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Impact of Process Management on Systems Development Quality: An Empirical Study

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Introduction

Problems such as poor quality, low productivity, cost over runs, late deliveries and user dissatisfaction have become common in systems development (Hamid & Madnick, 1989). Poor management of the software process is recognized as a major cause of quality problems in systems development (DoD, 1987; Seigel, 1990; Humphrey, 1987). A basic assumption here is that enhanced process quality is a prerequisite for improved product quality, increased productivity and customer satisfaction (Deming, 1986; Shingo, 1983; Taguchi, 1979).This premise is reflected in the Capability Maturity Model (CMM) which provides a framework for evaluating and improving software processes (Humphrey, 1989; SEI, 1991). The model characterizes software processes into one of five maturity levels which reflect the capability of the process. The progression from the initial level where a process is undefined and chaotic to the optimized level where systematic process improvement is institutionalized, requires a combination of control and improvement strategies (Humphrey, 1989)

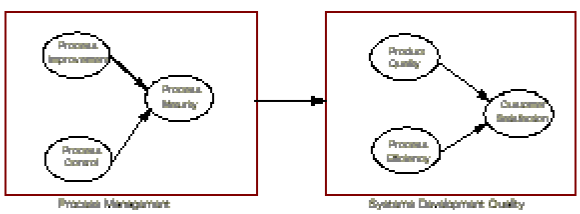

Figure 1: Conceptual Model

While the importance of process management in delivering quality systems is recognized, no systematic examination of the relationship between process management and the various dimensions of systems development quality has been done. We develop a theory based model (Figure 1) to examine these relationships. Further, we provide an empirical test of the proposed model.

The rest of the paper is organized as follows: first, a description of the empirical study is presented; this is followed by a discussion of the data analysis; next the results and findings of the study are presented and their implications are discussed.

The Empirical Study

A national survey was conducted to gather data for the study. A mailing list comprising of top IS executives was constructed from the *Directory of Top Computer Executives*. The organizations chosen belong to the fortune 500 and six non-industrial sectors and a randomly chosen set of government agencies.

A total of 710 questionnaires were mailed. 123 responses were received after three follow up mailings resulting in a response rate of 17.32% (Table 1).

Measures

Table 2 depicts the variables used in the study. Systems development quality is conceptualized to comprise of three dimensions - product quality, process efficiency and customer satisfaction with multiple items to measure each dimension. Process improvement pertains to systematic collection of data to understand process parameters and institute improvements. Process control pertains to establishment and use standards to monitor and control process outputs. Items constituting systems development quality, process improvement and process control were measured using a seven point Likert scale with values ranging from 'strongly disagree' to 'strongly agree'. Process maturity was measured using a unidimensional response matrix which listed the five maturity levels with a brief description of each. Respondents were asked to check off the one that best described the systems delivery process in their organization.

Structural Model

A fully specified structural model (Figure 2) was used to examine the relationship between the constructs. The hypothesized effects of process improvement and process control on process maturity and the effects of process maturity on product quality and process efficiency are supported by the CMM framework (Humphrey, 1989). The direct effects of process improvement and process control on product quality and process efficiency are supported by the quality management literature (Deming, 1986; Juran, 1986). The hypothesized relationships between customer satisfaction, product quality and process efficiency are supported by the IS management literature.

LISREL was used to perform structural equation analysis using the measured items for each construct in the input correlation matrix. The parameter estimates for the model are based on generalized least squares.

Results

Table 3 depicts the commonly used measures of model fit. While the c2 statistic (c2 = 407; *df* = 181) was not small enough to indicate a good fit of the model, the large number of indicators in the model may contribute to the significant c2 achieved. But, the normalized c2 (2.25) which is often used as an indicator of model fit is well below the recommended cut off value of 5. The goodness of fit (.80) and the adjusted goodness of fit (.79) indices are close to the generally acceptable values. The root mean square value of .09 is marginally above the acceptable level of .05. These measures indicate that there is a marginal fit of the model to the data.

Examination of the item loadings on the various constructs (Figure 2) indicate significant loadings of all items. The reliability measure for all the constructs exceed the cutoff level of .7 (Table 2) indicating a good fit of the measurement model. The high variance extracted (Table 2) for all the constructs provides further evidence of the measurement model fit. Examination of the path coefficients (Figure 2) indicate that nine out of the ten paths in the model are significant indicating the presence of significant relationships between the constructs.

Discussions

As theorized, both process improvement and process control have a direct effect on process maturity. This suggests that a dual emphasis on control and improvement is required to improve process maturity. The control strategies emphasize repetition and standardization which provide a basis to understand cause-effect relationships. This represents first-order learning as it involves more effective exploitation of familiar skills in addressing known problems (Sitkin et al, 1994). On the other hand process improvement strategies are oriented towards uncovering new problems and identification of improvement opportunities. This represents second order learning as it enhances organizational ability to identify and pursue novel solutions. The results indicate that information systems units need to adopt strategies to foster both types of learning to enhance process maturity.

The significant effect of process maturity on both product and process quality validates the fundamental premise of the CMM model that management efforts have to be focussed on enhancing process capabilities in order to improve systems delivery performance. It appears that the trade off between process efficiency and effectiveness discussed in the software project management literature may not be valid in all contexts. The results indicate that organizational efforts aimed at improving process maturity will enhance both process efficiency and effectiveness.

The relationships between the dimensions of systems development quality suggest that customer satisfaction is influenced by both product quality and process efficiency. The difference in the loadings (.59 & .34) suggest that product quality has a greater influence on customer satisfaction than process efficiencies. However, since in many organizations, systems delivery costs are charged to user departments, users concerns about process efficiencies should be expected.