An experimental investigation of Web-based information systems success in the context of electronic commerce

Edward J. Garrity\textsuperscript{a,1}, Bonnie Glassberg\textsuperscript{b,2}, Yong Jin Kimm\textsuperscript{c,3}, G. Lawrence Sandersd,*, Seung Kyou Shin\textsuperscript{e,4}

\textsuperscript{a}Information Systems Department, Canisius College, Buffalo, New York 14208, United States
\textsuperscript{b}Department of Decision Sciences and MIS, Miami University, Oxford, Ohio 45056, United States
\textsuperscript{c}School of Management, Room 240, State University of New York at Binghamton, Binghamton, New York 13902, United States
\textsuperscript{d}Department of Management Science and Systems, 3104 Jacobs Management Center, State University of New York at Buffalo, Buffalo, New York 14260, United States
\textsuperscript{e}College of Business Administration, University of Rhode Island, 210 Flagg Road, Kingston, RI 02881-0802, United States

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Abstract

In this paper, we examined Web-based information systems (WIS) success and focused on User Satisfaction in the context of a consumer purchasing decision. The results indicate strong support for the research model consisting of three fundamental User Satisfaction components: Task Support Satisfaction (TSS), Decision Support Satisfaction (DSS), and Interface Satisfaction. The model explains approximately 50% of the variance in users’ intention to use Web-based information systems. It is concluded that Decision Support Satisfaction plays an important role in Web-based information systems success. In light of these findings, implications for theory and practice are discussed.

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1. Introduction

The emergence of the World Wide Web as an electronic marketplace is having a profound impact on the world economy and the way business is conducted. In 1996, online sales were approximately US$500 million and have been expanding rapidly since [64]. The total electronic commerce spending estimates for 2004 range from US$963 billion to
US$4 trillion [20]. Many firms positioned and deployed systems to compete in the electronic marketplace. The systems, in general, are referred to as Web-based information systems (WIS) [76]. Web-based information systems [76] represent a new frontier for businesses trying to establish an on-line presence where consumers are free to shop in more efficient “friction free markets.”

Incorporating the radical changes in global marketplaces created by this new application of information technology, Web-based systems are considerably different from the traditional systems in terms of their scope and focus [91]. WIS are usually built to facilitate consumer oriented tasks and focus on enhancing the consumer decision making process. As the Web environment is characterized as non-linear in nature, presentation and delivery of information and frictionless work support are very critical for attracting consumers and enhancing the shopping experience. Lederer et al.’s [46] study found that the TAM model did not adequately explain Web use, and this implies that traditional information systems have different characteristics than WIS.

Given the importance of electronic commerce and WIS, in terms of the magnitude of its impact on business process and organization structure, there is little research addressing fundamental issues such as how electronic commerce systems success can be measured, whether existing measures of success can be applied, and how consumers react to the online shopping experience. Without a clear understanding of the dynamics of Web-based system success to guide firms, proper strategies and system designs are mere speculation. A central activity for researchers will be to define and operationalize the constructs for understanding the success of electronic commerce systems. This paper, while drawing on the traditional information systems success literature, extends that literature to the development of a Web-based model for electronic commerce success in the context of a consumer purchase decision.

The contributions of the current study are three-fold. First, this research addresses the issue of how to predict users’ intent to use a particular Web site utilizing traditional information systems success theory. The results should be of great interest to Web designers, IS staff and researchers. Second, by explaining the dynamic relationship between User Satisfaction components which influence WIS success, the current research can aid researchers in further refinement of information systems success models in general. Third, the current study provides a reasonable background for applying existing measures of information systems success to the electronic commerce environment.

2. Review of information systems success literature

There is a rich tradition of information systems success research including user information satisfaction, task–technology fit, user involvement, and participation. In this paper, three important, comprehensive studies are further examined in terms of providing theoretical background. They are the DeLone and McLean Model of IS Success [17], the Technology Acceptance Model (TAM) [13–15], and the Garrity and Sanders Model of IS Success [25].

2.1. DeLone and McLean Model of IS Success

DeLone and McLean [17] suggested a model of IS success that is comprised of six multi-level constructs: Information Quality, System Quality, User Satisfaction, System Use, Individual Impact, and Organizational Impact. While the model integrates the comprehensive dependent variables used by IS researchers, there exist several criticisms (although they do not reduce the importance of the model). First, IS Use in the DeLone and McLean model contains too many meanings to be appropriately examined [68]. IS Use is also argued to play a problematic and controversial role in modeling system success (cf. Refs. [15,49,68,69]). Second, because User Satisfaction represents individual impacts of IS in an organizational setting, investigating the causal path from User Satisfaction to individual impacts is fruitless [68]. Finally and most importantly, the model does not explain clearly and fully the relationship between User Satisfaction and individual/organizational impacts.

2.2. Technology Acceptance Model

A second stream of IS success research is focused on the use of information technology as conceptual-
ized by the Technology Acceptance Model [13–15]. This model of IS success asserts that Ease of Use and Perceived Usefulness are primary determinants of System Use. The model specifically postulates that technology Usage is determined by Behavioral Intention to Use the technology, which is itself determined by both Perceived Usefulness and Attitude.

TAM has been widely studied in a number of contexts using different information systems. More recently, it has been applied to examining the use of Web-based information systems [27,46,54,77]. However, this model does not capture the complex psychological and social influences on technology adoption [50] and long-term use [9,50]. In particular, when applied to the context of Web information systems, the model appears to account for only a small portion of variance for Usage [46]. Lederer et al. [46] called for researchers to develop better instruments for measuring antecedents of Perceived Ease of Use and Perceived Usefulness for assessing Web sites. In addition, they urged a reexamination of factors or latent variables related to Web site Usage via study replication, and additional use of factor analysis to uncover important subdimensions of the Technology Acceptance Model.

2.3. Garrity and Sanders’ Model of IS Success

Garrity and Sanders [25] extended the DeLone and McLean model and proposed an alternative model in the context of organizational and socio-technical systems (Fig. 1). The model identifies four subdimensions of User Satisfaction: Interface Satisfaction, Decision Support Satisfaction (DSS), Task Support Satisfaction (TSS), and Quality of Work Life Satisfaction. These factors were derived from an extensive review of IS success research and reasoning from basic principles of systems and general systems theory. The four factors correspond with three viewpoints of information systems: the organizational viewpoint (that views IS as a component of the larger organization system), the human–machine viewpoint (which focuses on the computer interface and the user as components of a work system), and the socio-technical viewpoint (that considers humans as also having goals that are separate from the organization and whereby the IT or technical artifact impacts the human component in this realm).5

Both Task Support Satisfaction and Decision Support Satisfaction attempt to assess the effectiveness of an IS within the context of the organizational

5 The fourth dimension of the Garrity and Sanders’ model is quality of work life satisfaction. This dimension addresses the fit between an IS and the socio-technical work world of the respective users. Quality of work life satisfaction is an important dimension of success in organizational settings. However, in the context of a consumer-oriented web information system, the users will not be impacted in terms of work-life or job satisfaction, and thus, this dimension will not be included in this study.
viewpoint of systems. The Task Support Satisfaction dimension captures the overall set of tasks associated with job activities while Decision Support Satisfaction is more focused on decision support (i.e., structuring, analyzing, and implementing a decision).

Interface Satisfaction assesses IS success from the human–machine viewpoint. Interface Satisfaction measures the quality of the interface in terms of presentation, format, and processing efficiency. The quality of the interface is related to both Task Support and Decision Support Satisfaction. An improperly designed interface can cause users difficulty with task completion or it can impair their ability to make decisions.

3. Research model and hypothesis

The model used in this study draws on the DeLone and McLean Model [17], TAM, and the Garrity and Sanders’ Model of IS Success [25] to examine Web-based information systems success. As outlined by Lederer et al. [46], we seek to discover important underlying factors that will help to explain Web-based information systems use and adoption. In essence, the research model, Web-based Information Systems Success Model (hereafter, referred to as WISSM), deals with the reciprocal relationship between User Satisfaction and systems use. This relationship has been touted as one of the key constructs representing information systems success [17,26,35,36,52]. Fig. 2 shows the proposed research model. The next sections elaborate a theoretical background of the proposed research model and detailed hypotheses developed to examine the relationships among the constructs of interest.

3.1. Theoretical background of the research model

In this research study, we are concerned with assessing User Satisfaction with Web-based information systems in the context of consumer purchasing activities. The nature of a consumer purchasing Web-based system is closely tied to providing decision support capabilities to aid consumers in product and service purchase decisions [57].

A consumer-oriented WIS can be decomposed into numerous tasks, subtasks and decisions. For example, a product purchasing WIS may involve a number of cognitive tasks, such as product searching, advice gathering, decisions on information presentation, rank ordering of alternatives, criteria discovery, learning about the domain of product use, deciding on the relevance of criteria, determining tradeoffs among criteria, prices, and products, actual purchase tasks such as “adding to shopping carts,” navigating from one task context to the next, checkout, payment, confirmation, and shipping methods. Many of these cognitive tasks can be categorized as intellectual or decision support based, while others may be more mundane tasks such as filling out self-report information.

In sum, Decision Support Satisfaction assesses the support provided by the WIS in the context of decision making. Task Support Satisfaction, on the other hand, assesses the overall support for the purchasing task. Since this is a general assessment of the overall task, it takes into account the overall design of the software and its usefulness. In addition to these variables, Trust in a Web site is regarded as an important determinant of EC success [27,82]. Gefen and Straub [27] included a Trust item as an indicator variable for the behavioral intention to purchase.

Fig. 2. Web-based Information Systems Success Model (WISSM).
However, the current study does not directly incorporate Trust as an indicator variable reflecting Behavioral Intention to Use an EC web site.

The dependent variable, Behavioral Intention to Use an EC Web site, was taken from the Technology Acceptance Model [13–15] and Seddon’s [68] respecification of the DeLone and McLean Model [17]. Their work provides the theoretical basis for the relationship between User Satisfaction and the Behavioral Intention to Use an information system.

System Use was not selected as the dependent variable because of the well-documented problems in measuring system success (cf. Seddon [68]). This paper posits that Behavioral Intention to Use a system represents an individual’s perception of the benefit from System Use [68]. In essence, Behavioral Intention to Use a system effectively mediates the effect of User Satisfaction on actual systems use. The positive relationship between User Satisfaction and Behavioral Intention has been frequently reported in the marketing literature (e.g., Refs. [2,53,83]). The innovation literature also reports that dissatisfaction with an innovation leads to the termination of the innovation [60].

It should be noted that the constructs used in this model are more context based than the System Quality and Information Quality measures from the DeLone and McLean model. Information Quality and System Quality were developed from a product focus as opposed to a system, tool, or goal directed focus. Our approach, using a more goal-oriented perspective, asserts that a system of high quality should support users in performing their task related responsibilities. This is the approach taken by Davis [13–15] in the development of the Perceived Usefulness dimension of IS Success. Recall that Perceived Usefulness is defined as the user’s subjective assessment that using a system will increase his or her job performance. The dimensions of Task Support and Decision Support Satisfaction are simply more specific measures of the type of job support provided by the system.

Finally, the Interface Satisfaction dimension may be thought of in several ways. It provides an assessment of the design of the hardware and software interface and is closely related to Davis’s Ease of Use dimension. If systems are tools to help workers accomplish tasks, then a well-designed tool should be made in such a way that it is easy and efficient to use. In addition, the interface is also the focal point of interaction between humans and information systems. Thus, Information Quality can also be explained by Interface Satisfaction, in the sense that the vehicle for presenting the information (e.g., a textbox, graph, listbox, or form) cannot be separated from the information itself [56]. A “chunk” of information is beneficial to a user if it is presented in an effective and efficient manner, helping users accomplish task objectives. “Providing high-quality data along the dimensions of value and usefulness relative to the consumers’ task contexts places a premium on designing flexible systems with data that can be easily aggregated and manipulated” [73]. Thus, we believe a separate assessment of the interface is especially critical for WIS because users must successfully navigate the Web site to obtain informational support for tasks and decisions.

Thus, the focus of the Web-based Information Systems Success Model presented in Fig. 2 is on: (1) How well the system supports workers in the accomplishment of their goals (an effectiveness measure via Task Support and Decision Support Satisfaction), and (2) How well designed and implemented the interface is so that workers may accomplish their goals more easily (an efficiency measure via Interface Satisfaction).

3.2. Research question and hypotheses

Fig. 2 illustrates hypothesized relationships between constructs in the study. The major determinant of Behavioral Intention to Use an electronic commerce Web site is hypothesized to be Task Support Satisfaction which is influenced by both Decision Support Satisfaction and Interface Satisfaction. Note that there is no direct relationship between Interface Satisfaction and Behavioral Intention to Use an EC Web site. The reasons are twofold. First, as discussed earlier, the current study assumes that Task Support Satisfaction is a focal construct that mediates the effects of Interface and Decision Support Satisfaction on Behavioral Intention. The second reason relates to the way that Interface Satisfaction affects technology acceptance.
3.2.1. Interface Satisfaction

Lohse and Spiller [47] showed that designing online stores with user-friendly interfaces is critical in traffic and sales, while Szymanski and Hise [75] found site design important in creating a satisfying customer experience. The Interface Satisfaction dimension captures the user’s overall impression of the interface in terms of presentation, navigability, format, ease of use and efficiency of interaction with the Web site. Shneiderman [70] argues that an appropriate design of user interfaces includes presentation, and interactivity. Zhang and von Dran [90] report that ease of navigation was the most important Web site quality across six electronic commerce domains. Poorly designed screens and interfaces make task support and decision support activities more difficult. In particular, high interface quality in hypermedia systems like the Web is critical in reducing cognitive overhead [11,48] and disorientation [11,78,81].

According to the theory of symbolic representation in problem solving [32,40,41], there are three types of symbolic representation: linguistic representation, visual imagery representation, and exploratory reasoning. These symbolic representations can be referred to as representational information quality [73], which is, in turn, interpreted as interface quality. In most problem solving situations, various combinations of these three representations are needed to provide dominant or controlling focus in problem solving. Two critical stages in the problem solving process are information search and the evaluation of alternatives [19,34,55], and they are fundamental for decision making and task performance.

The importance of the user interface has a rich research tradition. Assimilation Theory [3] posits that meaningful learning of computer systems begins with the human–computer interface. Davis and Bostrom [16] and Mayer [51] found that the interface can have a positive impact on task performance and decision making within the context of Assimilation Theory. High levels of usability are related to improved task performance [80]. Ausubel [3] emphasized the importance of external aids in the form of an “advance organizer” that facilitates the development of new knowledge structures. The user interface as an

“advance organizer” should enhance task performance and decision making performance. According to Nielsen [56], user-centered navigability significantly enhances user’s performance with various Web tasks. Poor interface design has been cited as a key element in a number of high profile Web site failures [58]. It is hypothesized, therefore, that Interface Satisfaction positively influences both dimensions of satisfaction (TSS, DSS) with the system.

H1a. Interface Satisfaction has a positive impact on Decision Support Satisfaction.
H1b. Interface Satisfaction has a positive impact on Task Support Satisfaction.

3.2.2. Decision Support Satisfaction

Decision Support Satisfaction is defined in terms of the capability of an information system to assist in decision-making and better performance of the user’s jobs [65], even when those decision-making activities are ill-structured, situation-specific, or involve choosing from a number of alternatives [44]. Humans tend to adapt their decision making strategies to specific situations and environments [61]. Individuals can be described as “cognitive misers” who strive to reduce the amount of cognitive effort associated with decision making [71]. The notion that people are typically willing to settle for imperfect accuracy in their decisions, in return for a reduction in effort, is well supported [8,37], and is consistent with the idea of bounded rationality and the concept of satisficing [72]. Due to this tradeoff between effort and accuracy, decision makers often satisfice when alternatives are numerous and/or difficult to compare, or when the complexity of the decision environment is high [62]. In the context of Web-based consumer purchasing decision systems, it is imperative not only to assess the Perceived Usefulness of these systems (the purchasing task itself) but also to include an assessment of the degree to which the system supports or reduces the decision making efforts of the user.

O’Keefe and McEachern [57] delineate five critical task areas that need to be modeled in a Web-based consumer decision support system: need recognition, information search, evaluation, purchase, and after-purchase evaluation. Decision support features that
can be provided by a Web-based consumer decision support system include virtual catalogs, internal search capabilities, structured interactions, and evaluative decision models. While a number of these features fall outside the realm of simply supporting the decision process, they are vital to supporting the entire task process (i.e., a purchase task). Examples of actions to support the task include placing an order, arranging a payment, or providing detailed information on the purchase task. Additionally, this would encompass after sale support and feedback, and response about the process itself.

Unlike traditional organizational decision support systems, Web-based consumer purchasing systems must be designed to “attract” consumers to use the system [57]. The non-linear structure of the Web environment entails more cognitive effort than the linear, sequential structure of the traditional system environment and without sufficient support for decision making and task performance, consumers tend to simply click-away to competitors.

Hence, decision support features or actions in WIS should not only support the decision process but also support the entire task process [57]. This reasoning leads to the hypothesis of a positive relationship between Decision Support Satisfaction and Task Support Satisfaction as in H2.

H2. Decision Support Satisfaction is positively associated with Task Support Satisfaction.

3.2.3. Task Support Satisfaction

Antecedents for e-commerce success examined by previous studies highlight the importance of supporting online consumers at each step of their activities with an e-commerce system. The most common online tasks include product search, comparison shopping, negotiation of terms, order placement, payment authorization, and receipt of product [38]. The essential question surrounding the success of the online experience relates to the net value of the benefits and costs of finding, ordering, and receiving a product [42]. User satisfaction with such task support can be referred to as the net benefits of a system [68].

The main behaviors of satisfied or dissatisfied customers with product or service offerings include complaining behavior, negative word of mouth, and repeat purchasing [74]. Complaining behavior is explained as consumers’ tendency to complain to suppliers and this works as a mechanism for dissatisfied consumers to relieve cognitive dissonance, while negative word of mouth behavior to other consumers stands for another type of complaining behavior of dissatisfied consumers. Repeat purchasing behavior represents the phenomenon that satisfied consumers will likely buy the offerings repeatedly. The two consequences of dissatisfaction negatively affect repeat purchasing behavior. The positive relationship between the level of satisfaction and the repeat purchasing behavior has been reported to be very strong (correlation 0.882) [74]. In the information systems context, the repeat purchasing behavior is interpreted as the repeated Use of an information system, which is primarily determined by Behavioral Intention to Use the information system [14,15,68,85].

Hence, the relationship between Task Support Satisfaction, as a global evaluation of systems support, and Behavioral Intention to Use an electronic commerce Web site as a precursor for future Use of a system, can be hypothesized as H3.


Hypotheses one through three relate to the specific paths of WISSM. Task Support Satisfaction is hypothesized to be the primary determining factor of Behavioral Intent to Use an EC Web site. Task Support Satisfaction is partially derived from Perceived Usefulness [25]. A separate but closely related dimension, Decision Support Satisfaction, is hypothesized to positively influence Task Support Satisfaction (see H2). Decision support capabilities are important and vital task considerations, and this is particularly true for systems used in electronic markets [6,7,57].

4. Research method

The research model was tested in the context of an Internet buying simulation. The subjects of this study were given a Web-based purchasing task. The task was to buy a digital camera under given limitation in terms of budget, time, and retail Web sites. The budget limit given to the subjects was US$600, which is the median price of digital cameras. This budget limit was required so that subjects would have a greater cognitive burden
on the decision task. It was expected that few of the respondents would have already purchased the target product, while most would be familiar with the general features of a camera.

4.1. Sampling method

Each subject was given two identical sets of survey instruments to be used in assessing the quality of two Web sites (CameraWorld.com and Advandig.com). Each set contained the four constructs (Decision Support Satisfaction, Task Support Satisfaction, Interface Satisfaction, and Behavioral Intent to Use) under study.

4.1.1. Data collection procedure

The data collection activity for this study consisted of three main phases. First, an expert survey, for identifying two diverse Web sites, was conducted. Second, a pilot study, involving 97 subjects and 194 observations, was performed. It was used to refine the items and constructs used in the study. It also enabled the researchers to clarify the wording, content, and general layout of the survey instrument. Finally, a main survey was administered, involving 163 subjects and 326 observations.

In the first phase of the data collection, ten experts who had practical and academic experiences with electronic commerce evaluated six Web sites. The experts were asked to rate the Web sites in terms of Decision Support, Task Support, Interface, and Overall Satisfaction level, by responding to a 7-point Likert scale questionnaire. The scores for Decision Support, Task Support, and Interface Satisfaction were summed. Both the sum of the scores and Overall Satisfaction level consistently indicate that all ten experts nominated CameraWorld.com as the superior commercial Web site. Nine of the experts voted Advandig.com as the least desirable (inferior) of the six Web sites.

The second phase of the data collection consisted of a pilot study. The objective of this phase was to focus on measurement issues and to refine the research instruments prior to the final data collection. Pilot survey questionnaires were distributed to 97 junior and senior undergraduate business majors.

The main study consisted of 163 students that were not involved in the pilot study. Two hundred fifty surveys were given out and 163 were returned (response rate: 65.2%). As noted earlier, the survey instrument consisted of two identical questionnaires that were used by subjects to evaluate the Web sites according to the research constructs. The order of the appearance of the Web site addresses on the questionnaire was randomized.

4.1.2. Sample frame

Identifying the sample frame for empirical research is an important step in ensuring that the population of interest has been correctly identified. The ideal candidate for this study was computer literate, had previous exposure to Web technology and had current access to a Web-enabled computer. The Web environment is highly graphical, requiring knowledge of the use of icons, frames, and scrolling. There may be multiple browser windows open at the same time, so general navigation and mouse skills were needed. As the purpose of this study was to predict purchasing behavior by individuals, in-depth knowledge of Web technology was neither assumed nor expected in the target population.

How much exposure to the technology is sufficient? Empirical studies based on specific technologies, where the individual is the unit of analysis, have employed a 1 hour hands-on task [14,84]. Other studies used exposure without a required hands-on task [39,50] and some asked subjects for pure speculation about a technology which did not exist [12]. Required courses at the institution used to conduct the study typically use the Web in a variety of ways including distributing course syllabi, presentation materials and handouts, online cases, and a variety of Web-based assignments. Subjects would thus have satisfied the exposure constraint. In addition, respondents were asked to rate themselves on their computer skills and Web experience.

The final requirement for the population of interest was current availability of a computer with Web access. All subjects had access to the Internet via school or work and many had their home computer.

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7 We selected six most popular commercial web sites specializing digital cameras and accessories, which commonly appeared in the lists of three Internet portal sites. The six sites include Advandig, Digital Camera, Digital Solution, Camera World, Digital Camera Club, and Digital Camera Store.
linked to the Web through an Internet Service Provider.

4.1.3. Subject pool

Human subjects identified for the pilot test and final data collection were a sample of upper level undergraduate students enrolled in management information systems courses at a state research institution in the northeast. All subjects voluntarily participated in the survey, and were advised that they could withdraw from participation at any time without adverse consequence. The survey was conducted in an unsupervised environment. All the participants were given extra credit for participating in the study. The final data collection utilized all undergraduates enrolled in introductory MIS classes taught by an instructor. This was a required course for all business majors.

Although the reliance on college students has been criticized for many studies in applied research, there is justification for using them under specific conditions [31]. In a meta-analysis comparing studies using both undergraduate students and non-students, Gordon et al. [31] noted that between-groups differences are less pronounced when no prior knowledge or familiarity with the task is needed to make judgments, or when the objective is to perform simple reasoning tasks. A majority of undergraduates taking courses are exposed to Web technology as part of the regular curriculum of their coursework. Any complexity or skill in performing experimental tasks is reduced by the graphical nature of the technology. Thus, only general knowledge of computers and English were required.

The use of undergraduate students made sense in this study because a primary focus of this research is on understanding Web-based decision behavior and college students are the present and future consumers of Web technology. It should be pointed out that major users of the Web are individuals who have a college degree and are 16–44 years old [33], which is similar to the subject pool used in this study (age range 18–50 years old).

4.1.4. Demographics

One hundred sixty-three upper-level undergraduates participated in the final survey. The demographics for this sample are shown in Table 1. Approximately 60% of the subjects were male and 40% were female. The age of respondents ranged from 18 to 50 years old, and the average age was 21.5 years. Respondents were asked to rate the extent of their experience with the Web and with computers in general on a scale of 1 to 7, with 1 being a novice and 7 being an expert. This group of subjects considered themselves to be relatively experienced users of the Web (4.90) and slightly above average on their use of computers (5.01). Most reported they logged onto the Web about 20 times a week, spending just under 16 h on the Internet (weekly). A majority of the subjects have one to ten buying experiences over the Internet, while 24% of participants have never bought over the Internet. Additionally, subjects reported they spend about 24 h per week on the computer itself. The majority of respondents (78%) had completed 3 years of college.

4.2. Partial Least Squares (PLS)

Assessment of the research model was conducted using PLS. PLS is a structured equation modeling technique that can analyze structural equation models (SEMs) involving multiple-item constructs, with direct and indirect paths. PLS works by extracting successive linear combinations of the predictors and is
effective in explaining both response and predictor variation [10]. PLS is a powerful approach for analyzing models because of the minimal demands on measurement scales, sample size, and residual distributions [89]. In addition, the component-based PLS avoids two serious problems, inadmissible solutions and factor indeterminancy [22].

SEM approaches, such as LISREL and AMOS, are not able to deal with non-normal distributions [21], and they can yield non-unique or otherwise improper solutions in some cases [22]. PLS is not as susceptible to these limitations [88,89]. In addition, the component-based PLS avoids two serious problems, inadmissible solutions and factor indeterminancy [22].

SEM approaches, such as LISREL and AMOS, are not able to deal with non-normal distributions [21], and they can yield non-unique or otherwise improper solutions in some cases [22]. PLS is not as susceptible to these limitations [88,89]. The emphasis of PLS is on predicting the responses as well as in understanding the underlying relationship between the variables [79]. For example, PLS is very useful in screening out factors that have a negligible effect on the dependent variables.

PLS has one additional property that is useful in studying the nature of the linkages between constructs and their measures. The nature of the links is referred to as epistemic relationships, or ‘rules of correspondence’ [4,21]. Two basic types of epistemic relationships are relevant to causal modeling: reflective indicators and formative indicators. In this study, we use reflective indicators for measuring the unobserved, underlying constructs.

4.3. Operationalization of research variables

As shown in Table 2, the variables of the study were operationalized using a variety of sources. All of the measures were taken directly or adapted from

Table 2
Operationalization of latent variables

<table>
<thead>
<tr>
<th>Decision Support Satisfaction</th>
<th>DBET</th>
<th>Use of the web site enables me to make better purchasing decisions [65]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFF</td>
<td></td>
<td>This web site assists me in making a decision more effectively Adapted from Ref. [14]</td>
</tr>
<tr>
<td>DPRI</td>
<td></td>
<td>Use of the web site enables me to set my priorities in making the purchase decision [65]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task Support Satisfaction</th>
<th>TUSE</th>
<th>This web site is more useful than I had expected [24]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEXT</td>
<td></td>
<td>This web site is extremely useful [65]</td>
</tr>
<tr>
<td>TQIK</td>
<td></td>
<td>Using this web site enables me to accomplish tasks more quickly [14]</td>
</tr>
<tr>
<td>TESY</td>
<td></td>
<td>This web site makes it easier to do my task [14]</td>
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<table>
<thead>
<tr>
<th>Interface Satisfaction</th>
<th>ICLR</th>
<th>The information provided by this web site is clear and understandable [18,28–30]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILEN</td>
<td></td>
<td>Learning to use this web site was easy for me [14]</td>
</tr>
<tr>
<td>IFRN</td>
<td></td>
<td>This web site is user-friendly [14,18,28–30]</td>
</tr>
<tr>
<td>IESY</td>
<td></td>
<td>This web site is easy to use [14,18,28–30]</td>
</tr>
<tr>
<td>IWNT</td>
<td></td>
<td>I found it easy to get this web site to do what I want it to do [14]</td>
</tr>
<tr>
<td>IINT</td>
<td></td>
<td>My interaction with this web site was clear and understandable [14]</td>
</tr>
<tr>
<td>ISKL</td>
<td></td>
<td>It would be easy for me to become skillful at using this web site [14]</td>
</tr>
<tr>
<td>INAV</td>
<td></td>
<td>This web site is easy to navigate [46]</td>
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</table>

<table>
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<tr>
<th>Behavioral Intent to Use</th>
<th>UINF</th>
<th>I predict I will use this web site to get the information I need Adapted from Ref. [86]</th>
</tr>
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<tbody>
<tr>
<td>UCRT</td>
<td></td>
<td>The use of this web site would be critical in my future decisions</td>
</tr>
<tr>
<td>UCRE</td>
<td></td>
<td>I would use my credit card to purchase from this web site</td>
</tr>
<tr>
<td>USIM</td>
<td></td>
<td>I would use this web site again for a similar task Adapted from Ref. [1]</td>
</tr>
<tr>
<td>UINC</td>
<td></td>
<td>I intend to increase my use of this web site in the future</td>
</tr>
<tr>
<td>UFUT</td>
<td></td>
<td>In the future, I plan to use this web site often Adapted from Ref. [86]</td>
</tr>
</tbody>
</table>

All questionnaire items use a seven-point Likert scale, varying from Strongly disagree to Strongly agree.
previous studies on IS success such as Doll and Torkzadeh [18], Franz and Robey [24], and Sanders [65] and on technology acceptance such as Davis [14] and Lederer et al. [46].

To keep the length of the instrument reasonable, four and five items were selected from the Task Support Satisfaction and the Decision Support Satisfaction categories, respectively, and eight items were selected for Interface Satisfaction. For Behavioral Intention to Use an EC Web site, the study draws on three previous studies including Agarwal and Prasad [1], Gefen and Straub [27], and Venkatesh and Morris [86]. The study follows the criteria recommended by Agarwal and Prasad [1] for choosing survey items. They recommend removing items that are not relevant to the specific innovation examined in the study, and also deleting items that are very similar to other items. By using these criteria, the items selected ensure complete coverage of the constructs at hand. Behavioral Intention to Use the EC Web site was measured using six items.

Among them, five items involve the likelihood of future use, while one item “Using my credit card to purchase from this Web site” is used to assess level of Trust. Trust is considered a critical aspect of electronic commerce success [67], and is an important determinant of Behavioral Intention to Use the Web site [82]. This item was also used in Gefen and Straub [27] to measure Intention to Purchase.

Two items were subsequently excluded from the final analysis because of their high correlation coefficient: one item from Decision Support Satisfaction (This Web site improves the quality of my purchase decision making) and one from Task Support Satisfaction (This Web site assists me in performing my task better).

5. Analysis and results

PLS analysis involves two stages: (1) the assessment of the measurement model, including the reliability and discriminant validity of the measures, and (2) the assessment of the structural model. For the assessment of the measurement model, individual item loadings and internal consistency were examined as a test of reliability. Individual item loadings and internal consistencies greater than 0.7 are considered adequate [23].

As shown in Table 3, loadings for all measurement items are above 0.7, which indicates there is sound internal reliability and all the weights are statistically significant at \( p < 0.001 \). The almost uniformly distributed weights show each item contributes to each construct equivalently. We used PLS-Graph Version 2.91.04.03 to perform the analysis.

5.1. Reliability and validity tests

In assessing the internal consistency for a given block of indicators, the composite reliability (CR), also referred to as convergent validity (see Werts et al. [87]), was calculated. All the CR values are over 0.9, which suggests that the parameter estimates are sound (Table 4).

The average variance extracted (AVE) was also calculated. AVE measures the amount of variance that a construct captures from its indicators relative to the variance contained in measurement error. This statistic

<table>
<thead>
<tr>
<th>Decision Support Satisfaction</th>
<th>Task Support Satisfaction</th>
<th>Interface Satisfaction</th>
<th>BI to use EC Web site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item Loadings</td>
<td>Weight</td>
<td>Item Loadings</td>
<td>Weight</td>
</tr>
<tr>
<td>DBET</td>
<td>0.9228</td>
<td>0.3579</td>
<td>TUSE</td>
</tr>
<tr>
<td>DEFF</td>
<td>0.9202</td>
<td>0.3862</td>
<td>TEXT</td>
</tr>
<tr>
<td>DPRI</td>
<td>0.8952</td>
<td>0.3511</td>
<td>TQIK</td>
</tr>
<tr>
<td>IWNT</td>
<td>0.8831</td>
<td>0.2196</td>
<td>TESY</td>
</tr>
<tr>
<td>ISKL</td>
<td>0.8368</td>
<td>0.1244</td>
<td>INAV</td>
</tr>
</tbody>
</table>
can be interpreted as a measure of reliability for the construct and as a means of evaluating discriminant validity [23]. AVE values should be greater than 0.50. All AVEs for the constructs used in this study are greater than .70. This indicates that more than 70% of the variance of the indicators can be accounted for by the latent variables.

The AVE can also be used to assess discriminant validity. The AVEs should be greater than the square of the correlations among the constructs. That is, the amount of variance shared between a latent variable and its block of indicators should be greater than shared variance between the latent variables. In this study, the square roots of each AVE value is greater than the off-diagonal elements (Table 5, refer to Appendix A which contains the cross loadings between the measurement items and the constructs). This indicates that there exists reasonable discriminant validity among all of the constructs.

The correlation between Decision Support Satisfaction and Task Support Satisfaction appears to be a little high although valid in terms of discriminant validity criteria. Such a close but distinctive relationship between Decision Support Satisfaction and Task Support Satisfaction was expected (see Garrity and Sanders [25]). Hence, Decision Support Satisfaction together with Task Support Satisfaction can be used to provide more insight into the features of the Web site.

To further evaluate/establish the discriminant validity of the constructs, we conducted discriminant analysis tests [5] using AMOS. These analyses compared the proposed four-factor model to all possible three-factor models (there were four such comparisons). In all cases the change in the \( \chi^2 \) comparing the proposed four-factor model to each of the three-factor models was significant at \( p < 0.001 \). The best three-factor model involved treating DSS and TSS as one construct, which was accomplished by setting the correlation between the two constructs to one. The \( \chi^2 \) difference between the four-factor model and this three-factor model was \( \chi^2 = 105 \) (df=1, \( p < 0.001 \)).

The analyses with both PLS and AMOS indicate that there exists reasonable discriminant validity among all of the constructs. It is important to note that this study is in fact examining an information systems success model consisting of dependent variable constructs (see Refs. [17,25] for a discussion of dependent variable models). Accordingly, the correlations between the research variables are expected to be high. However, they should not be so high as to preclude them from being considered separate constructs. As noted above, the constructs in the model do indeed satisfy discriminate validity criteria detailed by Fornell and Larcker [29] and Bagozzi and Phillips [5].

5.2. Assessment of the structural model

The path coefficients in the PLS model represent standardized regression coefficients. The suggested lower limit of substantive significance for regression coefficients is 0.05 [63]. In a more conservative

<table>
<thead>
<tr>
<th>Constructs</th>
<th>CR</th>
<th>AVE</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Support Satisfaction</td>
<td>0.9374</td>
<td>0.8332</td>
<td>( CR = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum \text{var}(\epsilon_i)} )</td>
</tr>
<tr>
<td>Task Support Satisfaction</td>
<td>0.9371</td>
<td>0.7884</td>
<td>( AVE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum \text{var}(\epsilon_i)} )</td>
</tr>
<tr>
<td>Interface Satisfaction</td>
<td>0.9610</td>
<td>0.7554</td>
<td></td>
</tr>
<tr>
<td>Behavioral Intention to Use EC web site</td>
<td>0.9413</td>
<td>0.7280</td>
<td></td>
</tr>
</tbody>
</table>

\( \lambda_i \) is the component loading to an indicator and \( \text{var}(\epsilon_i) = 1 - \lambda_i^2 \).

In personal correspondence with Wynne Chin, he indicated that the difference between the off-diagonal (correlation) and the diagonal (square root of AVE) should be greater than 0.1 in order to secure reasonable discriminant validity.

8 The number parentheses is the square root of AVE, and *** \( p < 0.001 \).
position, path coefficients of 0.10 and above are preferable. As shown in Fig. 3, all path coefficients are over 0.1 satisfying both conservative criteria and the suggested lower limit. They are also statistically significant at \( p = 0.001 \), which indicates that all hypotheses (H1a, H1b, H2, and H3) are supported by the data. Moreover, a high \( R^2 \) for each endogenous variable in the structural model shows that this model can be used to predict the Behavioral Intention to Use a Web site.

5.3. Order effects and treatment effects

The survey questionnaires were designed in two different formats with identical measures (Format A listed the inferior site first, and Format B listed the superior site first). Order effects during the experiments were investigated. The results of a two-way ANOVA (Table 6a) showed that there was no statistically significant difference in Behavioral Intention to Use caused by the order of the presentation of the Web sites on the questionnaire.

The treatment effects were explored next. Table 6a and 6b present that Behavioral Intention to Use the superior Web site (Mean=4.699, S.D.=1.192) was significantly higher than the inferior Web site (Mean=3.650, S.D.=1.417). As expected, most subjects (112 out of 156 respondents) decided to purchase a digital camera from the superior site. Additionally, there are no interaction effects between the order of presentation and the experimental treatment.

5.4. Effects of online buying experience

Experience entails general learning by trial and error, and an increasing awareness and familiarity with the types of domain problems and their structure [45]. Through the accumulation of online buying experience, the online buyers can develop a repertoire of Internet skills, knowledge, and meta-knowledge that leads to effective performance in a specific domain [66]. Thus, it is clear that online buying experience plays a role in individuals’ Web site assessment process and influences the selection of a Web site that a buyer would purchase from.

The current study investigated the impacts of subjects’ online buying experience on their Intention to Use for the four experience groups. Based on the

| Table 6a |
| Tests of between-subjects effects |
| Source | Sum of squares | df | Mean square | F | Significance | Eta squared |
| Superior/inferior sites | 74.34 | 1 | 74.347 | 43.411 | 0.000 | 0.138 |
| Formats | 3.603 | 1 | 3.603 | 2.104 | 0.148 | 0.008 |
| Superior/inferior×Formats | 3.244e−03 | 1 | 3.244e−03 | 0.002 | 0.965 | 0.000 |
| Error | 464.122 | 271 | 1.713 | | | |
| Total | 5340.028 | 275 | | | | |
| Corrected total | 543.474 | 274 | | | | |

Dependent variable: behavioral intention to use an EC web site.
mean score of the seven-scale items of Behavioral Intention to Use an EC Web site, the contrasts are developed by first performing an ANOVA test (Table 7b) and then conducting a post hoc test where the ANOVA indicates a difference among treatments (Table 7a). The post hoc tests involve three t tests on the difference between group 1 and the other groups.

The analysis offers evidence that a buyer’s online experience has significant impacts on Intention to Use. The results show that more experienced online buyers tend to more clearly observe the difference between two sites than less experienced buyers ($p < 0.005$). In order to investigate the divergence of subjects’ intention in different groups, mean score differences were calculated. While subjects in group 1 who have never experienced online buying do not show much difference in their buying intention with superior and inferior Web sites ($M_1 = 0.344$), ones in group 4 who have more than ten online-buying experiences better recognize the difference ($M_4 = 2.119$). In essence, the more an individual experiences online purchasing, the better they evaluate the quality of Web sites, and the more likely they intend to use a superior site.

6. Discussion and implications

This study has found support for the Web-based Information Systems Success Model introduced here. Overall, the results indicate strong support for the model. Table 8 summarizes the results of the hypothesis testing. WISSM explains almost 50% of the variation in Behavioral Intent to Use the Web information system ($R^2 = 0.486$). All of the paths in the model are statistically significant (at $p = 0.001$ level). Compared to prior studies, WISSM effectively predicts the intention to use a Web-based information system. Behavioral Intention to Use is primarily explained via Task Support Satisfaction. The results of this model also show, as in Davis et al.’s [15] findings, that Task Support Satisfaction (corresponding to Perceived Usefulness) directly influences Behavioral Intention to Use an EC Web site and Interface Satisfaction (corresponding to Perceived Ease of Use) has an indirect impact on Behavioral Intention to Use an EC Web site through Task Support Satisfaction.

Lederer et al. [46] have urged IS researchers to explore and develop different factors or latent variables that can better explain information System Use and lead to models that explain greater variance. In this research, important antecedents of Task Support Satisfaction, the Interface Satisfaction and Decision Support Satisfaction dimensions, were validated in the context of a Web-based purchasing information system. The results are consistent with researchers who study Web usability such as Nielsen [56]. Web systems that are well developed according to the Interface Satisfaction concept, will lead to high “Intention to Use the Web site” via an indirect path through Decision Support and Task Support Satisfaction.
The most important determinant of Task Support Satisfaction, for this study, is the user’s assessment of Decision Support Satisfaction, which involves activities such as comparing important product features and prices, and examining the myriad of tradeoffs in bundled attributes offered at a Web site. Given the new demands of electronic commerce and markets, such specialized task characteristics warrant further consideration and measurement by researchers.

7. Conclusion

This study attempts to address several of the issues in electronic commerce research: How should Web-based information systems success be measured in the context of User Satisfaction, whether existing measures of success can be applied, and how consumers react to commercial Web sites. The results of this study, which draw on the DeLone and McLean Model [17], the Garrity and Sanders’ [25] model of IS success, and TAM, support the use of WISSM for examining Web-based information systems success. The results also confirm three fundamental WIS User Satisfaction components (Task Support Satisfaction, Decision Support Satisfaction, and Interface Satisfaction) that explain approximately 50% of the variance in users’ Intention to Use a WIS. The amount of variance explained in Behavioral Intention to Use, however, needs to be carefully interpreted with the understanding that the experiment was done within a contrived situation. The respondents were not actually making a purchase.

An important facet of conducting WIS research is the availability of a dependent variable that is able to reflect the concept of system success. A set of questions has been presented that can be used to measure WIS success. This is, of course, not the only available scale nor should it be considered the final instrument. The brevity of the scale along with its reasonably interpretable and clear dimensions designates this measure as a useful addition to the current literature.

This research is not without limitations. First, this experiment utilized a Web-based information system, focusing on a fundamental but core purchasing task. The subjects in this study were asked to determine a product to purchase, given a constrained budget. A complete assessment of consumer purchasing behavior in an electronic market should, however, include after sale support, order tracking, and should be extended to the areas of “need assessment,” advertising, and promotion (see Ref. [57]). While the current study examined those respondents who were considered a major user group, further experiments could utilize new referent groups and control the experimental environment more closely. That is, future study needs to include various user groups (i.e., individuals in high school, those who do not go to college, and users with disposable income) and investigate differences in their behavior. Notwithstanding these limitations, the study supports the basic research question that Decision Support Satisfaction and Task Support Satisfaction do matter in WIS success. This follows recommendations by Lederer et al. [46] to develop more robust constructs to explain Web-based information systems success.

In the future, research on Web-based information systems assessment could be extended to consider variations in Web support required for different types of products. For example, the experimental design could manipulate differences in product information intensity and determine the effect on purchase behavior. Palmer and Griffith [59] call for research into Web-based product purchase decisions that manipulate the product type to account for differences in consumer “involvement” in the purchase. Web site design for high involvement products may require

<table>
<thead>
<tr>
<th>Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Satisfaction has a positive impact on Decision Support Satisfaction.</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>$p&lt;0.001$</td>
</tr>
<tr>
<td>Interface Satisfaction has a positive impact on Task Support Satisfaction.</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>$p&lt;0.001$</td>
</tr>
<tr>
<td>Decision Support Satisfaction is positively associated with Task Support Satisfaction.</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>$p&lt;0.001$</td>
</tr>
<tr>
<td>Task Support Satisfaction positively influences Behavioral Intention to Use an EC Web site.</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>$p&lt;0.001$</td>
</tr>
</tbody>
</table>
different types of decision and task support. In addition, most research in the Web success area has found a strong link between Trust and purchase behavior (e.g., Ref. [82]). For future work, it would be worthwhile to consider the effect of Trust on Behavioral Intention and different User Satisfaction dimensions. Future research might also examine the potential of the Web-based Information Systems Success Model for different Web-based applications. Models of success may need to be modified as technology changes and new models of business and computing evolve.

Acknowledgement

The authors thank two anonymous reviewers for their constructive comments and suggestions on earlier drafts of this article. The authors also thank Dr. Wynne Chin for his correspondence related to the discriminant validity issues.

Appendix A. Cross loadings between measurement items and constructs

<table>
<thead>
<tr>
<th>Item</th>
<th>Decision Support Satisf</th>
<th>Task Support Satisf</th>
<th>Interface Satisf</th>
<th>BI to use EC Web site</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBET</td>
<td>0.923</td>
<td>0.691</td>
<td>0.455</td>
<td>0.527</td>
</tr>
<tr>
<td>DEFF</td>
<td>0.920</td>
<td>0.732</td>
<td>0.511</td>
<td>0.580</td>
</tr>
<tr>
<td>DPRI</td>
<td>0.895</td>
<td>0.706</td>
<td>0.402</td>
<td>0.568</td>
</tr>
<tr>
<td>TUSE</td>
<td>0.692</td>
<td>0.847</td>
<td>0.563</td>
<td>0.632</td>
</tr>
<tr>
<td>TEXT</td>
<td>0.730</td>
<td>0.908</td>
<td>0.548</td>
<td>0.651</td>
</tr>
<tr>
<td>TQIK</td>
<td>0.666</td>
<td>0.910</td>
<td>0.556</td>
<td>0.604</td>
</tr>
<tr>
<td>TESY</td>
<td>0.671</td>
<td>0.885</td>
<td>0.592</td>
<td>0.586</td>
</tr>
<tr>
<td>ICLR</td>
<td>0.484</td>
<td>0.623</td>
<td>0.862</td>
<td>0.477</td>
</tr>
<tr>
<td>ILEN</td>
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<td>0.485</td>
<td>0.869</td>
<td>0.334</td>
</tr>
<tr>
<td>IFRN</td>
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<td>0.603</td>
<td>0.901</td>
<td>0.478</td>
</tr>
<tr>
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<td>0.927</td>
<td>0.428</td>
</tr>
<tr>
<td>IWNT</td>
<td>0.495</td>
<td>0.558</td>
<td>0.878</td>
<td>0.462</td>
</tr>
<tr>
<td>INT</td>
<td>0.420</td>
<td>0.558</td>
<td>0.878</td>
<td>0.419</td>
</tr>
<tr>
<td>ISKL</td>
<td>0.361</td>
<td>0.485</td>
<td>0.837</td>
<td>0.360</td>
</tr>
<tr>
<td>INAV</td>
<td>0.399</td>
<td>0.458</td>
<td>0.794</td>
<td>0.357</td>
</tr>
<tr>
<td>UINF</td>
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<td>0.639</td>
<td>0.491</td>
<td>0.858</td>
</tr>
<tr>
<td>UCRT</td>
<td>0.571</td>
<td>0.582</td>
<td>0.366</td>
<td>0.872</td>
</tr>
<tr>
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<td>0.458</td>
<td>0.776</td>
</tr>
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<td>USIM</td>
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<td>0.665</td>
<td>0.521</td>
<td>0.883</td>
</tr>
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<td>0.533</td>
<td>0.303</td>
<td>0.878</td>
</tr>
<tr>
<td>UFUT</td>
<td>0.475</td>
<td>0.560</td>
<td>0.293</td>
<td>0.848</td>
</tr>
</tbody>
</table>

References


Bonnie C. Glassberg is currently an Assistant Professor at Miami University/Ohio. She has a PhD from the University of South Carolina, an MBA from Indiana University, and a BSc degree from Cornell. As an Assistant Professor at the University at Buffalo (1997–2001), she also taught information systems at the graduate and undergraduate level. Bonnie has 10 years of industry experience as a Senior Analyst with a Fortune 100 company. She has been involved in the planning, design, implementation, and management of major corporate systems. She has served as a reviewer for JMIS, CACM, Database, and the Mid-America Journal of Business.
Yong Jin Kim is an Assistant Professor of Management Information Systems at the School of Management at the State University of New York at Binghamton. He holds a PhD in MIS from the State University of New York at Buffalo. He participated in large IT projects including a BPR implementation for Samsung Life Insurance, an online accounting systems development project for the Bank of Korea, and a business recovery planning project for the Korea Financial Telecommunication and Clearing Institute. His research interests are in IS success, e-commerce, and information technology valuation, and knowledge management. He has published papers in outlets such as *Communications of the ACM*, *Decision Support Systems*, and *Knowledge and Process Management*. He has also published book chapters on IS Success and e-learning.

Seung Kyoon Shin is an Assistant Professor of Information Systems in the College of Business Administration at the University of Rhode Island. Prior to joining academia, he worked in industry as a software specialist and system integration consultant. His research has appeared in *Communications of the ACM*, and the International Conference on Information Systems, and Hawaii International Conference on System Sciences (HICSS). His current research interests include strategic database design for data warehousing and data mining. Web-based information systems success, and economic and cultural issues related to intellectual property rights.

G. Lawrence Sanders, PhD, is Professor and Chair of the Department of Management Science and Systems in the School of Management at the State University of New York at Buffalo. He has taught MBA courses in the People's Republic of China and Singapore. His research interests are in the ethics and economics of digital piracy, systems success measurement, cross-cultural implementation research, and systems development. He has published papers in outlets such as *The Journal of Management Information Systems*, *The Journal of Business*, *MIS Quarterly*, *Information Systems Research*, the *Journal of Strategic Information Systems*, the *Journal of Management Systems*, *Decision Support Systems*, *Database Programming and Design*, and *Decision Sciences*. He has also published a book on database design and co-edited two other books.