European Journal of Management and Business Economics

Influence of HRM practices on innovation in software engineering: the mediating role of developer experience

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Received 15 May 2022
Revised 31 January 2023
15 May 2024
2 June 2024
2 July 2024
25 August 2024
Accepted 7 September 2024

Abstract

Purpose – This study examines the influence of developer experience between human resource management (HRM) practices and innovation in software (S/W) engineering. This study uses motivation theory and investigates how HRM practices influence the innovative behaviors of S/W developers by using a mediator of affective developer experience.

Design/methodology/approach – For this, this study used a survey of S/W developers working in Korea. Out of 431 responses collected from 35 companies, 352 responses from 34 companies were usable for analysis and takes structural equation modeling.

Findings – The results show that developmental appraisal, externally or internally equitable reward and comprehensive training increase their affective developer experience affecting innovative behaviors positively in turn. However, selective staffing has no effect.

Originality/value – The results show that S/W developers pursue individual growth rather than success in their organizations. The findings show the context of S/W engineering in Korea and provide universalistic perspective when top managers motivate their S/W engineers by HRM system.

Keywords Human resource management practices, Developmental appraisal, Externally or internally equitable reward, Comprehensive training, Selective staffing, Developer experience, Innovative behaviors, Software engineering

Paper type Research paper

1. Introduction

Software engineering (SE) is a professional human activity that demands numerous skills and qualities from developers. While the attributes of developers and development tasks have been extensively studied, there has been limited investigation into developers as users of development tools. As users of integrated development environments (IDEs), developers should be considered in the context of user experience (UX) definitions, applicable to all users (Nylund, 2020; Hassenzahl and Tractinsky, 2006). However, the dual role of developers as both system users and system creators sets them apart uniquely. To address the specificity of SE, the concept of Developer Experience (DX) has been proposed (Fagerholm and Münch, 2012; Henriques *et al.*, 2018; AlOmar *et al.*, 2021; Anders, 2020; Powell and Bodur, 2019; Morales *et al.*, 2019). DX encompasses cognitive, emotional, and intentional aspects, understanding which can help practitioners enhance development environments concerning developers' needs, perceptions, and feelings (Fagerholm and Münch, 2012).

European Journal of Management and Business Economics
Emerald Publishing Limited
e-ISSN: 2444-8494
p-ISSN: 2444-8451
DOI 10.1108/EJMBE-05-2022-0141

The research gap identified in this study is the limited investigation into developers as users of development tools within the field of Software Engineering (SE). Developers have a dual role as both users and creators of systems, which makes it challenging to evaluate them solely based on User Experience (UX). To address this uniqueness, the concept of Developer Experience (DX) has been proposed, but research on the impact of DX from the perspective of Human Resource Management (HRM) on software developers' innovative behaviors is still scarce. Therefore, this study aims to explore the relationship between HRM practices and the innovative behaviors of software developers through the lens of DX, providing new insights and practical contributions to HRM in the Korean software engineering field.

The structure of this paper is as follows: Chapter 2 describes the theoretical framework and presents the research model, including motivation theories and the theoretical background for how HRM practices influence software developers' behaviors using DX as a mediator. Chapter 3 details the research methodology. Chapter 4 reports the analysis results of the hypotheses. Chapter 5 discusses the key findings, presents several limitations of the study, and offers suggestions for future research.

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2. Theoretical framework and research model

DX is a concept that has emerged from the notion of user experience, but it differs from user experience in that it considers developers instead of users (Nylund, 2020). However, developers can be seen as users of software development tools. DX refers to the experience involving the interaction between development tools and developers in the software development process (AlOmar *et al.*, 2024; Fontão *et al.*, 2015; Henriques *et al.*, 2018; Alomar *et al.*, 2021; Anders, 2020; Powell and Bodur, 2019; Morales *et al.*, 2019). A complete understanding of DX can facilitate an understanding of the expectations, perceptions, and feelings of developers who participate in development tools. Furthermore, DX has a dualistic nature to UX-based DX, in which the developer is both a system tool user and a system producer who predicts the UX (Kuusinen, 2015). Understanding the relationship between the developer and the platform that a developer uses is essential because we can thereby predict whether the platform can satisfy developers and ensure usability and functionality (Fontão *et al.*, 2015; Parviainen *et al.*, 2015).

Individual innovation has been operationalized in various ways. For example, the construct has been thought of as a personality characteristic (Lua *et al.*, 2024; Hurt *et al.*, 1977). Others have taken a behavioral perspective (Schnellenbach, 2024; Janssen, 2000). According to Midgley and Dowling (1978), individual innovativeness refers to the individual's openness to new ideas and decision-making to adopt an innovation, free from the influence of the experiences of other employees. This definition is referred to throughout this study because it intuitively gives a more accurate interpretation of innovativeness, which is well supported in the literature, both directly and indirectly. Individually, innovation begins with the activity with employees who come up with novel ideas, and the ideas often result from solving incongruities and discontinuities encountered at work (Kanter, 1968; Scott and Bruce, 1994; Kleysen and Street, 2001; Sirega *et al.*, 2019).

Surprisingly, although software engineering requires a lot of innovation, few studies investigate the relationship between DX and the innovative behaviors of software engineers. Fagerholm and Münch (2013) describe developer experience as a concept that captures how

developers think and feel about their activities within their working environments, assuming that an improvement of the developer experience positively impacts software development project outcomes. They assume that several factors influence DX, which affects the outcomes of software development projects. The word "developer" refers here to anyone engaged in the activity of developing software, and "experience" refers here to involvement, not to being experienced, although the two are interlinked. The theoretical framework by Fagerholm (2015) is a presentation of the activities of developers in an individual and social environment, and how the experiences arise. The framework includes aspects such as experience objects, formations, influencers, content, progression, behavior outcome, and object outcome. These different aspects can be used to study DX from a wide variety of different viewpoints. Fagerholm and Münch (2013) takes an approach from psychology, and divide DX into three different sub-areas or categories – cognitive (How developers perceive the development infrastructure), affective (How developers feel about their work), and conative (How developers see the value of their contribution). Among them, affective DX consists of factors that influence how developers feel about their work. Respect and belonging are social factors that work to create a feeling of security. Attachment to persons, teams, or even work habits also belongs to this dimension. Positive feelings in general can be an important factor in good DX. Therefore, affective DX has been most strongly linked to positive work-related behaviors like innovative behavior. Organizations interested in increasing affective DX, seen as the one of most desirable forms of DX, might consider it seriously now simply because it can significantly influence software developers' innovative behaviors, which is one of the positive work-related behaviors their organizations desire. Therefore, in a software engineering context, affective DX to their organization is likely to play a role in their innovative behaviors. Thus, this study makes the following hypothesis.

H1. The affective developer experience of software developers is positively associated with their innovative behavior.

Existing studies argue that the human capital characteristics of the target should be strategically considered in HRM. Snell and Dean (1992) examined the relationship between integrated manufacturing, defined as the use of advanced manufacturing technology (AMT), just-in-time inventory control (JIT), total quality management (TQ), and human resource management from a human capital perspective. AMT was positively related to selective staffing, comprehensive training, developmental appraisal, and externally equitable rewards for operations employees and to selective staffing for quality employees. TQ was positively related to these same human resource practices in qualify and was also related to the comprehensiveness of training for operations employees. JIT was negatively related to selective staffing in operations and to performance appraisal in quality and positively related to staffing in quality. The two- and three-way interactions had negative effects.

Recognizing that not all employees possess knowledge and skills that are of equal strategic importance, Lepak and Snell (1999) draw on the resource-based view of the firm (Wernerfelt, 1984). Human capital theory (Stobe, 1990), and transaction cost economics (Williamson, 1989) to develop a human resource architecture of four different employment modes: internal development, acquisition, contracting, and alliance. They use this architecture to derive research questions for studying the relationships among employment modes, employment relationships. Human resource configurations, and criteria for competitive advantage.

Lopez-Cabrales *et al.* (2009) tested how human resources management (HRM) practices and employees' knowledge influence the development of innovative capabilities and, by extension, a firm's performance. The results of their study confirm that HRM practices are not directly associated with innovation unless they take into account employees' knowledge.

Developer motivation is another important factor in SE. Most studies on motivation in SE report that developers are distinct from other occupational groups concerning motivation (Beecham *et al.*, 2008). "The work itself" is the most commonly cited motivator. Still, there is a lack of detail regarding what aspects of the work are motivating, how motivational processes occur, and the outcomes of motivating developers (Beecham *et al.*, 2008). Investigations also show the importance of considering the affective aspects of SE. Over time, the presence and variation of developers' emotions have been documented (Shaw, 2008). Programming is influenced by mood (Khan, 2011), and happiness has been found to have productivity benefits (Graziotin *et al.*, 2014). This underlines the importance of considering affective aspects both for well-being and outcomes.

What are the prominent HRM practices in the software industry? That is the key question in this process. There have been some attempts to identify the salient practices in 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 known as the People Capability Maturity Model (P-CMM) (Curtis *et al.*, 1995). However, it isn't easy to generalize HRM practices, for organizational behavior can vary greatly from one industry to another. And relevant researches also show no consistent results (Agarwal and Ferratt, 1999). The diversity of results in the various studies invites researchers to probe for and identify the key HRM practices in the software industry to find the key practices for enhancing affective DX.

Therefore, to probe for the key HRM practice in the software engineering context, this study identifies the characteristics of software developers. The characteristics cited most often in the relevant studies are growth-oriented (Boehm, 1981; Chelsom *et al.*, 2005; Couger and Zawacki, 1978, 1980; Couger, 1992; Couger and Adelsberger, 1988; Couger and Ishikawa, 1995; Couger and McIntyre, 1987). They depict that growth-oriented software developers are challenged, learning new skills, etc. The need for growth may be due to the engineer's internal makeup, and they need to be marketable and keep up with the fast-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 presents the following HRM practices to motivate software developers into DX for the characteristics of software developers.

Developmental appraisal systems can contribute to the DX of software. When the appraisal system is focused on employee development, it nurtures a sense of attachment and belonging. The appraisal system that incorporates an informal approach and a genuine interest in the development of the employee would give the employee a chance to grow and might prompt them to contribute more to the company's goals. Therefore, developmental appraisal will be positively associated with affective DX.

Reward systems include rewards and incentives such as scope for increased pay and benefits linked to performance, which are motivators in the software development context (Chelsom *et al.*, 2005). Previous research studies found a significant relationship between compensation and employees' attitudes (Angle and Perry, 1983; Mottaz, 1988; Jaiswal, 1982; Mobley, 1982). Mottaz (1988) found compensation and rewards to be the main factor in employees' attitudes. Salary might be a major criterion in organization choice, but once they are members of an organization, software developers look for vertical and horizontal growth. It has also been observed that there has not been a significant difference in salaries across companies. And profit sharing leads to better cooperation, better communication, and better 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). Therefore, equitable rewards such as salary and promotional opportunities can positively influence affective DX.

Selecting a staffing process means recognition for a high quality, good job done based on objective criteria which can motivate software developers. Wimalasiri (1995) found some connection between selection and employees' attitudes. Paré *et al.* (2001) found that HRM practices such as recognition, empowerment, and competence development had a significant positive effect on IT professionals' attitudes. For most IT professionals, a significant part of their motivation comes from their affection for managers for doing an outstanding job. Therefore, selective staffing will be associated with affective DX positively.

Comprehensive training includes all training opportunities to widen skills and specialization, which are key motivators for software developers (Couger and Zawacki, 1980). Many previous studies found a significant impact on comprehensive training (Kalleberg and Moody, 1994). Those working in software development need continuous learning because of the rapid changes in technology. A comprehensive and customized training program gives a sense of confidence to the developers to venture into new projects and prove their mettle. Therefore, when learning opportunities are available, it creates a sense of attachment to the company and enhances affective DX. Thus, this study makes the following hypothesis.

H2. Human resource management practices are significantly associated with affective developer experience.

H2-1. Developmental appraisal is positively associated with affective developer experience.

H2-2. Equitable reward is positively associated with affective developer experience.

H2-3. Selective staffing is positively associated with affective developer experience.

H2-4. Comprehensive training is positively associated with affective developer experience.

To our knowledge, the mediating role of affective DX in the relationship between HRM and innovative behavior has not been tested. However, several lines of reasoning point towards this pattern of relationship. First, consistent with the social exchange theory, when employees perceive a contract breach, emotional attachment to the organization and employee performance are severely affected. Second, previous empirical research has demonstrated the role of affective commitment as a mediating variable between other antecedent variables and employee performance (Conway and Briner, 2002; Cropanzano *et al.*, 2003). Affective commitment has been found to mediate the relationship between psychological ownership and OCBs (Vandewalle *et al.*, 1995), between perceived organizational support and OCBs (Bishop *et al.*, 2000), between emotional exhaustion and indicators of performance (i.e. OCBs and job performance, Cropanzano *et al.*, 2003), between leadership behavior and job performance (Yousef, 2000), and between work status and OCBs (Conway and Briner, 2002). Third, the mediating role of affective commitment can be explained by Fishbein and Ajzen's (1975) attitude-behavior theory which proposes that work attitudes originate from individuals' beliefs about the various aspects of the environment. These attitudes, in turn, form the basis of intentions and behaviors. In the context of this study, affective DX can be considered an attitudinal response that results from employment experiences and beliefs about the work environment (Rousseau, 1995). A belief that the psychological contract has been kept should positively affect the attitude of developers. Elevated affective DX should then translate into behavior that inhibits employees' contributions to their organization. A high level of affective DX may keep employees from displaying civic virtue behaviors or performing their work responsibilities innovatively. Based on these empirical and theoretical considerations, this study proposes that HRM could increase affective DX. This, in turn, will result in more willingness on the part of the

employees to engage in innovative behaviors. Hence, this study proposes that affective DX should fully mediate the association between HRM practices and their innovative behaviors.

H3. Affective developer experience mediates the relationship between human resource management practices and innovative behaviors.

H3-1. Affective developer experience mediates the relationship between developmental appraisal and innovative behaviors.

H3-2. Affective developer experience mediates the relationship between equitable reward and innovative behaviors.

H3-3. Affective developer experience mediates the relationship between selective staffing and innovative behaviors.

H3-4. Affective developer experience mediates the relationship between comprehensive training and innovative behaviors.

Figure 1 shows the research model.

3. Methodology

3.1 Sample

The study's objective was to identify the types of HRM practices in software companies through empirical analysis. To achieve this, the perceptions of organization members regarding HRM practices were measured. A questionnaire survey was chosen for its efficiency in collecting data from a large number of individuals quickly and cost-effectively. The survey targeted software developers working in Korea, as they are directly involved in the software development process and can provide relevant insights into HRM practices. The reason this study surveyed in Korea is because Korea is one of the countries with developed IT, and as a result, many software developers work there and are required to take innovative actions. Out of 431 responses from 35 companies, 352 responses from 34 companies were useable for analysis. The sample included a diverse group of developers from various company sizes and demographics, ensuring a comprehensive understanding of HRM practices in the software industry.

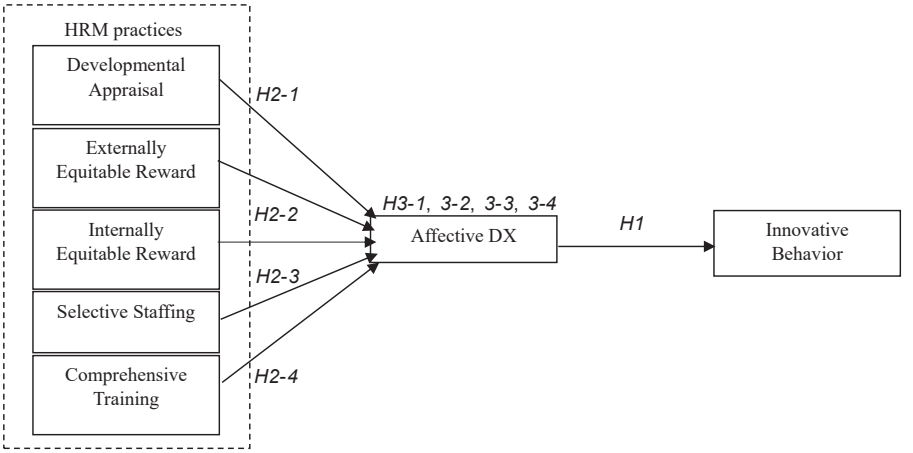

Figure 1.
Research model

Source(s): Figure by author

In Table 1, among the participants, 264 (75.0%) were men and 88 (25.0%) women. Regarding age, 101 people (28.7%) were in their 20s, 95 people (26.9%) were in their 30s, 87 people (24.7%) were in their 40s, and 69 people (19.6%) were in their 50s. Regarding work experience, 105 people (29.8%) had less than 5 years, 91 people (25.8%) had less than 10 years, 77 people (21.8%) had less than 15 years, and 79 people (22.4%) had more than 15 years. Regarding the level of education, 285 people (80.9%) graduated from college, and 67 people (19.1%) graduated from college. All companies where respondents work are located in Seoul, Korea. The percentages of software professionals responding broke down as follows: from the large-scale group, 156 (44.3%), from the small and medium-size enterprises, 91 (25.8%), and multinational companies, 105 (29.8%).

Before measuring validation and model testing, the responses were analyzed to identify the response set (Rennie, 1982). A response set is the tendency among subjects to respond to questions in a particular way independently of the content of the items (Kerlinger, 1973). No cases of response set were detected. Additionally, 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 also conducted (Podsakoff and Organ, 1986). This procedure stipulates 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, there were no significant changes in explained variance. Thus, it appears that common methods bias is not problematic.

3.2 Measurement

To select model criteria, this study extracted variables based on core theories through literature research and built a model. During this process, I listened to the opinions of software developers to hear opinions from the field. The present study involves the measurement of seven latent constructs, including developmental appraisal, externally equitable reward systems, internally equitable reward systems, selective staffing, comprehensive training, affective DX, and innovative behavior. These constructs were measured through scales borrowed from literature as follows. Appendix presents the survey questions for each variable.

HRM practices: Its survey contained scales developed by Snell and Dean (1992) to measure high commitment human resource practices: developmental appraisal measures whether performance appraisal is used for developing employees; externally equitable reward systems measure the extent to which the organization's pay levels were competitive

Category	Characteristics
Gender	Men: 264 (75.0%), Women: 88 (25.0%)
Age	20s:101(28.7%), 30s: 95(26.9%), 40s: 87(24.7%), 50s: 69(19.6%)
Work experience	0~5 years: 105 (29.8%), 5~10 years: 91(25.8%), 10~15 years: 77(21.8%), more than 15 years: 79 (22.4%)
Educational level	College: 285 (80.9%), Graduate school: 67 (19.1%)
Firm	Large-scale group: 156 (44.3%), Small and medium-size enterprises: 91 (25.8%), multinational companies: 105 (29.8%)

Source(s): Table by author

Table 1. The characteristics of the statistical population

with similar organizations; and internally equitable reward systems measured the extent to which the organization's pay structure was equitably construed: selective staffing measures the extensiveness of the firm's selection process; comprehensive training measures the extensiveness of the firm's training and development process;

Affective DX: Lee and Pan (2021) measured cognitive, emotional, and behavioral factors for the measurement of DX. In particular, affective DX includes the developer's feelings or emotions, such as positive emotion or pleasure.

Innovative behavior: Individual innovation has been operationalized in various ways. For example, the construct has been thought of 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 the individual's openness to new ideas and decision-making to adopt an innovation, free from the influence of the experiences of other employees. This definition is referred to throughout this study because it intuitively gives a more accurate interpretation of innovativeness, which is well supported in the literature, both directly and indirectly. This study used a modified version of Scott and Bruce's (1994) measure of innovative behavior to examine the innovativeness of nursing employees. More specifically, the questions (items) were rephrased to provide a better fit for examining nursing employees. Scales ranged from 1 to 5 but the anchors varied depending on the question. An additional eight questions were included for collecting demographic information such as gender, age, tenure, and job title.

4. Results

Gefen *et al.* (2000) suggested that the validity and reliability of the measures were assessed before hypothesis testing. Because the model included formative constructs, a component-based approach to structural equation modeling was taken; the calculations were performed using the Smart PLS 3.0 software package.

4.1 Analysis of reflective measures

Tests were conducted to evaluate the convergent and discriminant validity and the reliability of reflective measures. To begin, factor loadings were used to establish convergent validity. Loadings over 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. Test results indicate that both of these conditions have been met.

Discriminant validity is demonstrated when the square root of the AVE is greater than the correlations between constructs (Bollen, 1986). The square-rooted AVEs for affective DX and innovative behavior are 0.7521 and 0.7412 respectively. Their inter-construct correlation is 0.2123. For a second test of discriminant validity, individual items may be assumed to possess sufficient discriminant validity if they load higher on their respective construct than on any other latent variable (Gefen *et al.*, 2000; Straub *et al.*, 2004). This was true for all items. Based on both tests, the measures possess sufficient discriminant validity. Reliability is established by examining the internal consistency measure for each construct. Constructs that exceed the 0.70 level are judged to possess sufficient reliability (Fornell *et al.*, 1982).

4.2 Analysis of formative measures

The tests of validity and reliability were conducted on the formative constructs: developmental appraisal, externally equitable reward systems, internally equitable reward systems, selective staffing, and comprehensive training. 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.

Convergent validity is assessed via examination of item construct correlations (Chin, 1995). If items load significantly on their corresponding constructs, convergent validity is demonstrated. The results indicate that item weights are significant at a 0.05 level of significance, except for 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 holding other predictors 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, it is necessary to consider both perspectives, 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. Despite this, it may still have 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) should also be considered.

Because five items in this study have a low relative contribution, it is necessary to consider their unique relations with their associated constructs. The absolute contributions for five items are significant. Their values are 0.732, 0.713, 0.722, 0.711, and 0.714, respectively. Thus, although the contributions of the indicators are relatively low compared to other indicators, they have a strong, bivariate relation to their respective constructs (Nunnally and Burnstein, 1984). Furthermore, there did not appear to be any patterns in wording, polarity, or content 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, and rather than discarding the items and changing the meaning of the constructs, it was determined that the items should be retained. Finally, evidence of discriminant validity is presented when items correlate higher with their respective construct measures than with other construct measures and their composite values.

4.3 Structural modeling

Because the model was comprised of reflective and formative constructs, bootstrap sampling was used to test the proposed relationships among the constructs (Gefen *et al.*, 2000; Cheung and Lau, 2008). Path coefficients and *t*-values were obtained through this procedure, and are depicted in Figure 2. The results indicate that all paths are significant at the $p < 0.05$ level of confidence.

To ensure that affective DX mediates the relationship between each organizational culture type and innovative behavior, Baron and Kenny's (1985) steps for establishing mediation were followed. First, it was established that developmental appraisal, external or equitable reward, and comprehensive training are correlated with innovative behavior, but selective staffing is not. Second, it was determined that each is related to affective DX. Therefore, H2-1, H2-2, and H2-4 were supported, but H2-3 was not supported. Third, affective DX was found to be positively related to innovative behavior. Therefore, H1 was supported. Finally, HRM practices were then entered into the model, but some paths were statistically insignificant or other path coefficients decreased, which is partial mediation. This means that the impact of HRM practices on innovative behavior is partly through affective DX. Thus, as shown in Table 2, there is sufficient empirical support to conclude that affective DX mediates

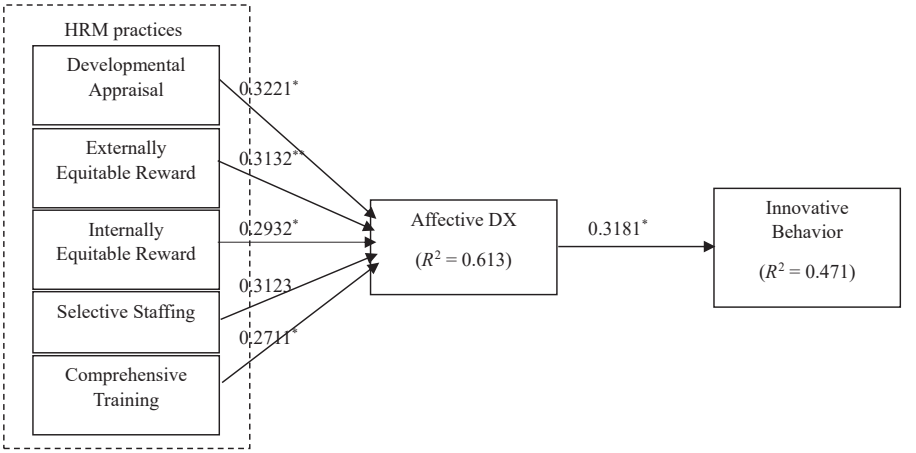

Figure 2.
Structural equation modeling results

Note(s): *significant at $p < 0.05$
**significant at $p < 0.01$

Source(s): Figure by author

HRM practices	Dependent variables: innovative behavior	Dependent variables: affective DX	Dependent variables: innovative behavior (mediating variable: affective DX included)
Developmental appraisal	$\beta = 0.3222, p < 0.05$	$\beta = 0.2815, p < 0.05$	$\beta = 0.2924, p = 0.13$
Externally equitable reward	$\beta = 0.1843, p < 0.05$	$\beta = 0.3213, p < 0.05$	$\beta = 0.1569, p = 0.15$
Internally equitable reward	$\beta = 0.2817, p < 0.05$	$\beta = 0.3224, p < 0.05$	$\beta = 0.2419, p = 0.02$
Selective staffing	$\beta = 0.2123, p = 0.12$	$\beta = 0.3226, p = 0.12$	$\beta = 0.1553, p = 0.15$
Comprehensive training	$\beta = 0.2777, p < 0.05$	$\beta = 0.3210, p < 0.05$	$\beta = 0.2526, p = 0.02$

Table 2.
Testing mediation effects of affective DX

Source(s): Table by author

partially the relationship between HRM practices and innovative behavior. Therefore, H3-1, H3-2, and H3-4 were supported, but H3-3 was not supported. The model's explanatory power was considered by observing the R^2 of endogenous constructs. As shown in Figure 2, the model accounts for 60.9% of the variance in DX and 49.1% of the variance in innovative behavior. All of the hypotheses are supported. Finally, several factors were introduced as controls on DX. They include gender, age, work experience, and educational level. It was found that work experience was significant ($\beta = 0.1881$, $p < 0.05$).

5. Conclusion

5.1 Discussion

DX, derived from user experience, focuses on developers rather than users, involving the interaction between development tools and developers in the software development process. (Nylund, 2020; AlOmar *et al.*, 2024). In the behavioral perspective of individual innovation,

the present study aimed to examine the linkage between HRM practices and innovative behavior in the software development process by focusing on this affective DX. This study illuminates HRM practices and identifies how HRM practices influence the motivation of software developers. Agreeing with the HRM practices and considering the characteristics of software developers, the author proposes HRM practices that increase their affective DX, positively affecting their innovative behaviors. The findings suggest three main conclusions. First, software developers' affective DX increases their innovative behaviors. Second, developmental appraisal, externally or internally equitable reward, and comprehensive training among all sub-factors of HRM practices increase software developers' affective DX. Finally, developmental appraisal, externally or internally equitable reward, and comprehensive training among all sub-factors of HRM practices increase software developers' innovative behaviors through their affective DX.

The results of this study supported that developmental appraisal, externally or internally equitable reward, and comprehensive training increase their affective DX, positively affecting innovative behavior. However, selective staffing has no effect. Selecting the staffing process means recognizing a high-quality, good job done based on objective criteria. Relevant researches suggest that it has a significant positive effect on organizational attitude (Wimalasiri, 1995; Paré *et al.*, 2001; Agarwal and Ferratt, 1999). The sample of this study is S/W developers who are growth-oriented, challenging, and learning new skills (Boehm, 1981; Chelsom *et al.*, 2005; Couger and Zawacki, 1978, 1980; Couger, 1992; Couger and Adelsberger, 1988; Couger and Ishikawa, 1995; Couger and McIntyre, 1987). As a result, they are not interested in acquiring high-quality, good jobs through selective staffing but give considerable thought to appraisal systems and rewards for their performance and want training for their growth. The results show that S/W developers pursue individual growth rather than success in their organizations.

5.2 Research contributions and practical implications

This study offers important insights and practical contributions to HRM, particularly in Korean software engineering. Korean companies' performance-based HR systems are influenced by U.S. "best practices" (Lee and Kim, 2006). In strategic HRM, three theoretical frameworks exist: universalistic, contingency, and configurational perspectives (Delery and Doty, 1996; Yu *et al.*, 2001). The research highlights how effective HRM practices, particularly the universalistic perspective, can motivate software engineers and enhance performance by aligning HRM with Korean companies' unique needs and cultures.

To extend these findings to other countries with low innovation orientation, numerous SMEs, or limited public support programs for innovation, several conditions must be considered. Firstly, assess if Korea's corporate culture and HRM practices apply elsewhere, as some countries emphasize individual growth over collective success. Secondly, countries with low innovation orientation might lack the capacity to invest in HRM, making it hard to provide fair compensation and comprehensive training. Thirdly, SMEs, having fewer resources than large enterprises, may struggle to enhance developers' affective experiences through HRM practices, requiring tailored strategies for SMEs. Fourthly, SMEs' flexible structures can promote innovation with customized HRM practices. Fifthly, in countries lacking public support programs for innovation, governments can support HRM practices through subsidies or tax breaks. Sixthly, industry associations can foster cooperation and resource sharing where public support is limited. Lastly, research indicates developers value personal growth over organizational success, which HRM practices should reflect. Additionally, a fair compensation system, aligned with each country's economic situation, is crucial to motivate developers and maintain fairness. Adapting these conditions locally can extend the study's results to other countries.

Although the findings of this study contribute to a better understanding of software developers' innovative behaviors, there are some limitations. First, although most relevant research has shown the direct effect of promotion and prevention goals on creativity, regulatory fit theory suggests moderating conditions for the promotion/prevention goal–creativity relationship. The findings don't consider the moderating conditions. Second, this study has a generalizability issue. It is difficult to say whether our findings can be generalized to other world regions. Since there are few studies on the subject, the extent to which the findings of this study can be generalized depends on its validation and replication in other settings and regions.

5.3 Future research directions

Future studies should explore several avenues for expanding this research. First, researchers should investigate moderating conditions affecting the relationship between HRM practices and the motivation of innovative behaviors in software engineers. Second, generalizing this study's results through replication in other regions and contexts, particularly in developing countries, is recommended. Third, more theoretical perspectives and core variables need examination. As the software industry's technology rapidly evolves, developers often lack confidence in new methodologies, making their self-efficacy crucial. Organizational learning can enhance this by keeping developers up-to-date with the latest practices. Investigating how organizational learning motivates software engineers is a valuable research question. Fourth, this study used a survey methodology and a cross-sectional sample for data collection. Future research should consider longitudinal studies to determine causal relationships between organizational culture types and software developers' motivation. Finally, this study focused on affective factors inducing innovative behavior, specifically examining DX as an affective antecedent. However, DX has three sub-factors, necessitating further investigation into their impact on innovative behavior. Comparative studies on these sub-factors' influence on innovation behavior are also necessary. By addressing these areas, future research can build on this study's findings and offer deeper insights into HRM and innovation in the software industry.

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Appendix

Variables		Instrument item	References
HRM practice	Selective staffing	How extensive is the employee selection process for a job in this unit? (e.g. use of tests, interviews, etc.)	Snell and Dean (1992)
		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 hours 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?	
		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 in 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?	
		To what extent are people paid what they are worth compared to others in the work unit?	
Developer experience		Developers are intrigued when they use the platform	Lee and Pan (2021)
		The platform is attractive	
		Developers get a positive feeling from the platform	
		Developers feel value from the platform	
Innovative behavior		You search out new technologies, processes, techniques, and/or product ideas	Scott and Bruce's (1994)
		You generate creative ideas	
		You promote and champion ideas to others	
		You investigate and secure funds needed to implement new ideas	
		You develop adequate plans and schedules for the implementation of new ideas	
		You are innovative	
Gender		Please indicate your gender	
Age		What is your age?	
Work experience		How long have you worked at your current organization?	
Educational level		What is your job title?	

Source(s): Table by author

Table A1. Instrument item