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Team Members' Perspectives on Information Systems Development Success

Lucian Zelazny
Accounting, Texas State University - San Marcos, San Marcos, TX, United States., zelazny@txstate.edu

F Belanger
Virginia Tech, Blacksburg, VA, United States., belanger@vt.edu

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

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Lucian Zelazny
McCoy College of Business Administration
Texas State University-San Marcos
zelazny@txstate.edu

France Bélanger
Pamplin College of Business
Virginia Tech
belanger@vt.edu

David Tegarden
Pamplin College of Business
Virginia Tech
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 theoretical 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 end result of this research is the theoretical model of ISD success. After subsequent research has established the links from ISD success to IS success, project professionals will be able to use the ISD Success to predict success of an ISD project. Early prediction may allow professionals to head off potentially unsuccessful systems.

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 throughout the years nearly 30% of IT projects are considered a success with nearly 50% considered challenged and 20% considered a failure. Critics of the CHAOS reports challenge the methodology and definitions used in the reports (Eveleens & Verhoef, 2010; Glass, 2005, 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, p. 110). Glass just does not believe that the software industry is in the state of crisis that the CHAOS report portrays (Glass, 2006). However, other studies confirm the CHAOS report's finding that far too many projects fail. The Robbins-Gioia survey, conducted in 2001, found that 51% of the companies surveyed viewed their ERP implementation project as unsuccessful (IT Cortex). The Conference Board Survey, conducted in 2001, surveyed executives at 117 companies 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 KPMG Canada Survey, conducted in 1997, found that over 61% of the projects were considered a failure by the respondents (IT Cortex). Disregarding the specific numbers, these studies tell us that far too many projects are reported as being 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 he found that 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, p. 191) 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 the theoretical 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 project manager and practitioners[1] 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 practitioners and project managers define the success of the development of an information system?

Since there is no existing theoretical model for ISD success, a grounded theory approach is used to build the model (Orlikowski & Baroudi, 1991; Strauss & Corbin, 1990; Yin, 2003). The methodology used to build the theory is adapted directly from Eisenhardt (1989) and Watson-Manheim and Bélanger (2007) and is depicted in Figure 1. In the next section, we discuss a priori constructs identified through an extensive literature review.
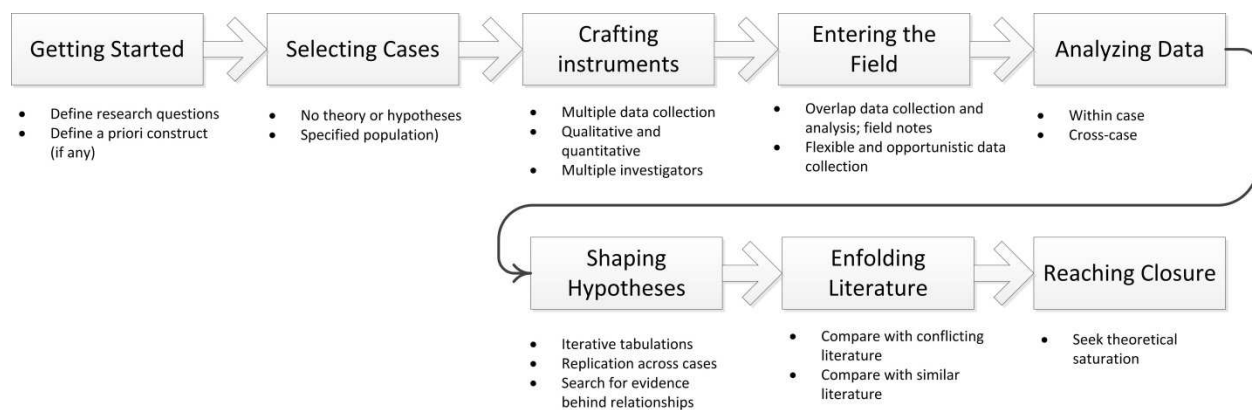

Figure 1. Grounded Theory Approach (Eisenhardt (1989); Watson-Manheim and Bélanger (2007))

LITERATURE REVIEW

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. In order to better understand the nature of success, the project management literature decomposes success into its component parts (Lipovetsky, Tishler, Dvir, & Shenhar, 1997; Pinto & Slevin, 1988; A. Shenhar, Dvir, levy, & Maltz, 2001; A. J. Shenhar & Levy, 1997; A. J. Shenhar, Tishler, Dvir, Lipovetsky, & Lechler, 2002). Baccarini (1999) breaks success into two distinct components: project management success and product success. The project management component deals with the project's process and focuses on meeting cost, time, and quality measurements. Product success concerns the effects of the project and is composed of meeting the project goal, project purpose, and satisfaction of stakeholders' needs. The IS literature has also separated success into parts (DeLone & McLean, 1992, 2003; Robey, Smith, & Vijayasarathy, 1993; Seddon, 1997). Saarinen (1996) breaks success into four components, two measuring the process and two measuring the product. The process components include the development process and use process while the product components include quality of the IS product and impact of the IS on the organization. van der Westhuizen and Fitzgerald (2005) describe project success as being composed of project management success and product success. Project management success is measured using within time, within budget, and within specification. Product success is measured using the updated DeLone and McLean IS success model (DeLone & McLean, 2003).

From the above discussion, we propose that ISD Success measures the perception of the process undertaken during the software development effort as well as the resulting product (artifact(s)) from the perspective of the software

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[1] Practitioners include software developers (including programmers), data base developers, systems analysts, etc. (Procaccino, Verner, Shelfer, & Gefen, 2005)

development team (the project manager and practitioners). Similar to IS Success, the ISD Success high-level conceptual framework is composed of multiple interrelated dimensions (Figure 2). The process quality dimension measures the success of the process and the product quality dimensions (functional and non-functional) measure the success of the product. Atkinson (1999) makes the argument that other measures may be necessary to better measure success. Net benefits and user satisfaction are important components in the IS success literature (DeLone & McLean, 1992, 2003; Rai, Lang, & Welker, 2002; Seddon, 1997). As such, team member benefits and team member satisfaction represent the high level measure of success. In Figure 2, team member benefits and team member satisfaction captures the benefits to and satisfaction of the important stakeholders during the project lifecycle. The constructs are further described below.
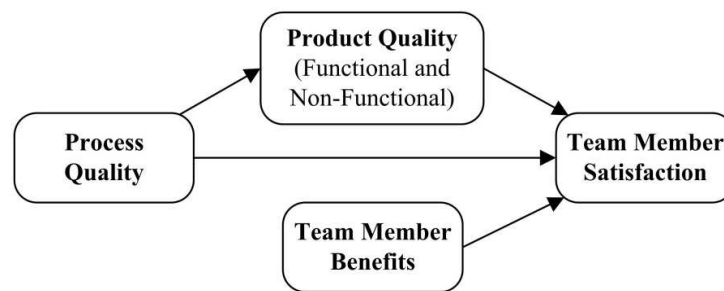

Figure 2. High Level Conceptual Framework of ISD Success

Process Quality

Process quality measures the success of the process undertaken to develop the information system. On time and within budget are measures that have been associated with project management success (Atkinson, 1999; Baccarini, 1999; van der Westhuizen & 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 information systems development project were managed.

Developing a quality process became a focus in the software engineering industry in the 1990's. During this time, 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 will lead to higher quality products. The current version of CMM is CMMI for Development Version 1.2 (where 'I' stands for integration) and 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. Since this study concerns information systems project success, 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.

Product Quality

Product quality measures the quality of the artifact(s); programs, modules, diagrams, documentation, specifications, etc.; produced during the system development life cycle (SDLC). 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, Brown, & Lipow, 1976), the McCall model (Cavano & McCall, 1978), the objectives/principles/attributes (OPA) framework (Nance, Arthur, & Dandekar, 1986), the FURPS model (Grady & Caswell, 1987), ISO 9126 (ISO/IEC, 2001), the Dromey model (Dromey, 1996), the Systemic model (Ortega, Pérez, & Rojas, 2003), and the Pragmatic quality model (PQM) (Yahaya, Deraman, & Hamdan, 2008). With the exception of ISO 9126, each of the models were developed by one company/researcher and were validated/tested on a limited number of projects. However, when comparing the models one notices that they are relatively consistent and complete. Using the factor definitions, the factors from the various models can be clustered based on their meaning. A listing of the factors for each model along with the proposed matching can be found in Table 1. When the models are combined, a distinct set of seven 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.

	Functionality	Reliability	Usability	Maintainability	Portability	Efficiency	Reusability
Boehm (1976)		Reliability	Human Engineering	Maintainability, Testability, Understandability, Modifiability	Portability	Efficiency	
McCall (1978)	Correctness	Reliability	Usability	Maintainability, Testability, Flexibility	Portability	Efficiency	Reusability
Nance & Arthur (1985)	Correctness	Reliability		Maintainability, Testability, Adaptability	Portability		Reusability
FURPS (1987)	Functionality	Reliability	Usability	Supportability, Testability, Modifiability		Performance	
ISO 9126 (1991)	Functionality	Reliability	Usability	Maintainability	Portability	Efficiency	
Dromey (1995)	Functionality	Reliability	Usability	Maintainability	Portability	Efficiency	Reusability
Systemic (2003)	Functionality	Reliability	Usability	Maintainability	Portability	Efficiency	
PQM (2008)	Functionality	Reliability	Usability	Maintainability	Portability	Efficiency	

Table 1. Comparison of Factor Definitions

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.

Team Member Benefits

Team member benefits measures the benefits team members receive resulting from working on the information system. In a series of studies, Procaccino, Verner, and associates (Pereira, Cerpa, Verner, Rivas, & Procaccino, 2008; Procaccino & Verner, 2002, 2006; Procaccino et al., 2005) study software practitioners' perceptions of project success. They divide their outcome success criteria into project and personal related items. Here, the personal related items are relevant with the top ranked items including: do a good job (i.e., delivered quality), sense of achievement, working on project is satisfying, results in professional growth, learning something new, increases recognition, and increase professional responsibility. The first three personal related items are included in the proposed model under the team member satisfaction construct (discussed below) while the last four are used to support the three sub-constructs that form the team member benefits construct: learning, professional growth, and recognition.

Team Member Satisfaction

Team member satisfaction measures the satisfaction of team members resulting from working on the information system. Seddon (1997, p. 246) 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, p. 785) 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. 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.

Literature Driven Model of ISD Success

The constructs discussed above that form ISD Success do not occur in isolation; they are interrelated. The expected relationships among the constructs are summarized in Figure 3. The grounded theory method is used next to validate these.
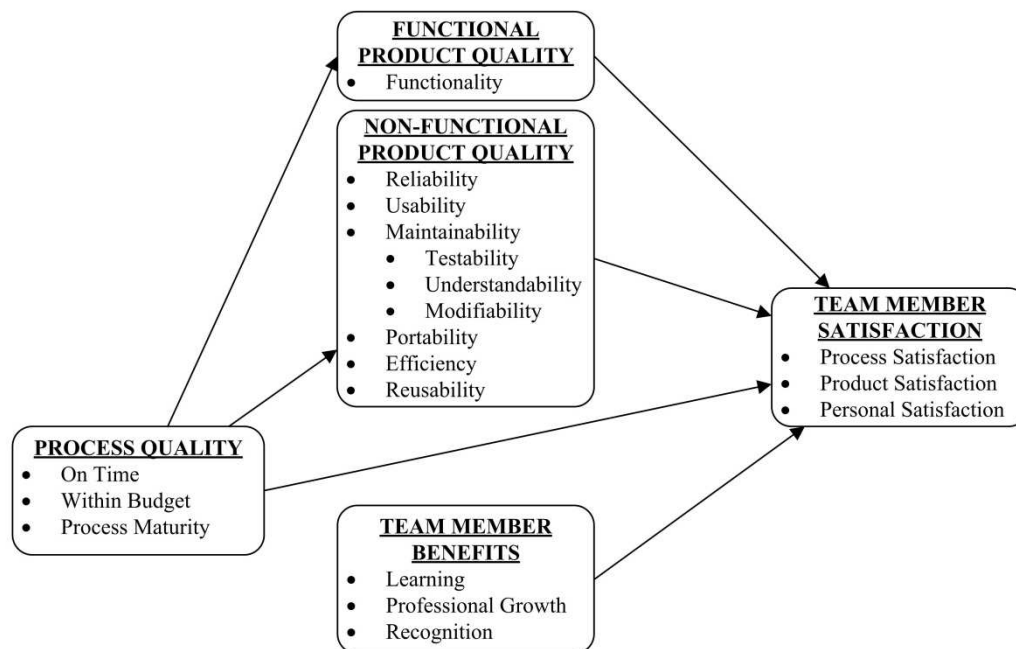

Figure 3. Literature Driven Model of ISD Success

METHODOLOGY

The research uses the grounded theory building methodology to allow for the discovery of emergent constructs, sub-constructs, and hypotheses, which can be used to refine the theoretical model developed from the literature review.

Methodology

As part of the grounded theory approach, we first needed to specify and select a population using a theoretical, not random, sampling scheme. The population of interest for this study is composed of team members developing information systems. A purposeful sampling scheme is used to select diverse cases for the theory building exercise since a general model of ISD success is desired. Project managers and developers from companies that work on different types of IS development projects were selected to be interviewed. A total of nine interviews were conducted (Table 3). The interviewees' have an average of 9.3 years of experience in IT, 5 years tenure with their current company, and 3.7 years of experience in their current role. Interviewees' ages range from 22 to 42 with an average of 33 years old. The number of interviews is based on saturation, as discussed later in this section.

Organization	Type of Service	Project Manager	Developer
Alpha	Product development	Alpha_Mrg	Alpha_Dev1; Alpha_Dev2;
Beta	3rd Party Development	Beta_Mgr	Beta_Dev
Gamma	3rd Party Development	Gamma_Mgr	Gamma_Dev
Delta	In-House Development	Delta_Mgr	Delta_dev

Table 2. Respondents

The primary data collection method for the theory building process was through semi-structured interviews. The interview guide was developed and tested to ensure full coverage of the phenomenon of interest while allowing the flexibility to follow-up on emergent themes and to clarify confusing points. The interviews were recorded, transcribed following developed transcription guidelines, and the transcripts were coded using a validated codebook. 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 & Koch, 1977). The primary researcher reflected on the procedures and supporting documents after each interview, and necessary changes were made before the next interview took place. The instruments and protocols created were designed to enhance the replication of the study documents and results. The use of a semi-structured interview allows for probing and follow-up questions on emergent themes specific to the case at hand. The primary researcher conducted all of the interviews and performed all of the transcriptions. This helped to elicit an intimate understanding of the phenomenon as described by the interviewees. Transcription of interviews occurred concurrently with subsequent interviews. Any necessary adjustments to the transcription guidelines and interview protocol were made during the process.

The transcripts of each interview underwent a thematic analysis by the primary researcher 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.

Results

The interviews were coded following the procedures described above. 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 Alpha_Dev2 "*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. Client satisfaction is viewed as part of the traditional models of IS Success as it is coming from the viewpoint of the client. Therefore, client satisfaction was not added to the ISD Success model.

All of the transcripts were reviewed to identify segments that 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 in nature. 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 (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. Company Alpha controls the need for portability by selling its product in a SaaS manner. Companies Beta and Gamma develop their solutions for a specific client with a specific hardware solution. Departments Delta and Alpha work for a large entity and develop for the hardware platform in place. Therefore, it is understandable that portability was not a major concern for the cases selected. Portability was retained in the model. The sub-constructs that occur with the most frequencies were on time, reliability, functionality, and learning/professional growth.

In an effort to identify patterns across categories, the data was aggregated in two different ways. The first aggregation investigates differences between managers and developers. No interesting patterns were discovered by this first aggregation. The second aggregation investigates the differences between the different project types (e.g. product/service, 3rd party development, and internal development). The companies that perform 3rd party development mentioned within budget and client satisfaction with a much higher frequency than the other project types. This result adds validity to the model as it is expected that companies that develop software for others are in the business to make money (or in the case of the not-for-profit to not lose money) and satisfied clients are necessary for repeat business and word-of-mouth referrals. The cases filling the product/service and internal development categories do not place as large a focus on 'budget' or 'client satisfaction' as the development work is internal to the organizations.

Proposed Model of ISD Success

As a result of the theory building exercise, the literature driven model (Figure 3) needs refining. The learning and professional growth sub-constructs are combined into learning/professional growth. The completed/cancelled sub-construct is added to the process quality construct and the teamwork sub-construct is added to the team member benefits construct. Figure 4 presents the updated Theoretical Model of ISD Success and the hypotheses to be empirically tested in future research.
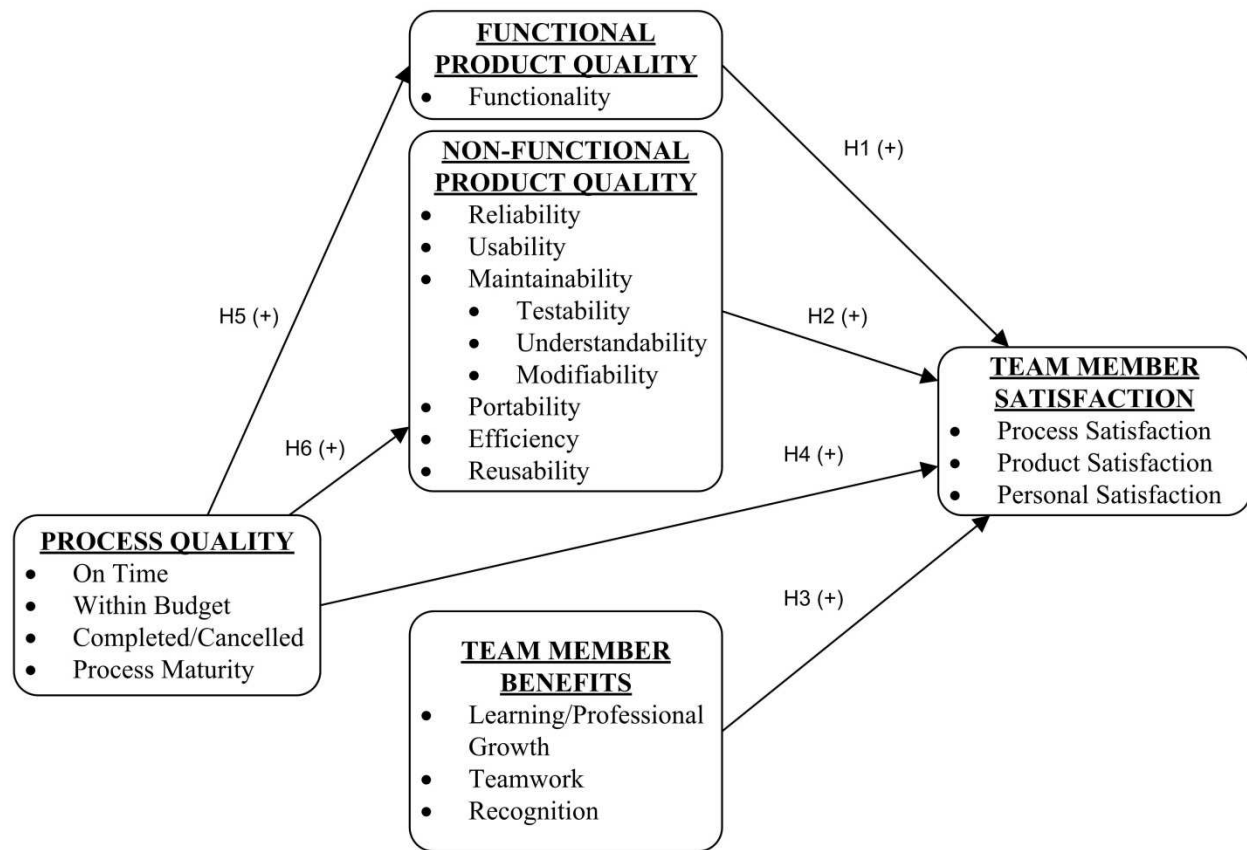
Figure 4. Proposed Model of ISD Success

CONCLUSION

Answering the call for further research on what makes ISD projects successful, this paper described the process used to build the theoretical model of ISD Success. The process began with the literature driven proposed model of ISD success. A purposeful sample was used to identify potential cases from different types of software development projects to develop a more general model that can be used across many project types. Predefined instruments and protocols were used to collect data from each case. The findings from each case were used to verify the proposed framework, evaluate the instruments used to collect the data, and evaluate the protocols used in order to capture any emergent themes from the data. The process was repeated until the addition of new cases and iterating between theory and data resulted in marginal improvement of the model. This process resulted in the theoretical model of ISD success.

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