

Social Exchange Model between Human Resource Management Practices and Innovation in Software Engineering

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Abstract

This study examines the relationship between human resource management practices and innovation in software engineering. We use social exchange theory to investigate how human resource management practices influence the innovative behaviors of software developers through the mediation of affective organizational commitment. The results show that developmental appraisal, externally or equitable reward, and comprehensive training increase developers' affective organizational commitment, which in turn positively affects their innovative behaviors.

Keywords: human resource management practice; social exchange theory; affective organizational commitment; innovative behavior; software engineering

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INTRODUCTION

Software developers are an increasingly important source of competitive advantage for companies seeking to leverage information technology (IT) resources to launch new products or reduce operating costs. Accordingly, many scholars are examining the possible ways of motivating software developers, whose task-related capabilities and personal attributes are distinct from those of conventional blue-or white-collar workers. However, the implications of the current literature are not readily applicable to this type of personnel for two reasons.

First, the software developer is part of a novel group that feels more professional attachment to its tasks than to its firm. This fact demands that this personnel type be analyzed carefully when conventional motivational techniques are developed for them. Second, most software developers work in large organizations, whereas most motivation research is done on small teams; current findings must be re-assessed with respect to the influence of complex organizations, such as their non-voluntary actions(i.e., rules) and instructions constituting human resource management (HRM) practices.

Given the importance of organizational issues in software developer motivation, we investigate the relationship between HRM practices and the innovative behaviors of software developers. Broadly, HRM is defined as the management of people and workplaces to achieve competitive advantage; it involves both HR professionals and top management. Scholars argue that developing and implementing HRM is vital to gaining critical employee motivation (Guest 1987). Although HRM practices can be critically important in bringing out the innovative behaviors of software developers, few studies have examined them. Given this gap in both the academic and practitioner literature, the following research question is posed:

RQ: What types of HRM practice bring out innovative behaviors in software developers?

THEORETICAL FRAMEWORK AND RESEARCH MODEL

The relatively longer payback period of software product-line engineering requires that organizational commitment be consistent if the organization's strategic objectives are to be achieved. Examining the antecedents of organizational commitment from the perspective of social exchange theory can produce a research model that provides a unique framework for understanding the influence of HRM practices on software developer motivation. This study's proposed conceptual research model, illustrated in Figure 1, suggests that HRM practices within organizations influence employees' organizational commitment in the context of software developer motivation. Including organizational commitment as a mediating factor between the effects of HRM practices in the motivation of software developers is purposeful and considered to remain consistent in the seminal works of Blau(1964) and Homans(1961), which articulate social exchange theory.

Surprisingly, although software engineering requires intensive innovation, few studies investigate the relationship between affective commitment and the innovative behaviors of software engineers. Affective commitment has been strongly linked to positive work-related behaviors such as organizational citizenship (Meyer et al. 2002) and has thus been the focus of much of the research. Organizations interested in increasing affective commitment, seen as the most desirable form of organizational commitment, might seriously consider it simply because it can significantly influence software developers' innovative behaviors, one of the positive work-related behaviors organizations seek.

Therefore, software developers' affective commitment to their organization is likely to play a role in their innovative behaviors. We thus propose the following hypothesis:

H1: Software developers' affective organizational commitment is positively associated with their innovative behavior.

Determining the prominent HRM practices in the software industry is a key to this process. Attempts have been made to identify the salient practices of software companies. The Software Engineering Institute (SEI) at Carnegie-Mellon University made

a detailed study of HRM practices in the software industry and designed a quality certification program, the People Capability Maturity Model, or P-CMM (Curtis et al. 1995). However, generalizing about HRM practices is difficult, as organizational behavior can vary greatly among industries, and the research has shown inconsistent results (Agarwal and Ferratt1999). The diversity of results invites researchers to probe for and identify the key HRM practices in the software industry in order to find the key practices for enhancing organizational commitment.

To this end, this study identifies software developers' characteristics. The most-cited characteristic is growth orientation (Boehm 1981; Chelsom et al. 2005; Couger and Zawacki 1980; Couger 1992; Couger and Adelsberger 1988; Couger and Ishikawa 1995; Couger and McIntyre 1987; Couger and Zawacki 1978). Studies show that growth-oriented software developers are challenging and enjoy learning new skills. This need for growth may be due to the engineers' internal make-up; they also need to be marketable and keep up with the rapidly changing technology. Software engineering requires a new software development methodology. To motivate software developers to learn and use this new methodology, HRM practices should focus on their growth-oriented characteristics. This study therefore presents the HRM practices described below to motivate software developers to grow into organizational commitment.

Developmental appraisal systems contribute to software developers' organizational commitment (Jaiswal 1982; Ogilvie 1986). An appraisal system focused on employee development nurtures a sense of attachment and belonging. A system that incorporates an informal approach and a genuine interest in the development of the employee gives employees a chance to grow and might prompt them to contribute more to the company's goals.

A reward system, offering incentives such as scope for increased pay and benefits linked to performance, is a motivator in the software development sector (Chelsom et al. 2005). The research suggests a significant relationship between compensation and organizational commitment (Angle 1983; Mottaz 1988; Jaiswal 1982; Ogilvie 1986; Mobley 1982). Mottaz (1988) found compensation and rewards to be the main factor in organizational commitment. Salary might be a major criterion in choosing an organization, but, once members of an organization, software developers look for vertical

and horizontal growth. It has also been observed that there are few significant differences in salaries across companies. Profit sharing leads to better cooperation, communication, and participation (Weitzman and Kruse 1990). Profit sharing and stock ownership encourage team members to identify with the organization and work hard on its behalf (Pfeffer 1998). Igarria and Greenhaus (1992) found that salary and promotional opportunities had a positive influence on the organizational commitment of professionals working in information systems.

Selecting staffing through the recognition of high-quality work based on objective criteria can motivate software developers. Wimalasiri (1995) found a connection between selection and organizational commitment. Pare et al. (2000) found that HRM practices such as recognition, empowerment, and competence development had a significant positive effect on organizational commitment among IT professionals. For most of these, a significant part of their motivation comes from the recognition they receive from managers for doing an outstanding job (Agarwal and Ferratt 1999).

Comprehensive training, the training opportunities designed to broaden skills and specialties, is a key motivator for software developers (Beecham et al. 2006; Couger and Zawacki 1980). A number of studies found that comprehensive training had a significant impact (Kalleberg and Moody 1994). Software development employees need continuous learning because of the rapid changes in technology. A comprehensive and customized training program makes developers confident about venturing into new projects and proving their mettle. Making learning opportunities available creates a sense of attachment to the company and enhances organizational commitment. Thus, we propose the following hypotheses:

H2: HRM practice is significantly associated with software developers' affective organizational commitment.

H2-1: Developmental appraisal is positively associated with software developers' affective organizational commitment.

H2-2: Equitable reward is positively associated with software developers' affective organizational commitment.

H2-3: Selective staffing is positively associated with software developers' affective organizational commitment.

H2-4: Comprehensive training is positively associated with

software developers' affective organizational commitment.

METHODOLOGY

Sample

The first objective of this study was identifying software companies' HRM practices through empirical analysis. Prominent types of HRM practice can be identified by measuring employees' perceptions of them. The survey research method is very useful in collecting data from a large number of individuals relatively quickly and inexpensively. Hence, a questionnaire survey was chosen for data collection.

This study is based on responses from software developers working in Korea. Of 431 responses collected from 35 companies, 352 responses from 34 companies were usable for analysis. Among the participants, 264 (75.0 percent) were men and 88 (25.0 percent) women. The percentages of the responding software professionals broke down as follows: 156 (44.3 percent) from the large-scale group, 91 (25.8 percent) from the small and medium-size enterprises, and 105 (29.8 percent) from multinational companies.

Prior to measure validation and model testing, the responses were analyzed to identify the response set (Rennie 1982), the tendency among subjects to respond to questions in a particular way independently of the item content (Kerlinger 1973). No cases of response set were detected. Two tests of common methods variance were employed. First, Harman's one factor test of common methods was conducted, with satisfactory results. An additional test of partial correlation was conducted (Podsakoff and Organ 1986), stipulating that the first factor from the principal components analysis should be introduced into the partial least squares (PLS) model as a control variable (Dijkstra 1983). This is based on the assumption that the first factor is the most likely to approximate common method variance (if any bias exists). If the factor produces changes in variance, it is assumed that common method variance is present (Podsakoff et al. 2003). As anticipated, no significant changes in explained variance were found. Thus, common methods bias is not problematic in this study.

Measurement

This study measures five latent constructs: affective organizational commitment, result-oriented culture, open-system culture, employee-oriented culture, and innovative behavior. These constructs were measured as follows:

HRM practices: The survey used scales developed by Snell and Dean (1992) to measure high-commitment human resource practices: developmental appraisal measured whether performance appraisal was used to help employees develop; externally equitable reward systems measured the extent to which the organization's pay levels were competitive with those of similar organizations; internally equitable reward systems measured the extent to which the organization's pay structure was equitably construed; selective staffing measured the extensiveness of the firm's selection process; comprehensive training measured the extensiveness of the firm's training and development process;

Affective organizational commitment: Meyer and Allen (1991) classified organizational commitment into three categories: affective commitment, continuance commitment, and normative commitment. Affective commitment is belief in and acceptance of the organization's goals and values and a willingness to help the organization achieve them. These feelings and beliefs motivate the employees to achieve those goals through new ways of doing things. For example, Mohd (2010) showed that affective commitment was positively related to innovative behavior in the retail sector. Affective commitment is measured by the Organizational Commitment Questionnaire (Mowday et al. 1979), with items reflecting the extent to which the employee is willing to put in a great deal of effort beyond that normally expected and "talks up" the organization as a great place to work.

Innovative behavior: Individual innovation has been operationalized in various ways. For example, the construct has been conceived in terms of a personality characteristic (Hurt et al. 1977). Others have taken a behavioral perspective (Janssen 2000). According to Midgley and Dowling (1978), individual innovativeness refers to an individual's openness to new ideas and decision making in the adoption of innovation free from the influence of the experiences of others. This definition was used throughout this

study because it intuitively offers an accurate interpretation of innovativeness, which is well supported, both directly and indirectly, in the literature. This study used a modified version of Scott and Bruce's (1994) measure of innovative behavior, used to examine the innovativeness of nursing employees, with the questions (items) rephrased to provide a better fit for examining those employees.

All scales ranged from 1 to 5, but the anchors varied depending on the question. An additional eight questions were included to collect demographic information such as gender, age, tenure, and job title.

RESULTS

Gefen et al. (2000) recommended that the validity and reliability of measures be assessed prior to hypothesis testing. Because the model included formative constructs, a components-based approach to structural equation modeling was taken, with calculations performed using the Smart PLS software package (Ringle et al. 2005).

Analysis of reflective measures

Tests were conducted to evaluate the convergent and discriminant validity and the reliability of the reflective measures. To begin, factor loadings were used to establish convergent validity. Loadings in excess of 0.70 on their respective factors are interpreted to indicate convergent validity (Straub et al. 2004). A second indicator of convergence was also employed. Here, a value above 0.50 for the average variance extracted (AVE) for each construct is assumed to indicate sufficient convergence. The test results indicated that both conditions were met.

Discriminant validity is demonstrated when the square root of the AVE is greater than the correlations between constructs (Bollen 1989). The square rooted AVEs for affective organizational commitment and innovative behavior were 0.7511 and 0.74121 respectively; their inter-construct correlation was 0.2122. For a second test of discriminant validity, individual items may be assumed to possess sufficient discriminant validity if they load higher on their own respective construct than on any other latent variable (Gefen et al. 2000; Straub et al. 2004). This was true for

all items. The tests thus indicated that the measures possessed sufficient discriminant validity.

Reliability is established by examining the internal consistency measure for each construct. Constructs exceeding the 0.70 level are judged to possess sufficient reliability (Fornell et al., 1982).

Analysis of formative measures

Alternative tests of validity and reliability were conducted on the formative constructs: result-oriented culture, open-system culture, and employee-oriented culture (Petter et al. 2007). To assess convergent and discriminant validity, patterns of correlation between items and latent variables are depicted in a modified multi-trait, multi-method (MTMM) matrix (Loch et al. 2003).

Convergent validity is assessed by examining item construct correlations (Chin 1995). If items load significantly on their corresponding constructs, convergent validity is demonstrated. The results indicated that item weights were significant at a 0.05 level of significance, with the exception of five indicators. The five non-significant items were further analyzed according to prescriptions for interpreting formatively measured construct results (Cenfetelli and Bassellier 2009).

The prescriptions developed by Cenfetelli and Bassellier (2009) distinguish between the relative and absolute contribution of an indicator to its construct. Relative contribution is the relation between an indicator and a criterion while other predictors are held constant: it is the importance of an indicator compared to other indicators of the same construct. Absolute contribution is the relation between an indicator and a criterion, ignoring other predictors. In some instances, both perspectives must be considered in order to develop a more accurate picture of an indicator's influence. For instance, an indicator may have a low or non-significant relative contribution to the construct but may still provide an important absolute contribution. It is therefore recommended that, when relative contribution (measured in terms of indicator weights) is low, absolute contribution (represented by item loadings) also be considered.

Because five items in this study have a low relative contribution, their unique relations with their associated constructs must be considered. The absolute contributions for five items are significant;

their values are 0.723, 0.731, 0.712, 0.721, and 0.711, respectively. Thus, although the contributions of the indicators are lower than those of other indicators, they have a strong, bivariate relation to their respective constructs (Nunnally and Burnstein, 1994). Furthermore, no patterns in wording, polarity, or content appeared among the items that would account for the differences, and no conceptual issues regarding the construct definitions were salient. Thus, there was no theoretical justification for removing the items. Rather than discarding them and changing the meaning of the constructs, therefore, it was determined that the items should be retained. Finally, evidence of discriminant validity is present when items correlate higher with their respective construct measures than with other construct measures and their composite values (Loch et al. 2003).

Structural modeling

Because the model comprised reflective and formative constructs, bootstrap sampling was used to test the proposed relationships among the constructs (Gefen et al. 2000; Cheung and Lau, 2008). The path coefficients and t-values obtained through this procedure are depicted in Figure 1. The results indicated that all paths were significant at the $p < 0.05$ level of confidence.

To ensure that affective organizational commitment mediates the relationship between each organizational culture type and innovative behavior, Baron and Kenny's (1986) steps for establishing mediation were followed. First, it was established that developmental appraisal, externally or equitable reward, and comprehensive training were correlated with innovative behavior, but selective staffing was not. Second, it was determined that each was related to affective organizational commitment. Third, affective organizational commitment was found to be positively related to innovative behavior. Finally, HRM practices were then entered into the model, but some paths were statistically insignificant while other path coefficients decreased. Thus, as shown in Table 1, there is sufficient empirical evidence that affective organizational commitment mediates the relationship between HRM practices and innovative behavior.

The model's explanatory power was assessed by observing the R^2 of the endogenous constructs (Chin 1998). As shown in Figure 1, the model accounts for 60.9% of the variance in organizational

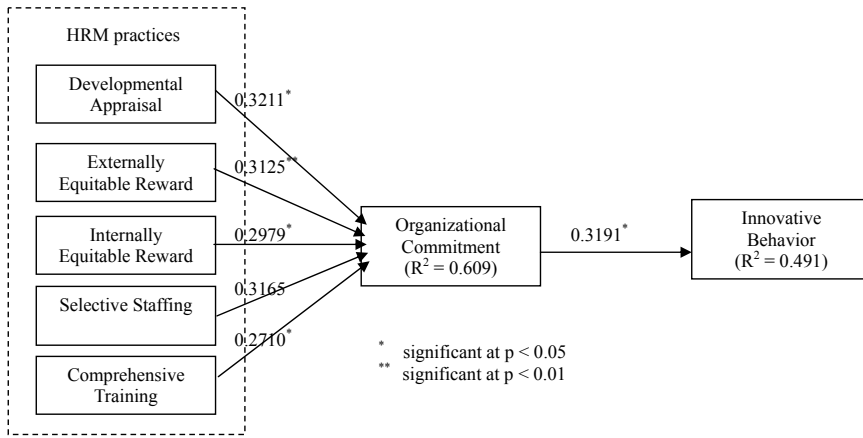


Figure 1. Social exchange model in HRM practices and Innovative behaviors of S/W developers (Results)

Table 1. Testing mediation effects of affective organizational commitment

HRM practices	Dependent variables: Innovative behavior	Dependent variables: Affective commitment	Dependent variables: Innovative behavior (Affective commitment included)
Developmental Appraisal	$\beta=0.3231, p<0.05$	$\beta=0.2825, p<0.05$	$\beta=0.2922, p=0.13$
Externally Equitable Reward	$\beta=0.1883, p<0.05$	$\beta=0.3223, p<0.05$	$\beta=0.1559, p=0.15$
Internally Equitable Reward	$\beta=0.2877, p<0.05$	$\beta=0.3220, p<0.05$	$\beta=0.2429, p=0.02$
Selective Staffing	$\beta= 0.2113, p=0.12$	$\beta=0.3223, p=0.12$	$\beta=0.1559, p=0.15$
Comprehensive Training	$\beta= 0.2797, p<0.05$	$\beta=0.3220, p<0.05$	$\beta=0.2529, p=0.02$

commitment and 49.1% of the variance in innovative behavior. All of the hypotheses are thus supported. Finally, several factors were introduced as controls on organizational commitment: gender, age, tenure, and job title. Of these, tenure was significant ($\beta=0.1881, p<0.05$).

DISCUSSION AND CONCLUSION

This study examined organizational HRM practices covered by social exchange theory and clearly identified which ones influence the innovative behaviors of software developers. Following the social exchange theory approach to HRM practice types and taking software developers' characteristics into account, we suggested that four types of HRM practice induce innovative behaviors in software developers. The results of this study found that developmental appraisal, externally or equitable reward, and comprehensive training increased developers' affective organizational commitment, which positively affected innovative behavior. However, selective staffing had no effect, though the research suggests that it has a significantly positive effect on organizational commitment (Wimalasiri 1995; Pare et al. 2000; Agarwal and Ferratt 1999). The sample of this study consisted of S/W developers, who are growth-oriented, challenging, and enjoy learning new skills (Boehm 1981; Chelsom et al. 2005; Couger and Zawacki 1980; Couger 1992; Couger and Adelsberger 1988; Couger and Ishikawa 1995; Couger and McIntyre 1987; Couger and Zawacki 1978). Our results indicate that they are not interested in acquiring high-quality jobs through selective staffing but do value appraisal systems, performance rewards, and training for growth. The results also show that S/W developers pursue individual growth rather than success in their organizations.

Our findings provide important research and practical implications. The performance-based human resource (HR) system, which many Korean companies claim to use, is thought to have originated from the so-called "best practices" notion employed by leading U.S. companies (Lee and Kim, 2006). Strategic human resource management applies three different theoretical frameworks: universalistic, contingency, and configurational (Delery and Doty 1996; Yu et al. 2001). Our findings reveal the context of Korean software engineering and provide a universalistic perspective by which top managers may motivate their S/W engineers using the HRM system. Although these findings enhance our understanding of the innovative behaviors of software developers, they also have limitations. First, although most of the relevant research has shown the direct effects of promotion and prevention goals on creativity, regulatory fit theory suggests that there are moderating conditions

between promotion/prevention goals and creativity (Pai et al.2010). Our findings do not consider those moderating conditions. Second, our study has generalizability issues. It is difficult to say whether our findings can be generalized to other regions of the world. Since there are few studies on the subject, the extent to which our findings can be generalized depends on their validation and replication in other settings and regions.

This study can be expanded in several ways. First, future researchers should investigate the moderating conditions in the relationship between HRM practices and the motivation for S/W engineers' innovative behaviors. Second, the results of this study could be generalized if replicated and validated in other regions and contexts. Future studies could utilize the same model in other developing countries. Third, future researchers should investigate more theoretical perspectives and core variables. For example, as technology in the software industry is changing at an unprecedented rate, software developers lack confidence in the face of new methodologies. Their self-efficacy on new methodologies, which is critically important, can be increased through the organizational learning of new technologies, methodologies, and processes, keeping software developers up-to-date with the latest practices. It would be worthwhile to investigate how organizational learning motivates software engineers. Finally, this study used a survey and cross-sectional sample to collect its data. Future scholars could conduct a longitudinal study to determine the causal relationships between organizational culture types and the motivation of software developers.

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Appendix A. Instrument Items

Variables	Instrument item
Selective staffing	How extensive is the employee selection process for a job in this unit (e.g. use of tests, interviews) ?
	How important is it to select the best person for a given job?
	In general, how long does it take to select someone for a position in this unit once the job becomes open?
	How many people are involved in the selection decision?
	How much money is generally spent in selecting people for a job?
	How many applicants are screened for each person hired for a job?
	How much importance is placed on the staffing process in this unit?
Comprehensive training	How extensive is the training process for members of your work unit?
	How much priority is placed on training employees in your unit?
	How formal or structured is the training process?
	What percentage of people have received training this past year?
	On average, how many hour of formal training does a typical member of your work unit receive per year?
	How many different kinds of training programs are available for members of your work unit to attend?
	How much money is spent on training individuals in your work unit?
	Do you feel training is viewed as a cost or as an investment?
Developmental performance appraisal	How much effort is given to measuring employee performance?
	How would you describe the performance standards in your unit?
	How much do employees participate in goal setting and appraisal?
	How often is performance discussed with employees?

Variables	Instrument item
	Do discussions focus on present performance or future performance?
	When performance is discussed, how much emphasis is placed on finding avenues of personal development for an employee?
	How closely are raises, promotions, etc., tied to performance appraisal?
	How would you describe the approach used to discuss performance?
	How many people provide input to the performance evaluation of each employee?
Equitable reward system	How would you rate pay levels in this unit relative to other firms?
	How would you rate the pay levels in this unit relative to past years?
	The wages in this work unit are not very competitive for this industry
	How much emphasis is placed on paying people in this work unit what they would be paid on similar jobs in other companies?
	How closely is pay tied to individual performance?
	How wide is the range in pay across members in this work unit?
	To what extent do differences in pay across members of this work unit represent differences in their contribution?
Affective commitment to organization	I am willing to put in a great deal of effort beyond that normally expected in order to help this organization be successful
	I talk up this organization to my friends as a great organization to work for
	I feel very little loyalty to this organization (R)
	I would accept almost any type of job assignment in order to keep working for this organization
	I find that my values and the organization's values are very similar

Variables	Instrument item
	I am proud to tell others that I am part of this organization
	I could just as well be working for a different organization as long as the type of work was similar (R)
	This organization really inspires the very best in me in the way of job performance
	It would take very little change in my present circumstances to cause me to leave this organization (R)
	I am extremely glad that I chose this organization to work for over others I was considering at the time I joined
	There's not too much to be gained by sticking with this organization indefinitely (R)
	Often, I find it difficult to agree with this organization's policies on important matters relating to its employees (R)
	I really care about the fate of this organization
	For me this is the best of all possible organizations for which to work
	Deciding to work for this organization was a definite mistake on my part (R)
Behavioral intent to follow security policies	I create new ideas for difficult issues
	I search out new working methods, techniques, or instruments
	I generate original solutions for problems
	I mobilize support for innovative ideas and solutions
	I encourage important organizational members to be enthusiastic about innovative ideas and solutions
	I transform innovative ideas into useful applications
Gender	Please indicate your gender
Age	What is your age?
Tenure	How long have you worked at your current organization?
Job title	What is your job title?

