TOWARD A MODEL OF INFORMATION SYSTEM DEVELOPMENT SUCCESS: PERCEPTIONS OF INFORMATION SYSTEMS DEVELOPMENT TEAM MEMBERS

Completed Research Paper

Lucian Zelazny
Texas State University – San Marcos
San Marcos, TX 78666
zelazny@txstate.edu

France Bélanger
Virginia Tech
Blacksburg, VA 24061
belanger@vt.edu

David Tegarden
Virginia Tech
Blacksburg, VA 24061
david.tegarden@vt.edu

Abstract

Many information systems development (ISD) projects are deemed a failure in the field. However, several practitioners and researchers argue these projects could actually be considered successful if we used a broader definition of software development project success. Answering the call for further research on what makes ISD projects successful, this paper describes the process used to build the model of ISD Success, which includes a thorough literature review to create an initial model followed by semi-structured interviews conducted to validate the model and to allow for the discovery of emergent constructs, sub-constructs, and hypotheses. The model is tested with data collected from practitioners using Partial Least Squares (PLS) analysis. The paper concludes with a discussion of the findings and conclusions.

Keywords: Information System Development Success, Process Quality, Product Quality, Team Member Benefits, Team member Satisfaction

Introduction

Studies reporting the rate of software project failure paint a dismal picture. A frequently referenced resource, the CHAOS report, implies that nearly 30% of IT projects are considered a success with nearly 50% considered challenged and 20% considered a failure (Johnson 2006). Critics of the CHAOS reports challenge the methodology and definitions used in the reports (Eveleens and Verhoef 2010; Glass 2005; Glass 2006). "How do you categorize a project that is functionally brilliant but misses its cost or schedule targets by 10 percent? Literalists would call it a failure, realists a success" (Glass 2005). Glass does not believe the software industry is in the state of crisis that the CHAOS report portrays (Glass 2006). However, other studies confirm the CHAOS reports' finding that far too many projects fail. The 2001 Robbins-Gioia survey found that 51% of the companies surveyed viewed their ERP implementation project as unsuccessful (IT Cortex). The Conference Board surveyed executives at 117 companies in 2001 and found that 34% were satisfied, 58% somewhat satisfied, and 8% unhappy with their ERP implementation while 40% of the projects failed to meet their business goals within one year (IT Cortex). And, the 1997 KPMG Canada Survey found that over 61% of the projects were considered a failure by respondents (IT Cortex). Disregarding the specific numbers, these studies suggest far too many projects are considered a failure.

Linberg (1999) describes a case study of a project that is 193% over the approved schedule, 419% over the approved budget, and 130% over the initial size estimates, which would be considered a failure by any of the studies mentioned above. However, in interviews with the developers, five of the eight software developers considered this project the most successful project on which they ever worked with the other three considering it their second best. Linberg (1999) concludes that "the current definition of software project success may be too narrowly defined and may create negative perceptions about software developers" and a new theory of project success may be in order. The goal of this research is to increase our understanding of information system project success by developing a model of information systems development (ISD) success. ISD success measures the success of the process undertaken to create the information system and the success of the resulting product. The perspective of success is measured through the eyes of the ISD team members since they are the most influential stakeholders during the development of the system. Hence, this research is guided by the following research question: how do ISD team members define the success of the development of an information system?

The first section of this paper presents the development of a model of ISD Success through a literature review and semi-structured interviews. The second section presents the testing of the model which includes the development and validation of a survey instrument, data collection, and Partial Least Squares (PLS) analysis of the research model. A discussion of the findings and conclusions are presented in the third and fourth sections respectively.

The Model of ISD Success

Success of an information system is a complex, multidimensional construct. Complexities arise due to the fact that success means different things to different stakeholders and that the perception of success can change over time. The important stakeholders during the project development phase include the end user/using organization, the project manager (PM), and the developers[1] (Agarwal and Rathod 2006; Atkinson 1999; Baccarini 1999; Karlsen et al. 2005; Milis et al. 2003). These three stakeholders each have a different set of goals and will thus define success differently. Research has proposed that the end user/using organization will define success using constructs such as use, user satisfaction, and benefits (DeLone and McLean 2003). Examples of benefits (or goals) include improved decision making, improved productivity, and increased revenues (DeLone and McLean 1992). The PM and developers' goals are similar more to each other than the end user/using organization (Procaccino and Verner 2006). Some of their goals include the project was delivered when needed, met requirements, and delivered sufficient quality (Procaccino and Verner 2006). The viewpoint of the user/using organization is a well-researched topic in the IS Success literature and is thus not included in this research (Petter and McLean 2009; Urbach et al. 2009). The model developed in this paper of ISD success is from the perspective of the project team members (i.e. the PM and developers). This model is not intended to replace the IS

[1] Includes software developers (including programmers), data base developers, systems analysts, etc.

success model but to be used to measure a different perspective of success and thus uncovering another facet of success. The model was developed using a two-step process: 1) a literature review and 2) semi-structured interviews. A literature review of the project success and IS Success literatures was conducted to identify the initial dimensions of ISD success. Afterwards, semi-structured interviews were conducted to confirm that the model contained the appropriate dimensions and to identify any emergent constructs that were not previously identified. The literature review and interviews are discussed in the next sub-sections. Model testing is in the Method section.

The resulting model of ISD Success is presented in Figure 1. ISD success is composed of the latent constructs *team member satisfaction*, *functional product quality*, *non-functional product quality*, *team member benefits*, and *process quality*. *Team member satisfaction*, *non-functional product quality*, *process quality*, and *team member benefits* are formative second-order constructs. *Functional product quality* is a reflexive first-order construct. The rationale for the constructs, sub-constructs, and relationships are described next.

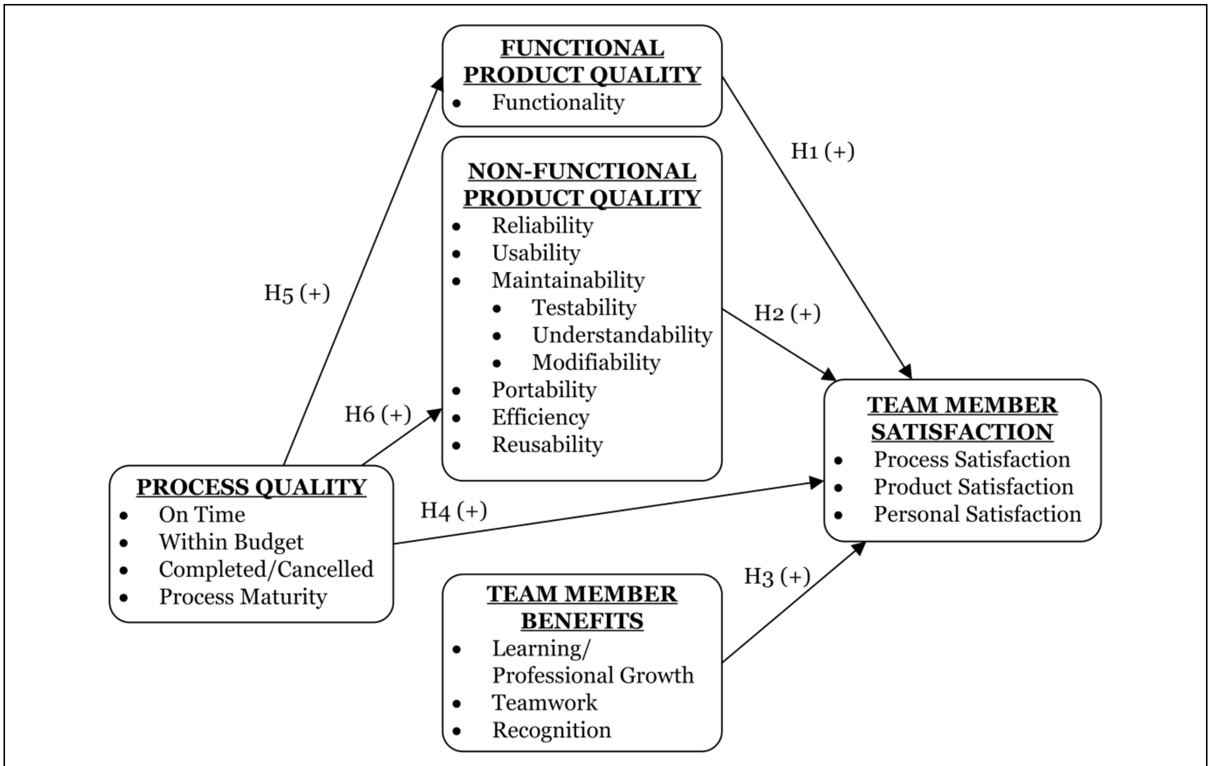

Figure 1. Model of ISD Success

Literature Review

Team Member Satisfaction

Team member satisfaction is a subjective evaluation of the various consequences from working on the IS development project. An ISD project considered successful is more than likely to have satisfied team members. Satisfaction is included in a number of project success frameworks and project success studies from the end user/organization's point of view (Table 1). Satisfaction from the team member's perspective has been included in two frameworks and five studies (Table 1).

Seddon (1997) defines user satisfaction as "a subjective evaluation of the various Consequences ... evaluated on a pleasant-unpleasant continuum. Of all the measures ... , User Satisfaction is probably the closest in meaning to the ideal Net Benefits measure." A frequently used instrument to measure user information satisfaction (UIS) was created by Ives et al. (1983) who describe UIS as a "perceptual or subjective measure of system success." Thus, satisfaction can be thought of as the overall net success of using an information system: perceived total benefits from using the system minus the overall perceived costs. In a series of studies, Procaccino, Verner, and associates (Pereira et al. 2008; Procaccino and Verner 2002; Procaccino and Verner 2006; Procaccino et al. 2005) study software practitioners' perceptions of project success. The top three ranked personal items include: do a good job (i.e., delivered quality), sense of achievement, and working on project is satisfying. Based on the above, satisfaction is viewed as a component of how team members define a successful ISD project. Since a person's satisfaction can be multifaceted, three sub-constructs are used to form *team member satisfaction*: *process satisfaction*, *product satisfaction*, and *personal satisfaction*.

Table 1. Literature Review of Constructs Included in the Model[2]

	Process Quality	**Product Quality**	**Benefits**			**Satisfaction**		
Source			**End User and Organization**	**Project Manager**	**IS Developer**	**End User and Organization**	**Project Manager**	**IS Developer**
Frameworks								
Pinto & Slevin (1988)	✓	✓	✓			✓		
Atkinson (1999)	✓	✓	✓	✓	✓	✓		
Baccarini (1999)	✓	✓	✓			✓	✓	✓
Lim & Mohamed (1999)	✓	✓				✓		
van der Westhuizen & Fitzgerald (2005)	✓	✓	✓			✓	✓	✓
Studies w/ Data								
Saarinen (1996)	✓	✓	✓					
Shenhar et al. (1997)	✓	✓	✓			✓		
Wateridge (1998)	✓	✓	✓			✓	✓	✓
Milis et al. (2003)	✓	✓	✓			✓	✓	✓
Karlsen et al. (2005)	✓	✓	✓			✓		
Procaccino et al. (2005)	✓	✓			✓			✓
Agarwal & Rathod (2006)	✓	✓	✓			✓		
Procaccino & Verner (2006)	✓	✓		✓			✓	
Thomas & Fernandez (2008)	✓	✓	✓			✓	✓	✓
IS Success								
DeLone & McLean (1992)	✓	✓	✓			✓		
Seddon (1997)	✓	✓	✓			✓		
DeLone & McLean (2003)	✓	✓	✓			✓		

Product Quality (Including Functional and Non-Functional)

Product quality measures the quality of the artifact(s); programs, modules, diagrams, documentation, specifications, etc.; produced during the system development life cycle (SDLC). An ISD project considered

[2] The list of articles is not an exhaustive listing of the project success/IS success literature but is representative of the constructs used and the points of view taken to measure project success. The studies listed are broken down into studies that are frameworks (without empirical testing), studies with some level of empirical analysis, and IS success.

successful is more than likely to have produced a quality product. Product quality is a commonly used construct in project success research (Table 1), and commonly measured with constructs such as meeting functional requirements, meeting technical requirements, reliability, and performance (Atkinson 1999; Karlsen et al. 2005; Shenhar et al. 1997; Wateridge 1998) and system quality and information quality (DeLone and McLean 2003; Saarinen 1996; Seddon 1997; van der Westhuizen and Fitzgerald 2005).

Within the CS and IS literature, a number of software quality models have been developed that list desired characteristics of quality software: the Boehm model (Boehm et al. 1976), the McCall model (Cavano and McCall 1978), the objectives/principles/attributes (OPA) framework (Nance et al. 1986), the FURPS model (Grady and Caswell 1987), ISO 9126 (ISO/IEC 2001), the Dromey model (Dromey 1996), the Systemic model (Ortega et al. 2003), and the Pragmatic quality model (PQM) (Yahaya et al. 2008). With the exception of ISO 9126, each of the models was developed by one company/researcher and was validated/tested on a limited number of projects. However, when comparing the models one notices that they are relatively consistent and complete. Using the definitions of the characteristics, it is possible to group them according to their meaning. When the models are combined, a distinct set of factors emerges that describe the quality characteristics desirable in an IS. The set of factors end up being developed by multiple companies/researchers across multiple projects which increases their validity. These factors are used to form the functional and non-functional product quality constructs.

Product quality in the ISD success framework is measured in two parts; *functional product quality* and *non-functional product quality*. *Functionality* will be used to form the *functional product quality* construct. It has been split into its own construct based on the importance of meeting the functional requirements of users, which may have a greater impact on success. The combination of the factors *reliability*, *usability*, *maintainability* (including *testability*, *understandability*, and *modifiability*), *portability*, *efficiency*, and *reusability* are used to form the *non-functional product quality* construct.

Empirical tests of the DeLone and McLean model of IS Success and Seddon's model have shown a correlation between system quality and user satisfaction (Iivari 2005; Rai et al. 2002; Seddon and Kiew 1994). While Rai et al. (2002) and Seddon and Kiew (1994) used various items such as ease of use and user friendliness to measure system quality, Iivari (2005) used a set of factors including; flexibility, integration, response/turnaround time, error recovery, convenience of access and language. Wixom and Todd (2005) also discovered a positive correlation between system quality and system satisfaction while reporting reliability, flexibility, integration, and accessibility as significant antecedents to system quality. Based on these findings, it is plausible that if product quality is measured with factors important to ISD team members then *product quality* (both *functional* and *non-functional*) should have a positive influence on *team member satisfaction*.

> *H1: Higher levels of functional product quality will lead to higher levels of team member satisfaction.*
>
> *H2: Higher levels of non-functional product quality will lead to higher levels of team member satisfaction.*

Team Member Benefits

Team member benefits measures the benefits team members receive resulting from working on the information system. It is likely that team members will receive benefits from working on successful ISD projects. Benefits is included in a number of project success frameworks and project success studies from the end user/organization's point of view (Table 1). Atkinson (1999) includes benefits from the PM and developers point of view in his project success framework using the constructs personal development, professional learning, and content project team. In the Procaccino, Verner, and associates studies mentioned before, the next four ranked items in the personal section are results in professional growth, learning something new, increases recognition, and increase professional responsibility. These items are used to support the three sub-constructs that form the *team member benefits construct*: *learning*, *professional growth*, and *recognition*.

In a meta-analysis of the DeLone and McLean model of IS success, Petter and McLean (2009) find that there is a strong relationship between user satisfaction and net benefits. Rai et al. (2002) empirically tested the relationship between individual benefits and user satisfaction and found it to be significant. However, they used perceived usefulness as a proxy for individual benefits. The definition used for perceived usefulness was "[t]he degree to which the user believes that using a particular system has enhanced his or her job performance" (Rai et al. 2002, Table 2). Kulkarni et al. (2006) tested the perceived usefulness (benefits) to satisfaction relationship in the knowledge management setting and Schaupp et al. (2009) tested it in the website setting. Both studies find the relationship to be significant. In a qualitative literature review on IS Success research, Petter et al. (2008) list four other studies that find this relationship to be significant when using perceived usefulness as a proxy for individual benefits (Devaraj et al. 2002; Hsieh and Wang 2007; Rai et al. 2002; Seddon and Kiew 1996). Petter et al. (2008) also list another five studies that find a positive relationship from benefits to satisfaction when satisfaction is measured as impact on job (Guimaraes et al. 1996; Wu and Wang 2006; Yoon et al. 1995), perceived productivity (Abdulla 1997), and decision making satisfaction (Bharati and Chaudhury 2006). Extending these findings from the user's perspective to the IS development team member perspective, *team member benefits* should have a positive influence on *team member satisfaction*.

> *H3: Higher levels of team member benefits will lead to higher levels of team member satisfaction.*

Process Quality

Process quality measures the success of the process undertaken to develop the information system. A successful ISD project is more than likely to have undergone a process of sufficient quality. Like product success, *process quality* is also commonly used in project success research (Table 1). *Process quality* has been measured with constructs such as project management success, project efficiency, and development process (Baccarini 1999; Saarinen 1996; Shenhar et al. 1997; van der Westhuizen and Fitzgerald 2005).

Most if not all of the frameworks and studies of project success include on time and within budget under constructs such as project management success, project efficiency, and development process (Atkinson 1999; Baccarini 1999; van der Westhuizen and Fitzgerald 2005). It is likely that if a project has been managed well (on time and within budget), it has undergone a quality process. Therefore, *on time* and *within budget* are included as sub-constructs of *process quality*. They measure how well the time and budget constraints imposed on the ISD project were managed.

Developing a quality process became a focus in the software engineering industry in the 1990's when the Software Engineering Institute (SEI) developed the Capability Maturity Model (CMM), which is used to measure the maturity of an organization's process. The premise behind the CMM is that a more mature process (or a quality process) will lead to higher quality products. The current version of CMM is CMMI for Development Version 1.2 ('I' stands for integration) (Software Engineering Institute 2006). It has two options for rating maturity: staged and continuous. The continuous representation allows a company to select a process or set of related processes on which to focus their process improvement efforts. CMMI for Development is composed of 22 process areas grouped into four categories of related processes. Characteristics of the six process areas comprising the engineering category (product integration, requirements development, requirements management, technical solution, validation, and verification) are selected to proxy for the *process maturity* sub-construct. The sub-constructs *on time*, *within budget*, and *process maturity* are therefore combined to form the *process quality* construct.

The proposed benefits of the software process improvement (SPI) movement is that improving the quality of the development process will lead to higher quality products, improve developer productivity and predictability, reduce cycle time, and increase customer satisfaction. Kuilboer and Ashrafi (2000) found that developers perceived that the use of a software process improvement framework lead to an increase in customer satisfaction. Since ISD Success is measuring success from the perspective of the ISD team members, it is plausible to believe that having a quality process would increase these stakeholders' satisfaction with the process and their sense of achievement. Therefore, *process quality* should have a positive influence on *team member satisfaction*.

> *H4: Higher levels of process quality will lead to higher levels of team member satisfaction*

Prior studies have found mixed results linking SPI with improved productivity but they have suggested that higher process capabilities lead to a higher quality product (Ashrafi 2003; El Emam and Birk 2000; Harter et al. 2000; Kuilboer and Ashrafi 2000). While Harter et al. (2000) define quality as errors uncovered during acceptance testing, Kuilboer and Ashrafi (2000) define quality using a set of factors similar to the ones proposed here. The top five factors perceived to be highly impacted by SPI in descending order were: reliability, expandability, intra-operability, correctness, verifiability, with flexibility and reusability tied at the rank of five. They also found a high correlation between the perceived importance of a factor and the impact SPI plays on that factor (Kuilboer and Ashrafi 2000). Therefore, *process quality* should positively influence *functional product quality* and *non-functional product quality*.

H5: Higher levels of process quality will lead to higher levels of functional product quality.

H6: Higher levels of process quality will lead to higher levels of non-functional product quality.

Semi-structured Interviews

Nine semi-structured interviews were conducted to confirm the literature driven model and to allow for the discovery of emergent constructs, sub-constructs, and hypotheses. Four project managers and five developers from a variety of organizations (i.e. one product development, two 3rd party development, and one in-house development) were selected to ensure a general model that cuts across all types of projects.

The interviews were recorded, transcribed following developed transcription guidelines, and the transcripts were coded using a validated codebook (Yin 2003). The codebook was validated by the primary researcher and a Ph.D. student with professional software development experience with Kappa statistics of 0.617, 0.756, and 0.728. Reliability testing was concluded after the third round since the Kappa statistic was above 0.7 and the remaining transcripts were coded by the primary researcher (Landis and Koch 1977). The instruments and protocols created were designed to enhance replication of the study documents and results. The primary researcher conducted all interviews and performed transcriptions. This helped to elicit an intimate understanding of the phenomenon as described by the interviewees.

The transcripts of each interview underwent a thematic analysis using the validated code book. Segments tagged as containing a success concept not included in the code book were considered potential success constructs and were evaluated for inclusion during cross-case analysis. Constructs that were common across multiple transcripts and determined appropriate were added to the proposed model, the code book was modified, and all transcripts were reviewed for segments that fit the added constructs. Saturation and closure on data collection and analysis was reached after analysis of the nine conducted interviews as there were no new sub-constructs identified during analysis of the later transcripts.

During the process of coding it was determined that statements referring to professional growth can be difficult to distinguish from learning. Some of the more salient segments for professional growth include "*and say the next time I do something like this it's gonna be easier because I've learned about it*", "*you can work on things like conflict resolution, you can work on process, there are so many different things you can work on. I think that what you can learn is try to tackle those things one at a time*", and "*but personally you can develop your own self*". Since the statements coded as professional growth could also be coded as learning, the *learning and professional growth* sub-constructs were combined.

A review of the potential new constructs identified during coding uncovered three recurring themes. The first is the importance of teamwork. This feeling is exemplified by a statement made by one of the developers at the product development organization "*what I would stress the most is you know software is not written by individuals anymore. Software is written by teams of people from multiple disciplines*." Teamwork was mentioned by six of the nine interviewees and by at least one interviewee at each organization. The statement "*and you know even if the project itself doesn't work out sometimes you get to work on a good team*" provides the example that teamwork is a benefit that can be gained by working as a member of a team. *Teamwork* was added as a sub-construct to the *team member benefits* construct.

The second recurring new theme was the belief that a project is a success, at least to some extent, if the project is completed. Statements such as "*I would not call the project a failure as long as there's a working deliverable in the end*" and "*if you've got it up and running and you completed the project something was successful in that project*" exemplify this belief. On the other hand when participants were asked how they judge a project to be a failure, statements like "*if it wasn't completed at all*", "*the project doesn't get finished... it gets abandoned because it's just so futile that everyone just kind of cans it and says it's better to start over from scratch*" and "*I guess if it was cancelled that would be the top criteria*" display the belief that the only time a project is considered a failure is if it is cancelled. The themes that 'a project is a partial success if it is completed' and 'the only time a project is a failure is if it is cancelled' were mentioned by six of the interviewees and by at least one interviewee at each organization. Therefore, *completed/cancelled* was added as a sub-construct to the *process quality construct*.

The third recurring new theme is the importance of client satisfaction. Client satisfaction was the sixth most frequently mentioned theme. It was mentioned by participants at the product/service organization and the 3rd party development organizations. Given that client satisfaction is viewed as part of the traditional models of IS Success, as it is coming from the viewpoint of the client, it was not added to the ISD Success model.

All of the transcripts were reviewed to include the two added sub-constructs of *completed/cancelled* and *teamwork*. Frequencies of the codes were calculated to evaluate the constructs of the proposed model and to identify patterns across cases. Even though frequencies were used as an indication of the strength of importance of a construct, the authors caution the reader that the nature of this data is still qualitative. Reviewing the frequencies of each of the categories shows that all of the sub-constructs were coded at least once with the exception of *testability* and *portability*. *Testability* is viewed as a sub-construct of *maintenance* along with *understandability* and *modifiability*. Segments reflecting *modifiability* that couldn't be placed into a specific category (i.e. *understandability*, *testability*, or *modifiability*) were coded in the general construct *modifiability*. *Understandability* has a frequency of three, *modifiability* a five, and *maintenance* a six. There are segments that mentioned testing but they seemed to fit the *reliability* construct better than the *testability* of the code. *Testability* was retained in the model. It is understandable that *portability* is not a concern with the cases selected. All of the cases selected control for the attribute of *portability* in one way or another. The product development organization controls the need for *portability* by selling its product in a SaaS manner. Both 3rd party development organizations develop their solutions for a specific client with a specific hardware solution. The in-house development organization develops for the hardware platform that is already in place. Therefore, it is understandable that *portability* was not a major concern for the cases selected. To ensure completeness of the model, *portability* was retained. The sub-constructs that occur with the most frequencies were *on time*, *reliability*, *functionality*, and *learning/professional growth*.

Method

Instrument Development and Validation

Since ISD success is a proposed model, there are no existing instruments for its measurement. This research follows an instrument development and validation process adapted from Moore & Benbasat (1991), Wallace et al. (2004), DeVellis (1991), and Spector (1992). First, the constructs and sub-constructs were clearly defined. Second, an initial item pool was composed of items from existing instruments and new items based on: 1) the literature review, 2) interview data, 3) professional standards, and 4) personal experience. Third, an expert review was conducted through three rounds of card sorting. The results were analyzed using the item placement ratio, the card placement percentage, and item-level analysis. Fourth, items remaining after the expert review were used to create an alpha version of the questionnaire. The alpha questionnaire was pre-tested by six participants from the target population (Netemeyer et al. 2003). The participants provided comments about the clarity and content of the items and instructions; and made suggestions for rewording items. Fifth, the result of the pre-test was the beta questionnaire used in the pilot test. Participants for the pilot test were recruited from upper division and graduate IT courses as well as IT personnel working within academic institutions. 133 usable responses remained for the validity and reliability analyses after incomplete, duplicate, and respondents with less than one year of information systems development experience were removed. The results were analyzed using Cronbach's Alpha, item-total correlations, and principal components analysis (PCA). The five step process followed for instrument development addresses the content validity, construct validity, and reliability analyses of an instrument as discussed by Straub (1989).

Data Collection

The questionnaire[3] was conducted using the SurveyMonkey online tool. Participants were recruited by

[3] Due to space limitations, the instrument and the details of its validation are omitted, but are available upon request.

sending a request to the owner, president, or board members of various user groups asking if they would forward the invitation to the members of their group. A total of 185 email requests were sent to 66 Java user groups and 73 .net user groups. 24 emails were returned as undeliverable for a bounce back rate of 12.97%. Other potential participants were recruited by contacting targeted local companies, personal contacts, local AITP chapters, and posting the invitation to participate on seven relevant LinkedIn groups. Participants were notified that upon completion of the questionnaire they would be entered into a drawing for a Nook Color from Barnes & Nobel to try to increase the response rate. Ten responses were received from Java user groups and 12 from .net user groups agreeing to post the invitation on their website or send an invitation in their newsletter. Where possible, the total number of members in the user groups was recorded. These were added to the number of emails sent to local companies and personal contacts to calculate the potential participant pool, which totals 5,040. A total of 204 potential participants responded to the invitation by the beginning of the survey, for a response rate of 4.05%. The seven LinkedIn groups have a total of 154,949 members. If it is assumed that every LinkedIn group member is active and viewed the invitation, this increases the potential participant pool to 159,989 and the response rate drops to 0.128%. It is stressed that the actual response rate cannot be calculated since it is impossible to determine how many invitations were actually sent to members of the various user groups and the number of active users in the LinkedIn groups cannot be determined.

A total of 204 potential participants agreed to take the survey. Respondents that did not complete the entire survey (88) were removed from the participant pool. One respondent indicated that he just clicked through the questions, answering them at random, so that data point was removed. Only one respondent indicated that their most successful project, the project used to answer the questions, was not completed. Since there was only one data point in this category, it was removed and the *completed/cancelled* sub-construct, part of the *process quality* construct, was removed from the model tested. This results in a total of 114 usable responses for testing the model. A priori power analysis using Cohen's (1988) power of regression analysis assuming a medium effect size (f^2=0.15), at α=0.05, and a power level of 0.8 indicated a sample of 103 was necessary. Therefore, the 114 usable responses were deemed an adequate sample size.

In order to test for non-response bias, the 114 usable responses were split into two waves and tested to see if there were differences between early and late responders (Armstrong and Overton 1977). The results indicate that there are no differences in terms of age, gender, education, development expertise, length of time in IT, size of organization, and number of IT employees. However, the tests do indicate that the late responders have more development experience (in months) than the early responders.

Various demographic variables were collected, which indicate a diversity of role, number of team members, methodology, type of project, project description, and duration for the project the participants thought of while answering the questionnaire. Respondents also show a diversity in age, gender, education, development experience, self-rated expertise, tenure in IT, current job, tenure in current job and at current employer, industry, organization and IT department size, and primary work location.

Instrument Refinement

Six sub-constructs contained items that were reworded after analysis of the pilot-test data. The rewording was an attempt to ensure at least three reliable and valid indicator items remain for each sub-construct for model testing. To evaluate these changes, principle components analysis (PCA) was performed on the three constructs containing the six sub-constructs with changes to assess dimensionality after the changes. Also, item analysis was performed on the six sub-constructs to assess the reliability and validity of the sub-constructs with the reworded items. The *non-functional product quality* construct had four sub-constructs with reworded items: *reliability*, *usability*, *understandability*, and *efficiency*. Items that did not load on the appropriate factor were removed. None of the *understandability* items load on the same factor so the entire sub-construct is removed from the model tested. *Understandability*, *testability*, and *modifiability* are viewed as parts of *maintainability*, since *testability* and *modifiability* remain in the model, coverage of the *non-functional product quality* construct is viewed as being comprehensive. Item analysis conducted on the remaining items for each of the subscales gives Cronbach's Alphas of 0.819 (*reliability*), 0.828 (*usability*), 0.755 (*testability*), 0.893 (*modifiability*), 0.78 (*portability*), 0.798 (*efficiency*), and 0.894 (*reusability*). The eight factor solution explains 69.6% of the variance. *Recognition* was the only sub-construct with a reworded item from the *team member benefits* construct. The PCA analysis shows that the item now loads strongly on the desired factor so the item is retained. Item analysis conducted on the remaining items for each of the subscales gives Cronbach's Alphas of 0.844 (*learning/professional growth*), 0.832 (*teamwork*), and 0.855 (*recognition*). The three factor solution explains 74.9% of the variance. *Product satisfaction* was the only sub-construct with reworded items from the *team member satisfaction* construct. The PCA analysis with varimax rotation shows that both items now load on the desired factor and are retained. Item analysis conducted on the remaining items for each of the subscales gives Cronbach's Alphas of 0.929 (*process satisfaction*), 0.859 (*product satisfaction*), and 0.868 (*personal satisfaction*). The three factor solution explains 77.8% of the variance.

Results

This research uses PLS regression to analyze the model of ISD success since it easily handles both formative and reflexive measures (Diamantopoulos and Winklhofer 2001), is recommended for theory building (Gefen et al. 2000), avoids problems with identification (Petter et al. 2007), handles complex models (Fornell et al. 1990; Wold 1985), and is used for prediction (Chin 1998; Gefen et al. 2000). This research uses SmartPLS version 2.0.M3 to analyze the measurement and structural models (Ringle et al. 2005). SmartPLS provides similar results to PLS-Graph (Temme et al. 2006).

Following Wilson (2010), the model of ISD success is analyzed in two steps: 1) evaluate the 2nd order constructs in individual models using the repeated indicators approach (Wold 1982) to generate factor scores and then 2) use the factor scores as indicator items for the 2nd order constructs and evaluate the overall higher-level model treating the second-order constructs as a first order model. This approach is necessary as there are two formative 2nd order endogenous constructs in the model. The variance of these endogenous 2nd order constructs is entirely explained by the formative sub-constructs and the disturbance term (i.e., the R^2=1) leaving no variance to be explained by the structural paths directed to the endogenous 2nd order constructs (Diamantopoulos et al. 2008; Wetzels et al. 2009). The use of factor scores in further model analysis is not uncommon in prior research. For example, factor scores have been calculated using the mean of the indicator items (Hsieh et al. 2008; Klein and Rai 2009; Mithas et al. 2008; Rai et al. 2009; Rai et al. 2006; Wu and Wang 2006), calculated from PCA results (Karimi et al. 2007), and using factor scores generated by PLS (Agarwal and Karahanna 2000; Chin and Gopal 1995; Henseler et al. 2007; Osei-Bryson et al. 2008; Reinartz et al. 2004; Yi and Davis 2003; Zhang 2006). The two step process used allows the testing of the effect of one 2nd order factor on another and keeps the constructs on the same theoretical plane.

Step 1a: 2nd Order Measurement Models Results

Initial analyses of the *process quality* model showed that two of the *process maturity* items had item loadings below the target of 0.6 (0.515 and 0.592 respectively) with the Average Variance Extracted (AVE) for the process maturity subconstruct (0.485) below 0.5 (Fornell and Larcker 1981; Wixom and Watson 2001). Both items were removed and the *process quality* model was run again.

Initial analyses of the *non-functional product quality* model showed that one of the *portability* indicators had item loadings below the target of 0.6 (0.447) (Wixom and Watson 2001). The item was removed and the *non-functional product quality* model was run again.

Analysis of the four 2nd order reflective measurement models reveals that all of the individual item loadings are above the threshold of 0.6 and are significant at the $p < 0.001$ level (Table 2) (Wixom and Watson 2001). All of the AVEs, composite reliabilities, and Cronbach's Alphas are above the set cutoffs, 0.5, 0.7, and 0.7 respectively, indicating that the items jointly do a good job measuring their intended construct (Table 2) (Chin and Gopal 1995; Fornell and Larcker 1981; Hair Jr. et al. 2010). Also, in all cases the square roots of the AVEs are larger than the construct correlations[4] and each of the item loadings are higher than the corresponding cross loadings by at least 0.1 (Chin 1998; Chin 2010).

[4] Discriminant validity tables not shown due to space limitations but are available upon request.

Table 2. Analysis of Reflective Measurement Model Constructs

Construct	No. of Ind.[a]	Mean	Std. Dev.[b]	Item Loading Range[c] (λ)	AVE[d]	Comp Rel.[e] (ρξχ)	Alpha[f] (α)
Process Quality							
On Time	4	5.092	1.710	0.822 – 0.947	0.821	0.948	0.926
Within Budget	4	5.386	1.576	0.837 – 0.939	0.797	0.940	0.914
Process Maturity	9	5.589	1.311	0.650 – 0.809	0.540	0.913	0.892
Non-Functional Product Quality							
Reliability	4	5.829	1.362	0.661 – 0.841	0.623	0.868	0.794
Usability	4	5.776	1.138	0.780 – 0.877	0.674	0.892	0.838
Testability	4	4.904	1.674	0.660 – 0.834	0.582	0.847	0.761
Modifiability	5	5.425	1.308	0.758 – 0.895	0.708	0.923	0.896
Portability	3	4.865	1.963	0.786 – 0.874	0.702	0.876	0.789
Efficiency	3	5.863	0.999	0.826 – 0.872	0.718	0.884	0.805
Reusability	5	5.135	1.581	0.753 – 0.886	0.703	0.922	0.894
Team Member Benefits							
Learning / Professional Growth	4	6.219	0.935	0.780 – 0.906	0.689	0.898	0.848
Teamwork	3	5.687	1.201	0.820 – 0.901	0.751	0.900	0.833
Recognition	3	5.635	1.183	0.887 – 0.926	0.816	0.930	0.887
Team Member Satisfaction							
Product Satisfaction	3	6.444	0.759	0.869 – 0.909	0.782	0.915	0.860
Process Satisfaction	5	5.711	1.308	0.846 – 0.922	0.783	0.948	0.931
Personal Satisfaction	5	6.068	1.006	0.752 – 0.927	0.708	0.923	0.896

[a]Final number of indicators; [b]Standard Deviation; [c]Highest and lowest loadings;
[d]Average variance extracted (AVE); [e]Composite Reliability; [f]Cronbach's alpha

Step 1b: 2nd Order Structural Models Results

The next step is to evaluate the structural models (Table 3). All of the paths in all of the models are highly significant with path coefficients in the expected positive direction. For the reasons mentioned above, evaluating the R^2 of the 2nd order constructs is pointless as all of the variance is explained by the formative sub-constructs. All of the structural models are found to be valid. Factor scores for the 1st order sub-constructs from all four models are generated.

Step 2a: Measurement Model Results of the High Level Research Model

The *functional product quality* construct is the only construct in the higher level model measured with reflective indicators. The item loadings are between 0.771 and 0.928 with all of them being significant at the $p < 0.001$ level (Wixom and Watson 2001). The items show some cross loadings with *non-functional product quality* and *team member satisfaction* but the difference between them is above the 0.1 threshold (Chin 2010). The AVE for *functional product quality* is 0.764, composite reliability is 0.928, and Cronbach's Alpha is 0.896 (Chin and Gopal 1995; Fornell and Larcker 1981; Hair Jr. et al. 2010). All are above the selected thresholds. The square root of the AVE for *functional product quality* is larger than the construct correlations and each of the item loadings are higher than the corresponding cross loadings by at least 0.1 (Chin 1998; Chin 2010).

The remaining indicators are formative and they are evaluated based on their weights and Variance Inflation Factors (VIFs) (Table 4). The weights for *within budget*, *process maturity*, *reliability*, *usability*, *testability*, *efficiency*, *learning/professional growth*, *teamwork*, *product satisfaction*, *process* *satisfaction*, and *personal satisfaction* are significant which is an indication of their validity (Chin 2010). The weights for *on time*, *modifiability*, *portability*, *reusability*, and *recognition* are not significant. However, due to the nature of these items forming the construct of interest they are not removed from the model as they represent different dimensions of the construct of interest (Chin 2010). Multicollinearity between formative items may lead to insignificant and/or small path weights. Multicollinearity was checked using the VIF. All of the VIFs are below the more restrictive value of 3.3 (Klein and Rai 2009).

Table 3. Hierarchical Measurement Model Results

2nd Order Models	Dimension	Path Coefficient	Significance[a]
Process Quality	On Time	0.377	***
	Within Budget	0.341	***
	Process Maturity	0.494	***
Non-Functional Product Quality	Reliability	0.174	***
	Usability	0.189	***
	Testability	0.147	***
	Modifiability	0.288	***
	Portability	0.113	***
	Efficiency	0.148	***
	Reusability	0.266	***
Team Member Benefits	Learning / Professional Growth	0.265	***
	Teamwork	0.494	***
	Recognition	0.431	***
Team Member Satisfaction	Product Satisfaction	0.265	***
	Process Satisfaction	0.494	***
	Personal Satisfaction	0.431	***

[a]Bootstrapping results (n = 500)
***Significant at p < 0.001 level

Table 4. Evaluation of Formative Indicators

Latent Variable	Indicator	Weight		VIF
Process Quality	On Time	0.033		3.123
	Within Budget	0.563	**	2.813
	Process Maturity	0.621	***	1.270
Non-Functional Product Quality	Reliability	0.290	**	2.227
	Usability	0.471	***	1.995
	Testability	0.219	*	1.660
	Modifiability	0.096		2.402
	Portability	-0.100		1.372
	Efficiency	0.224	*	2.062
	Reusability	0.007		2.109
Team Member Benefits	Learning / Professional Growth	0.809	***	1.550
	Teamwork	0.437	**	1.712
	Recognition	-0.146		1.921
Team Member Satisfaction	Product Satisfaction	0.493	***	1.667
	Process Satisfaction	0.209	*	1.579
	Personal Satisfaction	0.478	***	1.658

Step 2b: Structural Model Results of the High Level Research Model

The structural model was evaluated (Figure 2) and the model accounts for 81% of the variance in *team member satisfaction*, 35.7% of the variance in *non-functional product quality*, and 30.3% of the variance in *functional product quality*. All structural paths are significant, indicating all hypotheses are supported.

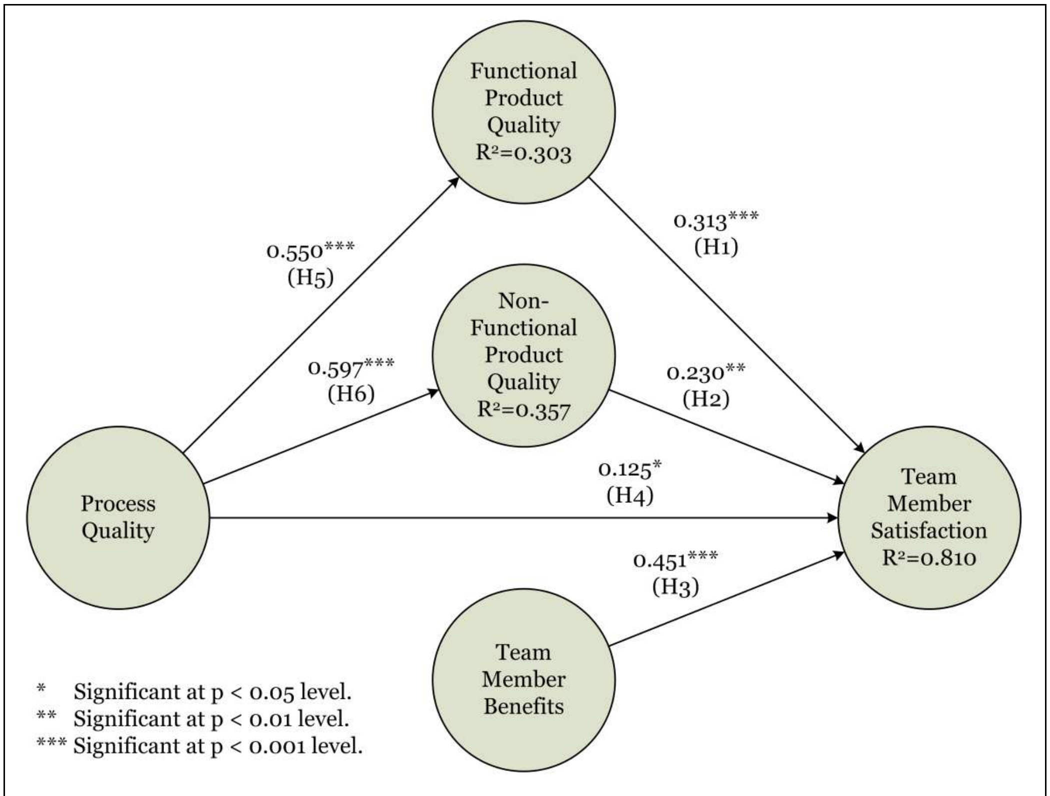

Figure 2. PLS Results

The influence of a construct is evaluated by calculating the effect size (f^2) using the following formula.

$$f^2 = \frac{R^2_{full} - R^2_{reduced}}{1 - R^2_{full}}$$

R^2_{full} is the explained variance of the entire model where $R^2_{reduced}$ is the variance explained of the model with the path being evaluated removed from the model. Values of 0.02, 0.15, and 0.35 indicate small, medium, and large influence respectively (Chin 2010; Cohen 1988; Gotz et al. 2010). Table 5 shows that *process quality* and *non-functional product quality* have a small influence on *team member satisfaction*, *functional product quality* has a medium influence on *team member satisfaction*, and *team member benefits* has a large influence on *team member satisfaction*.

Table 5. Influence Analysis

	R^2 Full	R^2 Reduced	f^2	Influence
Process Quality	0.81	0.802	0.042	Sm
Functional Product Quality	0.81	0.771	0.205	Med
Non-Functional Product Quality	0.81	0.789	0.111	Sm
Team Member Benefits	0.81	0.686	0.653	Lg

Discussion

The findings for each second-order construct (i.e., *team member satisfaction*, *process quality*, *product quality*, and *team member benefits*) are discussed separately before the overall implications are presented.

Findings for Team Member Satisfaction

In the model of ISD success, *team member satisfaction* is the overall dependent variable. Satisfaction has been widely used to measure success in IS research and Seddon (1997) states that satisfaction "is probably the closest in meaning to the ideal Net Benefits measure." Seddon views net benefits as the difference between all past and future benefits and costs attributed to using the system.

With formative indicators, the weights from PLS indicate the makeup and relative importance the indicators play in forming the construct (Chin 2010). As shown in Table 4, the weights of all three sub-constructs are significant and they indicate that product satisfaction (0.493) contributes the most to *team member satisfaction*, followed by *personal satisfaction* (0.478), and then *process satisfaction* (0.209). Reviewing the items used to capture these sub-constructs, the results indicate that ISD team members derive much of their satisfaction based on whether the product they produce will be used by and benefit the end users. The results also indicate that ISD team members perceive that a positive feeling about their accomplishments and a sense of pride in their work as contributing to their satisfaction. Lastly, while *process satisfaction* is a significant component of *team member satisfaction*, it is not as important as either *product satisfaction* or *personal satisfaction*. *Process satisfaction* indicates that team members believe that having an efficient, coordinated, and fair process is a component in determining their overall satisfaction.

These results are consistent with past research. In a series of studies, Procaccino, Verner, and associates (Procaccino and Verner 2006; Procaccino et al. 2006; Procaccino et al. 2005) presented a series of statements to software developers and project managers asking them to rate how important they believe each statement is to their definition of a successful software project. Across two studies, the affective items that correspond to the satisfaction items from this research rank at or near the top of the items for developers. The managers also ranked the affective items highly but not as high as the developers. These results support the findings from this research and add validity to Seddon's view that satisfaction can be considered the best overall measure of success. This also adds validity for having *team member satisfaction* as the overall dependent variable in the model of ISD success.

Findings for Non-Functional Product Quality

As shown in table 4, the weights of the *reliability*, *usability*, *testability*, and *efficiency* sub-constructs are significant, indicating that these dimensions are significant components of *non-functional product quality* as viewed by ISD team members. The weights indicate that *usability* (0.471) contributes the most to *non-functional product quality*, followed by *reliability* (0.290), *efficiency* (0.224), and *testability* (0.219). Reviewing the items used to capture these sub-constructs, the results indicate that ISD team members consider a system successful if it is easy to use and if it is easy to learn how to use the system as well as if the system is reliable, can handle errors, perform operations efficiently, and is easy to test.

When combined with *functionality*; the *reliability*, *usability*, and *efficiency* sub-constructs form the external quality attributes described by the ISO 9126 (ISO/IEC 2001). External attributes are observed and measured when the system is executed. The results suggest that ISD team members judge a system to be a success using these external quality attributes as opposed to the internal quality attributes. The internal quality attributes measure the details of the product's code, documentation, models, and other deliverables and include the *testability*, *understandability*, *modifiability*, *reusability*, and *portability* sub-constructs. The lack of consideration of the internal quality attributes may lead to the perception of an unsuccessful project over time as it may be hard to adapt and change the system to new and evolving circumstances.

Findings for Team Member Benefits

As shown in Table 4, the weights of the *learning/professional growth* and *teamwork* sub-constructs are significant and they indicate that *learning/professional growth* (0.809) contributes the most to *team member benefits* followed by *teamwork* (0.437). Reviewing the items used to capture these sub-constructs, the results indicate that ISD team members place a great deal of importance on learning. Learning has been shown to be such an important benefit that a project can be considered a partial success even if it is a failure as long as team members were able to learn something new or an important lesson (Linberg 1999). ISD team members indicate that another potential benefit of working on a successful project is that of increasing their relationship with their co-workers and increasing the efficiency of the team.

These results are supported by the interviews conducted during an earlier stage of this research. *Learning/professional growth* was coded nearly four times as frequently as *recognition* and *teamwork* was coded nearly twice as frequently. The results are also partially supported by prior literature. In one of the Procaccino et al. (2005) studies mentioned above, the sum of the top two categories rank the items relating to *team member benefits* in the order: *learning/professional growth* (professional growth then learning), *recognition* (increases recognition, increases professional responsibility, and then opportunity for career advancement), and *teamwork* (relationship with peers and relationship with subordinates).

Findings for Process Quality

As shown in Table 4, the weights of the *within budget* and *process maturity* sub-constructs are significant and they indicate that *process maturity* (0.621) contributes the most to *process quality* followed by *within budget* (0.563). Reviewing the items used to capture these sub-constructs, the results indicate that ISD team members view following a mature process as part of success. A mature process would include managing the systems requirements as well as validating and verifying the system. ISD team members also believe that delivering a system that was cost efficient and within budget as part of a successful project.

The result that ISD team members did not view *on time* as a necessary component of a successful project was unexpected. This result is not supported by the interviews conducted in an earlier stage of this research as well as in past research (Atkinson 1999; Baccarini 1999; Pinto and Slevin 1988; van der Westhuizen and Fitzgerald 2005). During the interview portion of this study, *on time* was coded the most frequently of all of the codes and *within budget* was the 8th most coded item. Numerous studies have used *on time* as a surrogate for project success or project management success. The item loadings and cross loadings[5] showed that the *on time* and *within budget* items tended to cross load which may lead to some statistical issues. However, the latent variable scores produced within PLS passed the test for multicollinearity (Table 4). Perhaps these results may be the effect of the IT job market or the relatively poor economic climate that is occurring today. Or maybe, *on time* may have just outlived its usefulness as a surrogate of success with the emergence of timeboxing, which is the practice of meeting the deadline at all costs, even if that means delivering a product with reduced functionality or reduced quality. However, this result is congruent with the belief that *on time* and *within budget* are simply constraints placed on a software development project (Nance and Arthur 2002). Future research into this result may explain these findings.

Model Findings

Process quality, *functional product quality*, *non-functional product quality*, and *team member benefits* have significant relationships with *team member satisfaction* and explain 81% of the construct's variance. These results show that the process undertaken, characteristics of the product developed, and the benefits gained from working on the project are positively associated with and can be used to predict the overall satisfaction of the ISD team members.

The influence analysis showed that *team member benefits* has a large influence on overall *team member satisfaction*. This indicates that learning and developing relationships with team members goes a long

[5] Not shown but available upon request

way to determine the satisfaction of ISD team members. This relationship is strongly supported within the IS success literature (Petter et al. 2008; Wu and Wang 2006).

The influence analysis showed that *functional product quality* has a medium influence on overall *team member satisfaction*. This indicates the importance ISD team members place on including the desired/required functionality within the delivered system. *Non-functional product quality* has a small influence on overall *team member satisfaction*. This indicates that while the characteristics of the software artifact are important in leading to *team member satisfaction*, the *non-functional product quality* characteristics are not as important as the *functional product quality* characteristics. In fact, the ISD team members place even less importance on the internal characteristics (i.e. *testability*, *modifiability*, *reusability*, and *portability*) of the software artifact. As noted above, this may be an important finding when it comes to measuring system success over the life of the system. If developers were to place a larger importance to these factors it may help to increase the ability of the software to change and adapt to new requirements. This relationship is strongly supported within the IS literature. Once again, Wu and Wang (2006) find that system quality (measured with stability, response time, user friendly interface, and easy to use) has a positive influence on user satisfaction in the KMS context. Iivari (2005) studied IS success in the context of a governmental accounting system. He found that perceived system quality (measured with flexibility, integration, response time, recoverability, convenience, and language) has a significant positive influence on user satisfaction. Wixom and Todd (2005) find system quality (measured as reliability, flexibility, integration, accessibility, and timeliness) to positively influence system satisfaction in the data warehouse context. Petter et al. (2008) report that 21 out of 21 studies that test this relationship find that system quality has a positive influence on user satisfaction (this includes the three studies mentioned above).

Process quality has a small influence on *team member satisfaction*. This finding indicates that while ISD team members feel that following a quality process is important, it doesn't have much of an effect on their satisfaction. The existence of this relationship is supported by the research of Kuilboer and Ashrafi (2000). They surveyed software developers at several software process improvement (SPI) meetings and found that 71% of the respondents indicated SPI has increased customer satisfaction.

Process quality has a significant relationship with *functional product quality* explaining 30.3% of the construct's variance. This result shows that the process undertaken is positively associated with delivering the required/desired functionality of the software artifact delivered. This relationship was supported by Kuilboer and Ashrafi (2000).

Process quality has a significant relationship with *non-functional product quality* explaining 35.7% of the construct's variance. This result shows that the process undertaken is positively associated with delivering a software artifact that is reliable, usable, testable, and efficient. These results indicate that managing requirements and verifying and validating the system lead to including the desired/required functional requirements and meeting the external quality attributes of the system. This relationship is supported within the literature. Kuilboer and Ashrafi (2000) report the percent of respondents that rate SPI as having a high or very high influence on differing dimensions of non-functional product quality (56.8% for reliability, 43% for usability, 38.9 % for maintainability, 54.5 for expandability, 55.6 for testability, 40.6 for portability, 25.7 % for efficiency, 46.9 % for reusability). Wixom and Watson (2001) find that project implementation success positively influences system quality in the data warehouse context. However, in their study, the authors measure project implementation success with items concerning meeting deadlines and providing required functionality.

Conclusion

This research provides several contributions to information systems research. First, this research fills gaps in the current IS success literature since DeLone and McLean's (1992; 2003) and Seddon's (1997) models of IS success measure success that result from using the system from the perspective of the end user or the using organization. An information system is an artifact, which is composed of the executable, the code itself, hardware, people, database, documentation, and procedures (Pressman 1997). The traditional models measure the success of a system as a set of behaviors when the code is executed in a specific context for a specific type of end user and those behaviors are composed of the lines of code used to create the executable. However, since the behaviors exhibited by an executable is composed of a set of lines of code it is plausible that if the creation of those lines of code followed a proven process and exhibited characteristics of quality programming, then it is more likely that the executing program will be successful when used by the user in their respective context. In fact, software process improvement (SPI) professionals believe that following an SPI process leads to overall customer satisfaction (Kuilboer and Ashrafi 2000). The research model of ISD success includes the code base as well as the process used to create the code when determining the successful development of an information system.

Second, the research model of ISD success defines success of an information system from the perspective of the ISD team members (i.e. the PM and developers). The ISD team members are important stakeholders during the implementation phase of the information system. The project manager manages the development of the artifacts which comprise the information system. The developers actually build the system. How these stakeholders define success at this stage influences the resulting artifacts, which in turn should influence IS success from the users' standpoint. Furthermore, techniques, knowledge, and code modules gained on one project can be transferred to another project.

Third, another contribution of this research is the development and validation of a survey instrument to measure ISD success. Following advised validation techniques (DeVellis 2003; Netemeyer et al. 2003; Straub 1989), the process began with a thorough literature review to identify potential components to be included within the model. Interviews with actual software developers and project managers were then conducted to identify any emergent constructs that needed to be added to the model. Where applicable, items from previous studies were adapted to the present context and new items were created to fill in the gaps. The items underwent a thorough validation process. The creation and validation of the instrument allows subsequent researchers to consistently measure the components within the research model of ISD success. This will help to make the results of any subsequent studies comparable.

For information system development professionals, this research provides insight into how ISD team members define success. Project professionals have historically determined a project to be a success if the project was on time, within budget, and included the desired functionality. Contrary to past research (Pinto and Slevin 1988; Procaccino and Verner 2006; Procaccino et al. 2005), this study indicates that ISD team members do not include the project being *on time* as an indicator of a successful project. Future research is necessary to investigate why the *on time* sub-construct is not considered a success metric by today's ISD team members.

References

Abdulla, H.A.-G. 1997. "Determinants of Computer-Mediated Communication Success among Knowledge Workers in Saudi Arabia," *The Journal of Computer Information Systems* (38:1), p. 55.

Agarwal, N., and Rathod, U. 2006. "Defining `Success' for Software Projects: An Exploratory Revelation," *International Journal of Project Management* (24:4), pp. 358-370.

Agarwal, R., and Karahanna, E. 2000. "Time Flies When You're Having Fun: Cognitive Absorption and Beliefs About Information Technology Usage," *MIS Quarterly* (24:4), pp. 665-694.

Armstrong, J.S., and Overton, T.S. 1977. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research* (14:3), pp. 396-402.

Ashrafi, N. 2003. "The Impact of Software Process Improvement on Quality: In Theory and Practice," *Information & Management* (40:7), pp. 677-690.

Atkinson, R. 1999. "Project Management: Cost, Time and Quality, Two Best Guesses and a Phenomenon, Its Time to Accept Other Success Criteria," *International Journal of Project Management* (17:6), pp. 337-342.

Baccarini, D. 1999. "The Logical Framework Method for Defining Project Success," *Project Management Journal* (30:4), pp. 25-32.

Bharati, P., and Chaudhury, A. 2006. "Product Customization on the Web: An Empirical Study of Factors Impacting Choiceboard User Satisfaction1," *Information Resources Management Journal* (19:2), p. 69.

Boehm, B.W., Brown, J.R., and Lipow, M. 1976. "Quantitative Evaluation of Software Quality," in: *Proceedings of the 2nd international conference on Software engineering*. San Francisco, California, United States: IEEE Computer Society Press.

Cavano, J.P., and McCall, J.A. 1978. "A Framework for the Measurement of Software Quality," in: *Proceedings of the software quality assurance workshop on Functional and performance issues*.

Chin, W.W. 1998. "The Pls Approach to Sem," in *Modern Methods for Business Research,* G.A. Marcoulides (ed.). Mahwah, NJ: Lawrence Erlbaum Associates, pp. 295-336.

Chin, W.W. 2010. "How to Write up and Report Pls Analyses," in: *Handbook of Partial Least Squares: Concepts, methods and applications,* V.E. Vinzi, W.W. Chin, J. Henseler and H. Wang (eds.). Berlin Heidelberg: Springer-Verlag, pp. 655-690.

Chin, W.W., and Gopal, A. 1995. "Adoption Intention in Gss: Relative Importance of Beliefs," *SIGMIS Database* (26:2-3), pp. 42-64.

DeLone, W.H., and McLean, E.R. 1992. "Information Systems Success: The Quest for the Dependent Variable," *Information Systems Research* (3:1), pp. 60-95.

DeLone, W.H., and McLean, E.R. 2003. "The Delone and Mclean Model of Information Systems Success: A Ten-Year Update," *J. Manage. Inf. Syst.* (19:4), pp. 9-30.

Devaraj, S., Fan, M., and Kohli, R. 2002. "Antecedents of B2c Channel Satisfaction and Preference: Validating E-Commerce Metrics," *INFORMATION SYSTEMS RESEARCH* (13:3), September 1, 2002, pp. 316-333.

DeVellis, R.F. 1991. *Scale Development*. Newbury Park, CA: Sage.

DeVellis, R.F. 2003. *Scale Development : Theory and Applications*. Thousand Oaks, Calif.: Sage Publications.

Diamantopoulos, A., Riefler, P., and Roth, K.P. 2008. "Advancing Formative Measurement Models," *Journal of Business Research* (61:12), pp. 1203-1218.

Diamantopoulos, A., and Winklhofer, H.M. 2001. "Index Construction with Formative Indicators: An Alternative to Scale Development," *Journal of Marketing Research* (38:2), pp. 269-277.

Dromey, R.G. 1996. "Cornering the Chimera [Software Quality]," *Software, IEEE* (13:1), pp. 33-43.

El Emam, K., and Birk, A. 2000. "Validating the Iso/Iec 15504 Measures of Software Development Process Capability," *Journal of Systems and Software* (51:2), pp. 119-149.

Eveleens, J.L., and Verhoef, C. 2010. "The Rise and Fall of the Chaos Report Figures," *IEEE Softw.* (27:1), pp. 30-36.

Fornell, C., and Larcker, D.F. 1981. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research (JMR)* (18:1), pp. 39-50.

Fornell, C., Lorange, P., and Roos, J. 1990. "The Cooperative Venture Formation Process: A Latent Variable Structural Modeling Approach," *Management Science* (36:10), pp. 1246-1255.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural Equation Modeling and Regression:

Guidelines for Research Practice," *Communications of the Association for Information Systems* (4:7), pp. 1-57.

Glass, R.L. 2005. "It Failure Rates--70% or 10-15%?," *IEEE Softw.* (22:3), pp. 112-111.

Glass, R.L. 2006. "The Standish Report: Does It Really Describe a Software Crisis?," *Commun. ACM* (49:8), pp. 15-16.

Grady, R.B., and Caswell, D.L. 1987. *Software Metrics: Establishing a Company-Wide Program*. Englewood Cliffs, NJ: Prentice-Hall Inc.

Guimaraes, T., Yoon, Y., and Clevenson, A. 1996. "Factors Important to Expert Systems Success a Field Test," *Information & Management* (30:3), pp. 119-130.

Hair Jr., J.F., Black, W.C., Babin, B.J., and Anderson, R.E. 2010. *Multivariate Data Analysis*, (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Harter, D.E., Krishnan, M.S., and Slaughter, S.A. 2000. "Effects of Process Maturity on Quality, Cycle Time, and Effort in Software Product Development," *Management Science* (46:4), pp. 451-466.

Henseler, J., Wilson, B., Gotz, O., and Hautvast, C. 2007. "Investigating the Moderating Role of Fit on Sports Sponsorship and Brand Equity," *International Journal of Sports Marketing and Sponsorship* (8:4), p. unpaginated.

Hsieh, J.J.P.-A., Rai, A., and Keil, M. 2008. "Understanding Digital Inequality: Comparing Continued Use Behavioral Models of the Socio-Economically Advantaged and Disadvantaged," *MIS Quarterly* (32:1), pp. 97-126.

Hsieh, J.J.P.-A., and Wang, W. 2007. "Explaining Employees' Extended Use of Complex Information Systems," *European Journal of Information Systems* (16:3), pp. 216-227.

Iivari, J. 2005. "An Empirical Test of the Delone-Mclean Model of Information System Success," *SIGMIS Database* (36:2), pp. 8-27.

ISO/IEC. 2001. "Iso/Iec 9126-1:2001," in: *Software engineering - Product quality - Part 1: Quality model*. Geneva, Switzerland.

IT Cortex. "Statistics over It Failure Rate." Retrieved October 15th, 2009, from http://www.it-cortex.com/Stat_Failure_Rate.htm

Ives, B., Olson, M.H., and Baroudi, J.J. 1983. "The Measurement of User Information Satisfaction," *Commun. ACM* (26:10), pp. 785-793.

Johnson, J.H. 2006. *My Life Is Failure*. West Yarmouth, MA: Standish Group International.

Karimi, J., Somers, T., and Bhattacherjee, A. 2007. "The Impact of Erp Implementation on Business Process Outcomes: A Factor-Based Study," *J. Manage. Inf. Syst.* (24:1), pp. 101-134.

Karlsen, J.T., Andersen, J., Birkely, L.S., and Odegard, E. 2005. "What Characterizes Successful It Projects," *International Journal of Information Technology & Decision Making* (4:4), pp. 525-540.

Klein, R., and Rai, A. 2009. "Interfirm Strategic Information Flows in Logistics Supply Chain Relationships," *MIS Quarterly* (33:4), pp. 735-762.

Kuilboer, J.P., and Ashrafi, N. 2000. "Software Process and Product Improvement: An Empirical Assessment," *Information and Software Technology* (42:1), pp. 27-34.

Kulkarni, U.R., Ravindran, S., and Freeze, R. 2006. "A Knowledge Management Success Model: Theoretical Development and Empirical Validation," *Journal of Management Information Systems* (23:3), Winter2006/2007, pp. 309-347.

Landis, J.R., and Koch, G.G. 1977. "The Measurement of Observer Agreement for Categorical Data," *Biometrics* (33:1), pp. 159-174.

Lim, C.S., and Mohamed, M.Z. 1999. "Criteria of Project Success: An Exploratory Re-Examination," *International Journal of Project Management* (17:4), pp. 243-248.

Linberg, K.R. 1999. "Software Developer Perceptions About Software Project Failure: A Case Study," *Journal of Systems and Software* (49:2-3), pp. 177-192.

Milis, K., Meulders, M., and Mercken, R. 2003. "A Quasi-Experimental Approach to Determining Success Criteria for Projects," *System Sciences, 2003. Proceedings of the 36th Annual Hawaii International Conference on*, p. 12 pp.

Mithas, S., Jones, J.L., and Mitchell, W. 2008. "Buyer Intention to Use Internet-Enabled Reverse Auctions: The Role of Asset Specificity, Product Specialization, and Non-Contractibility," *MIS Quarterly* (32:4), pp. 705-724.

Moore, G.C., and Benbasat, I. 1991. "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research* (2:3), pp. 192-222.

Nance, R.E., and Arthur, J.D. 2002. *Managing Software Quality: A Measurement Framework for Assesment and Prediction*. New York, NY: Springer.
Nance, R.E., Arthur, J.D., and Dandekar, A.V. 1986. "Evaluation of Software Development Methodologies: A Final Report," Virginia Polytechnic Institute & State University.
Netemeyer, R.G., Bearden, W.O., and Sharma, S.C. 2003. *Scaling Procedures: Issues and Applications*. Thousand Oaks, CA: Sage Publications.
Ortega, M., Pérez, M., and Rojas, T. 2003. "Construction of a Systemic Quality Model for Evaluating a Software Product," *Software Quality Journal* (11:3), pp. 219-242.
Osei-Bryson, K.-M., Dong, L., and Ngwenyama, O. 2008. "Exploring Managerial Factors Affecting Erp Implementation: An Investigation of the Klein-Sorra Model Using Regression Splines," *Information Systems Journal* (18:5), pp. 499-527.
Pereira, J., Cerpa, N., Verner, J.M., Rivas, M., and Procaccino, J.D. 2008. "What Do Software Practitioners Really Think About Project Success: A Cross-Cultural Comparison," *Journal of Systems and Software* (81:6), pp. 897-907.
Petter, S., DeLone, W., and McLean, E. 2008. "Measuring Information Systems Success: Models, Dimensions, Measures, and Interrelationships," *European Journal of Information Systems* (17:3), pp. 236-263.
Petter, S., and McLean, E.R. 2009. "A Meta-Analytic Assessment of the Delone and Mclean Is Success Model: An Examination of Is Success at the Individual Level," *Information & Management* (46:3), pp. 159-166.
Petter, S., Straub, D., and Rai, A. 2007. "Specifying Formative Constructs in Information Systems Research," *MIS Quarterly* (31:4), pp. 623-656.
Pinto, J.K., and Slevin, D.P. 1988. "Project Success: Definitions and Measurement Techniques," *Project Management Journal* (19:1), pp. 67-71.
Pressman, R.S. 1997. *Software Engineering: A Practitioner's Approach*, (4th ed.). New York: McGraw-Hill.
Procaccino, J.D., and Verner, J.M. 2002. "Software Practitioner's Perception of Project Success: A Pilot Study," *International Journal of Computers. The Internet and Management* (10:1), pp. 20-30.
Procaccino, J.D., and Verner, J.M. 2006. "Software Project Managers and Project Success: An Exploratory Study," *Journal of Systems and Software* (79:11), pp. 1541-1551.
Procaccino, J.D., Verner, J.M., and Lorenzet, S.J. 2006. "Defining and Contributing to Software Development Success," *Communications of the ACM* (49:8), pp. 79-83.
Procaccino, J.D., Verner, J.M., Shelfer, K.M., and Gefen, D. 2005. "What Do Software Practitioners Really Think About Project Success: An Exploratory Study," *Journal of Systems and Software* (78:2), pp. 194-203.
Rai, A., Brown, P., and Tang, X. 2009. "Organizational Assimilation of Electronic Procurement Innovations," *Journal of Management Information Systems* (26:1), Summer2009, pp. 257-296.
Rai, A., Lang, S.S., and Welker, R.B. 2002. "Assessing the Validity of Is Success Models: An Empirical Test and Theoretical Analysis," *Information Systems Research* (13:1), pp. 50-69.
Rai, A., Patnayakuni, R., and Seth, N. 2006. "Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities," *MIS Quarterly* (30:2), pp. 225-246.
Reinartz, W., Krafft, M., and Hoyer, W.D. 2004. "The Customer Relationship Management Process: Its Measurement and Impact on Performance," *Journal of Marketing Research* (41:3), pp. 293-305.
Ringle, C.M., Wende, S., and Will, A. 2005. "Smartpls." Hamburg, Germany: SmartPLS.
Saarinen, T. 1996. "An Expanded Instrument for Evaluating Information System Success," *Information & Management* (31:2), pp. 103-118.
Schaupp, L.C., Bélanger, F., and Fan, W. 2009. "Examining the Success of Websites Beyond E-Commerce: An Extension of the Is Success Model," *Journal of Computer Information Systems* (49:4), Summer 2009, pp. 42-52.
Seddon, P.B. 1997. "A Respecification and Extension of the Delone and Mclean Model of Is Success," *Information Systems Research* (8:3), September 1, 1997, pp. 240-253.
Seddon, P.B., and Kiew, M.-Y. 1994. "A Partial Test and Development of the Delone and Mclean Model of Is Success," *International Conference on Information Systems*.
Seddon, P.B., and Kiew, M.-Y. 1996. "A Partial Test and Development of Delone and Mclean's Model of Is Success," *Australian Journal of Information Systems* (4:1), pp. 90-109.
Shenhar, A.J., Levy, O., and Dvir, D. 1997. "Mapping the Dimensions of Project Success," *Project Management Journal* (28:2), pp. 5-13.

Software Engineering Institute. 2006. "Cmu/Sei-2006-Tr008," in: *CMMI for Development, Version 1.2*. Pittsburgh, PA: Carnegie Mellon University.
Spector, P.E. 1992. *Summated Rating Scale Construction : An Introduction*. Newbury Park, Calif.: Sage Publications.
Straub, D.W. 1989. "Validating Instruments in Mis Research," *MIS Quarterly* (13:2), pp. 147-169.
Temme, D., Kreis, H., and Hildebrandt, L. 2006. "Pls Path Modeling – a Software Review," Humboldt University, Collaborative Research Center 649.
Thomas, G., and Fernández, W. 2008. "Success in It Projects: A Matter of Definition?," *International Journal of Project Management* (26:7).
Urbach, N., Smolnik, S., and Riempp, G. 2009. "The State of Research on Information Systems Success," *Business & Information Systems Engineering* (1:4), pp. 315-325.
van der Westhuizen, D., and Fitzgerald, E.P. 2005. "Defining and Measuring Project Success," in: *European Conference on IS Management, Leadership and Governance,* D. Remenyi (ed.). Reading, United Kingdom: Academic Conferences Limited, pp. 157-163.
Wallace, L., Keil, M., and Rai, A. 2004. "How Software Project Risk Affects Project Performance: An Investigation of the Dimensions of Risk and an Exploratory Model," *Decision Sciences* (35), pp. 289-321.
Wateridge, J. 1998. "How Can Is/It Projects Be Measured for Success?," *International Journal of Project Management* (16:1), pp. 59-63.
Wetzels, M., Odekerken-Schröder, G., and van Oppen, C. 2009. "Using Pls Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration," *MIS Quarterly* (33:1), pp. 177-195.
Wilson, B. 2010. "Using Pls to Investigate Interaction Effects between Higher Order Branding Constructs," in: *Handbook of Partial Least Squares: Concepts, methods and applications,* V.E. Vinzi, W.W. Chin, J. Henseler and H. Wang (eds.). Berlin Heidelberg: Springer-Verlag, pp. 621-652.
Wixom, B.H., and Todd, P.A. 2005. "A Theoretical Integration of User Satisfaction and Technology Acceptance," *Information Systems Research* (16:1), March 1, 2005, pp. 85-102.
Wixom, B.H., and Watson, H.J. 2001. "An Empirical Investigation of the Factors Affecting Data Warehousing Success," *MIS Quarterly* (25:1), pp. 17-41.
Wold, H. 1982. "Soft Modeling: The Basic Design and Some Extensions," in *Systems under Indirect Observation: Causality, Structure, Prediction. Part Ii,* K.G. Joreskog and H. Wold (eds.). Amsterdam: North-Holland: pp. 1-54.
Wold, H. 1985. "Partial Least Squares," in *Encyclopedia of Statistical Sciences,* S. Kotz and N.L. Johnson (eds.). New York: Wiley, pp. 581-591.
Wu, J.-H., and Wang, Y.-M. 2006. "Measuring Kms Success: A Respecification of the Delone and Mclean's Model," *Information & Management* (43:6), pp. 728-739.
Yahaya, J.H., Deraman, A., and Hamdan, A.R. 2008. "Software Quality from Behavioural and Human Perspectives," *International Journal of Computer Science and Network Security* (8:8), August 2008, pp. 53-63.
Yi, M.Y., and Davis, F.D. 2003. "Developing and Validating an Observational Learning Model of Computer Software Training and Skill Acquisition," *Information Systems Research* (14:2), pp. 146-169.
Yin, R.K. 2003. *Case Study Research Design and Methods*, (3rd ed.). London: Sage Publications.
Yoon, Y., Guimaraes, T., and Quinton, O.N. 1995. "Exploring the Factors Associated with Expert Systems Success," *MIS Quarterly* (19:1), pp. 83-106.
Zhang, P. 2006. "Affective Quality and Cognitive Absorption: Extending Technology Acceptance Research," L. Na and S. Heshan (eds.), pp. 207a-207a.