skills (Hars and Ou 2002, Roberts et al. 2006). As a member of an open source project, the volunteers can work together with others who are more experienced in software development, and obtain help from others to improve their programming skills (Lee and Cole 2003). These skills would be helpful for their jobs as IT professionals. In addition, a developer who is more motivated by skill learning will take more activities in the project, which is important to the generation of involvement (Hartwark and Barki 1994).

Hypothesis 3: A voluntary developer’s skill learning is positively related to his involvement in the open source software project. The more the developer wants to learn software skills, the more he is involved.

**Reputation**
Reputation is an important motivation for voluntary knowledge contribution (Bock et al. 2005). In communities, reputation is a major incentive for contribution. Reputation gaining is an important factor that motivates individuals to participate in community activities (Wasko and Faraj 2005). In the context of open source, the reputation gained from project participation may help the developers’ future job opportunities, and such expectation is influential for an individual to take part in open source software development (Hars and Ou 2002). The developer who wants to build reputation from open source participation is more likely to be involved in the project.

Hypothesis 4: A voluntary developer’s reputation building is positively related to his involvement in the open source software project. The more the developer wants to gain reputation, the more he is involved.

**2.2.4 Enjoyment**
While reputation gaining is related to the rational calculation of benefits from community participation, intrinsic psychological rewards, such as joy or enjoyment also greatly affect human behavior. Individuals who experience immediate pleasure or joy from an activity and perceive the activity as inherently enjoyable, are likely to involve themselves more extensively in the activity (Davis 1992). Thus, a developer who perceive open source participation is enjoyable is more likely to be involved in the project.
Hypothesis 5: A voluntary developer’s enjoyment is positively related to his involvement in the open source software project. The more enjoyable the developer perceives open source participation is, the more he is involved.

Community Factors
As a special form of social community, an open source project community is an online social environment in which the community characteristics can influence the participants’ behaviors. Three types of community factors are chosen for study as antecedents to participant’s involvement.

Leadership Effectiveness
Thompson (2005) suggests that success of a virtual community may be obtained through “interference” or support from organizational managers. In an online community environment, leader’s enthusiasm towards the members is necessary for the members’ positive attitudes, and consequently their involvement in the community activities (Koh and Kim 2003). It has been confirmed by many prior studies that effective leadership behaviors can significantly influence employees attitudes to the organization and their contribution (Podsakoff et al. 1996; MacKenzie et al. 2001). So, in the context of open source projects, effective leadership also affects the participants attitudes to and engagement in the project.

Hypothesis 6: Leadership effectiveness in the open source project is positively related to a voluntary developer’s involvement in the project. The higher the leadership effectiveness, the more he is involved.

2.3.2 Interpersonal Relationship
Interpersonal relationship plays a key role as a foundation for effective collaboration (Kramer 1999, Rousseau et al. 1998) and is the salient factor in determining the effectiveness of many relationships. The most important aspect of interpersonal relationship, trust is particularly important in newer organizational forms such as virtual collaborative relationships (Paul and McDaniel 2004, Jarvenpaa and Leidner 1999). In the open source context, the members are globally dispersed and there is probably never a chance for face-to-face meetings, and the members do not know the background of others in the same project community. Trust is critical to hold them together for a common goal. Trust or the belief in others’ ability, competence and integrity is necessary for a member to input his effort in the project and attach his own hope and interests to the fulfillment of the project goals.

Hypothesis 7: Interpersonal relationship in the open source project community is positively related to a voluntary developer’s involvement in the project. The more trust the developer has towards others in the same project, the more he is involved.

Ideology
The similarity-attraction paradigm indicates that people with similar attitudes, beliefs and values are more likely to become attached to one another (Van der Vegt 2002). People are attracted to organizations whose general core or dominant values they share. In the open source context, the ideology of the project community is very important to the behaviors of participants, and consequently to the outcome of project. Stewart and Gosain (2006) defined the ideology of open source project community as composed of a set of norms, beliefs and values. So, the ideology of
project community can influence participant's sense of belonging, and consequently his involvement in the project.

Hypothesis 8: Ideology of the open source project community is related to a voluntary developer’s involvement in the project. The more the developer shares the ideology, the more he is involved.

**Research Method**

All constructs in the model are measured based on well-established scales from information systems, social psychology and organizational behavior. To test the hypotheses, data will be collected from developers on Sourceforge.net, which provides free hosting to tens of thousands of open source projects, and is a centralized place for open source developers to meet online for open source software development.

As a research in progress, the findings from this study are expected to contribute to the theory of open source software development, and also provide practical implications for open source project leaders on how to promote the involvement of voluntary participants.

**References**

(Full references list is available at request to the authors)
Study on Feedback System Combined with Escrow Service in C2C E-Market

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Abstract

Online business has become complementary to the traditional “brick and mortar” shopping. However, due to low transaction cost and asynchronous occurrence of purchase and delivery in online transaction, great risks exist when shopping online. It’s demonstrated that trust especially institutional-based trust is an effective method to prevent online fraudulence. This paper studies how two institutional-based mechanisms promote trust in C2C e-marketplace.

Keywords: reputation feedback system, escrow service, institutional-based trust, e-market

1. Introduction

The wide and deep application of internet has promoted prosperous online business. The online retailing is expected to hit US $ 211.4 billion by 2006 (ClickZStats, 2006). Among all the online transaction, customer to customer (C2C) market has shown good potential. For example, China’s online C2C transaction volume reached RMB13.71 billion in 2005 (iResearch, 2006).

However, great risks are also embedded in online business. It is reported that in 2005 the total loss of online transaction was more than US$13 million. (Internet fraud watch, 2005). The high risk is brought up by mainly two characteristics of online business, i.e., low transaction cost and asynchrony of payment and delivery. On one hand, by low transaction cost buyers can easily compare prices, qualities of products without going to “brick and mortar” shops. It is also inexpensive for sellers to sell products online, e.g., easier to open an online shop without owning a physical places, low cost to make advertisement, etc.. On the other hand, this characteristic is also easier for a seller to change his/her identity after deceiving. Secondly, buyers and sellers may not see each other during the whole transaction. Although it facilitates transaction across space and time, it also results in that buyers can not review the product when paying for it. These characteristics will expand the information asymmetry between buyers and sellers, giving rise to the so called “Lemon Market” (Akerlof 1970). Under this situation, sellers will take opportunistic behaviors, such as misrepresentation of the true product or service, unjustifiable delay in product delivery, receiving payment without delivering products, etc., which damage customers’ interests a lot. Therefore, many researchers and practitioners have begun to study how to build a well-functioning online market by focusing on trust, since it is the most efficient mechanism for governing transactions (Zucker 1986). It is generally agreed that trust has three main production mechanisms, i.e., characteristic-based, process-based, and institutional-based (Zucker 1986). Characteristic-based and process-based trust requires the previous interaction between trustor and trustee; however, sellers and buyers usually never have prior contact with each other when conducting a transaction in C2C market, thus institutional-based trust will be more effective than the other two antecedents in building trust in C2C online market. Therefore, this paper attempts to study trust building mechanisms from the institutional perspective.

The rest of the paper is organized as follows: section 2 makes a review on the current research related to institutional-based trust. Section 3 introduces the model. The results are presented in section 4, and this paper is concluded in section 5.
2. Institutional-based trust
Institutional-based trust is defined as a buyer’s perception that effective third-party institutional mechanisms are in place to facilitate transaction success (Gefen et al. 2006). There are several institutional mechanisms applied by the current C2C e-marketplaces such as feedback system and escrow service. Through reputation feedback system, buyers and sellers give positive, negative, and neutral ratings plus some comments to each other when finishing a transaction. The sum of these ratings serves as reputation indicator for a seller or a buyer. Dellarocas (2003) offers a systematic analysis of binary feedback system resembling the one mentioned above. He finds that although such feedback system incurs certain efficiency loss, it can induce high average level of cooperation that remains stable over time, if buyer’s evaluation of high quality is sufficiently high. Ba et al. (2002) test the mediating role of trust between seller’s feedback profile and price premium, and finds that higher feedback ratings leads to higher lever of trust which in turn results in higher price premium. Bolton et al. (2004) investigate the effectiveness of reputation mechanism by conducting experiments in stranger, feedback, and partner markets. It is demonstrated that feedback mechanism can facilitate transaction, but it exhibits a kind of public goods problem. By using escrow service, buyers can pay after they receive the product and evaluate it. The research on escrow service is little, but Hu et al. (2004) examine the viability of escrow service in online auction market by proposing a game model for online traders and a profit maximization model for the online escrow service (OES) provider. They conclude that OES does effectively prevent fraud, and the OES profit is positively associated with the risk of fraud. From a trusted third party perspective, Ba (2001) proposes a community responsibility system, and concludes that this system is effective in promoting online trust as well as can protect privacy and anonymity since this trust is built on community level not individual level.

An online transaction can be viewed as a two-phase process, i.e., online contracting phase and financial settlement/physical delivery phase (Hu et al. 2004). The aforementioned research just analyzes each mechanism separately in its corresponding phase, i.e., feedback system in contracting phase, and escrow service in financial/delivery phase. Thus, this paper investigates effects of these two methods on trust promotion by combining both research streams.

3. Model
There is a monopoly seller selling a product in an online C2C market over a finite period. In each period the seller sells one unit of product, and m buyers compete with each other for the product by second price Vickery auction. Each buyer has an evaluation for the product $w_i$, and assume that $w_1 > w_2 > ... > w_m$. The product has two types, one is high quality, and the other is low quality. The probability of the seller providing a high quality product (cooperation) is $s(x, t, h(t))$ where $x$ is the current profile of the seller (total number of negative ratings posted on the seller during the most recent N transactions.), $t$ is the current period, and $h(t)$ is the past behavior of the seller up to period $t$. If the seller cooperates, he/she will incur a cost $c$. We assume that the seller uses a stationary strategy, i.e., $s(x, t, h(t)) = s(x)$, and $s(x)$ takes two values of 0, 1. If $s(x)$ equals 1, the seller will cooperate; otherwise, he/she will not cooperate. The timing of events in each period is as follows:

1. Seller offers a unit of good, and promises high quality;
2. System publishes the seller’s current feedback profile $x$;
3. Buyers bid for the good, and the winner pays to Escrow Service Provider (ESP);
4. Seller decides to deliver high quality product or low quality product;
5. Winner examines the good, and then notices ESP to pay if he/she perceives high quality;
6. Winner grades the seller, and the seller’s profile is updated accordingly.
The following lists the notation used in this paper:

- **N**: Number of the most recent transaction
- **x**: Number of the negative reports received by the seller
- **s(x)**: Probability that the seller will cooperate
- **S**: Seller’s stationary strategy vector \( S = [s(0), s(1), \ldots, s(N)] \)
- **a**: Probability of the product perceived as not good when it is high quality
- **β**: Probability of the product perceived as not good when it is low quality, \( a < β \)
- **w_i**: Consumer \( i \)'s value for the product
- **c**: Seller’s cost if he/she cooperates
- **d**: Discount factor

System creates an unordered set \( W \) of cardinality \( N \) for the seller, and \( W \) is initiated to contain \( x_0 \) negative reports and \( N - x_0 \) positive reports. The seller’s profile is thus \( x_0 \) at the beginning. The seller’s profile is updated according to the following rule (Dellarocas 2003):

\[
\tau(x, +) = \begin{cases} 
  x, & \text{with probability } 1 - x/N \\
  x - 1, & \text{with probability } x/N 
\end{cases} \tag{1}
\]

\[
\tau(x, -) = \begin{cases} 
  x + 1, & \text{with probability } 1 - x/N \\
  x, & \text{with probability } x/N 
\end{cases} \tag{2}
\]

Each buyer’s expected valuation is

\[
G_i(x, s) = [s(x)(1 - \alpha) + (1 - s(x))(1 - \beta)]w_i, \quad i = 1, 2, \ldots, m \tag{3}
\]

The expected auction revenue for the current period is

\[
G(x, s) = [s(x)(\beta - \alpha) + (1 - \beta)]w_2 \tag{4}
\]

A seller’s profile is switched among \( N + 1 \) states as Figure 1 displays:

![Figure 1 Transition process of a seller's profile](image)

Where \( i = 1, 0 \), representing cooperation or not. The transition matrix is as follows:

\[
\begin{bmatrix}
  u_1 = \alpha[1 - (\frac{x}{N})] \\
  v_1 = (1 - \alpha)[(\frac{x}{N})] \\
  k_1 = \alpha[(\frac{x}{N})] + (1 - \alpha)[1 - (\frac{x}{N})] \\
  k_0 = \beta[(\frac{x}{N})] + (1 - \beta)[1 - (\frac{x}{N})]
\end{bmatrix}
\]

Seller’s payoff from the current period till the end if he/she cooperates is

\[
U_{coop}(x, s) = -c + (1 - \alpha)G(x, s) + \delta[u_1U(x + 1, s) + k_1U(x, s) + v_1U(x - 1, s)] \tag{6}
\]

Seller’s payoff from the current period till the end if he/she cheats is

\[
U_{cheat}(x, s) = (1 - \beta)G(x, s) + \delta[u_1U(x + 1, s) + k_1U(x, s) + v_1U(x - 1, s)] \tag{7}
\]

Seller’s expected payoff from the current period till the end is

\[
U(x, s) = s(x)U_{coop}(x, s) + [1 - s(x)]U_{cheat}(x, s) \tag{8}
\]
4. Results

The above problem is a dynamic programming with finite time frame. There is assumed to be \( n \) periods, and we use backward induction to solve this problem. For simplicity, we also assume \( U(x, s) = 0 \) when \( t > n \). Therefore, when in the last period, i.e., \( t = n \), if \( s(x) = 1 \), then

\[
U_n(x, 1) = -c + (1 - \alpha)^2 w_2
\]

If \( s(x) = 0 \), then

\[
U_n(x, 0) = (1 - \beta)^2 w_2
\]

Only if (9) > (10), the seller will cooperate in the last period, i.e.,

\[
w_2 > \frac{1}{c(2 - \alpha - \beta)(\beta - \alpha)}
\]

If we assume (11) can be satisfied, then \( U_n(x, s) = -c + (1 - \alpha)^2 w_2 \). When \( t = n-1 \), if \( s(x) = 1 \), then

\[
U_{n-1}(x, 1) = -c + (1 - \alpha)^2 w_2 + \delta[-c + (1 - \alpha)^2 w_2]
\]

\[
= (1 + \delta)[-c + (1 - \alpha)^2 w_2]
\]

If \( s(x) = 0 \), then

\[
U_{n-1}(x, 0) = (1 - \beta)^2 w_2 + \delta[-c + (1 - \alpha)^2 w_2]
\]

It is easily to verify that (12) > (13), so the seller will cooperate in the \((n-1)\)th period. Thus by induction, we can get that the seller will cooperate in each period. Then the seller’s discount payoff of the whole time frame is

\[
U_1(x, 1) = \sum_{i=0}^{n-1} \delta^i [-c + (1 - \alpha)^2 w_2]
\]

If (11) can not be satisfied, by the similar induction process, the seller will choose non-cooperation in each period, and his/her discount payoff is

\[
U_1(x, 0) = \sum_{i=0}^{n-1} \delta^i (1 - \beta)^2 w_2
\]

Without information asymmetry (first-best case), the seller’s expected payoff is

\[
U_{FB}(x) = \sum_{i=0}^{n-1} \delta^i [-c + (1 - \alpha)w_2]
\]

Compared (14) to (16), it is seen that \( U_{FB}(x) - U_1(x, 1) = \sum_{i=0}^{n-1} \delta^i \alpha(1 - \alpha)w_2 \), which can be seen as the efficiency loss due to information asymmetry.

5. Conclusion

From the above analysis, we can conclude that feedback system combined with escrow service can promote safe transaction in online C2C market, but this is dependent on product types. If the product with high value and the seller doesn’t need to incur great cost by providing high quality product to buyers, then these two trust-enabled institutional mechanisms will indeed make the seller honest; however, otherwise, these two mechanisms will not be so effective. In addition, although the two mechanisms can secure safe transaction environment, there still exist efficiency loss because of information asymmetry. This loss is proportional to the product’s value, and the buyer’s perceived quality of the product.
This is a preliminary study on institutional-based mechanisms to promote trust in both online transaction phases, thus there is a lot worth further research. For instance, high reputation will attract more buyers, thus future study can incorporate this effect into consideration. Besides, escrow service is an effective mechanism to facilitate trust, but how to build trust toward the service provider is another studying issue.

**References**

Web Assurance Seals in the Online Markets—A Theoretical Approach

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Abstract
This paper establishes a decision-making model for online shoppers. The decision-making criteria are derived to show when a shopper will trade with a less-established e-vendor rather than with a well-established one. The effects of a seal in promoting trust are discussed.

Keywords: Trust, Decision making, Assurance seal, Online markets

1. Introduction
The Internet and World Wide Web have emerged as powerful mediums for communication and merchandise distribution. Though Internet sales are booming, the risks associated with online trading are still perceived high by many consumers. We might wonder whether those small, less-established e-vendors could find some way to attract online shoppers and eventually prosper in the e-markets. Recently, the use of third-party assured Web seals as a trust-enhancing mechanism has attracted attention from both practitioners and academicians. The academic community has started to explore the impact of such Web seals on promoting consumers’ trust and increasing Web sales (e.g., Hu, Lin, and Zhang 2002; Kimery, K. M., and McCord M. 2002; Kovar, Burke, and Kovar 2000; Noteberg, Christaanse, and Wallage 2003). However, more research in this area is still in need. The literature lacks a theoretical analysis of how Web seals, as a “trust-enhancing” tool, affect consumers’ shopping decisions.

This paper establishes a decision-making model for risk neutral and rational online shoppers. After setting some assumptions, we derive a shopper’s decision-making criteria about when to trade with a less-established e-vendor rather than with a well-established one. Furthermore, the model analyzes the effect of a seal in helping an e-vendor to promote consumer trust.

2. Online Shoppers’ Decision Making Model
2.1 Basic Model Set-Up
In this model, we assume two types of e-vendors in the e-markets: high reputation type (HH-type) and low reputation type (L-type). The HH-type e-vendors refer to those with well-established reputation who trade honestly and are well trusted by the online shoppers. L-type e-vendors refer to those with less-established reputation. For the L-type e-vendors, we assume two sub-types: honest (denoted as LH) and strategic (denoted as LS) types. The LH-type e-vendors are honest and are committed to fair business practices. The LS-type e-vendors have the incentive to deceive online customers in order to reap higher illegal profits. However, LS-type e-vendors might not cheat on every trade. The HH and LH-types are assumed to act honest in every trade. Though there might be times of “dishonest behavior” by accident, we do not model that here.

We make several important assumptions before presenting the decision-making model.

1. Shoppers are rational and risk neutral. They set their goals to maximize the expected trading surplus/utility. We further assume that utility is linear.

2. The identities of the HH-type vendors are common knowledge among online shoppers. However, among the low reputation vendors, shoppers could not differentiate between
the LH-type and the LS-type. The real type of an L-type e-vendor is private information
unto himself.

3. Due to the differences in reputation, both LH- and LS-types e-vendors offer the same
lower price than that of the HH-type e-vendor. The price advantage serves as an
incentive for online shoppers to do business with the low reputation e-vendors.

4. Shoppers can purchase a product from either a high reputation or a low reputation
vendor.

We use the HH-type e-vendor as a benchmark. The price HH-type vendor offers is
denoted as $P_H$ and the price a L-type vendor offers is denoted as $P_L$, and we assume $P_H > P_L$.
Though sometimes, the reverse is true, in order to model the feasible chance for the L-type
e-vendor, we omit that from the model. The reservation value of a shopper for the underlying
merchandise is denoted as $V$, this could differ among shoppers, and we assume the following
relationship holds for interested shoppers: $V > P_H > P_L$. The risks associated with the HH-type
and LH-type vendors are normalized as zero, due to their honesty. In this e-markets, $\alpha$ portion
of the low reputation e-vendors are of honest type (LH), whereas $1-\alpha$ portion are of strategic
type (LS). The parameter $\alpha$ is within the range of $[0, 1]$, and its value is determined by nature.

2.2 Decision Criteria

Before the presence of Web seals in the e-markets, a less-established e-vendor mainly win
customers by lower product price and excellent customer services. Meanwhile, he is subject to
the uncontrollable factor of the general perception of $\alpha$’. In this model, we assume that HH
type e-vendors are not interested in any seal. Noteberg, Christiaanse, and Wallage (2003)
empirically confirm that for unknown vendors, consumers’ purchase intention increases
significantly when there is third-party assurance, whereas for known vendors, whether the
assurance is self-claimed or third-party assured makes no significant difference to consumers.

For low reputation e-vendors, as they are less established and generally unknown to
online shoppers, Web seals could be attractive and give them an opportunity to establish their
reputation. Both LH- and LS-types of e-vendors may consider adopting a seal. LH-type
e-vendors may consider employing a seal to indicate its true type. However, some LS-type
e-vendors may want to adopt a seal to deceive. We assume that when a LS-type e-vendor
employs no seal, it will more prone to cheat. Cheating will result in the shopper’s total loss of
the paid price $P_L$. When a LS-type vendor does employ a seal, we assume he will act honestly
with a probability of $\theta$, and cheat with a probability of $1-\theta$. where $\theta$ is within the range of
$[0,1]$. When the LS-type e-vendor acts honestly, a shopper’s payoff is $V-P_L$, otherwise, the
payoff is $-P_L$.

We assume in the e-markets, $\delta$ portion of the low reputation e-vendors employ a seal,
while the other $1-\delta$ portion do not. Shoppers can observe whether an e-vendor adopts a seal or
not when visiting the web site, but they do not know whether the e-vendor is of honest type or
strategic type. A LS-type e-vendor might cheat even with a seal on his web site; while a
LH-type e-vendor will not cheat even without a seal on the web site.

Therefore, the decision for the shopper are (1) whether he should trade with a low
reputation e-vendor, and (2) when he trades with a low reputation vendor, whether he should
trade with one that adopts a seal or one that adopts no seal. The decision tree for an online
shopper is showed in Figure 1. Due to the fact that a seal adoption can be observed by online
shoppers before they make their purchasing decision, we will analyze the expected utilities of
online shoppers with two distinct cases: trading with an e-vendor with a seal on his web site and
trading with one without any seal. The expected utility of trading with L-type e-vendors with a
The payoffs are shown below.

\[ EU(L_{\text{Seal}}) = \alpha'_1 (V - P_L) + (1 - \alpha'_1) [\theta (V - P_L) + (1 - \theta)(-P_L)] \]

\[ EU(L_{\text{NoSeal}}) = \alpha'_2 (V - P_L) + (1 - \alpha'_2)(-P_L) \]

In the following sections of the paper, we propose to use the same parameter \( \alpha' \) for both \( \alpha'_1 \) and \( \alpha'_2 \). Readers might argue that \( \alpha'_1 \) and \( \alpha'_2 \) are different due to the fact that they belong to two distinct groups: seal-adopting group and no-seal group. However, we have little information to project whether the percentage of the moral trader \( \alpha' \) should be higher or lower in the seal-adopting group than in the no-seal group.

**Figure 1: Decision Tree for an Online Shopper**

**Proposition 1:** On average, shoppers gain higher expected payoffs when trading with an L-type e-vendor with a seal than one without a seal.

**Proof:** We compare the expected payoffs of \( EU(L_{\text{Seal}}) \) and \( EU(L_{\text{NoSeal}}) \), we found that

\[ EU(L_{\text{Seal}}) - EU(L_{\text{NoSeal}}) = (1 - \alpha')(\theta)V \geq 0 \]

The above expression is equal to zero only when either \( \alpha' \) equals 1 or \( \theta \) equals 0. Those are the two extreme cases. In reality, both cases are impossible. In all other cases, a seal is of effect and the expected payoffs of trading with an e-vendor adopting a seal are always higher than trading with an e-vendor not adopting a seal. Empirical analysis also confirms this theoretical result (e.g. Kovar, Burke, and Kovar 2000; Noteberg, Christiaanse, and Wallage 2003).

**Proposition 2:** When the following condition holds, shoppers will purchase from a low reputation type e-vendor with a seal rather than from a high reputation type e-vendor.

\[ \theta > 1 - \frac{P_H - P_L}{V(1 - \alpha')} \quad \text{or} \quad \alpha' > 1 - \frac{P_H - P_L}{V(1 - \theta)} \]

**Proof:** We compare the expected payoffs of trading with a L-type e-vendor with a seal, \( EU(L_{\text{Seal}}) \), and the expected payoff of the benchmark case \( EU(HH) \).

\[ EU(L_{\text{Seal}}) - EU(HH) = (P_H - P_L)(1 - \alpha')(1 - \theta)V \]

When the above condition is greater than zero, we find the following condition:
Several observations are drawn. First, when fixing all other parameters, as the absolute price difference between the high and low reputation type \((P_H - P_L)\) is enlarged, the above condition will easily be satisfied, and shoppers will be drawn to the low reputation type e-vendor with a seal and enjoy price advantage. Second, the relative price advantage \(\frac{P_H - P_L}{V}\) is important. The higher the benefit ratio, the higher the chance will be that a shopper might trade with an L-type e-vendor. Last, as the two parameters \(\alpha'\) and \(\theta\) increase, shoppers are more likely to trade with a low reputation e-vendor.

**Proposition 3:** A seal can create a price premium for the L-type e-vendor with a seal, and the price premium can be up to \((1-\alpha')\theta V\).

**Proof:** We set the expected payoffs of \(EU(L_{Seal})\) and \(EU(L_{NoSeal})\) to be equal and find how much more a vendor with a seal can charge the online shoppers without losing them. We denoted the price premium as \(K\). \(EU(L_{Seal}) - EU(L_{NoSeal}) = 0\). Thus, \(K = (1-\alpha')\theta V\) holds. Therefore, as long as the price premium is between the range of \([0, (1-\alpha')\theta V]\), shoppers are more likely to purchase from an e-vendor with a seal than one without any seal.

### 3. Price Effect, Seal Effect, and Reputation Effect

In order to demonstrate the dynamics of these propositions and the shoppers’ decision making, we draw Figure 2 to show the range of various parameters and the conditions for a shopper’s decision making.

**Analysis w.r.t. \(\alpha'\)**

**Figure 2: Shopper’s Decision-Making w.r.t \(\alpha'\)**

Range I indicates that when a shopper perceives that the proportion \((\alpha')\) of honest e-vendors among the low reputation type is relatively low, which is within the range of \([0, 1 - \frac{(P_H - P_L)}{V(1-\theta)}]\), the shopper will surely purchase from a high reputation vendor even given that the low reputation type e-vendor provides a price advantage and may even have a seal on his web site. We call Range I the reputation effect range. When the e-markets are perceived to be risky, and the price advantages are not significant enough, the reputation effect plays a major role on a shopper’s purchasing decision. However, a shopper’s decision starts to change when the honesty level among the low reputation type is below a certain level.
type is enhanced, in other words, when the percentage of LH-type e-vendors increases. Now, shoppers will be drawn to the low reputation type e-vendors who display a seal on the web site (Range II), and will purchase from them rather than from the HH-type e-vendors. We call Range II the seal effect range. Range III implies that when the expected percentage of LH-type e-vendors is higher than \(1 - \frac{(P_H - P_L)}{V}\), the shoppers would prefer to purchase from low reputation e-vendors who adopt no seal than from HH-type e-vendors. Range III combines the effects of price advantage and a safer online environment, which draw shoppers to the L-type e-vendors. We call this range the combined effects.

4. Conclusion
In this paper, we examine when shoppers would purchase from a small, less-established e-vendor. The model indicates that given that a product can be purchased from either a less-established or a well-established vendor, relative price advantage is a key factor that attracts consumers to less-established e-vendors. When third-party Web seals are introduced to the e-markets, competition structure starts to change. Web seals, due to their scrutiny functions and the reputation of the seal issuers, could signal to online shoppers the trustworthiness of the vendor, thus enhancing online shoppers’ trust toward and likelihood of purchasing from such an e-vendor. Future study can relax some of the assumptions, and use simulation of the markets to derive some results.

5. References
1. Best Practices for Knowledge Flows between Client and Vendor in IT Outsourcing

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Abstract

This paper addresses the issue of communicating knowledge (explicit as well as tacit) in the course of an IT outsourcing project. Typically, the client and the vendor are in different locations and time zones. Project Managers at both the client and vendor sides have to ensure that project objectives are met without compromising on the other necessary long-term health factors of the client-vendor relationship such as trust and risk. The flow of knowledge, its retention and consequent application is synergistic to such a long term perspective of ongoing outsourcing activities in that, when effectively done, it leads to a stronger relationship that is conducive to project success. We hence present a knowledge communications framework that is field tested to describe best practices for the communication of knowledge between client and vendor in an IT outsourcing relationship.

Keywords: Knowledge Management, Information Risk, Communication Trust, Computer Mediated Communications, Outsourcing Knowledge Work, Project Knowledge Capture and Retention.

1. Introduction & Background

The literature on IT Outsourcing suggests a need to study further the information hazards in the outsourcing business (cf. Dibbern et al. 2004; Pinto et al 2003; Power et al. 2005). Recent research consistently reveal that hidden costs, high staff turnover, poor cross-cultural communications, poor communication between the onsite and offshore project teams as well as between management and employees are the key causes of mismanagement of information (Krishna et al. 2004). A commonly held view of why many outsourcing deals fail is the propagation of misinformation and confusion due to inadequate communications among the project team and its contacts, as well as within the general employee population, executive ranks and local community. Effective communications through the construction of seamless communication channels, regardless of size, structure, business or location, play a critical role in reducing risks in outsourcing projects. Thus, it is widely believed among researchers and practitioners that it is important to cultivate and maintain trust between the client and vendor to successfully manage an outsourcing project (Dibbern et al. 2004; Keil et al. 1998; Shockley-Zalabak et al. 2000).

An examination of issues identified by researchers and practitioners unearthed the following two factors which are hypothesized to influence the effectiveness of communication flows in an IT outsourcing project. The research described in this paper investigates if the success of an outsourcing project can be predetermined by the combination of overcoming information risks and enhancing trust, the degree of which can be predicted from the ability of the outsourcing project managers (at both the client as well as vendor side) to communicate technical information effectively.

Though there are several contractual measures in use today to ensure effective communication while outsourcing, no specific risk assessment has been established with respect to the information communication practices. This is mainly due to the intangible nature of the risks involved. This research can further help understand the very multidisciplinary topic of technical communication to cover the broader spectrum of outsourcing management issues related to organizational management as a whole – which involves the management of people, process and information. It addresses the key concept of technical communication as a directive
for the very sustenance of IT outsourcing and as a strategy for both client and vendor organizations. Since human elements are found to be critical for the success of this strategy, the focal point of the paper is narrowed down to how communication choices are related to interpersonal trust and risks due to human mistakes.

It is intended that this research would be useful for examining contracts for information technology outsourcing, to explore alternative contractual mechanisms for information risk sharing and risk shifting. Best practices derived may be adopted as useful strategies by companies in the business of IT outsourcing - client and vendors. Thus, it serves the communication needs of technologists in outsourcing. Most importantly, this paper hopes to bring in the awareness and realization to the business community that technical communication requires a conscientious effort and well researched strategy in critical business processes such as outsourcing.

2. Research Framework & Methodology
The conceptual model developed from a synthesis of prior work (cf. op. cit.; Carlson & Zmud 1999; Daft et al 1987; Gupta & Gavinderaj 2000) is reproduced below. This provided a framework for spawning field testable research assertions and hence identifying best practices measures for effective technical communication.

The spawned best practice assertions were conceived for outsourcing communication with this understanding of communication attitude, the availability of communication modes, the risks involved and their influence on trust. Based on the model, the following research assertions are made to test its applicability to existing effective technical communication practices. Hence, the empirical research methodology used a combination of the Delphi technique and Critical Success Factors method. The relevant literature on IT outsourcing, outsourcing risks, trust and communication was first analyzed and a framework of IT outsourcing success was developed as a central research model. Postulates and research assertions were then drawn from the model in consultation with a peer review team of expert – practitioners in the process of refinement and instrument testing for validity and reliability. The moderated assertions (after peer review and refinement) are stated below.

A1. Information risks are often controlled by building trust through the use of appropriate communication tactics, modes, media and channels.
A2. Regular face to face communication increases trust between client and vendor and therefore reduces information risks during communications, and is hence, necessary for project success.
A3. There is a need to meet members of my vendor/client team in order to trust them and effectively communicate with them.
A4. Inability to communicate regularly and casually with the vendor/client can reduce trust.
A5. Email is more effective than direct communication as they avoid gaps due to culture differences and are hence more helpful for successful project outcome.
A6. Email is better than telephone for responding in an effective manner to increase trust and is hence important for project success.
A7. When there is a time zone difference with the client/vendor, asynchronous modes such as email and fax are preferable to telephone or audio-video conferencing.
A8. Task responses to telephone communication are quicker than to email communication and hence reduce uncertainty and risks.
A9. Video conferences are preferred to telephone conferences as they induce more trust and reduce risks of misunderstanding information.
A10. The use of discussion forums and web repositories are more effective than overloading project discussions by email.
A11. The use of newsletters and bulletins to the project team creates awareness, reduces information gaps and hence controls organizational politics.
A12. Discussion forums are more effective than net meeting for communicating complex project issues.
A13. Discussing critical project issues through audio or video conferencing is more effective than email or discussion forums.

3. Key Findings
The field research was conducted through a survey of industry practitioners from vendor and client organizations with a sample size of 200+ respondents from 20+ organizations (about equal clients and vendors). Most of the respondents were very experienced IT professionals with typically 10 or more years in the practice and were currently managing fairly large (in excess of USD 1 million) international IT outsourcing contracts.

Not surprisingly, there was statistically significant (p < 0.025 using a standard confidence of 95% for a two-tailed test) support for the hypothesis that effective technical communication reduces information risks (P2). There is also significant support for the central postulate of this research that effective technical communication contributes to successful project outcome (P3). P1 was deliberately worded in an ambiguous manner (in contrast to the actual postulate stated in Section 3.1). Again this was to test for the possibility of a trend among respondents to consistently agree or disagree. The result was that the null hypothesis could not be rejected; in other words, there neither considerable agreement nor disagreement among respondents. Good technical communications skills indeed override the availability or lack of computer mediated communications. Cronbach’s Alpha (a measure conventionally used to express internal consistency) for attitudinal responses for the 3 postulates and 13 assertions was calculated to be in excess of 80%. Hence it may be claimed that the field survey instrument exhibits acceptable validity and reliability.

Next, similar two-tailed z tests were done on each of the 13 research assertions. There was statistically significant support (p < 0.025) for all but Assertion 3. More revealing was the descriptive statistics summarizing practitioners’ views. This is shown in the table below:

<table>
<thead>
<tr>
<th>Outsourcing Activity</th>
<th>Most Effective Communication Modes</th>
<th>Least Effective Communication Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Routine Project Meetings</td>
<td>Face to Face</td>
<td>Audio</td>
</tr>
<tr>
<td>Scope Changes</td>
<td>Conferencing</td>
<td>Conferencing</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>User Support</td>
<td>Audio Conferencing</td>
<td>Email</td>
</tr>
<tr>
<td>Delivery of Milestone Reports</td>
<td>Email</td>
<td>Audio Conferencing</td>
</tr>
<tr>
<td>Arbitration of issues such as non performance penalties</td>
<td>Face to Face</td>
<td>Audio Conferencing</td>
</tr>
<tr>
<td>Audit of Service Levels</td>
<td>Face to Face</td>
<td>Audio Conferencing</td>
</tr>
<tr>
<td>Informing Vendor/Client organization of changes that effect them</td>
<td>Email</td>
<td>Audio Conferencing</td>
</tr>
<tr>
<td>Addressing Cultural Gaps</td>
<td>Face to Face</td>
<td>Video Conferencing</td>
</tr>
<tr>
<td>Stakeholder Training (Addressing Knowledge/Information/Data Gap)</td>
<td>Face to Face</td>
<td>Video Conferencing</td>
</tr>
<tr>
<td>Stemming Knowledge Attrition</td>
<td>Face to Face</td>
<td>Web Repository</td>
</tr>
<tr>
<td>Top Management Review</td>
<td>Face to Face</td>
<td>Video Conferencing</td>
</tr>
</tbody>
</table>

It is clear that practitioners consider face to face communications to be the “gold standard” in carrying out project activities. Both Media Richness (cf. Daft et al. 1987) as well as Channel Expansion (cf. Carlson & Zmud 1999) theories suggest this and Kraut et al. (1988) reinforce such a paradigm; but often times, face to face may be uneconomical or impractical. In such instances, the framework presented in this paper suggests that there are ways to optimize the knowledge flows between vendors and clients that achieve the twin objectives of establishing trust whilst containing risks. Connolly and Zeelenberg (2002) suggest that in several instances the notion of regret sets in – forgoing a course of action (in this case, not communication with the richest media and biggest channel feasible) results in later regret that the information may have been mis-communicated. Whereas Wilson et al. (1996) investigated the limits of anchoring – suggesting that a priori knowledge and experience over-rides hesitations about an unsuccessful formula. Taking an analogy from football, two coaches of losing teams may take opposite courses of action – one making changes to the line-up and the other remaining unchanged. The coach making no changes will regret his action if the team loses again because he could have done something about it. However, if he is knowledgeable and experienced, this regret may be over-ridden.

4. Concluding Remarks
Boisot (1998) and Gupta and Govinderajan (2000) arrived at models for knowledge flows as functions of: the value of the stock attributed by the source; motivation of the source to share; channels from source to target; motivation of the target to receive; absorptive capacity of the target; and quality of relations between source and target. We have constructed a unified framework for knowledge flows that is applicable for the scenario of outsourcing IT services such as software development, operations and maintenance (including user support), and applications management.

The ensuing empirical study investigated the central postulate that: effective management of technical communication at every stage of executing an IT outsourcing contract reduces associated risks and establishes trust in an outsourcing relationship. The objective of the study was to provide knowledge managers with an insight into the effectiveness of knowledge flows for various outsourcing activities in order to support knowledge fusion within the organization.
While the risks and trust associated with the communication medium is understood, further research is needed to study the other aspects of managing technical communication processes and their resulting knowledge flows between client and vendor organizations, explicitly laying out a contingency table that includes the complexities of communications modes, multi-party relationships and knowledge creation, capture, and sharing during outsourcing projects. The findings of this study also suggest that a communication workflow for technical communications among project managers providing a high trust, low risk knowledge communication platform is conducive to success in IT Outsourcing. This was obvious from the onset. The revealed good practices for doing so was found to be a contribution to the practice.

References

The Influence of the Knowledge Contribution Incentives on the Knowledge Creation Performance of Group Support System Meetings

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Abstract

Knowledge has become critical in today’s highly competitive business environment. To acquire competitive advantage, organizations need to engage in knowledge management (KM). Group support systems (GSS) can be used as a knowledge management system (KMS) and support the knowledge creation process. In addition, knowledge contribution incentives studies exist to understand the effects on knowledge contribution of the KMS. To examine the effects of knowledge contribution incentives, which include economic reward, reputation, reciprocity and altruism, on the knowledge creation performance of GSS meetings, a laboratory experiment was conducted. Dependent variables were knowledge quantity (number of ideas), knowledge quality (idea usefulness and idea creativity) and perceived meeting satisfaction. The results indicate that: (1) Economic reward significantly affects the perceived meeting satisfaction; (2) Reputation feedback significantly affects both knowledge quantity and knowledge quality; (3) Reciprocity and altruism play significant moderating effects. Finally, managerial implications are also provided.

Keywords: Group Support Systems, Knowledge Contribution Incentives, Knowledge Creation

1. Introduction

To acquire competitive advantage, organizations need to engage in knowledge management (KM), and the most important way to promote it is by motivating people to share their knowledge with others, because knowledge is stored in human heads. However, as Davenport and Prusak (1998) argue, people’s time and energy are limited, and soon they will consider whether any reward offered matches the value of their knowledge contribution. Without the drive of an incentive system that rewards people appropriately, a KM program would not be successful (Davenport and Prusak, 1998; Alavi and Leidner, 2001; Ba et al., 2001; Bock and Kim, 2002).

There is a decision need that the decision maker needs to gather knowledge surrounding the decision (Jones, 2006). As research on applying group support systems (GSS) and KM continues to grow (e.g., Parent et al., 2000; Kwok et al., 2003), GSS would not only enable the gathering of knowledge and the sharing of knowledge among members, it would also encourage individuals to communicate, organize and evaluate knowledge by groups (Kwok et al., 2003). We often use groups because we believe that two heads are better than one, which is to say that group efforts are synergistic. The “KPMG Consulting’s Knowledge Management Research Report (1998)” shows that organizations have adopted a number of relevant technologies specifically suited for KM purposes. It also points out that 49% of the respondents used decision support technologies, and 43% used a groupware in this report. Thus, GSS can be used as a knowledge management system (KMS). This study focuses on two research questions. First, do incentives of the GSS...
environment, such as economic reward and reputation feedback, influence contributors’ knowledge performance in knowledge creation? Second, do incentives of individual intrinsic values, such as reciprocity and altruism, influence the relationship between the incentives of the GSS and the performance of knowledge creation? The objective of this study is to deepen our understanding on whether or not these incentives increase an individual’s tendencies to engage in knowledge contribution.

2. Background, research model and hypotheses

2.1 Knowledge contribution incentives

2.1.1 Economic reward

Money is the most obvious way for an organization to reward its employee, and plays an important role in the initiation stage. Carrillo et al. (2004) surveyed UK construction organizations and found that, if reward schemes were introduced in the organizations and, when such schemes existed, they were mostly found to be financial-based rewards (60%). Results from prior research are consistent and provide evidence that the more an individual gets monetary incentives, the more favorable his attitude will be towards knowledge sharing (Bock et al., 2005). Thus, under the GSS environment, the economic reward of contributing knowledge will enhance one’s perception and may motivate individuals to produce more and useful ideas, and which may lead to a satisfying process. Hence, we hypothesize:

H1a: GSS with economic reward provided will produce more people with ideas than those using GSS alone.
H1b: GSS with economic reward provided will produce more people with useful ideas than those using GSS alone.
H1c: GSS with economic reward provided will produce more people with creative ideas than those using GSS alone.
H1d: GSS with economic reward provided will perceive a higher level of satisfaction with the meeting than people using GSS alone.

2.1.2 Reputation

People who share knowledge can acquire a higher reputation (Davenport and Prusak, 1998). In present-day E-commerce websites, reputation is an important factor in winning business transactions (e.g. eBay, Amazon). Reputation mechanism can help an individual obtain and maintain his or her status within a collective (Jones et al., 1997) and prevent the retention of free riders who do not contribute to the team effort. Prior research suggests that people participate in KM practices because there they can establish their individual reputation and improve their present reputation (Constant et al., 1996; Donath, 1999; Wasko and Faraj, 2005) or earn peer recognition (Carrillo, 2004). In this study, GSS provides reputation feedback messages, helps knowledge contributors establish their reputation, and motivates the participant to propose with more quality ideas, and increase the satisfaction of the meeting process. Thus, we hypothesize:

H2a: GSS with reputation feedback will produce more people with ideas than those using GSS alone.
H2b: GSS with reputation feedback will produce more people with useful ideas than those using GSS alone.
H2c: GSS with reputation feedback will produce more people with creative ideas than those using GSS alone.
H2d: GSS with reputation feedback will perceive a higher level of satisfaction with the meeting than people using GSS alone.

2.1.3 Reciprocity

In order to contribute knowledge, individuals must always think that their contributions to others are or will be worth the effort. Previous studies have emphasized on the importance of individual intrinsic incentives in determining knowledge contributing behavior (Wasko and Faraj, 2005; Bock et al., 2006). There are two intrinsic contribution incentives. One is reciprocity, in that they
are able to offer something in exchange, such as help, in the future. The other is altruism, which is in contrast to reciprocity and can be seen as a form of unconditional kindness without the expectation of a return (Fehr and Gachter, 2000), just to provide help and feel happy about it (Kollock, 1999). Reciprocity is a form of conditional gain; that is, people expect future benefits from their present actions. Many studies have carried out detailed analyses of reciprocity and found that it can be beneficial to knowledge contributors because they anticipate future help from other people (Connolly and Thorn, 1990; Kollock, 1999). Under the environment of GSS, economic reward and reputation feedback may be positively related to knowledge creation by knowledge contributors contingent on reciprocity. When reciprocity is strong, knowledge contributors may expect to generate better performance in the GSS. We thus hypothesize:

**H3a:** Economic reward and reputation feedback are positively related to the number of ideas generated by knowledge contributors under conditions of stronger reciprocity.

**H3b:** Economic reward and reputation feedback are positively related to idea usefulness by knowledge contributors under conditions of stronger reciprocity.

**H3c:** Economic reward and reputation feedback are positively related to idea creativity by knowledge contributors under conditions of stronger reciprocity.

**H3d:** Economic reward and reputation feedback are positively related to satisfaction with the meeting process by knowledge contributors under conditions of stronger reciprocity.

2.1.4 **Altruism**

Davenport and Prusak (1998) argued that a lot of people are willing to share knowledge because people receive the urging of expertise and altruism. In short, individuals help others whether or not they get anything in return. Prior research suggests these individuals are motivated intrinsically to contribute knowledge to others because they enjoy helping others (Wasko and Faraj, 2005, 2000). Such situations suggest a positive relationship between economic reward, reputation feedback and knowledge creation performance by knowledge contributors, though the relationships may be contingent on altruism. Therefore, under the conditions of strong altruism, knowledge contributors may have better knowledge creation performance in the GSS. Thus, we hypothesize:

**H4a:** Economic reward and reputation feedback are positively related to the number of ideas generated by knowledge contributors under conditions of stronger altruism.

**H4b:** Economic reward and reputation feedback are positively related to idea usefulness by knowledge contributors under conditions of stronger altruism.

**H4c:** Economic reward and reputation feedback are positively related to idea creativity by knowledge contributors under conditions of stronger altruism.

**H4d:** Economic reward and reputation feedback are positively related to satisfaction with the meeting process by knowledge contributors under conditions of stronger altruism.

Synthesizing the above hypotheses, we propose a model as below.

### Figure 1 Research model.

3. **Research Methodology**
3.1 Experimental Design, Subjects and Tasks

This study employed a laboratory experiment. A completely randomized experimental design used for this study was a 2X2 factorial design. There were 24 groups in all, 6 groups in each treatment, and 5 participants in each group. A total of 120 undergraduate and MBA students volunteered for the formal experiments. But before this, 20 students were used as an additional four groups (five per cell) in a pilot study to test and fine-tune procedures and instruments. A total of 140 students volunteered to participate in the study. Each was given NT$100 in the form of cash prizes. Since the experiment results are likely to be influenced by the degree of familiarity with certain tasks, 120 students were first requested to accomplish a pilot task. This pilot task asked the following question: “What features should the new University library have?” After the completion of the pilot task, 120 students were then asked to complete another task. This second task involved the question: “How can tourism improve in our area?”

3.3 Variables and measures

In a GSS with economic reward, incentives were provided to the subjects in the form of cash prizes for participation (NT$100). Additionally, in order to motivate the subjects to perform diligently, cash bonuses (NT$200) were awarded to those who performed best, as measured by their performance. In a GSS with reputation, incentives were provided to the subjects in the form of information for their participation. Each period of time was done through the GSS to provide each participant an effective number of ideas and a rank within each period (seven minutes). The dependent variable showed how well the subjects performed in a generation task. **Knowledge quantity** was measured in terms of the number of ideas, counting the number of ideas generated by each participant. This was obtained from the GSS records and then judged by two experts. **Idea usefulness** was measured by the content analysis – whether the ideas were a question, a response to a question, or some other type of post (i.e., “Thank you,” “Me too”). **Idea creativity** was determined by the idea originality and idea paradigm relatedness from the study of Hender et al. (2002). **Perceived meeting satisfaction** was measured according to Green and Taber’s (1980) instrument. To account for the effect of intrinsic incentives that relate to knowledge creation performance, we include reciprocity and altruism as moderating variables from the knowledge market perspective used by Davenport and Prusak (1998).

4. Summary of results

A Multivariate Analysis of Covariance (MANCOVA) was the main statistical procedure used to test the hypotheses.

4.1 Number of ideas generated

The results showed that only the main effect of reputation was statistically significant (p-values < 0.01). Thus, we conclude that GSS with reputation feedback will produce more with ideas than ones using GSS alone (\(\text{Mean}_{\text{with reputation}} = 11.26 > 6.70 = \text{Mean}_{\text{without reputation}}\)). The main effect of economic reward was statistically insignificant. GSS with economic reward provided (Mean = 9.06, SD = 3.950) won’t produce more with ideas than one using GSS alone (Mean = 8.82, SD = 3.819). Also, in the confidence level of 0.05, the two covariates, reciprocity (p-value = 0.426) and altruism (p-value = 0.664), were statistically insignificant. Therefore, Hypotheses 1a, 3a, 4a were not supported, while Hypothesis 2a was supported.

4.2 Idea usefulness
The second analysis that evaluated idea usefulness as the dependent variable noted that only the main effect of reputation was statistically significant (p-values < 0.01). Thus, we conclude that GSS with reputation feedback will produce more useful ideas than ones using GSS alone (Mean\_with\_reputation = 2.67 > 2.14 = Mean\_without\_reputation). The main effect of economic reward was statistically insignificant. GSS with economic reward provided (Mean = 2.47, SD = 0.668) won’t produce more useful ideas than ones using GSS alone (Mean = 2.33, SD = 0.603). Also, in the confidence level of 0.05, the two covariates, reciprocity (p-value = 0.781) and altruism (p-value = 0.367), were statistically insignificant. Therefore, Hypotheses 1b, 3b, 4b were not supported, while Hypothesis 2b was supported.

4.3 Idea creativity

The results showed that only the main effect of reputation was statistically significant (p-values < 0.01). Thus, we conclude that GSS with reputation feedback will produce more creative ideas than ones using GSS alone (Mean\_with\_reputation = 6.88 > 5.13 = Mean\_without\_reputation). The main effect of economic reward was statistically insignificant. GSS with economic reward provided (Mean = 5.97, SD = 2.294) won’t produce more creative ideas than ones using GSS alone (Mean = 6.00, SD = 2.273). Also, in the confidence level of 0.05, the two covariates reciprocity (p-value = 0.686) and altruism (p-value = 0.635), were statistically insignificant. Hypotheses 1c, 3c, 4c were not supported, while Hypothesis 2c was supported.

4.4 Perceived meeting satisfaction

The covariate, reciprocity, had a significant effect on the satisfaction with the meeting process (p-value < 0.01). Another covariate, altruism, also had a significant effect on satisfaction with the meeting process (p-value < 0.05). This means that altruism had a moderating effect on satisfaction. The main effect of economic reward was statistically significant (p-values < 0.01). Thus, we conclude that GSS which provide economic reward will perceive a higher level of satisfaction with the process than one using GSS alone (Mean\_with\_economic\_reward = 4.78 > 4.36 = Mean\_without\_economic\_reward). The main effect of reputation feedback was statistically insignificant. GSS with reputation feedback (Mean = 4.71, SD = 1.009) won’t perceive a higher level of satisfaction with the process than ones using GSS alone (Mean = 4.42, SD = 0.956). Therefore, Hypothesis 2d was not supported, while Hypotheses 1d, 3d, 4d were supported.

5. Conclusion

The study’s findings have three important implications. First, this study shows that the economic reward provided are only a temporary attainment of knowledge contribution and is only efficient with respect to the meeting process. To establish a long-term attitude on knowledge contribution, it is necessary to rely on other mechanisms, such as one’s commitment in the relationship and one’s increase in reputation and image. This implies that organizations that intend to motivate knowledge creation should enhance individual intrinsic incentives. Second, our findings indicate that the reputation feedback influences knowledge quantity and quality on knowledge creation. Hence, the mechanism of reputation should be considered in information system design to equip it with immediate feedback. Finally, group knowledge creation is a very collective behavior, and we suggest that group-based reward and group-based reputation system should be considered. These are particularly suitable for group knowledge creation.

(References are available upon request)
Innovative Use of Information Technology: A Role Identity Perspective

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Abstract

Innovation in information technology (IT) is a critical issue in IT management. This study focuses on the factors that drive innovatively use of IS in the role identity perspective. Based on the role identity theory, this research argues that perceived organization, supervisors and coworker expectations and self-views of innovative behavior influence the innovative role identity. Perceived organizational valuing of innovation moderates the relationship between innovative role identity and innovative use.

Keywords: infusion of information technology, information technology innovation, role identity theory

1. Introduction

Innovation in information system (IS) plays the crucial role in contemporary business enterprises. Senior information technology (IT) executives rank creativity and innovation as a critical issue facing IT management (Nambisan et al. 1999). However, it remains a challenge for scholars and managers to find ways to facilitate IT-based innovation and creativity.

Zmud and colleagues proposed a six-stage assimilation model to describe the information technology adoption and implementation process (Kwon et al. 1987; Cooper and Zmud 1990; Saga and Zmud 1994). During the infusion stage, employees try to innovate with IT in order to meet existing needs and apply them to new demands. So studying the innovative usage is helpful to deeply understand the infusion stage which is an important stage in the assimilation process.

IT infusion has been the subject of scant research, and existing studies have been largely at the organizational level of analysis (Nambisan et al. 1999; Moore 2002; Subramani 2004). Information technologies are often adopted at the organizational level, but the employees are given the discretion by management to determine whether, and to what extent, to use the IT in support of the individual’s work process (Silver 1990; Silver 1991; Moore 2002; Jasperson et al. 2005). It was the user who perceived the business problem and integrated business and technical knowledge to develop a solution. Existing evidence have indicated that technology users might represent a largely untapped source of creativity within the organization and offer considerable promise for the initiation of IT innovation (Nambisan et al. 1999). So, we will focus on the factors that drive innovatively use the IS at the individual level of analysis.

2. Literature Review

Nambisan et al. (1999) viewed the initiation of IT innovation as knowledge creation and developed the taxonomy of organizational mechanisms based on the ability of various mechanisms to facilitate knowledge acquisition and knowledge conversion. Nambisan et al. (1999) argued that deliberate organizational design actions in the form of mechanisms can enhance technology users’ propensity to innovate in the information technology.
Grounded in the theory of trying, an extension to theory of reasoned action, Ahuja and Thatcher (2005) found that overload and autonomy are antecedents to trying to innovate with information technology. Quantitative and qualitative overload negatively influence trying to innovate with IT, while perceived autonomy positively influences trying to innovate with IT.

Motivation plays a critical role in determining IS use and the level of use (Moore 2002). Moore (2002) developed a model that synthesizes work motivation, social cognition and attitude/behavior theories that explains the affect of motivation on the relationship between work process reconceptualization (WPR) and IT infusion. Moore (2002) demonstrated the interaction of consequence expectancy, consequence valuation, personal expectance, and enactment cost expectancy upon the relationship between WPR and IT infusion.

Saga and Zumd identified a range of dependent variables linked to IT infusion — extended use, integrative use and emergent use. Wang and Hsieh (2006) drew upon the symbolic adoption theory, and proposed a research model for understanding extended use and emergent use in mandatory organizational contexts. Extended use and emergent use are two instances for extra-role behaviors. When symbolic adoption is less than actual adoption, employees are less likely to devote their resources, such as time and effort, to engage in extra-role behaviors with respect to the information technology (Karahanna and Agarwal 2006; Wang and Hsieh 2006). Wang and Hsieh (2006) argued that symbolic adoption positively influence extended use and emergent use.

3. Theoretical Basis and Research Model

3.1 Role Identity Theory

A role identity is a self-view, or a meaning attributed to oneself in relation to a specific role, that is generated reflexively through perceived appearance to self or others, self-judgment of that appearance and affected based on that judgment (Burke and Tully 1977; McCall and Simmons 1978). If a specific role becomes closely tied to an individual’s sense of self or identity, the individual tends to behave in accordance with this role identity in order to gain verification of the identity (Callero et al. 1987; Petkus 1996).

According to role identity theory, the self consists largely of the various social roles in which an individual engages (Piliavin and Callero 1991). A sense of role identity stems from two main sources: feedback about the self from social relations and associated self-views (Riley and Burke 1995). The generation of self-meaning by a role identity reflects a self-meaning by a role identity reflects a self-regulatory interpretative process of sense making in which relevant inputs from others and oneself are reconciled in an attempt to verify, support, and validate the identity (Riley and Burke 1995). Ultimately, a role identity reflects an internalized set of role expectations, with the importance of the identity being a function of commitment to the relevant role.

Self-identification as a creative person is a potential powerful antecedent of workplace creativity (Farmer et al. 2003). How we see ourselves - who we think we are- has a great deal to do with how we act. The self-concept of role identity holds particular relevance for understanding how an employee develops a sense of self relative to creativity and how this identity relates to creative action (Farmer et al. 2003).

3.2 Research Model
A sense of role identity stems from two main sources: (1) feedback about the self from social relations and (2) associated self-views (Farmer et al. 2003). Expectations of important social others are a major source of individuals’ self-concept through reflexivity or seeing oneself through such expectations. These perceptions reflect behavioral expectations and, more importantly, expectations about whom others expect one to be. Research has provided ample support for the effects of social expectations on role identity development (Callero et al. 1987). Organization, supervisors’ and coworkers’ expectations may influence innovation through encouragement, support, open communication, and informational feedback (Amabile et al. 1996).

In Chinese culture, the degree of concern for the expectations of social others is quite high (Yang 1981). Given the tendency in Chinese cultures to be particularly sensitive to the perceived views of others, we would anticipate the influence of perceived organization, supervisors and coworkers’ expectations on innovative role identity to be strong in Chinese culture. Hence, we can hypothesize as follows:

**H1:** Perceived organization innovation expectation is positively associated with innovative role identity.

**H2:** Perceived supervisor innovation expectation is positively associated with innovative role identity.

**H3:** Perceived coworker innovation expectation is positively associated with innovative role identity.

Identity construction is also a function of retrospective sense making which places experienced stimuli in organizing frameworks. A role identity can develop over time as a result of individual retrospectively interpreting past and continued role activity (Grube and Piliavin 2000) and become internalized because the social and personal costs entailed in no longer fulfilling a specific identity-based role increase as role behaviors continue over time. Hence, we can hypothesize:

**H4:** Self-views of innovative behavior is positively associated with innovative role identity.

The concept of role identity has been useful in predicting a variety of behaviors (Callero et al. 1985; Farmer et al. 2003). Role identities motivate role performance because enactment of relevant roles fulfills a critical need for self-verification and allows relevant others to identify and categorize an individual (Burke 1991). According to identity theory, the identity process is a control system. When an identity is activated, a feedback loop is established. A role identity tends to result in role-consistent performances only when the environments are consistent with the identity standard. When consistency exists, role support from the environment provides self-verification and confirms the relevant identity, thereby increasing the tendency of such role behavior. When the environments are inconsistent with the identity standard and identity-consistent actions are not valued or confirmed, people will feel some level of distress and the identity will be threatened (Burke 1991). An employee’s decision to engage in creative behavior is preceded by the estimation of a reasonable response regarding the innovative action from the relevant field. If the employee anticipates a negative response, he or she will avoid the innovative behavior. Employees with weak innovative role identities have no “ego-investment” in being innovative people, so they are less concerned about whether their organizations value innovation (Farmer et al. 2003). Hence, we can hypothesize:

**H5:** Perceived organizational valuing of innovation moderates the relationship between innovative role identity and innovative use.

Figure 1 shows the research model.
4. Conclusions

Based on the role identity theory, this study focuses on the factors that drive innovatively usage of IS. This research finds that perceived organization, supervisors and coworker expectations and self-views of innovative behavior influence the innovative role identity and innovative use consequently. Perceived organizational valuing of innovation moderates the relationship between innovative role identity and innovative use. The empirical demonstration of this model will be done in the future research.

References


Determinants of ASP Adoption in SMEs: An Empirical Study of Chinese ASP Clients
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Abstract
The actual adoption rate of ASP is experiencing a revival after cold reception by the market and initiates further study interest to guide industry development. To better understand client adoption drivers, we developed a conceptual model for ASP adoption based on the technology-organization-environment framework. Business and IT motivations of IS outsourcing, and Chinese IT implementation features are introduced to further specify factors in three contexts of TOE framework. Eleven adoption determinants were identified and corresponding hypotheses were presented. 147 current SMEs clients of Shanghai ASP industry were used as sample to study whether these factors influenced their intent to adopt ASP. Data analysis identified significant adoption facilitators of application service quality, infrastructure assurance, vendor reliability, contract pricing, top management orientation and industry or supply chain drive, and inhibitors of IT capability. Some specific Chinese features also were revealed to explain ASP adoption in SMEs in China as well. These empirical results are useful both for vendors to optimize the business model and clients to rationalize ASP adoption.

Keywords: ASP Adoption, TOE framework, Outsourcing, Chinese SMEs

1. Introduction
The development of ASP market has experienced a dramatic down and up since its appearance. ASP vendors have fared poorly in terms of attracting an initial large client base despite all advantages it brought about. Many ASP vendors are struggling to reach the minimal scale effect to be profitable. However, the previous disappointing ASP market seems to be on the verge of a revival, which has been bolstered by new technology and pushed by several big new entrants like Microsoft, IBM. Similar conceptions like “software as a service”, “on-demand application” become popular again.

To seize the opportunity of revival, it’s necessary for both industry players and researchers to use the prior lessons or experience to promote ASP into wider acceptance after the cold reception stage. However, recent ASP adoption studies have mainly concentrated on exploring theory-based research, like the comparing of ASP and other conventional IS outsourcing (Smith, Kumar, 2004), service quality factors of ASP vendors(Ma, Pearson, Tadisina. 2005) , the integrative perspective of ASP choice( Jayatilaka, Schwarz, Hirschheim, 2002). What is missing from the existing ASP adoption literature are: 1) A universal theoretical framework specific to ASP adoption; 2) The retrospective analysis of current ASP clients; 3) Empirical assessment based on large sample data. These research topics motivate our study of current Chinese ASP clients to find out their determinants of ASP adoption based on theoretical framework.

To better understand these issues, we developed a conceptual model for ASP adoption based on the technology-organization-environment framework from the technology innovation and
information systems (IS) literature (Tornatzky and Fleischer, 1990). Particularly we combine the TOE framework with two distinct IS outsourcing motivations, IT and business, and Chinese IT implementation features to further identify factors in each of the three contexts. Eleven adoption predictors were identified and corresponding hypotheses were developed. Then we tested them using survey data from 147 current SME clients of several Shanghai local ASP vendors. Data analysis identified key adoption determinants in general, like service quality, infrastructure assurance, vendor reliability, contract pricing, top management orientation, IT capability and industry drive.

2. Conceptual Model
Within the limited literature on ASP determinants, most of studies search for the determinants of ASP adoption based on authors’ cognizance without referring theoretical framework. Such as, Smith and Kuma(2004) explored the process of ASP use from environment, organization and IS management three aspects; Peterson and Fairchild(2003) think the business advantages, service level management, and technical advantages are the motivation of SMEs to adopt ASP. Such taxonomy usually would miss some important factors or induce high correlation or repetition of factors. Drawing upon the empirical evidence combined with the literature review, we believe that the TOE framework is an appropriate theoretical foundation to gain a comprehensive view on the determinants of ASP adoption, as ASP is an IT innovation (Daylami, Ryan, Olfman, 2005). As a useful starting point to study technology adoption, TOE framework has been examined by a number of empirical studies in various IS domains, e.g. EDI (Iacovou et al. 1995, Kuan and Chau 2001), e-business (Zhu et al. 2003) and open source platforms (Dedrick and West 2003). In further, the business and IT motivations of IS outsourcing are introduced to specify the factors of ASP adoption in each context of TOE framework. And the uniqueness of Chinese IT implementation is also considered to define detailed factors simultaneously. Drawing upon the TOE framework and IT and business perspectives of IT outsourcing, we reclassify the factors shown in previous literatures. And Chinese characteristics and authors’ personal understanding and experience of ASP industry are combined at the same time. Finally, eleven factors were identified to address ASP adoption in SMEs (Table 1).

<table>
<thead>
<tr>
<th>Table 1. A two-dimensional approach to identify ASP adoption factors</th>
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<tbody>
<tr>
<td><strong>Technology context</strong></td>
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<tr>
<td>Application Service quality</td>
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<tr>
<td>Infrastructure Assurance</td>
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<tr>
<td>IT capability</td>
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<tr>
<td>Prior IS experiences</td>
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<tr>
<td>ASP market maturity</td>
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<tr>
<td>Environment context</td>
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</table>

Thereby we develop the ASP adoption model which depicted as in Figure 1. The dependent variable in the conceptual model is acceptance degree in SMEs, rather than a mere discrepancy between adoption and non-adoption. A variety of different measures have been used as dependent variables for organizational adoption, like “intent to adopt” when the samples are potential users (K. Zhu, 2003), diffusion and assimilation (Agarwal et al. 1997), diffusion and infusion (Eder and Igbaria 2001, Daylami et al, 2005). Each of these measures has been operationalized in different ways by different researchers. Given the sample of this paper are current ASP clients who already have existed acceptance degree on ASP to represent the exact adoption, actual acceptance of SME would be a convenient and straightforward variable. The acceptance degree is measured by respondents’ evaluation on end users’ acceptance.
3. Research Methodology

3.1 Measurement Design and Content Validation

Based on the theoretical framework discussed above, we designed an initial questionnaire from related literature with the aim to learn ASP clients’ status and consideration when they decided to adopt ASP model. All the factors in the three contexts are measured by adopting or adapting from related literature measurements. After we finished the initial questionnaire, we held a focus discussion to evaluate the appropriateness and clarity of each measurement item based on the definition provided. Six salesmen or presales men from three Shanghai ASP vendors were invited to participate in the discussion. These six participators are those keep touch and communication with related decision-makers of clients before the contracts were signed, therefore, they are the proper candidates to tell us the determinants of clients’ ASP adoption since they had experienced the decision making process of clients most directly. They were asked to evaluate the completeness of listed factors, and each of the items on the questionnaire was reviewed for its purpose, content, clarity of depiction (content validity). Based on the feedback, we revised the measurements, and get the final version made up mostly of 5-point Likert scale questions.

3.2 Data Collection

Our sample is collected from the clients of several main Shanghai ASP companies. The clients of these ASP companies subscribe to many different kinds of applications, ranging from common office services (e.g. website, tax messenger) to enterprise management packages (e.g. OA, CRM, logistics management and ERP). Since our research interest is on those SMEs that have the basic IT applications and evaluate ASP model as an alternative IT development option in high level management application packages, we screened for only those enterprise management application subscribers.

In order to increase the return rate and improve the quality of questionnaire, the survey was executed by telephone interviews given we’ve got all clients phone number from these ASP companies. And the basic information of these clients, like business size and industry, were filled in beforehand with the help of these ASP companies and internet, to reduce the average time of each client’s call. After then, we called the IT managers or related IT staffs, to complete remained questions. We only reached 206 clients among all 234 qualified clients due to the number change or nobody listening, and 147 IT managers or related IT staffs accept our interview and complete the whole questionnaire.

4. Data Analysis and Discussion

A structural modeling approach was chosen so as to estimate the parameters of the research model. We use partial least squares (PLS) to conduct standard estimation procedures for structural equation models. We choose PLS over LISREL for three reasons: (1) due to the insufficiently large sample size used in this study, (2) due to the complexity of the proposed model (number of constructs used) and (3) due to the objective of this study, namely to explore organizations’ adoption of certain technological and managerial innovation.

4.1 Results

R2 reveals that 89.5% of the variance in ASP adoption can be explained by our conceptual model. PLS also shows the support of seven determinants. Results show that four of the
determinants are not supported while the other are supported (See Figure 1). R2 combined with path significances show our structural model satisfied these criteria on the whole, indicating a good model fit with the empirical data and satisficing statistical power.

For technological context, all the four determinants, application service quality, infrastructure assurance, contract pricing and vendor reliability are supported. Application service quality and contract pricing show an extraordinarily significant influence (p<0.01). For organizational context IT capability and top management orientation are supported while prior IS experiences and structural fit are not significant (p>0.1). Top management orientation shows an extraordinarily significant influence (p<0.01). For environmental context industry or supply chain drive is extraordinarily significant (p<0.01) while government promotion and available vendors are not significant (p>0.1).

![Conceptual Model and Regression Results](image)

**Figure 1 Conceptual Model and Regression Results**

### 4.5 Discussions

From the standpoint of TOE framework, our results show that all the three contexts have an explanatory power for ASP adoption in SMEs in China. The factors in the technological context are all supported, indicating a considerable importance of the features of the technology itself to organization adoption. As much of the former research has revealed (Kuan and Chau 2001, Zhu et al. 2003), the technology itself combined with the business model delivering real services is most important in ASP adoption in SMEs. This study further confirmed that when integrated with support services and established as a new business model, a technology is still the most important in determining its adoption.

The organizational context contains two supported factors. IT capability is an internal inhibitor of ASP adoption in SMEs. IS experiences is not supported probably because related experiences such as IS outsourcing and Internet use in operations are not common in SMEs in China. These SMEs are not able to base their evaluation on enough prior experiences and form a general assessment on ASP model, thus can hardly draw experience or lessons from former trials. Top management orientation is particularly significant from the business view while structural fit is
not supported. This reveals that SMEs tend to decide according to their subjective orientation rather than objective conditions.

Much of the former research has not found sound support of environment factors (Zhu et al. 2003). In this study environmental context factors of industry and supply chain drive is supported, showing that SMEs in China are increasingly mature and begin to take IT an industry imitation or be part of the electronic supply chain. Number of available vendors from the IT view is not considered by SMEs probably because the ASP market is rather small in China now and ASP adoption is dependent on the SME’s attitude towards trying new approach. While government promotion is not supported in the full sample, we also find that all the samples of state-run SMEs which adopt ASP give a point of five, which means they strongly agree that government attitude will influence their ASP choice. Government promotion acts in state-run SMEs mainly because financial aids are offered or bureaucratic relationships work in China. So we see SMEs take little consideration in the environment context from the IT view and it is consistent with much of the literature (e.g. Nam 1996).

Our empirical study on Chinese SMEs reveals much about the ASP market in China. Based on the study, ASP vendors should take care of these concerned issues such as application service quality and contract pricing, which facilitates ASP adoption, to improve their businesses. ASP vendors should also make efforts to improve the business model by adapting contracts and conducting propaganda so that the business model can be more fit to SMEs. On the client side SMEs could refer to these key organizational factors such as IT capability and Top management orientation to decide on the ASP option. The environment is also critical.

5. Conclusions

The actual adoption rate of ASP services is experiencing a revival after cold reception by the market and initiates further study interest to guide industry development. To better understand client adoption drivers, we developed a conceptual model for ASP adoption based on the technology-organization-environment framework from the technology innovation and IS literature. The empirical research of current ASP clients’ considerations and status during their pre-adoption period shows, all the three contexts of TOE framework have an explanatory power for ASP adoption in SMEs in China. Some Chinese features in ASP adoption are pointed out in discussion.

Due to the present market size and other practical reasons, there are some limitations in this study. First the factors listed in this study may not cover all the concerns in ASP adoption. We need to answer whether there are any other factors which may be important by applying other theories or perspectives. Second the sample in this study is satisficing but not sufficient. Even larger samples may be needed to apply comprehensive data analysis tools so that not only hypothesis support but also model fit can be displayed. Third we only survey the Chinese SMEs and most of them are Shanghai local firms. We need support from and comparison with sample in other country contexts.

Reference

The list of references is available upon request to the authors.
Improving Business Models with Rule Extraction and Sampling

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Abstract
For many business applications, one must be able to accurately distinguish between various types of customers. For example, within the domain of credit scoring, financial institutions will create predictive models to forecast whether a particular client will be able to pay back or default on his/her loan obligations. The predictive model will then be used by the financial institution to decide on new loan applications. Research has shown that modern data mining algorithms, like neural networks and support vector machines, are often able to achieve a superior performance on such problems when compared to more traditional techniques. However, the lack of explanation capability prohibits their adoption for various business problems as comprehensibility of the model is hereby often a crucial requirement. In this paper, it is investigated how one can create models that are comprehensible but at the same time offer the desired level of accuracy.

Keywords: Knowledge Management, Data Mining, Rule Extraction

1. Introduction
Various benchmarking studies have shown that newer machine learning techniques, like artificial neural networks or support vector machines, are able to provide very accurate forecasts for particular business problems (Baesens et al., 2003). For example, based on a data set with past applications, financial institutions will construct models to predict whether a particular applicant will be able to pay back the loan or will default on his/her loan obligations. Such models are then used by the financial institution to decide about acceptance of a new application (credit scoring). Similarly, insurance companies use the above techniques to predict whether a particular claim is likely to be fraudulent or not. The claims receiving the worst rating by the model are then subjected to further investigation before the insurer pays out the loss. By directing the limited resources towards the claims that are most likely to be fraudulent, the insurer will use these resources more efficiently and be able to detect more fraudulent claims per investigator.

For the above problems, accuracy of the predictions is probably the most important aspect to determine which model to use. However, interpretability of the model is often equally important, i.e. one must be able to understand how this model comes to a particular decision. For example, in the domain of credit scoring and to avoid discrimination, financial institutions are often legally required to be able to explain why a particular credit decision was made. Indefinite and vague reasons for denial are illegal. An explanation like `because our model says so' is therefore clearly not acceptable. For such applications, rule induction algorithms, which return a set of rules, or decision tree learners are therefore often the preferred choice as they can offer this desired level of interpretability. However, in various studies it has been shown that the accuracy of the models created by these algorithms is often inferior to the performance that can be achieved by black box models, like neural networks or support vector machines. It seems that the analyst is faced with a dilemma between performance and interpretability. He/she has to choose between either a model that is accurate but incomprehensible or elsewise for a model that is less accurate but for which the decision process can be explained and understood. However, rule
extraction can be performed to have the advantages of both approaches (Andrews et al., 1995; Huysmans et al., 2006). The goal of rule extraction is to extract a set of rules from a black box model, such as a neural network, which approximate the decision boundary of the black box as closely as possible and provide a more comprehensible representation to the end users at the same time.

In this paper, we first show with a small example one approach to rule extraction (RE). During the extraction process, artificial examples are created to make it easier to extract rules that closely match the black box decision boundary. In section 3, some different sampling techniques are discussed. In the final section, these different sampling techniques are used in combination with CART decision trees to extract rules from various real-life data sets. It is shown that the above approach can create models that are able to accurately distinguish between the different classes and that are also comprehensible.

2. An Example of Rule Extraction

One of the most straightforward approaches to convert a black box model into a set of equivalent rules, is running a rule learner on the original data set with the class labels replaced by the black box forecasts. By replacing the original class labels with the class labels predicted by the black box, one can filter out some of the noise that is present in the original data. An example is shown in Figure 1a, in which the Ripley data set is shown together with the decision boundary found by a black box model. For all points above this decision boundary, the black box model will predict the class label to be 1 (°) and for all other observations the predicted class will be 0 (+). One can observe that there is some noise present in the Ripley data set, various observations of one class are surrounded by a large number of observations from the opposite class. By replacing the class labels of these misclassified observations, i.e. removing the noise, it becomes easier for a white box learner to construct a model that approximates the black box decision boundary closely.

To ensure that the white box learner will mimic the decision boundary of the black box model even more, one could also create a large number of artificial examples and then ask the black box model to provide the class labels for these sampled points. An example of this approach is shown in Figure 1b. For this figure 10,000 artificial examples were created according to the distribution of the original Ripley data. The created samples are then given the class label that is predicted by the black box model. The decision tree that is learned on these artificial points will closely approximate the black box decision boundary, i.e. its fidelity will be high (Huysmans et al., 2006), and therefore show a similar level of accuracy on a separate test set. The performance is better than if we would just have learned the decision tree on the original training data. Thus by creating additional examples, we were able to find a model that is both comprehensible and performant.

In the next section, we discuss various approaches that can be used to create the required artificial examples. Afterwards, these different sampling methodologies are evaluated on a number of real-life data sets.

3. Sampling Techniques

In this section, we present the three sampling techniques used in this study, namely random sampling, sampling based on the marginal distributions and a sampling procedure that is similar to random sampling, but in which the samples are only included if they lie close to one of the original training observations.
3.1 Random Sampling (RS)
Random sampling is probably the most straightforward sampling methodology possible. Based on a set of training observations, the procedure will generate new examples as follows. First, if a variable is categorical, new samples will randomly select one of the values that appear in the training data. For this selection, the procedure does not take into account the actual distribution of these values. For the numerical variables, a value for each sample will be generated by choosing a random value within the interval defined by the lowest and highest value observed within the training observations. For the training data in Table 1, the procedure will therefore generate samples as follows. For ‘age’ and ‘income’ new values are randomly selected from the intervals [24,29], [10.000,19.000] and for the categorical variable ‘sex’ a new sample will have a 50% probability of being assigned male or female.

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Income</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>26</td>
<td>10.000</td>
<td>M</td>
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<td>14.000</td>
<td>F</td>
</tr>
</tbody>
</table>

Table 1

3.2 Sampling based on Marginal Distributions (MD)
It is clear that the random sampling methodology fails to take into account the actual distribution of the data and is also heavily influenced by outliers. In this second approach, values for each variable are created according to the actual distribution of the training data for that variable. For categorical variables, the marginal distribution can easily be obtained from the empirical frequency distributions. For the variable ‘sex’ in Table 1, this procedure will therefore assign the values male/female to the samples in a ratio of 2/1. For continuous attributes, it will first estimate the marginal distribution of the attribute by a kernel density estimate. The actual samples are then created according to this estimated distribution.
3.3 Random Sampling with Critical Distance (RS-CD)

One disadvantage of creating new samples with both of the sampling methodologies described above is that they will often generate samples that deviate strongly from the existing training points. To ensure that the newly created samples accurately represent the original data, one could however discard the samples that lie too far from one of the original observations. More specifically, this third sampling method will discard each sample that lies beyond some specified critical distance. To find an appropriate value for this critical distance, we follow the approach of Schmitz (1999). For each training point, we first calculate the mean distance between that observation and its 10 nearest neighbors. The average over all training observations is then used as the critical distance. By using this approach, we will ensure that all created samples lie near one of the existing observations.

4. Empirical Evaluation

In this section, the above sampling approaches are used to create artificial observations for various data sets. These data sets are obtained from the well-known UCI repository (Newman, 1998) and originate either from medical applications (Wisconsin and Indians) or from credit scoring (German), domains where comprehensibility is a key requirement. All data sets contain observations from 2 different classes with good/bad distributions of 625/625 for Ripley, 458/241 for Wisconsin, 500/268 for Indians and 700/300 for German.

<table>
<thead>
<tr>
<th>Sampling Amount</th>
<th>CART</th>
<th>RS</th>
<th>MD</th>
<th>RS-CD</th>
<th>CART</th>
<th>RS</th>
<th>MD</th>
<th>RS-CD</th>
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<td></td>
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<td>74.69(4.90)</td>
<td>72.25(5.90)</td>
<td>71.83(5.80)</td>
<td>Not Appl.</td>
<td></td>
</tr>
<tr>
<td>1</td>
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<td>77.15(12.80)</td>
<td>75.04(14.10)</td>
<td>76.13(10.40)</td>
<td>71.80(10.80)</td>
<td>72.58(7.80)</td>
<td>Not Appl.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>76.33(53.30)</td>
<td>75.86(28.30)</td>
<td>77.58(43.30)</td>
<td>73.21(45.90)</td>
<td>72.34(40.60)</td>
<td>Not Appl.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Out-Of-Sample Accuracy and Number of Leafs (averaged over 10 trials) (RS=Random Sampling, MD= Sampling based on Marginal Distribution, RS-CD= random Sampling with Critical Distance)

For the experiments, we randomly divide each data set 10 times into a 2/3 training and 1/3 test data set. For each of the training data sets, we learn both a CART decision tree (Breiman et al., 1984) and a black box model, namely a least-squares support vector machine (Suykens et al., 2002). Parameters for the RBF-kernel of the LS-SVM were selected with a basic gridsearch procedure. For the selected data sets, performance of the black box models was always better than the corresponding decision trees (Table 2). To improve the accuracy of the CART trees, we will train them on a combination of the original data and additionally generated examples. The number of extra samples depends on the number of training observations and is varied between
0.1 and 10 times this number. For example, because the Ripley data set contains 833 training observations, a sampling amount of 10 will result in the creation of 8330 additional examples. From the out-of-sample results in Table 2, we can conclude that the creation of artificial examples, can indeed improve the predictive accuracy of the CART decision trees. We do not observe clear performance differences between the three sampling methods. However, for all approaches, we can observe that the complexity of the created trees increases with the number of additional samples. For example, whereas the accuracy of the CART tree trained on the Ripley data set improves from 88.44% to more than 90%, the number of leaf nodes also drastically increases from 4.10 to more than 30. For practical applications, a domain specialist will have to decide about whether the improved accuracy weighs up against the reduced comprehensibility.

4. Conclusions
In this paper it was discussed how the creation of artificial examples can improve the accuracy of a decision tree. By creating artificial examples and labeling them according to the predictions of a black box model, one can obtain decision trees that are both accurate and comprehensible. The trees will also approximate the decision boundary of the black box model and can therefore be used to verify and validate the knowledge contained within. The empirical evaluation of the different sampling approaches on a number of data sets shows that the above approach is promising, but it remains undecided which sampling technique is best for a particular data set. Additionally, we have also observed that the creation of a very large number of artificial examples only results in more complex trees with little or no additional accuracy. More research is required to decide about the optimal number of generated points.

References

Process Based Business Reporting (PBBR): A Framework to Integrate Business Reporting into Business Processes

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Abstract
Due to the complexity of financial reports, companies are investing a great amount each year in business reporting activities. Recent trends towards using XBRL (eXtensible Business Reporting Language) to communicate financial data further increase the cost. Today, many companies have deployed business process management systems (BPMS) to automate their daily operations, where rich financial data are being handled. In this paper, we present a Process Based Business Reporting (PBBR) method to automatically generate financial documents by leveraging XBRL and BPMS. Our approach can greatly reduce the cost and improve the efficiency of business reporting and also lead to more accurate and trackable financial documents. We illustrate and validate our idea via a prototype system and present a number of research opportunities for this emerging research area.

Keywords: Business Process Management, Business Reporting, XBRL, XML

1. Introduction
Business reporting is an integral and important part of companies’ fundamental activities. Business statements formally record a business’s financial activities, profitability, internal control, and regulatory compliance, which include a large amount of complex financial data often in many different formats serving different purposes, including 10-K, 10-Q, and 8-K fillings (www.sec.gov). Filling financial statements usually happens at the end of each quarter and each year, where laborious and costly processes of manual entry, consolidation, and comparison of financial data are conducted (Willis et al. 2006).

In order to facilitate the reuse, exchange, and analysis of information contained in lengthy text-based financial reports, eXtensible Business Reporting Language (XBRL), an XML-based open standard has been proposed to tag individual items within financial documents (Baldwin et al. 2006). As a result, the reported financial information can be automatically accessed, validated and used within analytical models by computer software (Willis et al. 2006). Since its inception in 2000, XBRL has been adopted by many corporations, including Microsoft, Morgan Stanley, and EDGAR, and many countries, including the United States, China, Japan, and the United Kingdom. However, current XBRL fillings are usually the result of converting text-based financial statements, which does not reduce the cost of manual preparation processes as aforementioned (Bovee et al. 2005).

Business process management systems (BPMS) have been deployed by many organizations to automate their operations (Stohr et al. 2001). BPMS also serve as the integration hub that connect and coordinate different enterprise systems, such as ERP, CRM, and SCM (Basu et al. 2002). Thus, a tremendous amount of financial data is produced, consumed, and managed by BPMS, where the process context of financial activities, such as who, when, how, and where an event is recorded. In addition, process context can provide control and assurance information currently lacking in financial reporting. Although process context information is very important to the traceability and accountability of business reports, very little research has been reported on incorporating process context information into financial statements and leveraging BPMS to improve business reporting, resulting in a gap between commercial needs and academic research.
In this paper, we aim to bridge the gap by proposing a Process Based Business Reporting (PBBR) framework, where business reporting is integrated with business processes by leveraging XBRL and BPMS. PBBR can greatly reduce the cost of financial statement preparation by automatically generating XBRL financial documents from real-time process instances, and help enhance the traceability of financial data entries. In particular, our contributions are three-fold: 1) proposing a methodology for automatic business reporting based on process management, 2) increasing traceability and accountability by adding process context for financial data, 3) identifying a number of future directions for this emerging inter-disciplinary research area.

The rest of the paper is organized as follows. We present PBBR framework in details in Section 2 and validate it via a prototype system in Section 3. Then, we discuss some further research directions in Section 4 and conclude our research in Section 5.

2. Process Based Business Reporting (PBBR)
In this section, we discuss the details of process based business reporting. First, we present a purchase requisition process, which we use to illustrate some of our research concepts.

2.1 A Purchase Requisition Process

Figure 1 shows a purchase requisition process as a UML activity diagram. The process starts when an employee submits a purchase requisition request. Then his/her supervisor must approve it. After that based on the requested amount, additional controller and general manager approvals may be needed. If the request is not approved, a disapproval notification email is sent to the requester. Otherwise, the purchase request is forwarded to the purchasing department. Once an ordered item is received, an item received notification is produced. This process includes financial transactions and business controls that can directly affect the business reports of an organization.

As discussed in section 1, although both XBRL and BPMS have been widely adopted, very few applications and research efforts have been found that focus on integration of both technologies to improve the state of the art of financial reporting, which may due to a number of challenges as we present next.

2.2 Challenges of Integrating Business Reporting with Business Processes

Challenge 1: How process information can help business reporting has not been well understood.

From an accounting point of view, financial statements are based on the results of financial activities and do not include information about which process those activities belong to. In this paper, we argue that adding process information to financial data can increase the traceability and accountability of financial reports. For example, in the purchase requisition scenario, without process information we can only conclude that “John bought a $2000 laptop.” However, after considering process context, we can conclude that “John requested a $2000 laptop, which was
approved by his supervisor Tom and the controller Mary, and was bought by Greg from the Purchasing department”.

**Challenge 2**: What process information should be included in financial reports has not been studied.

Knowing the importance of process information to business reports is not enough. In order to prepare business reports, we need to know exactly what process information is relevant. For instance, it may be obvious that task name, starting time, and ending time are relevant to financial data. However, what other process information is needed remains an open question. Therefore, we argue a process taxonomy for business reporting is necessary and in demand.

**Challenge 3**: Extracting process information from business process management systems and integrating it with financial data imposes technical challenges.

Process information such as process name, task name, duration, etc., is stored internally by the business process management systems. What process information can be retrieved largely depends on what APIs BPMS vendors provide. In addition, different vendors usually have different formats to store process information, making the integration of process information with other financial information difficult.

Next, we present our Process Based Business Reporting framework and show how PBBR strives to address the three challenges above.

**2.3 A Framework for Process Based Business Reporting**

Figure 2 shows the framework for Process Based Business Reporting (PBBR), which includes three major components as discussed below:

1. **A process taxonomy for business reporting**. Aiming to address challenges 1 and 2, we develop a process taxonomy to add process context information to financial data as shown in Table 1. This taxonomy contains process information that is relevant and important for business reporting, which is expressed as an XML Schema. Our taxonomy serves as an extension to existing XBRL taxonomies. The completeness of this taxonomy needs to be further validated in future research.

2. **An XML machine agent**. This agent is used to extract process information from a process engine via APIs and integrate it with financial data supported by XBRL taxonomies and our PBBR process taxonomy. The agent should be flexible enough to communicate with different process engines and handle different taxonomies.

3. **A set of PBBR documents automatically generated by the XML machine agents**. These PBBR documents contain two sections: one section includes information on financial data tagged with existing XBRL taxonomies and the other section includes associated process information tagged with our PBBR taxonomy. These tagged documents can be automatically incorporated into business reports by computer software.

PBBR provides a solution to the challenges aforementioned and its uniqueness and benefits can be summarized by the following three propositions, which are validated next via the development of a prototype system.

**Proposition 1**: PBBR can reduce the cost and improve the efficiency of business report preparation by building reporting functions into real-time processes.

**Proposition 2**: PBBR can enhance the traceability and accountability of business reports.

**Proposition 3**: PBBR has minimal impact on process efficiency and is transparent to the end users.
Table 1. Process Taxonomy for Business Reporting

<table>
<thead>
<tr>
<th>Name</th>
<th>Explanation</th>
<th>PBBR Process Taxonomy (XML Schema)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProcessName</td>
<td>The name of the process</td>
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</tr>
<tr>
<td>ProcessID</td>
<td>Unique ID to identify a process</td>
<td><code>&lt;xs:element name=&quot;ProcessID&quot; type=&quot;xs:string&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
<tr>
<td>ProcessInstanceID</td>
<td>Unique ID to identify a process instance</td>
<td><code>&lt;xs:element name=&quot;ProcessInstanceID&quot; type=&quot;xs:string&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
<tr>
<td>ProcessStartTime</td>
<td>Start time of a process instance</td>
<td><code>&lt;xs:element name=&quot;ProcessStartTime&quot; type=&quot;xs:dateTime&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
<tr>
<td>ProcessEndTime</td>
<td>End time of a process instance</td>
<td><code>&lt;xs:element name=&quot;ProcessEndTime&quot; type=&quot;xs:dateTime&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
<tr>
<td>TaskName</td>
<td>The name of the task</td>
<td><code>&lt;xs:element name=&quot;TaskName&quot; type=&quot;xs:string&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
<tr>
<td>TaskOccurrence</td>
<td>Number of task executions in one process instance</td>
<td><code>&lt;xs:element name=&quot;TaskOccurrence&quot; type=&quot;xs:string&quot;/&gt;</code></td>
</tr>
<tr>
<td>TaskStartTime</td>
<td>Start time of a task instance</td>
<td><code>&lt;xs:element name=&quot;TaskStartTime&quot; type=&quot;xs:dateTime&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
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<tr>
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<td>End time of a task instance</td>
<td><code>&lt;xs:element name=&quot;TaskEndTime&quot; type=&quot;xs:dateTime&quot; minOccurs=&quot;1&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
<tr>
<td>TaskRecipient</td>
<td>Recipient of the task</td>
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</tr>
<tr>
<td>TaskExecutor</td>
<td>Actual executor of the task</td>
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</tr>
<tr>
<td>ProcessComment</td>
<td>Additional process information</td>
<td><code>&lt;xs:element name=&quot;ProcessComment&quot; type=&quot;xs:string&quot; minOccurs=&quot;0&quot; maxOccurs=&quot;1&quot;/&gt;</code></td>
</tr>
</tbody>
</table>

Table 1. Process Taxonomy for Business Reporting

3. Validation: A PBBR Prototype System

We use a commercial-off-the-shelf business process management suite, named Ultimus BPM Suite © (www.ultimus.com), as our development platform. We automate the purchase requisition process in Figure 1, and add XML machine agents after tasks that have impacts to financial reports and business control as illustrated in Figure 3. Those agents are transparent to end users and can complete their executions within a few seconds, which has minimal impact on process efficiency. Financial documents are generated in real-time based on XBRL and PBBR taxonomies, as opposed to costly manual quarterly or annual report preparation. Given the page limit, we could not show more implementation details.

The development of this prototype system validates our approach by supporting the three propositions defined previously. It also allows us to discover some limitations of existing tools and other interesting research questions as discussed in the next section.

4. Research Directions

Process based business reporting is a new research area, more research efforts are imperative to move this research domain forward. Some research directions are briefly discussed as follows:
• Qualitative and quantitative validation of the process based business reporting methodology. The prototype system only demonstrates the feasibility of the PBBR approach. Additional formal validation is needed for broader PBBR adoption and application.
• Comprehensive criteria for deciding where a business reporting function should be inserted in processes. Machine agents should only be inserted after tasks that affect business reports. Given large-scale processes with hundreds of tasks, formal criteria need to be developed to guide the decision making on where to incorporate a business reporting function.
• Process engine design. During our implementation, we found that Ultimus© provides limited APIs for accessing internal process information. For example, we cannot get task starting time, ending time, and task executor information out of the box. This implies that process engines should be designed to be more open and the process information included in the PBBR taxonomy should be the minimal set of information that can be accessed by process designers.
• Inter-organizational process based business reporting. Currently, PBBR only applies to an intra-organizational setting. Given trends towards process outsourcing, how to combine PBBR with other open process specifications, such as BPEL (Business Process Execution Language), to make PBBR applicable across organization boundaries, is another interesting topic.

5. Conclusions
In this paper, we present an innovative business reporting method named Process Based Business Reporting (PBBR). We demonstrate how PBBR can benefit business reporting by leveraging XBRL and BPMS technologies. A prototype system is developed to validate our approach and a number of research directions are proposed to stimulate more research endeavors. Our research contributes to both business reporting and process management research and is also of great practical value.

References
An Analysis of Real Options Theory in IT Investments

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Abstract
The application of real option theory in IT investment is one of the important topics in the IS field and although various studies have been conducted for two decades, there is little review about it. The main contribution of this paper is: (1) it is the first paper to outline past research methodology within this topic and highlight the knowledge gaps; (2) compare the problems and the methods in previous research; (3) propose new directions for the future research.

Keywords: Option theory, IT investment, evaluation

1. Introduction
Though well aware of, “productivity paradox” of IT is still a phenomenon frequently appearing in all types of enterprises. Since the increase in productivity is always accompanied by huge investments, the decision and management of IT investment is critical for maintaining the competitiveness and the long-term development of an enterprise. The application of real option analysis (ROA) in IT investment is one of the important topics in the IS field. Real option is derived from the definition of finance option. The underlying concept of it is to view opportunities as options to take actions in the future, which coincides with the characteristics of IT projects, in which future investment may have many options after the first stage or a pilot stage is implemented. Although various studies about the application of ROA in IT investment have been conducted for two decades, there is little review about it, which really motivates this research. In this paper, the previous application of the ROA in IT investment will be reviewed beyond the confine of research methodology, time or geographic region and their methodology will be analyzed. The main contribution of this paper is: (1) it is the first paper to outline past research methodology within this topic and highlight the knowledge gaps; (2) compare the problems and the methods in previous research; (3) propose new directions for the future research.

2. Literature Review
Papers were chosen from the top journals in IS field, and their references and papers citing them were also examined. The purpose is to examine the future direction of the application of ROA in IT investment; therefore, papers of the application to software development, software prototyping or other innovations were eliminated. The authors analyzed the literature according to its application in different sub-topics in IT investment, including IT project valuation, IT investment timing, IT project management. Furthermore, the research investigated the relationship between different topics and research methodology. In order to guarantee concept-central and method-central, two dimensions, sub-topics and research methodology were chosen, forming 12 categories.
2.1 Real Option Theory

Real option aims to identify and specify real options embedded in strategic investments, not in contracts. As an extension of financial option theory to real assets, it offers an asset owner with embedded flexibility the possibility but not the obligation. The owner can obtain the benefits of the underlying asset by investing a given cost at a certain time points (Taudes 1998; Taudes et al. 2000). From the perspective of real option, uncertainty is no longer a disadvantage, but an opportunity given a flexible management. It coincides with the characteristics of new technology investment (Li & Johnson 2002), especially when expensive projects are completed in several stages with small investments first, followed by bigger investments. This can avoid unnecessary risk and providing more time for organization learning. The initial stage which is primarily intended for resource planning and project tracking will, at the same time, create more alternatives for future decision, establishing the options for the second stage: to abandon, or change scale, or switch to other utilities.

Once the option is established, then it needs to be evaluated. Option pricing model is used to assess the price of a financial option, such as Margrabe’s exchange option model, Binomial model, Black-Scholes (B-S) model, and their extensions, in which B-S model is by far the most popular one because of its simplicity. It can easily calculate the value of a call option using the following formula with only five parameters.

\[
C = SN(d_1) - Xe^{-R_f(T)}N(d_2)
\]

\[
d_1 = \left( \ln \left( \frac{S}{X} \right) + \left( R_f + \frac{\sigma^2}{2} \right) T \right) \frac{1}{\sigma \sqrt{T}}
\]

\[
d_2 = d_1 - \sigma \sqrt{T}
\]

Where:
- \( C \) — value of a call option;
- \( S \) — value of option's underlying risky asset;
- \( \sigma \) — volatility, the standard deviation of the expected rate of return on \( S \);
- \( X \) — option's exercise price;
- \( R_f \) — the risk-free interest rate;
- \( T \) — option's time to maturity or expiration; and
- \( N (d_1) \) is the standard normal distribution function and \( i \) the index of \( d \), the substitute variable.

2.2 The Application of ROA in IT Investment

The option pricing models were introduced into IS field to evaluate the real options brought by new technologies. Although the application in real option may violate the original assumption, they still can provide a different perspective of uncertainty to IT project managers by quantitative analysis. In addition, due to their flexibility, those models can be used to solve kinds of problems in project management besides the simple option valuation. In general, the application of ROA in IT investment can be classified into three categories, IT project valuation, IT investment timing and other IT project management.

2.2.1 IT Project Valuation

IT project valuation refers to the valuation of an IT investment, that is, whether the firm should or should not invest on a certain IT project. In 1991, DosSantos pioneered to valuate an IS project using Margrabe’s exchange option model. He argued that the project will generate new option to use the new techniques in case it turns out helpful (DosSantos 1991). Taudes (1998) investigated ways of evaluating different software growth options via applications of real option models, including sequential exchange option, Margrabe’s exchange option, B-S model, Geske’s
formula for a compound option (Taudes 1998). Their research lays the foundation for valuing software platforms.

Kambil et al. (1993) used binomial option pricing model to evaluate a pilot project, whether or not it should be undertaken. The study indicated that the option value of the smaller pilot project will exceed its cost; therefore it should be undertaken (Kambil et al. 1993). Later, Taudes et al. (2000) applied B-S model into a real-life decisions case, they compared different valuation techniques, NPV, decision tree-based NPV, and option pricing model, and discussed their respective advantages and drawbacks. They demonstrated the practical advantages of employing option pricing models in the case studies (Taudes et al. 2000).

Kambil (1996) found unlike the financial option, real option values could either increase or decrease with increase in project risk (Kumar 1996). Later, he differentiated between risks that can be resolved by action and risks that require hedging and presented a framework for assessing the business value of information technology infrastructure (Kumar 2002; Kumar 2004). Some frameworks or models derived from ROA appeared to help to evaluate the IT investment. For example, a framework of strategic actions (Kim and Sanders 2002), models for the entry and exit options of the market (Singh et al. 2002), and models accounting for uncertainty both in the costs and benefits associated with the investment opportunity (Schwartz & Zozaya-Gorostiza 2003), etc.

2.2.2 IT Investment Timing

In some cases, the concern is not on the adoption decision, but the adoption time. IT investment timing refers to the optimal time for a certain IT investment, which can return the highest value. It is an extension of IT project valuation based on the calculation of the option value to solve the timing problem by comparing the value of the project in different timings, choosing the optimal one. McGrath (1997) argued that the boundary condition and uncertainty will influence the timing of the technology investment (McGrath 1997). Benaroch and Kauffman (1999; 2000) studied the timing issues of the technology deployment in a real environment. The particular network infrastructure of Yankee 24 in New England brought itself the options on the expansion of the point-of-sale debit services. When to exercise the option? They applied the B-S approximate to solve this problem and get the empirical confirmation. Their studies gave a formal theoretical grounding for the validity of B-S model in evaluation of IT investments (Benaroch and Kauffman 1999; Benaroch and Kauffman 2000).

Later, researchers extended the application scope of ROA to the e-commerce investment and the results indicated that the optimal timing of investment in e-commerce depends on uncertainties of future cash flows and the opportunity costs (Chang and Hung 2006). The effect of the technology properties on the adoption timing of IS were also found -- whether a new technology can bring very-high positive cash flow immediately after system implementation was proved to be the main determinant for the adoption time by numerical analysis (Campbell 2002).

From another perspective, Kauffman and Li (2005) analyzed the timing strategy for a firm that is deciding about whether to adopt one or the other of two incompatible and competing technologies. A continuous-time stochastic model was developed to determine the optimal timing for managerial adoption within the framework of ROA. The result suggested deference of a technology investment until its probability to win out in the marketplace and when the critical mass reaches a critical threshold (Kauffman and Li 2005). Zhu and Weyant (2003) tried to integrate game-theoretic models of strategic market interactions with a real option approach to analyze the investment decision of IS. Both the timing and ordering were included into the model.
Their results show competition leads to early exercise and aggressive investment behaviors (Zhu and Weyant 2003).

2.2.3 Other IT Project Management
Besides IT project valuation and IT investment timing, there are some other application of ROA in IT project. Keila and Flatto (1999) examined escalation of commitment using options theory. They argued that traditional theories of escalation behavior give an incomplete picture. The paper applied options theory to show that some projects that might otherwise be viewed as cases of unwarranted escalation, actually involve situations in which escalation is warranted. The options theory perspective offers new theoretical insights that challenge the traditional assumptions and yet complement existing theories regarding escalation behavior (Keila and Flatto 1999). Fichman et al. analyzed several kinds of option with real cases. They argued that real options are not only a new approach to evaluate IT investments, even the determination of IT investment timing, but also provide a new way of thinking about how to manage and structure IT projects (Fichman et al. 2005). A conceptual model was developed of the determinants of option value associated with IT investment. The effect and the interaction of the factors, technology strategy, organizational learning, innovation bandwagons and technology adoption, on the option value were studied (Fichman 2004).

Grenadier and Weiss (1997) developed a model of optimal investment strategy for a firm confronted with a sequence of technological innovations using ROA. The model yielded four investment strategies: laggard, leapfrog, compulsive, and buy-and-hold (Grenadier and Weiss 1997). Another framework was provided to justify the application of the ROA in IT investment based on two criteria: technology switching costs and the nature of competition, forming four categories. The author argued that different real options models should be adopted for each category and they also studied their argument with a real case (Li and Johnson 2002).

McGrath (1997) extended ROA to technology positioning projects and addressed that the option value can be amplified by investments to shift boundaries, ideally in ways that are idiosyncratic to the firm (McGrath 1997). In his following research, McGrath examined the initiation of the technology positioning investments using ROA and provided a method to access uncertain projects that approximates option value through scoring a series of statements. The approach integrated both technological and strategic considerations (McGrath 2000).

Risk management is another topic in project management. Dewan et al. (2005) investigated the risk-return relationship of IT investment and showed that IT capital investment makes a substantially larger contribution to overall firm risk and IT return are associated with a substantial risk premium (Dewan et al. 2005). Benaroch (2001) proposed a methodology for planning the creation of specific operating options designed to maximize the value of a technology investment in light of the risks underlying that investment (Benaroch 2001) and later presented an approach for managing IT investment risk to help to rationally choose which such options so as to optimally control the balance between risk and reward (Benaroch 2002). Together with other researchers, he validated the risk-option mappings for choosing the particular real options embedded in an investment to control risks by empirical testing from 50 IT investments and showed the use of formal real option models to control risk is still needed to supplement (Benaroch et al. 2006).
2.3 The Distribution of Previous Studies
We examined the distribution of previous studies we searched in journals from 1991 to 2007, of the application of ROA to IT investment, and tried to investigate the relationship between different topics and research methodology. The subtopics used are the same as those previously mentioned. The methodology part consists of descriptive study, modeling, and empirical study, in two main approaches: case study and survey. The distribution is illustrated in Table 1. There could be more than one category of subtopics or methods in one paper, thus the total exceeds the number of papers used.

<table>
<thead>
<tr>
<th></th>
<th>Descriptive Study</th>
<th>Modeling</th>
<th>Case study</th>
<th>Empirical study</th>
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<td>58</td>
</tr>
</tbody>
</table>

Table 1. The distribution of previous studies

3. Conclusion and Implication
The research about the application of ROA in IT investment is somehow limited, only around 40 papers in the past 17 years. One reason for this phenomenon probably is that researchers are not familiar with the option theory. The financial models are hard for IS researchers to handle or to reconfigure to evaluate the option value of an IT project. It is also possible that many researchers still doubt whether the assumption of the model can be realized in IT investment.

The distribution of the IT project evaluation and IT project management is quite balanced with the number of paper 26 and 22 respectively. However, research on IT investment timing needs more emphasis of researcher. The distribution of the methodology, including descriptive study, modeling and empirical study is evenly spread. One interesting finding is that there is little empirical study in IT project management and only one study found on this topic are conducted by survey, which is a widely used research method in empirical study. For IT project evaluation and IT investment timing research, the purpose is to examine a certain case in a specific environment using option pricing models. Therefore, case study is the main empirical method. However, for IT project management, the research topics are much broader, not focusing on a specific situation. However, only 3 empirical studies have been performed. Actually, the findings provide us a very clear future research direction.

For future work, we proposed three different research directions. Although researchers have achieved a lot in the validation of the application of the option pricing model in IT investment projects (Tallon et al. 2002), it still needs to be explored, which will clear more hindrance and enhance the research in this area. The second research direction is to keep working on the investment timing issue using real option theory and game theory. Now investment timing is becoming more and more critical among the rivals in such a competitive age. The research in this direction will have both academic values and practical values. To confirm the previous conceptual research, using empirical methods such as survey, is our third advocate to IS researchers in the future. Till now, most of the research of ROA in IT investment is embedded or hypothesized. Scientific and systematic research needs confirmatory studies to build the theories.

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Real Options Analysis of the Community Source Approach: Why Should Institutions Pay for Open Source?
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Abstract
Community source development has emerged as a new way for institutions to develop new applications that are either not available or too expensive to acquire. One of the interesting questions is whether or not an institution should pay a significant amount of partnership fee in order to join the development community, considering the community output will become open source in the end. In this paper, we strive to understand this question in the context of a real world case, the Kuali project using a real options analysis and the Black-Scholes model. We summarize the main findings of our analysis into several observations and propositions, which will be validated in our future research.

Keywords: Real options analysis, Community source, Black-Scholes, Kuali case, Open source

1. Introduction
Community source has emerged as a new way for institutions to develop applications. Community source approach is a unique form of open source approach, in which application developers are employees designated to the project by the partner institutions. The key difference between community source and open source is the significant investment by development partners in the former. The community source approach is important because it provides a viable alternative by combining features of in-house development and outsourcing. As such, community source deserves the attention of MIS researchers.

The critical decision for each institution is therefore whether or not it should pay a significant amount of partnership fee in order to join the development community, which we refer to as the community investment decision. The decision to invest seems to be counterintuitive since the result of the development community will become open source in the end, thus free for adoption.

In this short paper, we strive to provide the rationale that can provide some guidance with respect to this decision. We do so in the context of a real world project named Kuali, which has been referred to as community source because it is an open source project developed by a community of eight major universities plus one software vendor (www.kuali.org). The goal of Kuali is to share resources from multiple universities to minimize development risk and financial burdens.

The approach we use in this paper is based on real options analysis (ROA) originated from the field of investment finance, which have been adopted by MIS researchers for IT investment analysis. Our main research contribution is to apply ROA in the context of community source. In particular, we use the Black-Scholes (BS) model to understand how institutions might think about the community investment decision.

The remainder of paper is structured as follows. In Section 2, we review briefly the literature of ROA and the BS model. In Section 3, we introduce the Kuali case as a community source project. In Section 4, we study various real options that could be applied in the community source approach. In Section 5, we summarize our research findings into several
observations and propositions. In Section 6, we outline our contributions and future research directions.

2. Brief Literature Review
In recent years, the use of Real Options Analysis (ROA) to support IT investment decisions has been investigated in the MIS literature. In contrast to financial options, a real option is not tradable. Real options can greatly affect the valuation of potential investments. However, valuation methods, such as Net Present Value (NPV), do not include the benefits that real options might provide (Trigeorgis 1996). The main benefit of ROA is that it offers more correct valuation compared to traditional capital budgeting techniques like NPV (Benaroch 2002). Taudes et al (2000) compared different valuation techniques of implementation opportunities. An application that can be implemented on a specific software platform offers the firm the opportunity to obtain the benefits of the application by investing on a given implementation at certain decision points.

Benaroch (2002) presented an approach for managing IT investment risks that helps to rationally choose which options to deliberately embed in an investment so as to balance between risk and reward. The author recognized that IT investments can embed various types of real options, including: defer, stage, explore, alter operating scale, abandon, lease, outsource, and growth. In this paper, we specialize these real options to the case of Kuali.

One of the basic models for pricing financial options is the Black-Scholes model (Hull 1993). The Black-Scholes model is a closed-form formula that computes the price of a European call option for a risk-neutral investor (Benaroch et al. 2000). In this paper, we use the Black-Scholes model to explain why an institution might be willing to pay for developing the open source.

3. Community Source Development: the Kuali Case
Kuali is an example of community source (www.kuali.org), starting with the conversion of the Indiana University’s Financial Information System to the web in 2004. There are currently nine partners in Kuali project including Indiana University, Cornell University, University of Arizona and University of California. In addition to financial services, the scope of the Kuali project has recently been extended by including two additional modules, research administration and student management.

The project encompasses two phases that span twenty-seven months. Phase II will be completed in the fifteen months following phase I. To deploy the releases as open source, institutions who are not the development partners can become a member of the deployment community by paying about $25,000 per year to collaborate in the deployment and customization efforts.

The original motivation of the project is that existing university financial systems are outdated and too difficult to maintain. The commercial products are often too expensive and hard to customize. The Kuali project provides an attractive alternative to the “buy or build” dilemma by pooling institutional resources to develop an open source financial system in higher education.

The Kuali project is mainly funded by member institutions. A Kuali partner must pay from half million to one million dollar consisting of 25% cash and 75% personnel costs. Although the Andrew Foundation endowed two and half million dollars to Kuali, the endowment
is a much smaller amount compared to the overall investments needed to complete the whole project. As such, Kuali remains a good case for studying the community source environment. In the context of Kuali, the community investment decision leads to a more specific question. Should a university decide to pay a hefty partnership fee in order to join the development community or simply wait for the open source application is released to avoid the partnership fee? We believe this question is generalizable to community source projects outside higher education.

4. Real Options Analysis of Community Source
IS research on real options recognizes that IT investments can embed various types of real options such as defer, stage, explore, alter operating scale, abandon, lease, outsource, and growth (Benaroch 2002). In a community source approach, there are different types of real options the institution can choose as shown in Table 2 based on the Kuali case.

<table>
<thead>
<tr>
<th>Options</th>
<th>Investment features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Become a development partner</td>
<td>IT investment is realized when becoming a partner in the development community.</td>
</tr>
<tr>
<td>Wait and deploy Phase I (open source)</td>
<td>IT investment is realized when becoming a member of the deployment community in Phase I.</td>
</tr>
<tr>
<td>Wait and deploy Phase II (open source)</td>
<td>IT investment is realized when becoming a member of the deployment community in Phase II.</td>
</tr>
<tr>
<td>Expand</td>
<td>Expand to the new modules</td>
</tr>
<tr>
<td>Monitor and learn</td>
<td>The institution does not invest in the community source project.</td>
</tr>
<tr>
<td>Abandon (switch-use)</td>
<td>The institution invests in the community source project, but later on switch to acquisition from a vendor.</td>
</tr>
</tbody>
</table>

Table 1. Possible types of real options in the Kuali community source environment

![Diagram of real options analysis for Kuali partners and non-partners](image)

Figure 1. Possible scenarios of real options analysis for Kuali partners and non-partners

Figure 1 illustrates two scenarios of real options applied to a partner and a non-partner; for simplicity, we assume that both only deploy Phase II without Phase I. As shown, a non-partner typically takes much longer to deploy Kuali than a partner because of several reasons. First, a partner has less need to customize the system since its requirements are more likely to be satisfied by the original system without customization. Second, a non-partner takes longer to understand the system due to lack of knowledge. This simple real options analysis gives useful insights towards understanding the community investment decision. Therefore, we have
• **Observation 1 (Partnership advantage in deployment).** Partners gain an advantage by being able to deploy successfully sooner.

Next, we apply the Black-Scholes model (BS) to the Kuali case as given below:

\[
BS = VN(d_1) - Xe^{-rT} N(d_2)
\]

where \( d_1 = \frac{\ln(V/X) + (r + \sigma^2/2)T}{\sigma \sqrt{T}} \) and \( d_2 = d_1 - \sigma \sqrt{T} \), \( N(.) \) is the cumulative standard normal distribution function, and \( d_1 \) and \( d_2 \) are used to determine the cumulative value of the distribution, which in turn affect the value of the asset. The remaining symbols are defined in Figure 3.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Finance</th>
<th>IT investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V )</td>
<td>The value of asset</td>
<td>The market value of the system</td>
</tr>
<tr>
<td>( s )</td>
<td>The volatility of ( V )</td>
<td>Variance of the system value</td>
</tr>
<tr>
<td>( X )</td>
<td>The option’s exercise price</td>
<td>Total partnership fees</td>
</tr>
<tr>
<td>( T )</td>
<td>The time to maturity</td>
<td>Time deployment can start</td>
</tr>
<tr>
<td>( r )</td>
<td>Risk-free discount rate</td>
<td>Yield on government bond</td>
</tr>
</tbody>
</table>

Figure 3. The meaning of various Black-Scholes symbols in finance and IT investment

Now, we examine the Black-Scholes model and make several observations in the context of community source approach:

• **Observation 2 (Institutional dependency of system value).** Unlike a stock price, which is the same to all investors, the value of a system \( V \) varies from university to university. That is, larger universities will derive more value from the same system development project due to more users on the same application.

• **Observation 3 (Impact of flexibility on the variance of system value).** The variance of system value \( s \) depends on the flexibility of the technology used to implement the application. The more flexible the technology, the higher the expected value of the system.

• **Observation 4 (Impact of Partnership on total cost of ownership).** The total cost of ownership \( X \) varies between a partner and a non-partner. While a partner might have to pay a large sum of initial investment, but it can reduce its total cost of ownership by including its needed features in the community source, thus reducing customization and training costs, shortening deployment time, and minimizing implementation risks.

5. **Research Findings**

Next, we summarize our observations in the last section in a semi-formal manner:

• **Proposition 1.** Institutions who want to deploy the community source software earlier are more likely to become partners.

This is easy to follow based on Observation 1, which indicates that a partner institution can achieve faster deployment.

• **Proposition 2.** Larger institutions are more likely to become partners.

Larger institutions are more likely to become partners based on the following two reasons. First, larger institutions are more likely to be able to afford the partnership fee. Second, the institutional gain in future implementation opportunities is more significant in larger
institutions because of the economy of scale (Observation 2). In the Black-Scholes model, the market value of the system \( V \) is larger, and the total fee \( X \) is then relatively smaller.

- **Proposition 3.** The more flexible the technology is, the more likely it will attract partners. The Kuali community has been aggressively implementing flexible technologies in its platform including service-oriented architecture, which makes Kuali relatively easier to add new modules (Liu et al. 2007). Therefore, institutions that intend to learn about the new technologies to increase the value of the system are more likely to become partners in order to train its employees in the new technologies. This has to do with the larger value of \( s \) in the Black-Scholes model as previously explained. (Observation 3).

- **Proposition 4.** The more internal development capability the institution has, the more likely it will become partners. Institutions with more internal development capability are likely to take on development projects even individually. Therefore, they are more likely to join the development community to share costs and reduce risks, leading to lower total cost of ownership (Observation 4).

### 6. Conclusions

In this paper, we defined and studied the community investment decision. Using real options analysis and the Black-Scholes model, the decision on whether or not an institution should invest in a community source can be better understood. As we have shown in this paper, becoming a development partner in the Kuali project, the institution can influence the application features, complete the deployment sooner, minimize the total cost of ownership, and reduce the variance of the system value. As a future research topic, we plan to validate the propositions outlined in this paper. Further, we will include in our consideration additional IT investment alternatives such as in-house development, purchasing COTS, and outsourcing.

### References

E-Auction Website Assessment Model

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Abstract
This study develops an electronic auction web assessment model from a consumer perspective. This model suggests that user intentions of whether or not to continue using an e-auction website is partly based on their quality impression with the website which are determined by their perceived website user friendliness, functionality and interactivity. User trust belief serves as an important antecedent to user friendliness and functionality of the e-auction website. Website promotions and social impact both contribute to forge this user trust belief. To validate this model, a survey was conducted using 200 users of Taobao.com from 15 cities in China. Results provided strong support for this model and also yielded important implications and suggestions for further research in this direction.

Keywords: Web assessment, online auction, Taobao, EWAM, e-auction WAM, e-commerce

1. Introduction
Electronic auction (E-auction) refers to Internet market mechanism that uses a competitive process by which a seller solicits consecutive bids from buyers or a buyer solicits bids from sellers (Turban, 2006). E-auction is becoming a new hotspot in China and is especially popular among young Chinese netizens. Despite the growing interest in e-auctions, however, only limited research about e-auctions has been published in scholarly journals (Pinker, et al., 2003). There exists a need to characterize the behaviors and responses of participants in e-auctions to particular market conditions and rules (Hayne, et al., 2003; Pinker, et al., 2003), a need to shed light on e-auctions in developing countries, and a need to study e-auction effectiveness using a consumer perspective.

Given the increased importance of e-auctions today, this paper focuses on assessment of e-auction Web site. Specifically, this paper analyzes e-auction Web sites in China using a consumer perspective. For this purpose, we will (1) review literature on e-auction business and related research, (2) develop an e-auction web assessment model, (3) validate this model using empirical data from a survey in China in 2006, and (4) discuss the effectiveness of e-auction websites in China with implications for e-auction research and practices and recommendations for further effort in this direction.

2. E-Auction Website Assessment Model and Hypotheses
We believe that a website is a most valuable component of any e-auction customer touch points. The success of any e-auction website should be reflected in user perceived website quality and resulted in user intentions to return. User perceived website quality relies on website friendliness, website functionality, and website interactivity. Website friendliness and functionality have a common antecedent - perceived trust toward e-auction business. This trust perception is more or less shaped by the social impact and web promotions. Figure 1 exhibits our research model - E-auction Website Assessment Model (EAWAM). Based on the findings in the relevant literature, we develop the following hypotheses:

H1: E-auction Web promotions positively influence online user trust toward e-auctions.
H2: Social impact positively influences user trust toward e-auctions.
H3: Trust toward e-auction business positively influences perceived website user friendliness.
H4: Trust toward e-auction business positively influences perceived website functionality.
H5: E-auction website user friendliness positively influences e-auction website functionality. H6: E-auction website user friendliness positively influences user perceived website quality.
H7: E-auction website functionality positively influences user perceived website quality.
H8: E-auction website functionality positively influences user website Interactivity perception
H9: Website Interactivity perception positively influences user perceived website quality.
H10: Website Interactivity perception positively influences intentions to continue using an e-auction website.
H11: User perceived website quality positively influences their intentions to continue using E-auction websites.

3. Research Methodology

3.1 Measure Development

Our EAWAM instrument is designed specifically for evaluating all the phases of an auction transaction using a website. Survey items in our instrument are mostly from the relevant literature or adapted from Schubert’s Extended Web Assessment Method (2003). To facilitate data analysis, a five-point Likert scale was employed for all the closed questions, ranging from strongly disagree (1) to strongly agree (5). User background data section was also attached to this instrument to explore whether and how personal characteristics affect their website assessment. The personal data comprise age, gender, education, career, Internet experience, online transaction experience and e-auction experience.

Our instrument (available upon request) was first developed in English to serve as the basis for Chinese translation in late 2005. The second author of this paper took the major responsibility to translate it into Chinese. A panel of e-commerce experts in China was then consulted for precision and clearness of the preliminary Chinese version. Subsequently, the instrument was pre-tested in a face-to-face interview of 22 university students in Hangzhou, China who were users of Taobao.com, a well-known e-auction portal in China, in fall 2005.

3.2 Measure Validation and Data Collection

We deliberately selected users of Taobao.com as the sample for this study. Taobao.com keeps 70% of China's web users aged 30 or younger and has remained the first Internet enterprise in China for the fiscal year of 2005-2006 for their online market share (Lu, et al., 2006). All the evidence has ranked Taobao.com the most successful C2C online auction portal in China. Two authors managed the entire research process starting from sample selection to data collection. Fifteen cities in China were targeted for sample selection. A research firm in each of those cities was then contacted for agreement to assist in this survey. The survey data collectors from those firms were trained using detailed survey guidelines via teleconferencing to somehow minimize the researcher bias. The data collectors identified a sample of 233 from the 15 cities from their databases and narrowed it down to 200 Taobao users who agreed to participate in the survey. The data collectors in each city interviewed the participants from the same city individually face to face. After receiving all the completed questionnaires, the researchers did one follow-up to the questionable ones. The entire process took about five months and ended in March 2006. One hundred and ninety-one valid data points are actually used in data analysis, which secures a return rate of 95%.
3.3 Data Analysis
The data were first analyzed using SPSS by using some common descriptive statistics. We chose the partial least squares (PLS), a structural equation modeling (SEM) technique, for analyzing the hypothesized relationships between the constructs in our research model. PLS is tolerant of small sample size and least demanding of measurement scales and residual distributions. Moreover, PLS procedures are appropriate for a theory model at its initial stage and to suggest propositions for later testing (Chin, 1998). This study employed PLS-Graph Version 3.0 to test the proposed hypotheses. With PLS, structural equation modeling involves assessment of the measurement model and examination of the structural or predictive model.

3.4 Measurement and Structural Model Results
Confirmatory factor analysis was first examined using the partial least squares to establish the discriminant validity of the principal constructs. The value of each construct’s average variance extracted (AVE) is larger than the square of its correlations with other constructs. This indicates a clear discriminant validity which means that the partial least squares indicators load much higher on their hypothesized factor than on other factors (Chin & Gopal, 1995). Measure validation was also examined for reliability analysis by computing Cronbach’s alpha coefficient. All the alpha values exceed 0.80, which shows that all the measures have high levels of reliability. Detailed results are available upon request. We also examined the loading value of each individual indicator to ensure adequate convergent validity. All the indicators, with two exceptions, loaded highest on their target constructs. Those two items are deleted. All the loading values exceeding 0.6 are kept for further data analysis. Four items are withdrawn from further analysis. Overall, the results suggest adequate convergent and discriminant validity of the measurement model, so we proceed to the structural model testing.

For the evaluation of the structural model, we first analyzed the strengths of the hypothesized relationships among the constructs. One hypothesized path is significant at 0.01 alpha level and all the other hypothesized causal relations are significant at 0.000 level. The research model, therefore, seems supported by the empirical data in the study. The results of the baseline model using an inner model path weighting scheme shows a R-Square of 0.49 for the construct of website user friendliness, 0.477 for trust and 0.455 for website functionality. A more moderate level of 0.37 is obtained for web quality and a weak level of 0.23 for intention construct. We opted to use Bootstrap resampling (100 resamples) throughout this study for significance testing of path estimates. The path coefficients for the associated hypotheses, significance level for each path through bootstrapping, and the variances obtained are available upon request.

4. Discussion
4.1 Summary of Findings and Limitations
The empirical data from Taobao.com users from 15 cities in China in 2006 generally supported our theory model. We notice that the variances explained in Trust, Website Friendliness, Website Functionality are close to 50%, which indicate a fairly strong explanatory power. The empirical data are thus largely consistent with our theoretical model. Meanwhile, we also note that the variances explained by web quality and interactivity are moderate to small, and that the research model is not strong in predicting Intention to Continue with variance explained less then 25% (Please see Figure 2). The specific study findings are available upon request.
It is important to acknowledge the following limitations: (1) The sample size in our study was relatively small for validating the research model. Hopefully, employment of PLS procedures somehow has helped to alleviate the possible bias caused by the sample size; (2) The data came from 15 different cities in China. The generalizability of the findings is limited to urban e-auction customers in China. (3) Only one e-auction website is involved in our study. However, this e-auction website is considered the most popular and largest in China, and therefore, could be representative of the current status of e-auction websites there.

4.2 Implications for Research and Practice
This study combines perceived website quality in marketing research with behavioral intentions in TAM related research, which is rare in literature. This study assesses the consumer perceptions of e-auction website quality in an oriental cultural context, which is a direct response to the research need for more global EC studies and perception-based research. Further, this study initiated a nomological network for assessing quality of an e-auction website from a customer perspective. It systematically examines the direction and strength of relationships between the theoretical constructs and how those relationships lead to e-auction website quality and behavioral intentions. In another word, it has attempted to explore the use predictive power of e-auction website assessment. Drawing upon research in IS and marketing, our research model has proposed three sets of determinants of e-auction website quality: website user friendliness, functionality and interactivity. This helps to extend our understanding of e-auction website importance to the customers and can serve as the basis for future model development.

Our study has important implications for e-auction service providers and especially those in China that desire to maintain a successful e-auction website. Our results indicate that e-auction service providers need to dig deeper into the details to understand how each promotion incentive or social influence work on a particular user trust variable to get ideas as how to foster and maintain trust using online as well as offline channels. Taobao.com especially needs to explore the reasons for a low customer trust toward their website and design actions to raise customer confidence in their website. Since user friendliness, functionality and interactivity all strongly affect e-auction website quality, special efforts have to be made to look into each for improvement. Taobao.com in particular has to put substantial effort to improve their website functionality and interactivity with their customers. More attention has also to be paid to the importance of managing the associated online community in terms of the communications and relation maintenance in it.

5. Conclusion
This study provides a basis for further inquiry into e-auction website assessment. It examines the effectiveness of a well-known e-auction website in China using a consumer perspective, which to some extent, helps us to observe the status of e-auction website services in China. All these contribute to providing an insight into e-commerce practices in developing countries.

References


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**Figure 1 – The E-auction Website Assessment Model (EAWAM)**

**Figure 2 – The Empirically Supported EAWAM Model**
Competing Keyword Auctions [Best Paper]

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Abstract

Most research done on keyword auctions is under monopoly settings. This paper models an unaddressed but critical issue: the competition between search engines in the keyword advertising market. We analyze the advertisers’ equilibrium participation and bidding strategies and the auctioneers’ strategies on the ranking rules, and eventually predict the market segmentation under the competition.

Keywords: Keyword Auctions, Search Engine, Ranking Rule, Competition, Google

1. Introduction

Keyword advertising in which advertisers pay to be listed along search results for specified keywords on search engines has led the resurgence of online advertising. This successful business not only has attracted much attention from marketers and investors, but also poses new challenge for academicians. One of the main challenges is to understand how well the auction mechanism used by search engines works and what are the implications. Several research has been conducted on keyword auctions, such as (Feng, 2007; Liu et al., 2006; Weber and Zheng, 2004). However, to our best knowledge, all research done on keyword auctions is under monopoly settings. This paper considers the competition between search engines in the keyword advertising market.

Search engines allocate advertising slots to advertisers by pay-per-click auctions, an approach pioneered by Overture (now acquired by Yahoo!). In pay-per-click auctions, advertisers place bids on how much they are willing to pay for every click (price per click), and they pay the realized clicks at a price determined by their bids.

The keyword advertising market has been marked by competition from the outset. There are industry leaders Yahoo! and Google, trailed by MSN. There are also many other smaller players inspired by their successes. While search engines unify on the front of using unit-price auctions, they differentiate themselves in the implementation of them. Yahoo! ranks advertisers and allocates advertising slots solely based on their bids. In contrast, Google ranks advertisers by both their bids and their click-through rates (CTRs). In particular, advertisers are ranked by their scores that are product of their bids and past CTRs. It is imperative to understand implications of such differentiation to advertisers and the competition between search engines.

In this paper, we focus on deriving equilibrium bidding strategies under competing auctions with different ranking rules. The research on competing auctioneers is pioneered by McAfee (1993) who shows that in a large market each auctioneer will hold an efficient auction as the result of competition. Berguet and Sakovics (1999) study competition between two auctions, in which auctioneers can set different reserve prices. Both papers assume bidders differ by a single parameter. In our paper, however, bidders differ on two dimensions and auctioneers differentiate by ranking bidders differently.
We examine a model of two search engines and $n$ advertisers. All are risk-neutral. Advertisers differ both in their valuation per click and expected CTR (either high or low). Two search engines compete for advertisers by setting different ranking rules, while both hold unit-price auctions. As a starting point, we take the ranking rules as given. Specifically, one search engine auctions off a slot using standard unit-price auction (analogous to Yahoo!’s approach), and the other uses a weighted unit-price auction that discounts bids from advertisers with lower expected CTR (analogous to Google’s approach).

We find that when high expected CTR is more likely, advertisers with low expected CTR participate in the standard unit-price auction for sure, and the weighted UPC auction generates higher expected revenue than the standard one. When low expected CTR is more likely, all advertisers with high expected CTR participate in the adjusted unit-price auction for sure. In the later case, however, the expected revenue from two auctions can not be unanimously ranked.

2. The Model

There is a pool of $n$ risk-neutral advertisers (bidders). An advertiser's valuation for a slot is its CTR, $r$, times its valuation per click, $v$. Advertisers do not know their exact CTRs due to the uncertainty in realization. But they form expectations of their CTRs based on some signals, e.g., their historical CTRs. An advertiser's expected CTR is assumed to be either $E_H$ or $E_L$, $E_H > E_L$. We call bidders with high (lower) expected CTR H-type (L-type). It is believed that an advertiser is H-type with a probability $a$. An advertiser learns its own valuation per click before the auction, but not others'. Advertisers hold a common belief about the distribution for $v$, denoted as $F(v)$, $v \in [0, 1]$. Advertisers place their bids on how much they are willing to pay for every click. $n$ and $a$ are public knowledge. Search engines also learn advertisers' expected CTRs, e.g., by tracking advertisers' past CTRs.

There are two search engines (auctioneers) in the market, A and B. Each search engine auctions off a single slot to advertisers. For simplicity, we assume two slots are perfect substitute. Neither search engine values the advertising slot itself. Both implement unit-price auctions, in which each advertiser submits a bid price in a sealed form, and if it wins, pay for actual number of clicks at the price it bids. The two search engines can nevertheless differentiate themselves by choosing different ranking rules. As a starting point, we take the ranking rules as fixed. We assume A ranks advertisers by bids only while B discriminates advertisers based on their expected CTRs. Specifically, we assume B discounts L-type’s bid by a weighting factor $\beta$ ($\beta = 1$) (the weighting factor for H-type is normalized to 1). We assume each advertiser can participate in at most one of the two auctions. One reason is that advertisers avoid ending up winning and paying for both slots.

The timeline of the game is as follows: advertisers' valuation and types (expected CTR) are realized and intermediary B announces the weighting factor $\beta$. Each advertiser chooses one auction to participate in and, without the knowledge of other advertisers' choice, place its bid. The winners are determined by the announced rules and are assigned slots. The actual number of click-throughs is realized and winners pay according to their bid price.

3. Main Results

Proposition 1. When $a = 1/2$, the following defines an equilibrium for bidders' game:

1) All L-type bidders participate in auction A.
2) All H-type bidders participate in auction A with probability $(2a-1)/(2a)$ and participate in auction B with probability $1/(2a)$. 

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3) All bidders bid according to
\[ \beta(v) = v - \frac{\int_0^v \left[ \frac{1}{2} + \frac{1}{2} F(x) \right]^{n-1} dx}{\left[ \frac{1}{2} + \frac{1}{2} F(v) \right]^{n-1}} \]

Due to limited space, all proofs are omitted. Note that when H-type advertisers participate in A with probability \((2a-1)/(2a)\), the expected numbers of bidders in both auctions in equilibrium are equal. All L-type advertisers participate in A because with the same expected number of competitors, an L-type advertiser prefers auction A, where its bid does not get discounted and it has higher winning probability.

In auction B, since there are only H-type bidders, the winner is purely determined by bids also. As a result, H-type bidders are indifferent between two auctions in terms of their ranking rules and would attend whichever has fewer bidders in expectation. The equilibrium is reached when A and B have the same expected number of bidders, which implies H-type advertisers attends A with probability \((2a-1)/(2a)\) at each valuation-per-click level.

From this proposition, we can see the participants of auction B have higher average CTR than those of auction A. Proposition 1 implies that the distribution of equilibrium bid price is the same in A and B. Hence,

**Proposition 2.** When \(a = 1/2\), auction B with ranking factor \(? (\tau < 1)\) generates higher expected revenue than auction A.

\[
\pi^A = n \left[ E_L (1-\alpha) + E_H \left( \frac{2a-1}{2} \right) \right] \int_0^1 \left[ \frac{1}{2} + \frac{1}{2} F(v) \right]^{n-1} \left( v - \frac{1-F(v)}{f(v)} \right) f(v) dv
\]

\[
\pi^B = \frac{1}{2} n E_H \int_0^1 \left[ \frac{1}{2} + \frac{1}{2} F(v) \right]^{n-1} \left( v - \frac{1-F(v)}{f(v)} \right) f(v) dv
\]

It is worth noting that, for a large range of \(\tau\) (as long as \(\tau\) is tangibly less than 1, to be more specific), the auctioneer B’s revenue is the same. This is in sharp contrast with the monopoly case where a change of the ranking factor would have an immediate impact on the auctioneer’s revenue (Liu et al., 2006). Indeed, because of L-type advertisers’ outside option (attending auction A), B’s weighted ranking rule has turned into a highly effective screening device which allows B to attract only high-CTR advertisers.

We now turn to the case \(a < 1/2\), where a bidder is more likely being L-type. In general, H-type bidders prefer auction B to auction A, if the number of bidders were the same, since they are favored in the former. The opposite holds true for L-type bidders. Since a bidder is more likely being L-type, the expected number of L-type bidders is higher than the expected number of H-type bidders. Thus, H-type bidders strictly prefer to participating in B whereas L-type bidders may choose to participate in B, when trading off between being discriminated against in auction B and competing with more rivals in auction A.

When all H-type bidders are in auction B (we can show this is an equilibrium choice), we can write advertisers' payoff functions in a symmetric equilibrium as follows:

\[
U_L^A (v,b) = E_L (v-b) \left[ \alpha + (1-\alpha) F(\phi_L (b)) + \int_0^1 \left[ \frac{1}{2} + \frac{1}{2} F(x) \right] \left( 1-\tau(x) \right) f(x) dx \right]^{n-1} \tag{1}
\]

\[
U_L^B (v,b) = E_L (v-b) \left[ \alpha F(\phi_L^B (\gamma b)) + (1-\alpha) \left( F(\phi_L (b)) + \int_0^1 \tau(x) f(x) dx \right) \right]^{n-1} \tag{2}
\]

\[
U_H^B (v,b) = E_H (v-b) \left[ \alpha F(\phi_H^B (b)) + (1-\alpha) \left( F(\phi_H (b/\gamma)) + \int_0^1 \tau(x) f(x) dx \right) \right]^{n-1} \tag{3}
\]
In (1), (2), and (3), \( b \) is one's bid (willingness to pay for each click), and hence \( E_L(v-b) \) or \( E_H(v-b) \) is the surplus if it wins the auction. The remaining long terms represent the equilibrium winning probabilities. \( t(x) \) is the probability for L-type bidders with valuation \( x \) to participate in auction A in equilibrium. \( \phi_H^L(\cdot) \) and \( \phi_L^B(\cdot) \) are reverse bidding functions for H-type and L-type bidders respectively in auction B. To satisfy the incentive compatibility condition, L-type bidders who use mixed strategy must be indifferent between participating in A or in B, by which we can solve \( t(x) \).

**Proposition 3.** When \( a < 1/2 \), the following defines an equilibrium for bidders' game:

1) All H-type bidders participate in auction B

2) L-type bidders with valuation \( v \) participate in auction A with probability \( t(v) \) and in auction B with probability \( t(v) \), where \( t(v) \) is given by

\[
\tau(v) = \begin{cases} 
\frac{1}{2} \left[ 1 + \frac{\alpha}{1-\alpha} \frac{f(v)}{f'(v)} \right] & \text{for } v \in [0, v^*] \\
1 & \text{for } v \in (v^*, 1]
\end{cases}
\]

and \( v^* \) is determined by \( \alpha \left[ 1 - F(\gamma v^*) \right] = (1-\alpha) \left[ 1 - F(v^*) \right] \). The bidding functions for H-type advertisers, L-type advertisers who participate in A, and L-type advertisers who participate in A are given by, respectively

\[
\beta_H^A(v) = v - \int_0^v \rho_H^A(x) dx / \rho_H^A(v), v \in [0, 1] \\
\beta_L^A(v) = v - \int_0^v \rho_L^A(x) dx / \rho_L^A(v), v \in [0, v^*] \\
\beta_H^B(v) = v - \int_0^v \rho_H^B(x) dx / \rho_H^B(v), v \in [0, 1]
\]

where

\[
\rho_L^A(v) = \left[ \alpha + (1-\alpha) \left( F(v) + \int_v^1 [1-\tau(x)] f(x) dx \right) \right]^{n-1} \\
\rho_H^A(v) = \left[ \alpha F(v\gamma) + (1-\alpha) \left( F(v) + \int_v^1 \tau(x) f(x) dx \right) \right]^{n-1} \\
\rho_H^B(v) = \left[ \alpha F(v) + (1-\alpha) \left( F(v/\gamma) + \int_{v/\gamma}^1 \tau(x) f(x) dx \right) \right]^{n-1}
\]

Unlike the case \( a < 1 \), the expected numbers of bidders in two auctions depend on the value of \( ? \) and need not to be the same. We can show that as \( ? \) decreases (so that L-type is more disfavored in B), \( v^* \) decreases, implying high-valued L-type advertisers are fleeing auction B. It is also interesting to note that as \( ? \) decreases low-valued L-type advertisers may attend B more often, as shown in the following example.

**Example 1.** When the valuation per click is uniformly distributed, \( a < 1/2 \), L-type attends auction A with probability \( \frac{1}{2} \left( 1 + \frac{\alpha}{1-\alpha} \right) \) and \( v^* = \frac{1-2\alpha}{1-\alpha-\alpha} \).

The following proposition characterizes each auctioneer's expected revenue.

**Proposition 4.** The expected revenue for auction A and auction B are given by, respectively
\[
\pi^A = n \alpha E_L \int_0^{v^*} \left[ v \rho_L^A (v) - \int_0^{v} \rho_L^A (x) \, dx \right] \tau (v) f (v) \, dv + n (1 - \alpha) E_L \int_v^{v^*} \rho_L^A (v) \left( v - \frac{1 - F(v)}{f(v)} \right) f (v) \, dv
\]
\[
\pi^B = n \alpha E_L \int_0^{v^*} \left[ v \rho_L^B (v) - \int_0^{v} \rho_L^B (x) \, dx \right] \left[ 1 - \tau (v) \right] f (v) \, dv + n \alpha E_H \int_0^{v^*} \rho_H^G (v) \left( v - \frac{1 - F(v)}{f(v)} \right) f (v) \, dv
\]

Search engine B's expected revenue comes from both H-type bidders, the first term, and L-type bidders, the second. Search engine A's expected revenue comes purely from L-type bidders. The first term of \( p_A \) represents the expected revenue from L type bidders with valuation less than the cutoff value \( v^* \) and the second term, from L-type bidders with valuation above the cutoff value.

Different from the case \( a = 1/2 \), there is no straightforward revenue ranking between the two auctions. Furthermore, the choice of \( \tau \) at search engine B generally affects both its own and its opponent's revenue.

This research can grow in several ways. One is about the optimal ranking factor in a competing-auctions setting. In paper (Liu et al., 2006), the optimal ranking factor is discussed in a monopoly setting. It will be interesting to investigate how the optimal ranking rule in competing auctions differs from that in a monopoly setting. Allowing search engines' user traffic to be different (in terms of size or quality) may also yield additional managerial implications. We can assume the traffic from one search engine is less or generates less click through than the other. The former captures the competition between small and big search engines, while the latter may shed light on the competition between different types of search engines, e.g., general search engines, such as Google, versus special search engines, such as shopping.com.

References
Alternative Approaches to Grid Computing

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ABSTRACT

Technical advances have enabled multiple processors to be connected through the Internet and other networking technology to provide a computing grid that can be used to process computationally intensive applications. In this paper, we describe a type of large scale computing environment that we term sequential grid computing that makes it cost effective to process computationally intensive programs without adding expensive processing power. We present two models that solve the static and dynamic versions of the scheduling problem in sequential grid computing. In the static version, a scheme is created that maximizes the chance of completion within service level agreement parameters. In the dynamic model, the static scheme is modified to accommodate deviations from the plan. We also outline research issues that we plan to pursue.

Keywords: Grid Computing, Grid Scheduling, Stochastic Shortest path

1.0 Introduction

Recent advances in technology have made it possible to connect numerous disparate systems around the world through the Internet and other networking technology to create a virtual grid of computing resources that can be harnessed to solve computationally intensive problems (Eilam et al. 2004; Rosenberg 2004). While the concept is known by various related terms such as grid computing, utility computing and web based computing, there are two fundamental motivations behind the basic concept. First, research has shown that a large number of relatively inexpensive CPUs can be harnessed together to provide the equivalent processing power of a supercomputer by executing numerous small computations in parallel on individual CPUs. Second, it is well recognized that many corporate systems have idle CPU times during certain periods of the day that are based on geographical location. By utilizing these unused CPU cycles at each period, a computing infrastructure is made available at low (and perhaps zero) cost, making several computationally intensive applications feasible and cost-effective (Krass 2003).

The last few years have also witnessed the emergence of many computationally intensive applications, especially in the scientific, technological, biological and business fields, that are often impractical to perform on a single system. Examples include the human genome project and other phylogenetic analysis (Ellisman et al. 2004), astronomical calculations (Korpela et al. 2001), security motivated number-theoretic calculations, actuarial calculations, business analytics (Krass 2003), and several others that require thousands of hours of CPU time to execute. Consequently, several vendors (e.g. IBM, Sun and HP) are developing technology to enable a grid computing environment for such computationally intensive applications. There are two basic variations by which the concept can be implemented in practice. In the first approach, which we term parallel grid computing, an application is written to execute in parallel
on multiple machines. This requires that large computations in a software program be divided into numerous smaller calculations that can be executed in parallel and their results combined after completion. Parallel grid computing harnesses numerous CPUs to provide the equivalent processing power of a supercomputer at low cost, but requires that software programs be written in a manner that makes it feasible to process computations in parallel.

In the second approach, which we term *sequential grid computing*, a computationally intensive software program is viewed as a sequence of calculations performed one after the other, with the results of one set of calculations serving as an input for the next. The idea here is to take advantage of the idle CPU cycles in corporate servers and mainframes, which do not occur concurrently. Thus, the application is routed from one CPU to the next based on where the maximum idle processing cycles are available during that time period. In sequential grid computing, the computationally intensive application runs in the background and utilizes unused CPU cycles of the corporate servers and mainframes during off-peak hours. Thus, it increases CPU utilization and provides a computing environment for performing computationally intensive calculations at a relatively low cost. Sequential grid computing does not require software applications to be rewritten to enable parallel processing, and hence does not substantially reduce the processing time. Its main purpose is better utilization of existing infrastructure and the ability to process computationally intensive applications in a cost effective manner.

While there is significant research that focuses on parallel grid computing algorithms and methods (Kaya and Aykanat 2006; Korpela et al. 2001; Penmatsa and Chronopoulos 2005; Rosenberg 2004; Venugopal and Buyya 2005), research on sequential grid computing is much more limited. Consequently, in this research, we focus on sequential grid computing. We first explain the advantages of the concept and provide some details on the software architecture required to support the concept. We then describe alternative approaches for implementing the concept, especially related to how a computationally intensive application is routed through the grid of computing resources, and the trade-offs inherent in the alternatives. We then conclude the paper by outlining the research questions that we are attempting to study.

2.0 Definitions and Problem Environment

2.1 Advantages and Disadvantages of Sequential Grid Computing

Sequential grid computing has several advantages. First, unlike parallel grid computing, sequential grid computing does not require us to rewrite applications to take advantage of parallel processing, a major bottleneck in implementing the grid computing concept. Sequential grid computing merely requires a software application to be written in a modular fashion, with each module called in sequence and passed input parameters that are required for its processing - a normal software engineering practice. Second, the process is easy to implement. Once it is decided where each module will be executed, the software can be sent in advance to those locations. As each module completes, its output is sent to the location where the next module is executed. If these data transfer requirements are high, the grid controller can cause the subsequent module to be executed at the same location as the previous module, choosing just the best machine to execute the entire application. On the other hand, when data transfer requirements are low, each module can be allocated to the location on the grid that maximizes its chances of completion within the required time frame. Third, many grid providers (such as IBM and HP) have clients and infrastructure located around the world that are connected through secure networks. These clients and resources have different peak usage times based on location.
and other characteristics. Sequential grid computing provides a method to harness the unused capacity of existing infrastructure to process computationally intensive programs.

There are two key disadvantages of sequential grid computing. First, since there is no parallel processing, computations are not dramatically speeded up. Instead, the purpose is to effectively use existing infrastructure with minimal changes to the application. Second, the concept requires the installation of grid manager software on every machine on the grid and adds significant overhead to the processing of applications.

### 2.2 Problem Description
Consider a job that requires $U$ CPU units and has a deadline of $D$ time units from the present time, as specified by a service level agreement. The grid manager has at its disposal a set of $M$ processors. As a first step, the grid manager divides up the time horizon into $T$ time buckets that correspond to each step of the problem. For example, the job in question may have a deadline of 10 hours from now and the grid manager might think it appropriate to divide the horizon into 20-minute intervals. The number of time periods is arbitrary and increasing granularity will provide more accurate solutions, but require more processing to determine the optimal schedule.

The amount of CPU units available in time bucket $t$ at processor $i$, denoted as $c_{it}$, is a normally distributed random variable with a mean $\mu_{it}$ and a variance $\nu_{it}$. Further, if a job is transferred from one processor to another in subsequent time periods, a penalty (in CPU units) is assessed. The objective for the grid manager is to schedule the job on the grid in a manner so as to maximize the chance of completing it over $T$ time buckets.

### 2.3 Architecture of the Sequential Grid Computing Environment
The grid manager software has two parts. Following other research (Joseph et al. 2004; Meliksetian et al. 2004), we assume a centralized, software-based grid manager who accepts jobs submitted by users, decides how the job will be routed through the processors, and adds control information to the job so that it can be effectively routed. In addition, distributed grid manager software resides on the individual processors on the grid and coordinates with the centralized grid manager software to process and route the job to completion.

Specifically, when a job is submitted to the centralized grid manager software, it estimates the CPU processing time required and electronically enacts a service level agreement (SLA) that specifies a deadline by which the job will be completed. We assume that the grid manager has estimates, based on historical data, of the mean and variance of processing cycles available at each CPU in the grid during each time period. Based on this information, the grid manager determines the optimal routing of the job to maximize the probability of completion within the deadline specified in the SLA. It then attaches control information to the job that can be utilized by the distributed grid manager software located at each CPU to process the job and pass the job to the next processor on the optimal path at the end of each time period.

### 2.4 Alternative Models for Routing the Job through the Grid
We describe two models for the routing of an application through several processors, based on the stochastic availability of idle processing cycles at each time period. We first describe a static model that determines at the start of processing, a scheme that assigns the software application to a single CPU during each time period. We also present a dynamic model that allows reassignment at later times based on the current status of the computations. We also discuss solution approaches for the two problems.
The static model can be described as follows. Given the mean ($\mu_{it}$) and standard deviation ($\sigma_{it}$) of estimated CPU units available at each processor $i$ in each time period $t$, and the cost (in CPU units) associated with transferring a job from one processor to another in subsequent time periods, determine a path that picks a processor in each time period such that the job has the highest probability of obtaining $U$ CPU units within the $T$ time buckets. The static model can be solved efficiently through a modified version of the stochastic shortest path algorithm in Murthy and Sarkar (1998). Once this path is determined, it can be sent with the job so that the distributed grid manager software in each processor can forward the job to the next processor at the end of each time period. The path remains static during the execution of the job and does not change based on the state of the processing in any time period.

Unlike the static model, the dynamic model does not define a single path. Instead, at each processor $i$ in each time period $t$, let $u_{it}$ denote the amount of CPU units obtained by the job thus far. The dynamic model calculates for each node $i$, at each time period $t$, and for each possible state $u_{it}$, the next node to send the job to, so as to maximize the probability of the job obtaining $U$ CPU units by the end of the $T$ time buckets. The dynamic model can be solved by a dynamic programming formulation and will require significantly higher computational time to solve. It also requires significantly higher overhead information to be transmitted with the job. However, heuristics can be developed to provide approximate solutions.

3.0 RESEARCH QUESTIONS AND CONCLUSIONS

There are two fundamental research questions that we plan to address in the research.

(a) When does sequential grid computing provide benefits over scheduling the entire job on a single machine? Specifically, how do the number of machines, number of time periods, and the mean and variance of CPU units available at each processor affect the difference in probability of completion between sequential grid computing and the single machine case?

(b) When does the dynamic model (which requires much greater computational time and overhead) significantly outperform the static model? How well do the heuristics perform in closing the gap between the dynamic and static model results, without incurring the computational costs of the dynamic model.

In this paper, we have defined a sequential grid computing environment that enables the cost effective processing of computationally intensive applications by utilizing the unused processing cycles of processors connected to a grid. We present two models to develop an initial processing schedule (static model) and modify the schedule (dynamic model) to incorporate changing situations. We outline possible solution approaches for the two models and indicated future research directions.

References


On the Motivational Perspective of ICT Design

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Abstract

A motivational perspective to user technology interaction research can reveal both the intensity and the directions of user behaviors toward technology. This paper reviews primary human motivation sources and then proposes design principles that can guide the design of technologies that satisfy users’ motivational needs.

Keywords: motivation, information and communication technology, design theory, design principle, user acceptance and use of ICT

1. Introduction

Organizations invest a great deal in information and communication technology (ICT), hoping for improved employee productivity, increased strategic advantages, and a competitive edge. Software vendors and other stakeholders have been increasing investments in new ICT, hoping to attract potential consumers during the trials with the technology and trusting that consumers eventually will decide to purchase and use it. Understanding what contributes to behaviors of ICT acceptance and use is an important research topic in the contemporary information systems and other disciplines.

A motivational approach can provide the understanding of ICT use behaviors and feed this understanding back into ICT development. A motivational approach can thus address questions such as “Why do people initiate, continue, stop, or avoid using ICT?” “Why do ICT use behaviors vary in intensity?” Although the motivational aspect has been addressed in technology acceptance research to some extent (Davis et al. 1992; Venkatesh 1999; Venkatesh 2000), few studies have taken a comprehensive view of human motivation to study technology acceptance and use behavior. In this paper, we provide a brief overview of findings in modern motivational studies. Then we propose ten design principles for achieving highly motivational ICT.

2. Motivation Sources

Motivation studies attempt to answer two questions: what causes behavior and why does behavior vary in its intensity (Reeve 2005). The theory of motivation explains the processes that give behavior its energy and direction. Energy implies that behavior has strength, which is relatively strong, intense, and persistent. Direction implies that behavior has purpose, which is aimed or guided toward achieving some particular goal or outcome or avoiding some particular situations (Higgins 1998).

Motivation has two clusters of sources: internal motives (needs, cognitions, and emotions) and external events (environmental incentives) (Reeve 2005). Needs are conditions within the individual that are essential and necessary for the maintenance of life and for the nurturance of growth and well-being. There are three types of needs: physiological, psychological, and social needs. Physiological needs are inherent within the workings of biological systems. Psychological
needs arise from the self’s requirement and desire to seek out interactions with the environment, creating practices that promote psychological vitality, well-being and growth. A social need is an acquired psychological process that grows out of one’s socialization history that activates emotional responses to a need-relevant incentive. Cognitions refer to mental events, such as beliefs, expectations, and the self-concept. Emotions orchestrate how we react adaptively to the important events in our lives.

To focus, we develop 10 design principles that draw on the following motivational sources: psychological, social, cognitive and emotional. This focus is also consistent with other studies that identify the most fundamental needs of humans (Sheldon et al. 2001). We acknowledge the importance of studying physiological and external sources, but we leave them outside the scope of this paper.

3. Design Principles for Motivational ICT

Design principles are high-level and context-free design goals (Shneiderman et al. 2005) (Te'eni et al. 2007). They are primarily derived from theoretical understandings and design experiences. A motivational approach to study behaviors serves to unearth their motivational drives, the reasons behaviors are undertaken. ICT can have certain qualities and capabilities to make them motivationally significant, that is, to provide feasibility to fulfill a motivational need. This is where the motivational approach to ICT design attempts to focus. The principles presented here are structured around four motivational sources: psychological, social, cognitive, and emotional.

3.1 Autonomy and the Self

Autonomy is the psychological need to experience choice in the initiation and regulation of behavior. Autonomy-supportive social contexts tend to facilitate self-determined motivation, healthy development, and optimal functioning (Deci et al. 1985). Other positive outcomes from an autonomy-supporting style include development gains (greater perceived competence, higher self-esteem, and enhanced sense of self-worth), engagement gains (greater engagement, positive emotional tone, stronger perceptions of control, preference for optimal challenges, pleasure from optimal challenges), performance gains (improved performance, higher achievement), high quality learning (greater flexibility in thinking, enhanced conceptual learning, more active information processing, and greater creativity), and optimal functioning (maintenance of behavioral change, long-term retention) (Reeve 2005).


The province of the self is to pursue the quality of one’s psychological well-being. Motivational analysis of the self has three aspects: defining or creating the self, relating the self to society, and discovering and developing personal potentials (Reeve 2005). Here we focus on defining and creating the self, specifically self identity. ICT, just as many other objects in one’s environment, should support one’s need for defining and representing the self. Identities function in a social context. Thus identities normally contain information about the particular individual, the immediate group, the social context, and the cultural context that the individual belongs to.

Principle 2. Promote creation and representation of self-identity

3.2 Competence and Achievement

Everyone wants and strives to become competent. As a psychological need, competence provides an inherent source of motivation for seeking out and putting forth the effort necessary to master optimal challenges that are developmentally appropriate (Deci et al. 1985; Reeve 2005). When we engage in a task with a level of difficulty and complexity that is precisely right for our current
skills, we feel the strongest interest and the greatest involvement of the need for competence. One key condition that involves competence need is optimal challenge, and one key condition that satisfies our competence need is positive feedback (Reeve 2005).

Optimal challenge, represented by a level of difficulty and complexity, is related to goals one may set or be assigned. Each person may have different levels of skills, thus would require different levels of challenges. For an ICT to support all possible targeted users, identifying and setting different challenge levels are central to design.


Achievement is one’s desire to do well relative to a standard of excellence that encompasses (1) competitions with a task, (2) competitions with the self, and (3) competitions against others (Heckhausen 1967). Standards of excellence offer people two-edge swords: sometimes they excite us and we react with approach emotion and behavior; other times, they bring us anxiety and we react with avoidance emotion and behavior (Reeve 2005). Individuals need to perceive or evaluate their performance toward goals. Feedback provides support for this evaluation. “Timely” response is essential so that the “flow” of cognition and action does not break. “Positive” means to focus on the informational aspect of feedback (how far it is from achieving the goal) rather than on criticism of behavior. The combination of goals/challenge and feedback produces an emotionally meaningful mixture: goal attainment breeds emotional satisfaction, while goal failure breeds emotional dissatisfaction.

Principle 4. Provide timely and positive feedback.

3.3 Relatedness

Relatedness is a psychological need indicating the innate desire to belong. Interaction with others is the primary condition that involves the relatedness need; perception of a social bond then satisfies the relatedness need (Reeve 2005). Providing human-human interaction mechanisms via ICT (thus computer mediated human-human interaction) thus provides a condition for users to feel being related; and providing ways of displaying the social bond is to show interaction results, thus confirms one’s feeling of being related gives users the satisfaction to this need.


3.4 Power, Leadership and Followership

Power is another learned social need. Its essence is a desire to make the physical and social world conform to one’s personal image or plan for it. A person’s need for power can be determined by personality (“born with it”) and social situations (“social role or identity”). People high in the need for power desire to have impact, control or influence over another person, group or the world at large. High-need-for-power individuals seek to become (and stay) leaders. Leadership thus is a condition that involves and satisfies the need for power. Very often, we also experience the desire to follow (even for those who have a strong need for power). We seek, admire, and respect those who lead us by providing us certain emotional feelings. A good ICT design should realize both leadership and followership needs.

Principle 7. Facilitate one’s desire to influence others.
Principle 8. Facilitate one’s desire to be influenced by others.
3.5 Affect and Emotion
Affect is a general word for mood, emotion, and feeling. Emotions are induced affective states that typically arise as reactions to important stimulus in one’s environment. Emotion relates to motivation in two ways. First, emotions are one type of motive that energize and direct behavior. Second, emotions serve as an ongoing “readout” system to indicate how well or poorly personal adaptation is going.

Modern affect studies propose that human beings have two synchronous systems that activate and regulate emotion. The primitive biological system is an innate, spontaneous, physiological system that reacts involuntarily to emotional stimuli. The contemporary cognitive system is an experience-based system that reacts interpretatively and socially. The two systems influence each other and combined they provide a highly adaptive emotion mechanism (Buck 1984; Levenson 1994; Norman 2004). The key for applying emotional studies to ICT design is thus two-fold: induce intended emotions via the biological system that is invoked by initial exposure, and induce intended emotions via the cognitive system that is based on intensive cognitive activities.

Principle 9. Induce intended emotions via initial exposure to ICT.
Principle 10. Induce intended emotions via intensive interaction with ICT.

Recent effort in ICT design has focused much on affect and emotion. Examples include emotional design, aesthetics and beauty in design, affective quality, funology, optimal flow experience, computer enjoyment, among others (Sun et al. 2006). Sometimes, negative emotions may be desirable. For example, anxiety is negative. But anxiety can be motivational in achieving certain goals. Thus designers want to induce anxiety via ICT interaction.

4. Conclusion
The overarching goal of the design principles proposed in this paper is to support human motivational needs. Yet, an ICT design is dependent on users, tasks, and use context, and certain design principles can support conflicting goals (Te’eni et al. 2007). This means that the same design principles may not serve all ICT design goals the same way, and not all principles are of equal interest in designing a particular ICT. However, it is beyond the scope of this paper to discuss this in more detail.

A motivational perspective, although less emphasized in the literature, can be very promising in providing theoretical guidance to ICT design (Zhang et al. 2000). A motivational perspective may function as a framework to unite various ICT design approaches to represent a holistic picture of issues in ICT design and use.

References
An Analysis of Dynamic Review Policies in Software Development

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Abstract

Dynamic project review embraces changes and accepts the idea that software requirements will evolve throughout a project. Dynamic requirement reviews can incorporate new market and customer information and fix initial design and development shortcomings. We study the optimal timing of dynamic requirement reviews for software projects. We have obtained some analytical results from the model. We find that the review intervals are not equally spaced; instead, the review interval becomes larger as time goes on due to the increase of the review cost. The increase in review cost would increase the total number of reviews while the increase in rework cost would make the reviews less often.

Keywords: Poisson Process, Dynamic Requirement Review, Optimal Timing

1. Introduction

$60 billion to $70 billion is the conservative estimate of the annual cost for failed software projects in the United States alone (Charette 2005). Among the causes of software project failures are: 1) incomplete requirements and specifications, and 2) mis-management of customer requirements and lack of user inputs (ESPITI 1995; The Standish Group 1994). Many times, it is too late for companies and software development teams to realize that their projects are not meeting the market requirements and the only option is to delay the project. The long delay of Microsoft’s Vista operating system is a classic example. The delay is due to the fact that Microsoft needed more time to enhance security and other functions (Linn 2006).

Traditional software engineering approach such as the Waterfall model conducts software requirement study at the beginning of the project phase followed by sequential processes of software design, development, and testing. However, external and internal factors often cause changes to the software project. For example, emerging security threats and increasing security concerns constantly change the expectation and requirement of a software system. On average, 25% of the requirements for a project will change during the course of the development (O'Neal et al. 2001). Inability to embrace changes proactively can result in project delays and failures, which could negatively affect a company’s financials and market positions.

Rather than resisting changes and developing a product that does not meet customers’ needs properly when it is released, companies need to recognize that changes are inevitable, and have to proactively plan and manage changes. One approach is to conduct dynamic software requirement reviews to keep abreast of customer needs during the software development process. Such review has taken many forms such as setting up a User Experience Center in industry tradeshows. Dynamic project review embraces changes and accepts the idea that software requirements will evolve throughout a project (Ambler 2002; Leffingwell et al. 2000). The purpose of this research is to investigate policies of conducting reviews for software projects.
Particularly, we study the optimal timing of such reviews. Quite often, modeling work in software engineering literature implicitly assumes that external environment such as the customer preferences remain unchanged once the software project has started. One of our contributions in this study is that we explicitly incorporate into the model the cost of obtaining new information through requirement review and making adjustment in the software development process.

Dynamic requirement reviews have the two major benefits: 1) New market and customer information can be incorporated into the project. 2) Initial design and development shortcomings can be discovered and fixed, saving time and efforts in later stages. A project team needs to plan the reviews carefully. If conducted too frequently, the total cost of review could be too high. However, the cost of rework at the later stages could be costly if there are too many requirements discovered too late due to the lack of proper requirement review. By seeking the optimal timing of requirement review, our model strikes a balance between reducing the rework cost through early and timely review and controlling the review cost.

The rest of the paper is organized as follows. We present the dynamic review model in Section 2 and its solutions in Section 3. Section 4 concludes the paper.

2. The Dynamic Review Model

The software project team starts at time 0. During the project development, the development team creates modules based on a set of requirements collected from customers during the initial requirement analysis phase. We assume that the completion of modules follows a Poisson distribution with arrival rate $\lambda$. Poisson arrival process is used in modeling various kinds of stochastic arrival processes in general and software module growth in particular (Chiang et al. 2004).

As the time goes on, customers may change their needs. For example, due to some new external regulation, customers may require a higher level of security in the system being developed. This would lead to rewriting some finished modules. The longer the time of the requirements not being reviewed, the higher the chance that the customer requirements will change. Let $T_i (i = 1, \ldots, K)$ be the time instances when each review is conducted, $N_i$ the (expected) number of modules finished by $T_i$, and $m_i$ the (expected) number of requirement modification generated between $T_{i-1}$ and $T_i$. The probability of modifications being produced is positively related to the elapsed time since the last review $T_{i-1}$. By assuming that the modifications are generated independently from each completed module, we have

$$m_i = h \cdot (T_i - T_{i-1}) N_i$$  \hspace{1cm} (7)

where $h$ is the increase rate in modification probability and $N_i$ is given by

$$N_i = \lambda T_i$$  \hspace{1cm} (8)

Denote $C_{CR}^i$ as the cost of customer review at $T_i$. The cost $C_{CR}^i$ should be proportional to $N_i$, the size of developed system. A large system will incur a high cost to be thoroughly reviewed. Therefore, $C_{CR}^i$ is given by
\[ C_{CR}' = c_2 \cdot N_i \quad (9) \]

where \( c_2 \) represents the unit review cost due to the system size. Each requirement modification obtained from the customer review should be taken care of. Let \( C_r \) be the corresponding rework cost:

\[ C_r' = c_3 \cdot m_i \quad (10) \]

where \( c_3 \) is the unit cost of handling requirement modifications in the system.

After the final \( K \)-th review, the development team might continue the development until \( T \) if it is optimal to do so. Then there will be some unhandled modifications generated between \( T_k \) and \( T \). The expected cost is:

\[ C_u = c_4 \cdot h \cdot (T - T_k) \lambda T \quad (11) \]

where \( c_4 \) is the cost per unhandled requirement modification and \( \lambda T \) the expected size of the final system.

The revenue of the project increases as more features are built into the system and the system becomes more valuable to the customers. However, as the development time becomes longer, the revenue could decrease due to several reasons: the market share of the system could be lost as customers might switch to a competitor’s system; the system could become less valuable as it is released later. We use a simple concave curve to represent the revenue function:

\[ R = (r_0 - r_1 T)T \quad (12) \]

where \( r_0 \) is a constant proportional to the average value per module and \( r_1 T \) the variable cost rate. The variable cost rate is used to model the trend of increasing marginal cost of lost revenue. Then the net value of developing this project for the duration of \( T \) is given by:

\[ NV = R - c_1 T - \sum_{i=1}^{K} (C_{CR}' + C_r') - C_u \quad (13) \]

where \( c_1 \) is the personnel cost per unit time.

3. The Initial Results of the Model

We solve the optimal timing problem proposed in Section 2 in two steps. We will first study the optimization problem for a given number of reviews in the system. Analytical solutions are presented. Then the optimal number of reviews can be found numerically.

For a given number of reviews \( K \), the problem of the optimal review timing is the following:

\[ NV^*(K) = \max_{T, i} NV \quad (14) \]

Taking the derivative of (13) with respect to \( T_i \) \((i = 1, \ldots, K - 1)\), we can get
\[ \Delta T_{i+1} = \Delta T_i + c_2 l(c, h) \quad (15) \]

where \( \Delta T_i \equiv T_i - T_{i-1} \). From the above equation, we can see that, the review interval increases as time goes on. The increase is due to the fact that it becomes more and more expensive to conduct a customer review as the system size grows. The increment of a review interval is larger when the unit review cost \( c_2 \) becomes more expensive; fewer reviews should be planned. On the other hand, when the rework cost \( c_3 \) increases, the increment will decrease; more reviews will be called for.

We obtain two more first-order conditions by taking the derivative of (13) with respect to \( T_K \) and \( T \):

\[ -c_2 + c_1 h \cdot \Delta T_K + c_1 h \cdot T_K - c_2 hT = 0 \quad (16) \]

and

\[ -c_1 + c_1 h \lambda (2T - T_K) = r_0 - 2r_1 T \quad (17) \]

After some long and direct derivation which is not present here due to the space constraint, we can solve (15), (16), and (17) together and get the expressions for \( T_i \) (\( i = 1, ..., K \)) and \( T \):

\[ T_1 = c_4 \left[ \lambda \cdot c_2 c_3 K l(2c_3) - (r_0 - c_1) \right] / \left[ K \lambda c_3^2 h - 2(\lambda c_4 h + r_1)c_3(K + 1) \right] - Kc_2 l(2c_3 h) \quad (18) \]

\[ T_i = i \cdot T_1 + i(i-1)c_2 l(2c_3 h), i = 2, ..., K \quad (19) \]

and

\[ T = (r_0 - c_1 + c_1 h \lambda T_K) / \left[ 2(\lambda c_4 h + r_1) \right] \quad (20) \]

To completely solve the problem, we still need to find the optimal \( K \) that will maximize \( NV^*(K) \) which can be obtained by plugging (18), (19), and (20) into (13). Finding the optimal value of \( K \) from \( NV^*(K) \) is a discrete optimization problem and it is generally hard to find analytically the optimal \( K \). Instead, we can numerically search for the optimal \( K \). Such search is very simple and straightforward and finds the optimal \( K \) very quickly.

4. Future Work and Conclusions

We study the optimal timing of dynamic requirement reviews for software projects. Dynamic requirement reviews allow projects to be aligned with market demand and user requirements. If reviews are conducted too infrequently or too late, the cost may rise sharply as the system further decays. If reviews are too frequent, then the review cost will be too high. We find the analytical solutions for the simple model proposed in this paper. Our results show that as review cost becomes higher, requirement reviews should be conducted less frequently. As the rework becomes more expensive, the reviews should occur more often in order to control the rework cost.

Requirement analysis is an important aspect of software engineering. It is expected that different software projects may require different review policies. Future research can compare
the requirement review policies for different types of software engineering projects by modeling
the projects’ unique development processes.

References

Effectiveness of the Policy Framework for Consumer Protection in E-Retailing – Australia Case

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Abstract
This paper examines the attitudes of consumers, e-retailers and other stakeholders towards the current policy framework for consumer protection in e-retailing. Three web-based surveys were conducted to collect responses from 166 consumers, 28 e-retailers and 20 other stakeholders. The findings reveal that most respondents thought that the current measures to address issues associated with e-consumer protection were insufficient and ineffective, and more government regulations could enhance the level of e-consumer protection.

Key words: consumer protection, e-retailing, e-shopper, regulations/guidelines, self-regulation.

1. Introduction
Although several measures have been employed to address consumer protection in e-retailing, the number of e-retailing-related complaints has steadily increased, and consumers have not been confident in the online marketplace (Majoras et al., 2005). Also, there has been insufficient research on the effectiveness of the current measures to protect e-consumers. This paper aims to examine the attitudes of consumers (Group 1), e-retailers (Group 2), and other stakeholders (Group 3) towards the current policy framework for e-consumer protection in Australia. This paper will provide a better insight into the sufficiency and effectiveness of the current policy framework which can help the relevant authorities to have better approaches to enhance e-consumer confidence, and to gain support from all stakeholders.

2. Literature Review
2.1 E-retailing and Issues associated with Consumer Protection in E-retailing in Australia
In Australia, the volume of online retail transactions reached A$6.171 billion in 2004 (New Zealand Trade and Enterprise, 2005). The percentage of Australian e-shoppers was 31% in 2005 (Australian Bureau of Statistics, 2005) and there was 5.9 million Australians e-shoppers in September 2006 (ACNielsen Australia, 2006).

Although consumers can enjoy many benefits offered by e-retailing, there are many problems associated with e-retailing. The first issue relates to information disclosure by e-retailers. The second and third issues relate to security and privacy. Trans-national online fraud, online security and privacy incidents have weakened consumer confidence in the digital marketplace (Majoras et al., 2005). Consumers are worried about the misuse of their personal and financial data (Ha, 2006). The fourth issue relates to dispute resolutions (Dekleva, 2000). Many consumers are not able to deal with problems with e-transactions. It is difficult for customers to settle their disputes with overseas e-retailers due to different jurisdictions (Ong, 2005).

2.2 The Current Policy Framework for Consumer Protection
Currently, e-consumer protection has been addressed by regulation and self-regulation. Many countries have strictly governed e-retailing by regulations (Rotenberg, 2001). However, this approach has not worked well as e-retailers believe that the Internet should not be regulated given its transient and trans-border nature (Creed, 1998). The current regulatory framework has slowed down the adoption of e-retailing because of the lack of transparency, legal ambiguity, and
weak enforcement (Primo Braga, 2004). Other countries have promoted a self-regulatory approach to govern e-retailing. Although a self-regulatory approach can enhance the image of e-retailers and their global competition (Drake, 2004), the outcomes of self-regulation have not fully materialised. According to Sylvan (2002), co-regulatory and self-regulatory measures do not work for consumers as e-retailers have more power in setting their own standards.

In Australian, e-customers have been protected by a number of measures. The primary legislation regarding consumer protection is the Trade Practices Act 1974 (Australia) and state Fair Trading Acts, which have been applicable to both the online and offline markets. Consumers have also been protected by guidelines designed specially for e-commerce such as the Australian Guidelines for Electronic Commerce (2006) which encourages stakeholders to adopt self-regulatory measures to enhance consumer sovereignty (Hockey, 2000). Yet, these guidelines are not mandated. Industry associations have established codes of practice to promote best practice in doing business. Nevertheless, their members can choose not to become subscribers of these codes. Consumer associations have been active in providing educational programs, and conducted activities to identify fraudulent e-retailers (Australian Consumers’ Association, 1984).

2.3 The Current State of Consumer Protection in E-retailing
There has been no formal evaluation on the effectiveness of the current regulatory framework for e-consumer protection in Australia. However, the growing number of e-shoppers has also entailed a higher number of complaints related to e-retailing (Nasir, 2004). The proportion of e-retailing-related complaints was 7.5% in 2005 in Australia.3 Given several measures to protect e-consumers, the question here is whether these measures have been adequate and effective to protect e-consumers. As it is not easy to evaluate the policy framework for e-consumer protection at the macro level, this paper examines the adequacy and effectiveness of this framework from the micro level, from the stakeholders’ views.

3. Research Questions and Hypothesis
This paper aims to test whether there is a significant difference between
H1: Three groups and “more regulations could increase e-consumer protection”,
H2: Three groups and “e-consumers receive the same protection as consumers in the offline market”,
H3: Three groups and “regulations to protect e-consumers are sufficient and effective”,
H4: Three groups and “guidelines to protect e-consumers are sufficient and effective”,
H5: Three groups and “self-regulatory measures adopted by e-retailers to protect e-consumers are sufficient and effective”,
H6: Three groups and “industry codes of conduct to protect e-consumers are sufficient and effective”,
H7: The three groups and “activities of consumer associations to protect e-consumers are sufficient and effective”. It also discusses the policy implications for e-consumer protection.

4. Justification for the Research
This study is significant for two main reasons. Firstly, although e-retailing has offered many advantages to e-consumers, there have been a number of risks associated with online shopping. The number of consumers’ complaints has also increased. Thus, it is necessary to do research on how to address these risks in a more effective way which can encourage consumers to take better

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3. This is an unofficial figure provided by a government agency which is in charge of consumer protection in Australia.
advantage of e-retailing. Secondly, there have been insufficient empirical studies on governance of e-consumer protection, and insufficient formal evaluation of the current policy framework for e-consumer protection. Therefore, this study provides examines the attitudes of different stakeholders towards the current state of e-consumer protection which can, in turn, provide a new governance approach to improve the protection of e-consumers.

5. **Data Collection and Analysis**

Regarding data collection, three web-based surveys collected data from consumers, e-retailers, other stakeholders (including government agencies, industry and consumer associations). Participants as consumers were selected from staff and students of a university in Victoria, Australia. All e-businesses, being listed in the 2006 Yellow Pages (Melbourne) directory, which have sold one of the top popular items purchased online, namely (i) travelling, (ii) entertainment ticket, (iii) book, (iv) music and CD/DVD, and (v) computer hardware/software were selected for this study (Department of Communications Information Technology and the Arts (DCITA), 2006). Purposive sampling procedure was employed to select participants from other stakeholders in Australia and overseas who were involved e-consumer protection. Concerning data analysis, descriptive statistical technique such as percentage frequency distribution and inferential statistics, including chi-square tests were used to analyse the data.

6. **Findings and Discussion**

A total of 166 consumers, 28 e-retailers and 20 other stakeholders took part in this study. Table 1 shows that there was no statistically significant relationship between the three groups and “more government regulations could increase consumer protection in e-retailing”.

**Table 1: Relationship between the Three Groups and Variables relating to the Current Policy Framework for E-consumer Protection**

<table>
<thead>
<tr>
<th></th>
<th>Consumers (n = 166)</th>
<th>E-retailers (n = 28)</th>
<th>Other stakeholders (n = 20)</th>
<th>$\chi^2$ value</th>
<th>Cramer’s V</th>
</tr>
</thead>
<tbody>
<tr>
<td>More regulations could increase e-consumer protection.</td>
<td>48.2</td>
<td>53.6</td>
<td>70.0</td>
<td>7.37</td>
<td>0.13</td>
</tr>
<tr>
<td>E-consumers receive the same level of protection as consumers in the offline market.</td>
<td>18.7</td>
<td>42.9</td>
<td>20.0</td>
<td>8.42</td>
<td>0.14**</td>
</tr>
<tr>
<td>Regulations to protect e-consumers are sufficient and effective.</td>
<td>12.0</td>
<td>32.1</td>
<td>20.0</td>
<td>11.90</td>
<td>0.17**</td>
</tr>
<tr>
<td>Guidelines to protect e-consumers are sufficient and effective.</td>
<td>10.2</td>
<td>21.4</td>
<td>5.0</td>
<td>12.93</td>
<td>0.17*</td>
</tr>
<tr>
<td>Self-regulatory measures adopted by e-retailers to protect e-consumers are sufficient and effective.</td>
<td>14.5</td>
<td>28.6</td>
<td>10.0</td>
<td>14.06</td>
<td>0.18*</td>
</tr>
<tr>
<td>Industry codes of conduct to protect e-consumers are sufficient and effective.</td>
<td>13.3</td>
<td>35.7</td>
<td>15.0</td>
<td>21.63</td>
<td>0.23*</td>
</tr>
<tr>
<td>Activities by consumer associations to protect e-consumers are sufficient and effective.</td>
<td>15.1</td>
<td>28.6</td>
<td>10.0</td>
<td>14.81</td>
<td>0.19*</td>
</tr>
</tbody>
</table>

* $p < 0.01$, ** $p < 0.05$  
Source: Survey Data

About 48.2% and 70% of Group 1 and Group 3 respectively agreed on the introduction of more government regulation to protect e-consumers. The respondents in Group 1 might not understand how much government regulations could help them, and how much government regulations were needed to ensure the effectiveness of e-consumer protection. Whilst, the respondents in Group 3 probably knew about the advantages and disadvantages of regulations, and about what needed to be done to improve e-consumer protection. More than 50% of Group 2 thought that consumers would be better protected with more regulations. Two possible explanations of this proportion are: (i) e-retailers realised the importance of consumer protection...
regulations, and (ii) they thought that they were not able to effectively protect e-consumers without support by government.

Table 1 also shows statistically significant differences regarding the attitudes of the three groups towards all other variables. All Cramer’s V values indicated a medium effect size. The proportions of Group 2 who agreed with all statements (except from “more government regulations”) were the highest among the three groups. However, this proportion was less than 50% which means many e-retailers disagreed that e-consumers protection was sufficient. This implies that some issues in the current policy framework need to be addressed. Only 18.7% and 20% of Groups 1 and 3 respectively thought that e-consumers were equally protected as consumers in the offline market. Obviously, consumers did not perceive that they were adequately protected in the online market. Their perceptions might affect their decision to shop online, i.e. it was too risky to shop online since there was limited protection provided to them.

Very few respondents in Groups 1 and 3 agreed on the adequacy and effectiveness of regulations, guidelines, self-regulatory approaches, industry codes of conduct, and activities of consumer associations. The respondents in Group 3 have worked for government agencies, industry and consumer associations, and have known about government regulations/guidelines relating to e-consumer protection. Yet, only 20% and 5% of them thought that such regulations and guidelines were adequate and effective respectively. If they perceived the current policy framework insufficient, this framework needed to be reviewed. Regarding self-regulation, there are two possible explanations of the low proportion of e-retailers (28.6%) who agreed on the adequacy and effectiveness of self-regulatory measures. Firstly, some e-retailers might not comprehend what a self-regulatory approach meant. Secondly, some e-retailers might understand about self-regulation, but they did not think self-regulation was appropriate because there are both good and bad, honest and dishonest e-retailers in the online marketplace. Good and/or honest e-retailers would fulfil both their social responsibilities, and business objectives by going beyond regulations and guidelines to provide protection to e-consumers. Nevertheless, dishonest e-retailers would violate the laws to gain unfair advantages. Thus, a self-regulatory regime might not be appropriate to address e-consumer protection according to these respondents.

7. Policy Implications
Firstly, most respondents as consumers and other stakeholders shared the same view that the current policy framework for e-consumer protection was unfavourable to them, whereas most of e-retailers agreed with the statements in Table 1. Secondly, government has still played a very important role in protecting consumers since most stakeholders have had more confidence in government regulations. Thirdly, although self-regulatory measures have been promoted, many stakeholders, especially e-retailers might not think that such measures could provide effective protection to e-consumers. Overall, a stand-alone approach of governance, such as strict regulation or self-regulation, is insufficient to address the issues relating to e-consumer protection. Too much government intervention or lack of initiatives from e-retailers, industry and consumer associations may hinder the development of e-retailing, and discourage consumers from shopping online. Thus, this paper suggests an integrated governance approach in which all stakeholders need to cooperate to provide effective protection to e-consumers.

8. Limitations
Firstly, the sample of Group 1 was not randomly selected because the individual email addresses of members in the mailing list of the university were not revealed due to the university’s privacy policy. This problem was overcome by inviting all list members to participate in this study via
the moderator. Secondly, the sample sizes of Group 2 and Group 3 were small. Yet, the use of the chi-square test did not require the equal sizes of the three groups.

9. Conclusion
E-retailing has generated many benefits to consumers, but has also posed many risks. Several measures have been implemented to protect e-consumers, but the desired outcomes have not fully materialised. One possible reason is the inadequacy and ineffectiveness of the current policy framework for e-consumer protection as perceived by the three groups. Co-operation among stakeholders may enhance e-consumers protection. Further research can focus on different industries to examine how to improve e-consumer protection in order to encourage more online purchases.

Reference list
Developing Context-Aware Service in the Mobile Environment: A Context Description Model for the Taxi Industry

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Abstract

User context is important in the mobile environment. It's the key of improving the quality of mobile application service. This paper concludes the concepts of context and context-awareness, especially looking on the existing context description models. Then a framework of context-aware service is proposed for the taxi industry. Finally, a case study is taken to discuss how to apply the context-awareness in the taxi industry.

Key words: Mobile Commerce; Context; Context Awareness

1 Introduction

In the recent years, the rapid advances in the new technologies like wireless communication and wireless device tracking enable new types of business application. In order to improve the mobile service quality, it is of great importance to conduct the research of context-awareness. The concept of context-awareness is one approach in improving the quality and acceptance of mobile service. By processing and applying the user related mobile information, it could enhance the interaction between the user and service provider, and improve the quality of mobile service. In this paper, we first review the basic concepts of context and context-awareness. Then, we illustrate the potential of context-aware service for the taxi industry. At the end of this paper, we will discuss a case on how the context description model could be used in a real taxi company.

2 Context and Context-aware

2.1 Definition of Context

From the literal meaning of context, it could be described as situation, environment. For this reason, some researchers defined context as the environment of the user or the application itself. Hull et al. included the entire environment by defining context to be aspects of the current situation. But with such kind of definitions, it’s difficult to apply context in practice. Considering the previous definitions and the operational view of point, we give the definition of context as follows: Context is such information that could be used to describe the features of the object and its environment. And such information is recordable and could be used as input parameters for application or service to enable them the ability of self-adaptive.

2.2 The Definition of Context-aware

Context-aware has become somewhat synonymous with other terms like adaptive, responsive, environment directed. The first definition of context-aware applications given by Schilit and Theimer restricted the definition to applications that could simply adapt themselves to context. Brown defines context-aware applications as applications that automatically take actions according to the user’s present context as detected by sensors. The definition is very close to the concept regarding of mobile environment and mobile commerce.

3 Context description model and the corresponding service process

3.1 Context description model

The common context description methodology is to categorize the key types of context in the mobile environment and build the context description model. Because of the different research interests, the selection of key types of context is not always the same. Here we summarize
several typical context description models. Dey\textsuperscript{[8]} enumerates context as the user’s emotional state, focus of attention, location and orientation, date and time, objects and people in the user’s environment. But this kind of definition is difficult to apply. Figge construct the context in three dimensions which are position, time and person. \textsuperscript{[9]}

In this paper, based on previous categorization of context description and the specific situation in the taxi industry, we use dynamic profile as an important context type. The so called dynamic profile here should be relevant to the application service. In the mobile environment, the change of environment is real time and dynamic. Adding dynamic profile to the context description model could identify the user’s context information more clearly so that better service could be provided.

3.2 Context-aware based service process

Although the elaboration of this context description model would be in the next section, we can now propose a context-aware based service process.

![Figure 1 Context-aware based service Process](image)

For each specific service which is based on context-awareness, the context information is considered as the basic reference information. When the service is initiated, the context information will be collected and processed first to construct a full context description model. Then this model will be combined with the application service to provide specific and customized service. The following is the service process diagram we propose in this paper.

[1] Service Initiation: Service Initiated by the user.
[2] Context awareness: Get basic context data and process the data.
[3] Context Application: Apply the context information to the service.

The procedure to build context description model is also illustrated in the Figure 1. The typical procedure includes three stages.

[1] Context recognition: Obtain all types of basic context data needed. In this stage, the expression of data collected is largely dependant on the technology adopted. But the data could not be used by the application service directly.
[2] Context explanation: Process the basic context data for the context description stage. Here, the most important job is to process the basic data obtained in the first stage, and form the context information for preparation of context description.
In stage 2, the basic context data could be transformed into context information by using the predefined database. And in this stage, the key function is to integrate the context information to form the systematic description model so that could be applied by services. Then it is possible to deliver context-aware services.

Now, we have built the context description model, and elaborate the context-aware based service process. According to this theory basis, we will introduce the possible context-aware service in the taxi dispatching control system in the following part.

4 Context-aware service in the taxi industry

Because of the specific characteristics of the taxi industry, namely the high mobility of the taxi itself, the concept of context-awareness is very important and useful. The services include real-time monitoring, dispatching, controlling and street navigation etc.

4.1 The context description model for the taxi industry

We will regard the taxi as the service user to analyze the four dimensions of the context for the taxi dispatching system. Then the integrated context description model could be formulated.

1. Position

Because of the high mobility of the taxi itself, its position is important. The dynamic position information is the key to realize the real-time dispatching and operation management for the taxi. Most of the existing dispatching systems run inefficiently. The taxi drivers have to tell their approximate positions to the dispatching control center by wireless communication devices, and then the center sends out the dispatching orders. But with the fast development of mobile technologies, it becomes possible to collect the taxi information like position, direction in the mobile environment which may help to improve the dispatching efficiency.

2. Time

The dimension of time is also basic context information for the taxi. Here the time could be divided into idle time and carrying time. The idle time means there is no passengers in the taxi and the carrying time means that the taxi is providing service to the passengers. Further, the time could also be divided in the rush time, night time and etc. according to the operation time period. With the complete time description, it is possible to trigger the taxi service accordingly.

3. Identity

Here, the concept of identity not only includes the preset static information, but also includes the dynamic status of the user itself. Extending this concept to the taxi industry, the plate number of the taxi could be used as the identity of the taxi. A series of preset information could be identified through backend processing, such as the model of the car, the personal information of the driver. Meantime, the taxi identity context information also includes the real time operation status which could be used to monitor the running of the taxi.

4. Dynamic Profile

The taxi and/or the driver are both the user of context-aware service and the provider of passenger service. While delivering the service to the passenger, there must be some other environment factors that affect the quality of the service. It is necessary to extract dynamic information as an individual dimension of context.

We define the dynamic profile here as traffic information because of the current situation of the taxi industry. The traffic information could be divided into two groups, one is navigation
information, and the other is road condition. For navigation information, the services like e-map could be offered to the taxi with the combination of taxi position and e-map information. For road condition, taxi could get the real time road condition service to avoid traffic jam, which would greatly improve the quality of passenger service and the efficiency of taxi operation.

4.2 Case Analysis

In this section, we will take Shanghai Dazhong Traffic Co. Ltd for example to analyze how context-aware services used in this one of the largest taxi companies in Shanghai. The first dispatching system of Dazhong Traffic was built in 1990. This system was just a wireless audio system. It can’t collect any information from the taxi. The dispatching center could only query every taxi driver whether he could get the passenger who booked the taxi.

In 1998, Dazhong Traffic introduced the so-called “Intelligent Taxi Dispatching System based on GPS Positioning” from Australia. This system could identify the position of taxi and intelligently choose the right taxi to pick up the passenger who booked the taxi service. The preliminary concept of context-aware service was formed at that time. But in this stage, the audio and data transmission network was still the analog communication network built by the company itself, the stability and expansibility was not of high quality.

Then come to the existing dispatching system which was built from 2001 when the company realized the importance of context information and built the context description model step by step. The system now is based on China Mobile GPRS and China Unicom CDMA1X. The following is the system architecture.

![Diagram](image)

Figure 2 the dispatching control system of Dazhong Traffic

The mobile telecom carriers (China Mobile and China Unicom) act as the infrastructure for the whole dispatching system. They provide basic audio and data transmission platform. And Dazhong Traffic only has to focus on how to collect the context information and use the information to provide context-aware services both to the taxi drivers and passengers.

The main technologies that Dazhong Traffic used to collect context information include GPS Positioning System, GIS (Geographic Information System) and sensors installed in the taxi. With these technologies, the context information of the taxi could be collected and transmitted to the dispatching control center where the context information will be processed and the corresponding services could be provided.
Till now, the dispatching system of Dazhong Traffic could already offer different kinds of services like taxi positioning, remote security alarm, tracking, communication, dispatching management and etc.

To conclude, the dispatching system of Dazhong Traffic is a prototype of context-aware service process we mentioned before. By collecting and processing the context information, the application service could be offered. But in the current dispatching mode of Dazhong Traffic, the context information is not fully used to optimize the quality of service. The context-aware service is not mature. And it is an important research subject in the future.

5 Summary
Mobile and ubiquitous computing together with wireless technologies enable new forms of user adaptive applications like context-aware service which could increase the interaction between service user and provider and enhance the quality of service. In the taxi industry, the integrated taxi operation management could be realized. Also, the total cost could be reduced and the efficiency of taxi operation could be increased. Comprehensively, the service level of taxi service can be largely promoted.

But there are still some challenges that will influence the future development and implementation of context-aware service. Bus as one of key applications in mobile commerce, the context-aware service model extends the concept of LBS (Location based service) and it’s a very promising area both for research and real business application. In the consequential research, we will keep on perfecting the context description model and service process. Also, we will carry on the research of related technologies, business and legal issues.

References
Customer Commitment to Mobile Services: An Empirical Study

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Abstract
This article develops and tests a model to explain customers’ intention to adopt mobile service. According to Diffusion of Innovations theory and organizational commitment theory, the authors propose eight overall influences on affective commitment, two influences on continuance commitment, and both affective and continuance commitment will impact customer behavioral intention to adopt mobile services. The empirical evidence from a survey supports most of the hypotheses in the model and important implications are discussed.

Keywords: mobile services, commitment, adoption

Introduction
The development of wireless or mobile services has become so strikingly rapid in the last decade. It has been driven by three main factors: the excitement regarding mobile technology; the continuing growth of e-commerce, and the high penetration level of wireless devices worldwide (Shankar et al., 2003). However, the mobile service adoption has not progressed as expected even the development of mobile services has been intense for years. One of the most important reasons for this disappointing uptake of mobile services is the failure of mobile services providers to understand customer value creation. Basic services of mobile devices, such as voice services, have been successfully adopted, but more advanced services, such as mobile payment, mobile shopping, mobile search, etc., have not yet found their ways into the everyday lives of consumers (Carlsson et al., 2005). Therefore, it is important to understand the driving forces of consumers’ intentions of choosing mobile services and their commitment to the mobile services.

Commitment is a psychological state generated by an individual’s perceptions, beliefs and emotions which provoke the willingness or intention of developing and maintaining a stable and durable relationship (Kiesler, 1971). It can influence customers’ motivation, target-relevant positive attitudes, and behaviors independently (Allen & Meyer, 1990; Meyer & Herscovitch, 2001). Commitment theories represent a departure from popular views widely adopted in previous technology adoption/acceptance literature (Venkatesh et al., 2003). Therefore, the notion of commitment captures a broader view of the forces driving an individual’s continuous actions (Allen & Meyer, 1990).

The objective of this study is to investigate important issues of web services adoption and give a deeper insight in the factors driving consumers’ acceptance of mobile services. In particular, this study attempts to determine the factors influencing mobile services adoption based on diffusion of innovations theory and organizational commitment theory.

Research Model and Hypotheses
Diffusion of Innovations (DoI) theory intends to describe the patterns of adoption, explain the mechanism, and assist in predicting whether and how a new invention will be successful (Rogers, 1983). According to this theory, technological innovation is communicated through particular channels, over time, among the members of a social system. Compared to the Technology Acceptance Model (TAM), DoI theory provides more robust structures (Slyke et al.
a, 2002). Therefore, in this study, we are trying to adopt this theory to explain factors influencing customer commitment and behavior intention. Moore and Benbasat (1991) suggest six constructs in DoI theory: **relative advantage**, the degree to which it is perceived to be better than what it supersedes; **compatibility**, consistency with existing values, past experiences and needs; **complexity**, difficulty of understanding and use; **trialability**, the degree to which it can be experimented with on a limited basis; **result demonstrability**, the degree to which the results of using an innovation are perceived to be tangible; **visibility**, the degree to which the results of using an innovation are visible to the user.

Meyer and Herscovitch (2001) demonstrate three dimensions in their commitment theory: affective, continuance, and normative. Affective commitment is the customer’s emotional attachment to the services or an organization because of favorable attitudes, affect, emotion, and perceptions. From the perspective of the diffusion of Innovations theory, relative advantage provides a strong indication of why customers keep the relationship with their service providers (Olsen, 2002); complexity ultimately influences users’ intention toward mobile services (Cyr et al., 2006); compatibility, trialability, result demonstrability and visibility are also related to customer emotional activities toward services or an organization (Da Silva & Syed Alwi, 2006; Hwang and Lee, 2005), which builds a bridge between these constructs and affective commitment. Additionally, customer satisfaction and trust directly impact customers’ emotional attitudes toward the services. Thus, these two factors are suggested to be antecedents of affective commitment (Bansal & Taylor, 2004). Therefore, we propose eight hypotheses (H1-H8) described in Table 1.

Continuance commitment is the motivational intent to continue the relationship, given high switching costs and scarcity of alternatives (Bendapudi & Berry, 1997). Switching costs and alternative attractiveness are found to correlate with continuance commitment (Bansal & Taylor, 2004). As switching costs such as time and money increase, customers are more likely to remain in the current relationship, which results less chance in switching their services. Conversely, as alternative attractiveness increase, customers are less likely to feel “locked in” with their current relationship, which results more chance in switching their services. Therefore, we propose two hypotheses (H9-H10) described in Table 1.

As we discussed above, affective commitment and continuance commitment will directly influence customers’ decision: either keep current services or switch to other services (Bansal & Taylor, 2004). Therefore, we propose two hypotheses (H11-H12) described in Table 1. Normative commitment explains moral obligations, and one’s responsibility to the other party in the relationship (Meyer & Herscovitch, 2001). It is less likely focused on the C2B relationship (Allen & Meyer, 1990), therefore we omit normative commitment in our study.

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Continuance commitment is positively associated with behavioral intention

Research Method
To examine the research model, a survey method was used for data collection. The survey was sent to 436 undergraduate students at three large research universities. The student sample is a typical segment of mobile services users and has been widely used in previous m-commerce research (Jih and Lee, 2004). A total 378 surveys were kept in the final sample for data analysis after removing incomplete questionnaires and respondents who had no mobile service experiences. The sample can be characterized as follows: gender (female: 54%, male: 46%), age (average: 21), experience of using mobile devices (5 years).

The items used in this survey were adapted from previous studies. The measures of relative advantage, complexity, compatibility, trialability, result demonstrability, and visibility were adapted from Agarwal and Prasad (1997). Satisfaction was measured by items adapted from Bansal and Taylor (1999). Trust was measured by items adapted from Eastlick et al. (2006). Switching costs and alternative attractiveness were measured by items adapted from Ping (1993). Both affective and continuance commitment constructs are adapted from Meyer and Allen (1997). Behavioral intention construct was adapted from Oliver and Swan (1989).

Results
The reliability of the items was evaluated by Cronbach’s alpha (Cronbach, 1970). The coefficient alphas for the relative advantage, compatibility, complexity, trialability, result demonstrability, visibility, satisfaction, trust, switching costs, alternative attractiveness, affective commitment, continuance commitment and behavioral intention were 0.87, 0.73, 0.79, 0.81, 0.86, 0.79, 0.83, 0.75, 0.89, 0.72, 0.81, 0.86, and 0.80, respectively. Pearson’s correlation coefficients were also determined to assess the convergence validity. Since all the attribute coefficients were somewhere from high to moderate ranges, they were all retained for future analysis. Additionally, validity using structural equation models is supported by variance-extracted scores for each construct of >.5 (Hair et al., 1998). The calculated variance-extracted scores exceeded the 50 percent recommended criteria. Chau (1997) suggested the fit indices as a good fit of the measurement model, therefore we adopted this method to test the research model (Figure 1).

Discussion and Conclusions
Our results indicate that issues related to relative advantage, compatibility, complexity, trialability, result demonstrability, satisfaction, and trust would determine customer affective commitment to mobile services. Switching costs will influence continuance commitment. And, eventually, affective commitment and continuance commitment will impact customers’ behavioral intention to adopt mobile services. The results support that increasing the level of relative advantage, compatibility, ease of use, trialability, result demonstrability, satisfaction, trust, switching costs can help mobile services providers retain their current customers and attract new customers.
The findings indicate that level of visibility of using mobile services is not significantly related to customer affective commitment. The possible reason to explain this result may be that behaviors using mobile services are more likely individual activities, such as mobile email service. Therefore, people are not very concern about their surroundings. This could cause a low level of visibility in the study. Additionally, alternative attractiveness was found non-significant related customer continuance commitment. This may result from the service similarity from most current mobile service providers. Under this situation, customers are unlikely to switch to another service provider (Meyer and Allen, 1997).

Understanding the mechanisms that drive consumers’ intentions to adopt mobile services is of vital importance for mobile services providers, especially in developing new services (Watson et al., 2002). This study reveals the significant relationship between some innovation characteristics and customer commitment, and the significant relationship between customer commitment (affective and continuance) and behavioral intention. Findings indicate that mobile service providers should be aware of innovation variables, such as relative advantage, compatibility, ease of use, trialability, and result demonstrability, in addition to satisfaction, trust, and switching costs when they are developing mobile services or business campaigns.

References

5. Bendapudi, N., and Berry, L. “Customers’ Motivations for Maintaining Relationships with
A 2-Stage Individual Acceptance Model for BPR Project Implementation

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Abstract
This paper proposes a new model contributed to the individual acceptance of business process reengineering (BPR) project. This model comprises 2 sub-models with the purpose of covering all the stages of BPR project implementation. In each implementation phase, the corresponding sub-model is designed to contain all the factors associated with individual’s adoption decision.

Keywords: BPR; Individual acceptance model; BPR implementation stage

1. Introduction

Business process reengineering (BPR) is a management thinking approach proposed by Hammer and Champy in 1993 (Hammer, Champy, 1993). Since been propounded as a management idea in the early 1990s, BPR has been theoretical and practical concerns. While more and more attention is paid on BPR by a growing number of companies, the failure rate of implementing BPR remains high. Though many reasons are found to be associated with the failure of BPR, there is an important factor that the individual involved in the project doesn’t understand the BPR concept clearly or accept the outcome of BPR. Therefore it leads to resistance from both awareness and behavior, and ultimately the whole project falls short. These related "human" factors work like: feelings of fear and anxiety induced by BPR, the resistance to change, difficulties of daily work, inconvenience of replacing the old processes, suspect about the BPR project and so forth.

Although BPR becomes a research focus for many years, very few studies have investigated what affects the individual acceptance decision of BPR project. In this paper, we propose a new individual BPR acceptance model which is supposed to include the factors affecting the individual adoption process. We also divide this adoption process into 2 stages and 2 sub-models will be established to give an analysis of each stage’s factors.

2. Literature review

2.1 Theory of reasoned action (TRA)

TRA is proposed by Fishbein and Ajzen in 1975, which sources from the psychology theory. TRA becomes one of the foundations of personal behavior theory in 1980s, and is widely applied to the personal behavior research area (Fishbein, Ajzen, 1975). TRA is based on the proposition that an individual’s behavior is determined by the behavioral intention, which is influenced by individual’s attitude and subjective norm. Individual’s attitude is defined as “an individual positive or negative feeling towards performing the target behavior”. Subjective norm is defined as “the person’s perception that most people who are important to him think he should or should not perform the behavior in question”.

2.2 Theory of planned behavior (TPB)

The theory of planned behavior is proposed by Ajzen in 1985, and it is an adaptation of the theory of reasoned action (TRA). Individual behavior is actually affected by time, money,
information, the ability and so on. Thus perceived behavioral control is added as an additional factor to overcome the inadequacy of TRA (Ajzen, 1985). TPB holds that individual’s behavior is directly determined by behavioral intention and perceived behavioral control. Behavioral intention is formed by attitude, subjective norm and perceived behavioral control. Individual’s attitude, subjective norm and perceived behavioral control are influenced by internal and external constraints such as user characteristics, task characteristics and context.

2.3 Technology acceptance model (TAM)

The technology acceptance model (TAM) is also a revised version of TRA. Compared to TRA, TAM varies in two ways: first, subjective norm is not considered as a determinant of usage intention; second, a direct path exists from perceived usefulness to usage intention.

2.4 Leonard-Barton & Deschamps model

Leonard-Barton and Deschamps proposed a model of individual innovation adoption in 1988. This model is different from past researches which focused principally on the adoption and initiation stages, and this model is in the level of analysis of implementation stage (Leonard-Barton, Deschamps, 1988). Leonard-Barton & Deschamps model holds the opinion that managerial influence is the essential factor in implementation of innovation, and the perception of high management actions directly affect individual’s adoption decision in this stage. Personal characteristics and skills work as mediators between the managerial intervention and the adoption decision. Some control variables, such as peer opinions, resource accessibility, training, will also influence the individual’s decision.

2.5 Adoption phase of BPR individual acceptance

BPR is a complicated process, and the implementation of BPR project can be separated into several periods. When the project is going on, its targets and contents also vary. Thus the individual’s adoption of BPR also can be divided into different stages correspondingly. In each stage, individual may encounter different changes or face up different reformation aims. In this paper, we split the individual’s adoption of BPR into 2 stages. The first stage is the BPR concept adoption stage. In this stage, the corporation initiates the BPR project so that individual will definitely be infused with the BPR concept. This interaction between individual and the BPR concept is the content of adoption. The second stage is the BPR implementation adoption stage. In this stage, individual has experienced almost the whole project. After implementation, there would be some changes in the company-wide environment. Individual is required to adapt the new work process. The interaction between individual and the outcome of BPR is the adoption content in second stage.

3. Research model

After investigating a mass of literature and drawing attention to the various factors in the 2 stages of individual acceptance of BPR project, we propose the individual acceptance model.

3.1 Acceptance model for stage 1

The acceptance model for stage 1 can be decomposed into 3 dimensions: attitude, subjective norm and perceived behavioral control. Behavioral intention, which is a measure of the strength of one’s intention to perform the adoption behavior, is determined by attitude, subjective and perceived behavioral control. These factors are determined by several sub-factors as well. The detail of the sub-factors are described below.
(1) Perceived usefulness. Perceived usefulness is the user’s subjective probability that accepting BPR project will increase his or her job performance within an organizational context (Davis, 1989). When facing the choice of adopting BPR, individual will evaluate what BPR will result in, and whether the outcome will make sense to him or her.

(2) Perceived ease of use. Perceived ease of use is defined as the degree to which the user expects the result of BPR to be free of effort (Davis et al., 1989). If individual perceives the adjusted work process is easier to operate, BPR project may be accepted.

(3) Anxiety. Anxiety is related to an individual’s emotional feeling about new technologies (Cheon-Pyo Lee, 2004). BPR implementation will inevitably bring in new technology into corporation, and a level of technology anxiety will also exist. Furthermore, BPR will probably restructure the organization, and individual may worry about their prospect in this corporation.

(4) Superior influence. The opinion from high management or supervisors will inflict a heavy pressure on individuals (Taylor, 1995). Normally, people tend to be compliant with the superior will.

(5) Peer influence. In the initial adoption phase, individuals have little or no experience on BPR project, and their beliefs would be greatly influenced by opinions expressed by peers (Taylor, 1995).

(6) Voluntariness. Voluntariness is a variable defined as “the extent to which potential adopters perceive the adoption decision to be non-mandatory” (Venkatesh, Davis, 2000). Scholars found that even when individuals perceive BPR acceptance to be organizationally mandated, intentions vary because someone is unwilling to comply with such mandates.

(7) Self efficacy. Bandura defines self efficacy as “People’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances”. Individuals with high level of self efficacy are anticipated to be more likely to accept BPR project.

(8) Technology facilitation. Individual’s perception of technology condition will impact on the adoption intentions (Taylor, Todd, 1995). When individual lacks some necessary skills required after BPR implementation, he or she would tend to reject adoption decision.

(9) Resource facilitation. The resources and opportunities available to a person must to some extent dictate the likelihood of behavioral achievement (Ajzen, 1991). With respect to the
BPR adoption decision, the resource factors such as time and money may constrain one’s intentions (Taylor, Todd, 1995).

3.2 Acceptance model for stage 2

The acceptance model for stage 2 can be decomposed into 3 dimensions: management influence, individual characteristics and control variables. Like the behavioral intention described in model for stage 1, the implication of behavioral intention means the willing of individual to perform the adoption action. Each factor is determined by several sub-factors described below.

(1) Perceived authority messages. A message about the adoption of BPR outcome issued by high management may alter the individual’s adoption decision, though this kind of message doesn’t necessarily ensure compliance. However, when individual perceives this indirectly signal, the interaction between subordinates and superiors is influenced.

(2) Perception of management support. The direct influence of management’s support would rest on more ambiguous and open to more individual interpretation than authority messages mentioned above. If management shows a very clear attitude towards the BPR project, the individual’s opinion can be altered by this direct information from a superior.

(3) Job-determined need. A key element of the acceptance of BPR project is the extent to which it meets individual’s job-determined need. In corporation, the degree to which a particular person performs the relevant task determined the opportunity to involve in the BPR project. Individuals who perceive a high need for the BPR in their jobs could thus be more likely to accept BPR project than those who do not perceive need.

(4) Innovativeness. The receptivity towards change is an important determinant of BPR project success. Some people are more willing than others to try new work processes or other changes. This pro-innovation attitude is likely to lead people to early adoption.

(5) Resource facilitation. As mentioned in the model of stage 1.

(6) Training. In the diffusion of BPR within an organization, individual can be influenced by training (Popper, 1983). Training is an approach to enhance people’s knowledge level which may relate to the technology facilitation mentioned in model of stage 1.

(7) Peer attitude. As mentioned in the model of stage 1.

4. Conclusions and limitations
This paper describes the individual acceptance model for the BPR project implementation, based on a mass of theoretical researches and analysis. This 2-stage model may help to fill the vacancy of BPR individual research and to give some advice to the BPR practice. We hope to conduct a further verification on this model and make it a research basis for the future study.

References

- Cheon-Pyo Lee, Haiwook Choi, Merrill Warkentin, “The Role of Technological and Social Factors on the Adoption of Mobile Payment Technologies”, AMCIS, 2004, P2781-2786
Examining CIO Compensation: A Managerial Discretion Perspective

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Abstract

The purpose of this study is to investigate the compensation of the CIO through the theoretical lens of "managerial discretion". The managerial discretion describes the latitude of actions that executives have to make strategic choices. Based on extant strategic management and CIO literature, we propose to empirically examine the influence of organizational and individual discretionary factors on the CIO’s managerial discretion and the impact of this executive’s discretion on compensation. The model will be tested using survey data collected from a sample of CIO/CEO matched pairs.

Keywords: Chief Information Officer, Compensation, Managerial Discretion, Human Capital

1. Introduction

The attention directed to the topic of executive compensation can be attributed to the belief that compensation influences the top management team’s (TMT) perception of fairness, the motivation and behavior of top executives, and firm performance mediated by executive behavior (Carpenter and Wade 2002, Finkelstein and Hambrick 1996). In this study, we examine the compensation of the chief information officer (CIO). Understanding the factors that influence CIO compensation is important since the literature suggests that compensation may influence executive effectiveness (Carpenter and Wade 2002, Finkelstein and Hambrick 1996). CIO effectiveness is of the utmost relevance to organizations since information technology (IT) capability has become both strategically and operationally important to contemporary firms (Bharadwaj 2000) and such effectiveness has been found to influence the operational and financial performance of the organization (Karahanna and Chen 2004).

Based upon the seminal work by Hambrick and Finkelstein(1987), we argue that a CIO’s compensation is a function of his/her managerial discretion. Based on the existing compensation literature as well as CIO studies, we identify organizational and individual factors that determine CIO managerial discretion and thereby impact CIO compensation. The next section provides the conceptual background and develops research hypotheses. We then describe our proposed research methodology that will be employed to test our hypotheses. The paper concludes with a discussion of its expected contribution to the field.

2. Theoretical Underpinnings and Hypotheses Development

Hambrick and Finkelstein (1987) introduced the concept of managerial discretion, defined as an executive’s latitude of actions, to reconcile the opposite views of how much impact a corporate executive have on the organization. Finkelstein and Hambrick (1996) argue that depending upon the degree of discretion, “an organization’s fate may lie totally outside of the control of its top managers, completely within their control, or more typically, somewhere in between” (p. 26). High-discretion contexts have fewer constraints and provide the top manager with greater potential to impact organizational outcomes and firm performance (Finkelstein and Boyd 1998).
Because pay reflects the contribution of an executive to a firm, it follows that high managerial discretion leads to high executive compensation (Hambrick and Finkelstein 1987).

**Figure 1: Research Model**
Managerial discretion stems from contextual forces but is also derived from within the executive (Hambrick and Finkelstein 1987). Hambrick and Finkelstein proposed three sources (environmental, organizational, and individual) of CEO managerial discretion. Based upon an extensive review of strategic management and IT management literature, in this work, we focus on the factors that are most relevant to the CIO within the organizational context, while controlling other individual, organizational, and industry variables (see Figure 1).

### 2.2.1 Resource Availability

Firms with greater slack resources will provide executives with greater leeway in the options they pursue. We posit that a CIO’s managerial discretion will be contingent upon the resources provided for strategic IT initiatives. Prior literature indicates that the CEO and TMT members often do not understand the purpose of strategic IT initiatives and as a result do not provide adequate support and resources to the IT department to pursue such initiatives (Armstrong and Sambamurthy 1999). If the CIO is provided with the necessary resources to carry out strategic objectives, s/he will consequently have wider latitude of options that can potentially influence organizational outcomes. Further, if the firm allocates greater resources toward IT, it may act as a signal that IT is central to the organizational mission (Jarvenpaa and Ives 1991). Thus,

**H2**: The availability of resources made available to the IT department and to support strategic IT initiatives will positively influence the level of the CIO’s managerial discretion.

### 2.2.2. CEO Strategic IT Vision

Strategic IT vision is defined as the shared, aspired state of the role that IT should play in the firm (Armstrong and Sambamurthy 1999). Schein (1992) identified four major categories of strategic IT visions (automate, informate up, informate down, and transformate). The CEO’s vision of IT is the most important factor that contributes to the success of IT in the organization (Jarvenpaa and Ives 1991) and the effectiveness of the CIO (Gupta 1991). A CEO who espouses an automate vision will generally view IT as merely a tool to reduce operating cost; a CEO who espouses a transformate vision will generally view IT as a strategic resource that can bring competitive advantage. Armstrong and Sambamurthy (1999) found that the CIO can have a greater impact in the firm’s competitive success in organizations where the TMT conveys a transformate vision. We argue that the CIO will most likely be recognized as key to the organization’s success and therefore provided more leeway in making strategic decisions when the CEO has a transformate vision and least likely when the CEO has an automate vision. Thus,

**H3**: The CEO’s strategic IT vision will influence the level of the CIO’s managerial discretion.

### 2.2.3. CIO Personal Characteristics

Following Hambrick and Finkelstein (1987), we posit that a discrentional CIO must have certain cognitive traits (i.e., high levels of aspiration level, tolerance for ambiguity, locus of control) that are characterized by many successful executives. In addition to these cognitive traits, we argue that political acumen and persuasiveness are important CIO characteristics that will enhance this executive’s level of discretion in the organization (Smalt et al 2006). The CIO’s role and actions are crucial in ensuring that IT is deployed for strategic advantage and delivers value (Earl and Feeney 1994). Thus, the CIO must be able to articulate the need for IT initiatives and have the political acumen to understand how to best approach the TMT to obtain greater latitude.
H4: CIO personal characteristics (high levels of internal locus of control, tolerance for ambiguity, aspiration, political acumen, and persuasiveness) will positively influence the CIO’s level of managerial discretion.

2.2.4. CIO Human Capital

Hambrick and Finkelstein (1987) argue that a manager may be able to see or capitalize on alternatives that others cannot see due to his/her experiences and level of knowledge. This assessment is congruent with human capital theory which suggests that a manager’s human capital (i.e., education, work experience, managerial knowledge and functional expertise) influences his/her managerial capabilities and productivity (Agarwal 1981, Carpenter and Wade 2002). In accordance with these authors, we examine the effect of a CIO’s human capital on his/her managerial discretion along four dimensions: CIO education level, work experience, business knowledge, and strategic IT knowledge. Educational level and work experience have been demonstrated as important factors to improve a manager’s productivity in general (Agarwal 1981, Finkelstein and Boyd 1998, Carpenter Wade 2002). In addition, we contend that a CIO’s business knowledge and IT knowledge are particularly important to contribute to this his/her managerial discretion (Applegate et al 1991, Gupta 1991). Thus,

H5: Greater CIO human capital (educational level, work experience, business knowledge, strategic IT knowledge) will positively influence the CIO’s level of managerial discretion.

2.2.5. TMT Membership

We posit that the relationship between each of the antecedent variables and managerial discretion will be moderated by the power base of the CIO. Smith et al (2006) indicated that within executive teams, power is the capability to influence other social actors regarding the strategic decisions of the firm. In this study, we focus on the positional power (i.e., legitimate power) of the CIO, which is “derived from the position of a leader in the organizational hierarchy due to appointment or election” (Pearce and Robinson 1987). The CIO’s formal membership in the TMT facilitates knowledge exchange between the CIO and TMT, allows the TMT to better understand the strategic capabilities of IT, and positively influences the TMT’s perception of the CIO’s level of effectiveness (Smaltz et al 2006, Preston and Karahanna 2004). Therefore, the potential marginal product of the CIO will be greater when the CIO is a formal TMT member. Carpenter and Wade (2002) found that lower-level executives were paid more for their human capital when they held strategically sensitive positions. Thus,

H6: CIO membership in the TMT will moderate the relationships between the four determinant variables (resource availability, CEO strategic IT vision, CIO personal characteristics, and human capital) and CIO managerial discretion.

3. Research Methodology

This study will employ a dual-stage matched-pair mail survey to empirically examine the relationships within the research model. There will be two survey instruments used to collect data in this study: 1) CIO instrument; and 2) matched CEO instrument. The sources for the instrument measures are valid items from prior studies and various CIO interviews conducted by the authors. The CIO instrument covers items measuring resource availability, CIO cognitive characteristics (i.e., locus of control, aspiration level, and tolerance for ambiguity), human capital (educational level and work experience), power, managerial discretion, and compensation. The CEO will be asked to assess his strategic vision of IT, the CIO’s demonstrative characteristics (political acumen and persuasiveness), and CIO business and IT knowledge. The sample frame
includes 3700 CIOs of US based organizations listed in the Dun and Bradstreet’s Million Dollar Database. At this moment, we have collected 477 valid CIO surveys. We are in the process of sending the CEO instrument to the corresponding CEO of each company from which we have received a completed CIO questionnaire. Once the data collection completes, the research model will be analyzed using partial least squares (PLS), a component-based approach that allows for the testing of both formatively and reflectively modeled constructs. The model to be tested is a second-order factor model with reflective measures for the first-order factors and formative measures for the second-order factors. CIO personal characteristics and CIO human capital are modeled as second-order factors while all other constructs are modeled as first-order factors.

4. Expected Contributions

By applying the concept of managerial discretion to study the determinants of CIO compensation, we expect the findings of this work would contribute to strategic management literature in general and CIO studies in particular. First, this work advances our understanding of managerial discretion. To our knowledge, our work is the first attempt to comprehensively operationalize and empirically examine the construct of managerial discretion. We created items to directly measure managerial discretion, which will allow us to directly test the explanatory power of the two sources of managerial discretion proposed by Hambrick and Finkelstein (1987). Secondly, we answer the research calls (Carpenter and Wade 2002) for studying non-CEO executive compensation. The approach and framework of this study may be applied to study the level of managerial discretion and compensation of other top managers who assume newly created positions such as the chief knowledge officer (CKO) or chief customer officer (CCO). Finally, this research also has several practical implications. Many previous economic based studies, which dominate the compensation research, suggest executive pay is a function of firm performance. A goal of this research is to demonstrate that social-psychological and political perspectives provide an appropriate framework to examine how executive compensation is determined. For a CIO within an organization for which the performance is difficult to define, s/he may leverage certain managerial characteristics (e.g., locus of control, political acumen) as well as human capital to influence the compensation level.

References

Available Upon Request
Reaping Information Technology Payoff: Does Corporate Governance Matter?

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Abstract
This study investigates the role of corporate governance, an important management control system, in the IT investment-firm performance relationship in the Taiwanese high-tech industries. Two specific corporate governance factors, i.e., board independence and foreign ownership, are explored across firms with different sizes and in industries whose degrees of competitiveness run a wide gamut. We find a strong effect of board independence on the IT investment-firm performance relationship, especially when competition intensifies. Furthermore, we find that the association between foreign ownership and firm performance is negative but not significant. Yet, foreign ownership is a significant moderator for small firms, suggesting that foreign investors may bring IT expertise to help small firms reap the benefits of using IT.

Keywords: IT Value, Corporate Governance, Board Independence, Foreign Ownership

1. Introduction
Companies are increasingly leveraging information technology (IT) and adopting various management accounting practices to improve business processes. While significant investment in IT has been made and IT in general is expected to increase operational efficiencies (Hitt and Brynjolfsson 1996), prior studies have shown that the organizational application of IT improves (Brynjolfsson and Hitt 2002), reduces, or has no effect on firm performance (Kohli and Devaraj 2003). Skeptics place caution on the high risks associated with IT investment and point to the failures of firms that may have invested excessively in IT. The cautionary lesson reflects the need for better management control in making technology investments. In a recent survey conducted by InformationWeek in 2004, U.S. executives indicated that corporate accountability is a key differentiator for realizing IT performance impacts. However, in the academic literature, consistent and rich evidence on the role of corporate governance in IT value creation is yet to document. To reap IT payoff, does corporate governance matter? This is the research question of interest to this study.

2. Model and Hypotheses
2.1. Model
Specifically, this research analyzes how corporate governance shapes IT performance impacts in the Taiwanese high-tech industries. We develop a conceptual model as shown in Figure 1. This model evaluates the relationship between IT investment and firm performance. In this research setting, corporate governance should play a significant role because it is normally used to reduce conflicts between managers and shareholders in managing new technology investment (Fan and Wong 2005). A strong monitoring system affects how IT resources are integrated into an organization, which subsequently results in better firm performance. Especially in emerging
markets such as Taiwan, companies are normally project- and relationship-based, lacking sound monitoring systems and professional knowledge (Fan and Wong 2005). Board independence offers more objective monitoring and is considered important in corporate governance. Thus, companies may achieve different results from their IT investment, contingent on board structure. In addition, foreign ownership helps enhance board structure in the setting of a newly industrialized market, and may have a spillover effect that would help firms that typically lack IT knowledge. This is particularly important in our context given the fact that the Taiwanese high-tech industry has attracted more foreign investment over the past decade. As such, we specifically examine the moderating role of the two governance factors (shown in Figure 1).

2.2. Hypotheses
Next we propose hypotheses based on the conceptual model. First, the board of directors is established to monitor top executives’ investment decisions and to evaluate their performances. An independent board is expected not only to more objectively advise senior executives but also to better monitor the IT deployment to avoid uneconomic or excessive investment. We thus expect a positive moderating effect of board independence (the percentage of independent and outside directors in board) on the IT investment-firm performance relationship. Furthermore, we expect that industrial competitiveness may shape the influence of independent boards. In highly competitive markets, there exists a greater rate of technology diffusion. Since companies in highly competitive industries normally find it more difficult to capture rents, they tend to pursue returns from the adoption of new technologies. Nonetheless, firms facing intense competition tend to reflect a bandwagon mentality in making IT investments. The use of blind imitation may reduce the economic return to IT investment. Under such circumstances, an independent board would play a more significant role because it can serve as a monitoring system to prevent uneconomic and excessive IT investment. This accentuates the importance of having sound monitoring systems for IT investment in highly competitive industries. Therefore,

**H1**: Board independence positively moderates the relationship between IT investment and firm performance. Such moderation effect is more positive for more competitive industries.

Second, foreign ownership (i.e., proportion of common stock owned by foreign investors) increases ownership dispersal, which may incur additional agency costs (Short 1994). On the other hand, foreign investors are expected to enhance board structure and can generate a “spillover effect” (Aitken and Harrison 1999). This is because foreign ownership may offer expertise and experience in deploying IT resources, which bridges the productivity gap of IT investment between developing and developed markets. Therefore, the role of foreign ownership
ownership in the IT investment-firm performance relationship is an empirical issue, and additionally foreign ownership’s impact may differ across firms with different sizes.

In new technology diffusion, firm size may reflect differences in relative risks of failure that companies face. Large firms normally have greater free cash flow and are more likely to invest in new technologies, and hire major consulting firms to help advise them in the use of IT. In contrast, small firms have resource disadvantages and typically lack expertise for managing IT. Most of the Taiwanese high-tech companies are manufacture-based and are small- and medium-sized. To attain benefits from IT, small companies need professional knowledge and experience in IT deployment. In this regard, we expect the role of foreign ownership to differ in significance, dependent on firm size.

H2: The moderation effect of foreign ownership in the IT investment-firm performance relationship is more positive for small firms than for large firms.

3. Data
Starting in 2001, the Taiwanese government required all companies in the high-tech industries to report their annual IT investment (in software, hardware and training). These high-tech industries include sectors that make electronic components, photoelectric products, motherboard scheme, integrated circuits, electronic channel, communication products, etc. Our sample includes 719 Taiwanese high-tech companies from 2001 to 2005. Corporate governance information was collected from the Corporate Database created by the Taiwan Economic Journal.

4. Regression and Results
Our regression model builds on a previous cross-sectional analysis regressing firm performance on board structure and lagged performance (Klein 1998). We extend that model by including two specific corporate governance variables—board independence and foreign ownership, both used as independent variables. We also add IT investment as a new independent variable, which is the point of interest in this study. The model is as follows:

\[ \text{ROA} = \beta_1 \text{ITINV} + \beta_2 \text{BIND} + \beta_3 (\text{ITINV} \times \text{BIND}) + \beta_4 \text{FOR} + \beta_5 (\text{ITINV} \times \text{FOR}) \]
\[ + \beta_6 \text{ROA}_{-1} + \beta_7 \text{GROWTH} + \beta_8 \text{LEV} + \beta_9 \text{SHARE} + \beta_{10} \text{RD} + \beta_0 \]

where \(\text{ROA}\) = return on assets, \(\text{ITINV}\) = IT investment/assets, \(\text{BIND}\) = board independence, \(\text{FOR}\) = foreign ownership, \(\text{GROWTH}\) = one-year sales growth rate, \(\text{LEV}\) = debt-to-asset ratio, \(\text{SHARE}\) = market share, \(\text{RD}\) = R&D spending/assets.

To evaluate the moderation of corporate governance, the model incorporates interaction terms between IT investment and corporate governance (\(\text{ITINV} \times \text{BIND}\) and \(\text{ITINV} \times \text{FOR}\)). The model also controls for lagged performance (\(\text{ROA}_{-1}\)), as well as for other variables (\(\text{GROWTH}, \text{LEV}, \text{SHARE},\) and \(\text{RD}\)) which are identified from the IT business value literature (e.g., Hitt and Brynjolfsson 1996). We first estimated the model on the full sample (Table 1), and found a significant interaction term \(\text{ITINV} \times \text{BIND}\), indicating a significant moderation effect of board independence. Then, we estimated the model on two subsamples—highly competitive industries and less competitive industries (industry competitiveness measured by four-firm concentration ratio). Compared to the full-sample results, a significant change is that the interaction term \(\text{ITINV} \times \text{BIND}\) becomes non-significant on the highly competitive industries. Lastly, we estimated the model on large firms and small firms (firm size measured by total assets). Compared to the
full-sample results, a significant change is that the interaction term $ITINV \times FOR$ becomes significant for small firms. Next, we discuss our major findings based on these results.

5. Discussion

Based on the regression results, we find that IT investment does not have a direct association with firm performance but interacts with board independence in affecting firm performance. Also, our results show that board independence has a stronger effect on the IT investment-firm performance relationship when competition intensifies. Specifically, there is a significant interaction between IT investment and board independence in more competitive industries. Further, we find that the association between foreign ownership and firm performance is not significant. Yet, foreign ownership is a significant moderator for small firms. This suggests that foreign investors may bring IT expertise to help small firms reap the benefits of using IT.

Our study adds to the extant literature in three different ways. First, we offer insights into why the mixed findings are reported in the prior literature on the IT investment-firm performance relationship. Our results show that IT investment \textit{per se} does not affect firm performance but that corporate governance plays an important moderating role in the IT investment-firm performance relationship. Clearly, a better monitoring system can help companies achieve better financial performance through their IT investment. These results suggest that future research should incorporate corporate governance in exploring how IT investment affects firm performance.

Second, this study demonstrates the importance of including structural differences across firms and industries in examining the moderating effect of corporate governance in the IT investment-firm performance relationship. Our findings show that a monitoring system captured by board independence is beneficial for companies in more competitive industries but not for less competitive industries. This demonstrates that performance improvement from IT can be enhanced by board independence in more competitive industries rather than in less competitive industries. Also, we find that foreign ownership’s “spillover effect” is most robust for small firms, not for large firms. This suggests that foreign investors can mitigate resource

<table>
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<th>Table 1. Regression Results: Full Sample</th>
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<tr>
<td>Coefficient</td>
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<tr>
<td>$ITINV$</td>
</tr>
<tr>
<td>$BIND$</td>
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<tr>
<td>$ITINV \times BIND$</td>
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<tr>
<td>$FOR$</td>
</tr>
<tr>
<td>$ITINV \times FOR$</td>
</tr>
<tr>
<td>Controls</td>
</tr>
<tr>
<td>$ROA_{t}$</td>
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<tr>
<td>$GROWTH$</td>
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<tr>
<td>$LEV$</td>
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<td>$SHARE$</td>
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<td>$Intercept$</td>
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<tr>
<td>$F$-statistic</td>
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<td>Adjusted $R^2$</td>
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***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.
disadvantages of Taiwanese small firms by bringing IT expertise and experience to help these companies use IT more effectively.

Third, our finding has an important implication for research on board composition. Using a meta-analysis of 54 empirical studies, Dalton et al. (1998) report no association between board composition and financial performance. Yet, this study provides empirical evidence that while board composition alone does not affect firm performance, its interaction with IT investment has a positive effect on firm performance. As such, we believe that board composition should be a promising avenue for future research.

6. Concluding Remarks

This paper addresses the question: “To reap IT payoff, does corporate governance matter?” In brief, our answer is: in competitive markets, firms with more independent boards are more likely to realize payoff from IT investment. For small firms, foreign ownership helps convert IT investment to payoff. By evaluating these moderation effects of corporate governance in IT value creation, this research provides one theoretical lens through which different outcomes of IT can be analyzed. This theoretical lens may lay out a fruitful area for future research.

References

A Study of Classification Algorithm for Data Mining Based on Hybrid Intelligent Systems

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Abstract
Facing the huge amounts of data, the familiar classification algorithms show the shortages on time efficiency, robustness and accuracy. So this article puts the Hybrid Intelligent Systems into the research of classification algorithm. Based on the cognitive psychology and aggregative model theory, the article proposes a new Hybrid Intelligent Systems: R-FC-DENN, according to Rough Set, Clustering theory, Fuzzy Logic, Genetic Algorithm and Artificial Neural Network. Firstly, R-FC-DENN uses the Rough Set to reduce the data. And then it clusters the data by the Clustering theory. After that, it uses different and improved ANN to train. Subsequently, the data which are trained are integrated by fuzzy power. Lastly, the integrated data are trained by another improved ANN and the whole process of training is completed. In the end, experiments are carried out based on the data of UCI database and it is observed that the system is valid.

Keywords: Data Mining; Hybrid Intelligent Systems; Classification algorithm; Artificial Neural Network; Rough Set; Clustering Theory; Fuzzy Logic; Genetic Algorithm

1 Introduction
As a great number of data are collected in database, classification analysis has been a very active research subject in Data Mining research field. At present, there have been lots of classification algorithms, for example, classification based on decision-tree, Bayesian classification based on statistics, classification based on neural network (Hsu et al. 2006). And recently some new classifications have appeared, for example, classification based on association rules, classification based on database, classification based on K-nearest, classification based on case-based reasoning, classification based on genetic algorithm, classification based on Rough Set, classification based on Fuzzy Logic and so on (Ordonez 2006). Although algorithms about classification have many kinds, even some are mature, but a few algorithms exist in several problems on time-efficiency, robustness, accuracy, when they face huge data (Lin et al. 2000). T.S. Lin, W.Y. Loh and Y.S. Shih compared every classification algorithm with the experimental method in Lin et al. (2000), but the method which can deal with all data better than other methods hasn’t been found presently.

In view of Data Mining in international development, the research of Data Mining majors in from putting forward concept and finding method to system application and method innovation, and the research leans to the integration of several finding strategies and skills and the penetration among several subjects, at the same time, data-mining development needs system science’s theory urgently (Minsky 1991). For solving these problems, a few scholars have started to introduce the Hybrid Intelligent Systems, which is a new skill on an artificial intelligence among Data Mining’s three branches, to integrate every method organically, making them show their strong points and hide their weaknesses (Meesad 2002; Langari et al 2005; Hamedi 2005). The integrated effects of every model can solve the new problems of Data Mining classification. According to the above clew, the article puts forward a new Hybrid Intelligent Systems R-FC-DENN based on cognitive psychology and integration theory-based model. In cognitive psychology, human cognitive process is divided into different phases, mainly it has primary...
cognition and second cognition, besides cognition has also different strategies. When we see complicated things, the most important cognitive process of human is that firstly we classify the things and then further cognize every kind in order to make the complicated things arrive at the simplified aim (Hamedi 2005). As an important branch of artificial intelligence, neural network can study cognition, but any former model doesn’t attach importance to cognitive psychology. The Hybrid Intelligent Systems R-FC-DENN which is mentioned in the article has made an important application on classified cognitive principle among cognitive psychology. Firstly, original data are divided into several kinds by R-FC-DENN with Clustering sub-model. Secondly it uses different neural networks to study, and through Fuzzy Logic it integrates the cognitive results which are studied by different neural networks. Then the elementary results of studying cognition are put into another neural network to study again. Finally the whole system could make improvement on efficiency and accuracy. Besides, people have usually accepted the method which “adds” several models to improve model’s accuracy and robustness. And the method was set forth by Bates and Granger in 1969. Whether the Hybrid Intelligent Systems R-FC-DENN that we have brought forward can reach the purpose, six practical datasets in UCI are adopted to verify the model's validity in the 3th section of the article.

The next section of this paper presents the classification algorithm for Data Mining based on Hybrid Intelligent Systems. And it describes the function and structure of every sub-model in detail. The third section does experiments to validate the R-FC-DENN and discusses the major outcomes. The final section provides some suggestions for further research and practice.

2 The Classification Algorithm for Data Mining Based on Hybrid Intelligent Systems

Hybrid Intelligent Systems R-FC-DENN synthesizes the characteristics of Rough Set, Clustering theory, Fuzzy Logic, Genetic Algorithm and Artificial Neural Network. Firstly, R-FC-DENN uses the Rough Set to reduce the input data, and then it clusters the data with the Clustering theory. After that, it uses different and improved ANN to train the data. Subsequently the trained data are integrated by fuzzy power. Lastly, the data are trained by another improved ANN and the whole process of training is completed. The whole Hybrid Intelligent Systems is divided into RS sub-model, FCM sub-model, DENN sub-model and FNN sub-model, the concrete formed frame is shown in Figure 1.

3. Experiment and Result Analysis

To verify the validity of Hybrid Intelligent Systems R-FC-DENN on classification for Data Mining, we use six datasets of UCI’s database (UCI 2007) as experimental data. Every dataset’s essential information sees Table 1. Machine environment is that CPU CeleronII 600Mhz, 128MB Memory. The operating system is Microsoft Windows2000. RS sub-model is implemented in Rosetta (Rosetta 2007). And the other sub-model is programmed by Matlab 6.5.
As every experimental dataset is trained by Hybrid Intelligent Systems R-FC-DENN, the parameter of RS sub-model sets defaults by Rosetta, clustering center’s number of FCM sub-model is ensured by subtractive model in Matlab6.5 and every parameter sets default. Meanwhile FCM model in Matlab 6.5 finishes fuzzy C-means clustering. To ascertain the neural networks structure, we use the neural network whose structure has 3 layers, and the node number of the hidden layer is ascertain by empirical formula $n_l = \sqrt{m+n} + \beta$ (Fine et al. 1999), in which $m$ is the node number of the output layer, or the attribute number of every dataset; $n$ is the node number of the input layer, or the classification number of every dataset; $\beta$ is the constant between 1 and 10. The neural network error of DENN sub-model and FNN sub-model is defined to 0.1 unanimously. In the following contrast experiment, every neural network error is defined as 0.1 to compare. To acquire training set and testing set, we use the preserving method which is that two thirds data of original dataset are used as training set at random and remaining one third data are used as testing set. Considering the space of the printed page, the concrete process is omitted.
Comparing the classification algorithm which is brought forward by us with classical BP algorithm and LM algorithm, in which every algorithm’s parameters are in correspondence with the model of Hybrid Intelligent Systems R-FC-DENN. We can get the average results of thirty repeated experiments and Table 2 shows the results. In table 2, BP and LM express the neural networks of BP algorithm and LM algorithm, R-FC-DENN expresses Hybrid Intelligent Systems R-FC-DENN. And “?” expresses that under certain precision all neural networks can arrive at convergence values which are in experiment process, “?” expresses that only sometimes neural networks can arrive at convergence values, “-” expresses that neural networks can’t arrive at convergence values under certain precision. Toward every algorithm, the data of the first list express the time which is spent on training, and unit is second. The data of the second list express the accurate centigrade of classification.

<table>
<thead>
<tr>
<th>Data Set</th>
<th>BREAST</th>
<th>CAR</th>
<th>CMC</th>
<th>IRIS</th>
<th>YEAST</th>
<th>ZOO</th>
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<tbody>
<tr>
<td>BP</td>
<td>8421.7</td>
<td>-</td>
<td>-</td>
<td>11754.3</td>
<td>-</td>
<td>10825.8</td>
</tr>
<tr>
<td></td>
<td>70.66%</td>
<td>-</td>
<td>-</td>
<td>76.67%</td>
<td>-</td>
<td>81.26%</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>-</td>
<td>?</td>
</tr>
<tr>
<td>LM</td>
<td>276.5</td>
<td>534.9</td>
<td>301.4</td>
<td>24.6</td>
<td>438.7</td>
<td>32.8</td>
</tr>
<tr>
<td></td>
<td>73.33%</td>
<td>67.28%</td>
<td>63.57%</td>
<td>80.00%</td>
<td>66.24%</td>
<td>83.66%</td>
</tr>
<tr>
<td>R-FC-DE</td>
<td>254.5</td>
<td>437.2</td>
<td>186.4</td>
<td>2.3</td>
<td>397.6</td>
<td>19.3</td>
</tr>
<tr>
<td>NN</td>
<td>74.33%</td>
<td>66.96%</td>
<td>68.66%</td>
<td>80.00%</td>
<td>67.16%</td>
<td>81.36%</td>
</tr>
</tbody>
</table>

By contrast to the experiment, we can see easily that with sample quantity increasing, the original BP algorithm and LM algorithm meet with the situation that the algorithm can’t converge. But on the condition of ensuring definite classification precision, Hybrid Intelligent Systems R-FC-DENN can converge basically, which makes the algorithm improve on time efficiency, robustness and accuracy.

4 Concluding Remarks

In the 80th of the century of twenty, database and Internet technology skill have developed rapidly. Meanwhile, management information system and network data center have also been applied extensively. Data access, data query and statistics become mature gradually. But decision analysis and knowledge discovery of the high layer are still immature, as a result these lead to the phenomenon of “information explosion” and “knowledge poverty”. At this time, data mining appears to improve these problems which have occurred. And owing to its broad application the classification problem among these is paid more and more attention.

Although different fields have researched the classification problem, every traditional algorithm can’t deal with a large number of data. Therefore, the article leads Fuzzy Clustering into traditional neural network model. By means of clustering and simplifying the original dataset, the article can arrive at the purpose of enhancing training efficiency and robustness. Moreover, we have succeeded in verifying the thought with the experiment.

However, Hybrid Intelligent Systems R-FC-DENN which the article has put forward has still many problems which are worthy of going on being researched, for example, the effect of the clustering number on system efficiency and classification precision and so on. But we believe
that with Hybrid Intelligent Systems R-FC-DENN being researched further, these problems must get satisfying answers.

Acknowledgments
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References
Abstract
We address the question of whether people have unique signatures - or clickprints - when they browse the Web. The importance of being able to answer this can be significant given applications to electronic commerce (e.g. product recommendation, targeted marketing, etc.). In this paper we present a general framework and specific formulations of this “unique clickprint determination problem”. We explore one specific formulation for which we show how the unique clickprint determination problem can be cast more generally as an aggregation problem. We conduct experiments on user-centric Web browsing data and present empirical results showing evidence of unique clickprints.

Keywords: Signature Discovery, User Profiling, Data Mining, Web Browsing Data

1. Introduction
People are believed to have many unique characteristics such as fingerprints and handwriting styles. In this paper, we study the distinguishing characteristics that are behavioral, as opposed to characteristics that are physiological. We use the term “behavioral signatures” to refer to such distinguishing characteristics. The importance of being able to identify people based on their behavioral signatures can be significant. The applications that can benefit from behavioral signatures can include personalization, product recommendation, targeted marketing, etc. Given the vast impact technology has had in everyday life, there has naturally been interest in recent years on whether there might be unique signatures in technology mediated applications. For instance: In an experiment involving 42 user profiles, Monrose and Rubin (1997) shows that depending on the classifier used, between 80 to 90 percent of users can be automatically recognized using features such as the latency between keystrokes and the length of time different keys are pressed. Recent research that studied online message board postings showed that users may have online “writeprints” (Li et al. 2006) - unique ways in which they write messages on online bulletin boards. A group of researchers in Finland have recently shown (Mäntyjärvi et al. 2005) that individuals may have unique “gait” or walking patterns when they move with these devices. In the same spirit, consider behavior when consuming online content. Are there unique “clickprints” based on how users browse, or consume content online? This is an open question, the answer to which can have significant implications. This paper provides a new formulation of, and some answers to this question. While this paper presents an approach and discusses small scale experimental results that show evidence of clickprints, extensive research is needed before the question can be conclusively answered given several hard challenges noted later in this paper.

2. Framing the unique clickprint determination problem
In this study we address the general problem of determining whether users have unique online clickprints. From a data mining perspective, there are two natural ways in which the question can be addressed:

a). Build features and classify. Specifically, the Web browsing data is transformed into a data set of user sessions, where each row corresponds to a single session that a user conducts online. The
variables are behavioral features that are constructed, such as the time spent in the session or the nature of the content or Web sites seen, and the dependent variable is the user ID for the session. If a classifier built on this data set has high accuracy, it suggests that unique clickprints exist since the classifier is able to identify users from their behavior. Note that the actual clickprints are implicit in the learned classifier. These may be extracted by analyzing the classifier using standard methods.

It is common in the literature to treat a single Web session as the unit of analysis, and build models that predict purchase in the session, or as is the case here, models that predict the user ID corresponding to the session. This approach assumes that an online signature manifests itself in the chosen unit of analysis, here a single Web session. This may not be the case always. For instance, a news event may prompt an individual to visit a Web site and read an article and perhaps watch a related video. If the news event is of wide interest there may be several sessions that are similar. However over time – across many sessions - more information is captured. Searching for unique clickprints may therefore require a greater time period at which activity is observed.

Rather than considering time as the grouping factor (e.g. grouping a day’s browsing activities from a user into one unit of analysis) we consider the number of sessions as the grouping (or “aggregation”) factor and ask if there is some level of aggregation, \(agg\), such that every \(agg\) sessions may have enough information to uniquely distinguish individuals. \(agg\) here refers to the number of sessions we aggregate together into one unit of analysis.

b). A patterns-based approach - pick a pattern representation, and search for distinguishing patterns. This approach assumes a specific representation for clickprints, say conjunctions of feature-value pairs (itemsets), and then searches for patterns in that representation that distinguish different user sessions. For example, the output of such a learning algorithm may be an itemset for each user (e.g. for user \(k\), “\(total\_time < 5\) minutes, \(number\_of\_pages > 50\), \(visits\_xyz.com=yes\) and \(visits\_www.pqr.com=yes\)” may be a unique clickprint if there is no other user for whom this is true.)

Note that when the above two approaches determine that the answer is “yes” then we can conclude that unique clickprints exist in this data. However when they do not provide a confirmation there is no guarantee that unique clickprints do not exist, it may just be the case that these approaches could not find them. Specifically, the first approach depends on a specific set of features and a chosen classifier. It may always be possible that a new set of features, or a new classifier, may be used to find unique clickprints. Unfortunately the set of feature construction methods and classifiers is not enumerable and it is not possible to consider an exhaustive list. Similarly, the second approach depends on a representation for clickprints. Perhaps a chosen representation did not result in learning unique patterns, but there may be a different representation for which unique clickprints exist.

In the following section, we present the experiments we conducted using the first approach and we are currently conducting research on the second approach.

3. Experiment Design
The approaches presented in this paper use five inputs: the data, the feature construction function, the classification algorithm, model goodness and threshold goodness. Below we describe the choice of and rationale for the inputs.
The data: The data set that we used was provided by a commercial data vendor. The firm captures the Web browsing history of a panel of users who volunteer to be tracked in this manner. The data provided to us was the anonymized browsing behavior of a sample of 50,000 users over one year. The raw data has simple summary statistics for each Web session of a user, specifically the name of the site visited, number of pages seen and starting time and duration. Rather than running the method on the entire data set, we create multiple data sets by combining data from a specific number of users. This will enable us to (a) explicitly study the impact of the number of users (b) use standard classifiers that may not scale with the size of the dependent variable (a challenge we discuss later) and (c) deal with data sparsity by selecting those users for whom enough data is available. Specifically, we create several sub-datasets by combining sessions belonging to 2, 3, 4, 5, 10, 15 and 20 different users. That is, for each such sub-dataset the dependent variable, \( userID \), may take seven (2, 3, 4, 5, 10, 15 and 20) different values respectively. However since each such sub-dataset represents only one sample of a chosen set of users we repeat the random selection process twenty times to create 140 data sets, each of which we apply the method to. There are three additional criteria that we used when selecting the users, discussed below. First, each panelist in the sample represents a computer that is tracked. Hence we restrict our selection of users to those corresponding to a household size of one in the household demographic file provided. However we note that this still does not guarantee that only a single “person” uses each computer. Second, we need to sample users with enough browsing activity such that we have enough out of sample data on which the models can be tested. In the experiments here we used 300 sessions as the minimum cutoff (i.e. we chose users who had at least 300 sessions in the data). Third, when a given number of users are selected the priors in the data are unequal to start with. For instance, when constructing a data set of three users, the number of sessions for each user may be 300, 600 and 2100 (resulting in class priors of 0.1, 0.2 and 0.7 respectively). A naïve classifier predicting the most frequent class will start with an accuracy of 70%. To avoid this from providing any accuracy gains we select the same number of sessions for all users selected in any given sub-dataset (in the example just mentioned this would mean selecting the first 300 sessions for each user). This guarantees exactly equal class priors (a 20 user data set would have exactly 5% class priors for all the classes). Note that this would mean ignoring the later sessions of some of the users selected. However this also makes it hardest for the classifier to achieve target accuracy levels.

The classifier, goodness and threshold: We chose weka’s J4.8 as the classifier since classification trees in general have been shown to be highly accurate classifiers. The specific choice of J4.8 was also for convenience since weka is an open source data mining platform that also lends itself easily to automation within scripts.

The choice of the goodness criterion is important and we use time-based hold out testing where the first 2/3 of data is used for model building, while the last 1/3 is used as the hold out set where the accuracies are measured. This split (2/3, 1/3) is done before any aggregation and hence there is no overlap in any form between the training data and the hold out data.

Hence if 300 sessions are selected for three users, the first 200 sessions of each user is used in the training set while the last 100 sessions of each user is in the hold out test. When a model corresponding to \( agg=10 \) is built, this will therefore use 191 (=200-10+1) points from the training data, and will use 91 (100-10+1) points from the hold out set. This guarantees that there is no overlap between the training and test sets at any point in the process. Note that this process
ensures that the hold out set also has exactly equal class priors always, making it difficult to improve on the baseline accuracy of 1/(# of users) by chance.

Finally the threshold goodness measure (accuracy level on the hold out data set) was set to four different values in the runs – 75%, 80%, 85% and 90% accuracies.

**Feature construction:** The raw data provides information about basic time statistics during a session and the specific list of domain names (Web sites) visited in the user’s session. Hence for each user session we construct four continuous measures: (i) the duration of the session (ii) number of pages viewed (iii) the starting time (in seconds after 12.00am) and (iv) the number of sites visited. Since the specific sites visited (or combinations thereof) are important features, for each user session we also construct a set of binary indicators for specific Web sites indicating whether there was access to a specific site in a session. Given the very large number of domains, it is impossible to construct a binary indicator for every domain in the data. Instead we construct this set of features in the following manner. Assume that for a three user data set there are 900 total user sessions. Recall that the first 2/3 of this (first 600 sessions) is used as the training data. From the training data (i.e. the first 600 sessions) we extract the top $k$ sites for each of the three users (we conducted experiments with $k=5$ and 10) and take the union of these sites to create specific binary variables. Since there are common domains this results in a maximum of $3^k$ binary indicators Note that the binary features created here are done only from the training data and do not use any information from the sessions in the hold out data.

Hence for a single user session we construct four continuous variables and $p$ binary variables. The process also requires features to be constructed from groups of sessions. The natural approach is to use these aggregations to estimate the distributions of these measures. Hence for any aggregation we compute the mean, median, variance, maximum and minimum values for the four continuous measures giving us $5 \times 4 = 20$ specific variables. Based on the $p$ binary variables in each session, for any group of sessions we construct $p$ integer variables that represent the counts of the binary variables in this group. Hence on any aggregation we construct a total of $20+p$ variables plus the categorical dependent variable ($userid$).

**4. Empirical estimation**

We test accuracies at increasing levels of aggregations. Given the limited data we set a stopping criterion of $agg=30$ – so in a specific run if the threshold accuracy is not reached by this aggregation then that specific run terminates without a specific $agg$ value returned. We have results for four different thresholds (75%, 80%, 85%, 90%). Because of space limitation, we only report the result for 90% level.

**Table 1** Agg values across users for $k=10$ (i.e. top 10 sites for each user chosen as binary features as discussed in Section 3 in “feature construction”). (Accuracy threshold 90%)

<table>
<thead>
<tr>
<th>Median</th>
<th>Mean</th>
<th>% runs with agg &lt; 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.05</td>
<td>100%</td>
</tr>
<tr>
<td>3</td>
<td>1.26</td>
<td>95%</td>
</tr>
<tr>
<td>4</td>
<td>1.78</td>
<td>90%</td>
</tr>
<tr>
<td>5</td>
<td>2.16</td>
<td>95%</td>
</tr>
<tr>
<td>10</td>
<td>4.24</td>
<td>85%</td>
</tr>
<tr>
<td>15</td>
<td>5.2</td>
<td>75%</td>
</tr>
<tr>
<td>20</td>
<td>8.9</td>
<td>50%</td>
</tr>
</tbody>
</table>

- The second col. in the table represents the median $agg$ value computed from 20 runs.
• The third column is the mean over terminated runs (i.e. runs for which accuracy threshold was hit within the stopping criterion of max \( agg=30 \)). For reference the last col. shows the % of such runs – i.e % of runs where the threshold was reached before termination.

Our results show that in most cases the models accurately predict user IDs for the range of users considered here, often with very few sessions. These results show evidence of unique clickprints in the online behavior of users.

Some important limitations and challenges remain and our on-going research is trying to address them. First, Building accurate classifiers when the class label takes on a large set of values is known to be hard. We need to study how these results will change as the number of users considered increases to higher levels. A second challenge is determining the classifiers and features to use. Our approach was presented as one that works given any specific choice of these. The classifier is relatively a simpler issue since there are a finite number of classifiers that exist and more than one can well be tried. Determining the optimal set of features to generate is harder. In this paper we presented some guidelines on how to do this. Specifically suggesting that session-level features can first be identified, and then aggregations can be used to estimate various statistical measures of these features. However identifying good session-level features is important and may be critical to determine whether such identification can scale to higher levels.

Third, our approach cannot easily be used to qualitatively describe what a user signature is. We are currently working on the second approach described in section 3 to generate user profiles as a list of patterns.

5. Conclusions
In this paper we addressed a fundamental and new problem – the identification of unique clickprints in Web browsing data. We presented specific problem formulations and showed how this problem can be cast as an aggregation problem. If an optimal level of aggregation can be found then it follows that the classifier making the predictions can uniquely identify individuals when given such data, and unique clickprints therefore do exist. We then applied our method on real user-centric Web browsing data and showed that there was evidence for unique clickprints given the optimal level of aggregation computed by our method.

While important challenges remain, this paper has developed a general framework and methods that can be built on. The specific contributions of this paper are:
- Presented a novel and important problem regarding determining unique clickprints online and discussed specific formulations.
- Showed how this problem can be cast as an aggregation problem.
- Presented empirical results from user-centric Web browsing data showing evidence of unique clickprints, an important and new result in the literature.

References