

# The Moderating Effect of HRM on the Relationship between Environmental Uncertainty and Technological Innovation of SMEs

Jae-Hyeok Choi

International Business Management Program, BINUS

Business School, Bina Nusantara University, Jakarta, Indonesia

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## ABSTRACT

In the global economy, competition between companies is gradually intensifying, and companies' unique strategic competitive advantage is gradually weakening due to changes in the internal and external environment. Different from the past, the environmental impact on corporate organizations has increased tremendously, and companies can only survive if they adapt to environmental changes. Accordingly, technological innovation has been more emphasized to revitalize companies and the economy. Therefore, this study aims to empirically analyze the relationship between environmental uncertainty and technological innovation and the moderating effect of human resource management (HRM) on this relationship. 174 samples were collected from SMEs in Daegu and Gyeongsangbuk-do province, South Korea, and the results of this study confirm that environmental uncertainty positively affects technological innovation. Also, HRM has a positive moderating effect on the relationship between environmental uncertainty and technological innovation. Through this, it contributes to theoretical and practical implications by presenting a new direction to scholars and highlighting the importance of HRM to practitioners.

Keywords: Environmental Uncertainty, HRM, Technological Innovation, SMEs.

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## 1. INTRODUCTION

In the 21st century's global economy, tangible and intangible barriers between countries have been broken down, and competition between companies is gradually intensifying. Due to changes in the internal and external environment of companies according to the global economy, companies' unique strategic competitive advantage is gradually weakening. Unlike in the past, the environmental impact on corporate organizations has grown tremendously, and companies cannot survive if they do not properly adapt to environmental changes.

To respond to this trend, companies should focus on developing new technologies and products and launch new products and services that meet global standards (Barkema *et al.*, 2002; Qazi, 2023). Accordingly, technological innovation has been more emphasized to revitalize companies and economies. This is because organizations that reject corporate innovation and creative change find it difficult to survive long term (Hipp & Binz, 2020; O'Regan *et al.*, 2006). Therefore, innovation is a way to determine a company's profitability and growth potential and achieve a sustained competitive advantage (Mendoza-Silva, 2021).

Technological innovation is motivated by environmental uncertainties such as customer needs, product technology changes, and the emergence of new competitors. The reason is that the necessity of technological innovation is often not recognized in a stable and simple environment. The sense of crisis felt in such an uncertain environment becomes a situational factor that makes companies recognize the value and importance of technological innovation. Therefore, companies become more receptive to innovation when the environment changes in complex and diverse ways (Kafetzopoulos *et al.*, 2020). Management uncertainty is one of the most significant factors influencing strategic decision-making in a company's technological innovation process (Stoyan & Gregory, 2021).

Generally, it is not easy for most companies to produce or reliably procure all resources independently, and they always constantly interact with the environmental factors involved. In this situation, the environment is recognized as the most important factor in research related to corporate strategies, such as technological innovation, because the goal of survival and growth must be pursued simultaneously. However, previous studies have only analyzed the effect on the relationship between environmental uncertainty and technological innovation, and few studies introduce and analyze moderating factors in the relationship between them.

US companies have long attempted to innovate through strategic HRM, and in the case of Korea, large companies have already strategically established and implemented HRM systems. So-called top companies such as 3M and Hewlett-Packard, famous for technological innovation, and IBM, which pursues quality management, are implementing excellent HRM to faithfully support the achievement of vision or strategy (Lee, 2005). This means that human resource management that can develop and utilize human resources more effectively is important for technological innovation.

In an uncertain environment, the importance of HRM is more emphasized as a means of successfully achieving technological innovation for SMEs. Nevertheless, few studies have dealt with human resource management in innovation studies (Jimenez-Jimenez & Sanz-Valle, 2005). Therefore, it is necessary to analyze the impact of environmental uncertainty on technological innovation according to human resource management.

In responding to an uncertain environment, SMEs and corporate activities such as HRM greatly influence technological innovation. Therefore, it is necessary to consider HRM, which affects the technological innovation of SMEs in an uncertain environment.

From this point of view, this study aims to examine how environmental uncertainty affects technological innovation for Korean small and medium-sized enterprises and to investigate whether the relationship between them varies depending on the use of HRM.

The purpose of this study is as follows:

First, this study empirically identifies the relationship between environmental uncertainty and technological innovation of SMEs.

Second, this study examines the moderating role of human resource management in the relationship between environmental uncertainty and technological innovation of SMEs. In other words, it empirically investigates whether the relationship between them varies depending on the human resource management level.

## **2. RESEARCH MODEL AND HYPOTHESES**

### **2.1 Research Model**

This study aims to investigate the relationship between environmental uncertainty and technological innovation targeting SMEs. According to existing studies, the fundamental reason for the limited technological innovation of companies is not

grasping the demands of the external environment (Kafetzopoulos *et al.*, 2020; Shao *et al.*, 2020). Accordingly, companies recognize the importance and necessity of technological innovation required for survival and development in an externally uncertain environment and achieve technological innovation through active activities to obtain information and resources required for technological innovation (Soyan & Gregory, 2021).

One of the essential factors in securing an organization's competitiveness is human resources, and the organization seeks to achieve a continuous competitive advantage through strategic and efficient management of human resources (Barney, 1991). In addition, in terms of human resource management determining the abilities and attitudes of members of the organization, human resource management becomes a decisive factor in organizational innovation (Easa & Orra, 2021). The Action Approach (Jackson & Schuler, 1995) and the Knowledge Management Approach (Darroch & McNaughton, 2002) emphasize the importance of human resources in organizational innovation. Therefore, companies recognize the importance of securing effective talent and managing and developing their capabilities (Sardi *et al.*, 2021), and it is necessary to adapt to an uncertain environment and actively manage and utilize human resources with active movement for a company's successful technological innovation.

From the above perspectives, this study aims to examine the interaction effect with environmental uncertainty by introducing human resource management, which can be seen as a determinant of technological innovation, as an organizational situation factor. In other words, unlike existing research on technological innovation that focuses on the independent effect of human resource management, it aims to investigate the relationship between environmental uncertainty and technological innovation, including the moderating effect of human resource management. Therefore, the research model is shown in Figure 1.

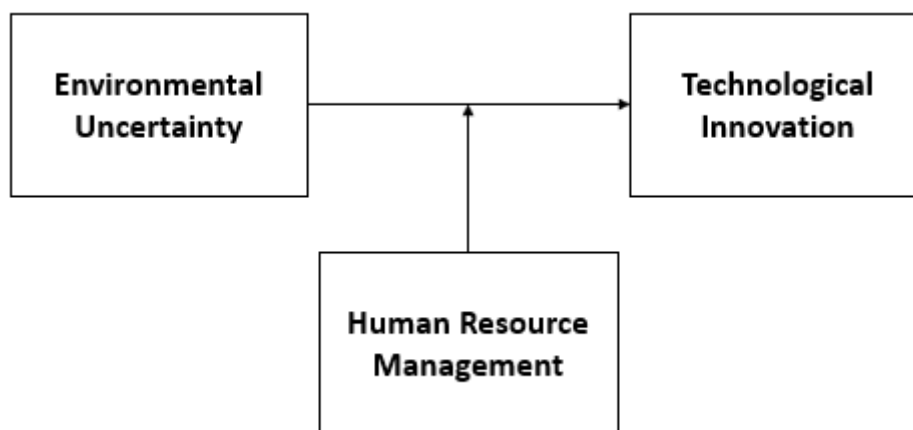


Figure 1. Research Model

## 2.2 Hypotheses Development

### 2.2.1 Relationship between Environmental Uncertainty and Technological Innovation

Technological innovation has a positive effect on corporate performance, and a company's internal capabilities and external environment are important factors that increase a company's technological innovation (Wong & Zhang, 2022). According to a study by Kafetzopoulos *et al.* (2020), companies cannot innovate because they do not

properly recognize the demands or demands of the external environment. Therefore, companies must strive to obtain the information and resources necessary for technological innovation, and only when they recognize the importance of technological innovation can they achieve corporate development.

The more unstable the business environment, such as the degree to which a company's survival is threatened, the degree of fierce price competition, and the degree of competition for product quality and novelty, the more likely the company is to actively carry out technological innovation because the need to acquire a competitive advantage in terms of production costs and market differentiation increases (Kim *et al.*, 1993). In particular, SMEs are more required to innovate due to narrow products and services, small markets, and insufficient resources than large companies. Therefore, this study intends to establish the following hypothesis on the relationship between environmental uncertainty and technological innovation of SMEs.

H1. Environmental uncertainty has a positive effect on technological innovation.

### **2.2.2 Moderating Effect of Human Resource Management**

Several previous studies have shown that the successful operation of strategic human resource management becomes the organization's core competency and positively affects organizational performance (Haque, 2021; Lim, 2021; Sheppeck & Millietllo, 2000). For a company to gain a competitive advantage, it must maintain the manufacturing capacity of a strong internal human resource source. This can be achieved by recruiting and maintaining a well-trained workforce with knowledge, skills, or experience that enables innovation (Leonard-Barton, 1995). In other words, the skills and knowledge that enable innovation have implicit characteristics and can be developed through training.

Also, the more professional knowledge and up-to-date information on the field, the better they know the needs and opportunities for technological innovation (Baldwin & Johnson, 1996).

Existing technological innovation researchers were aware of the impact of human resources on technological innovation activities and performance creation and the proportion of human resource management in this process. However, most studies have been focused on large companies (Pham *et al.*, 2023; Welbourne & Andrews, 1996; Zhou *et al.*, 2021), and studies on human resource management for SMEs were relatively weak (Aldrich, 1999). In particular, human resource management was a moderator, and efforts to investigate the sexual interaction effect of variables related to technological innovation were neglected.

In today's uncertain environment, SMEs cannot ignore the importance of human resource management to successfully achieve technological innovation. This is because companies are interested in how to make good use of the opportunity environment and minimize the threatening environment to sustain and thrive corporate organizations.

As such, companies recognize that it is important to effectively secure talent according to the environment and manage and develop their capabilities for business success (Zardasht *et al.*, 2020). In response to accelerating environmental uncertainty, companies can successfully lead a company's technological innovation by equipping the human resource management system with the power it pursues (Kamzmi & Ahmand, 2001). Based on these theoretical discussions, a hypothesis about the moderating effect of human resource management in the relationship between environmental uncertainty and technological innovation was established as follows.

H2. Human resource management (education training and performance evaluation) positively moderates the relationship between environmental uncertainty and technological innovation.

### **3. RESEARCH METHODOLOGY**

This section explains the measurement of variables and conducts reliability, validity, and correlation analyses. In addition, the hypotheses are verified through regression analysis.

#### **3.1 Measurement of Variables**

In this study, a self-report questionnaire was conducted for the efficiency and ease of investigation. However, to reduce the common method bias that can occur when the independent variable and the dependent variable are measured by the same measurement tool and the respondent, the independent variable is a subjective measurement, and the dependent variable is answered with objective data (number of new product introductions). In addition, the respondents were not aware of the relationship between the measurement variables through questionnaire signs (psychological separation), and the order of the measurement items was arranged differently.

##### **3.1.1 Environmental Uncertainty**

In this paper, environmental uncertainty means that environmental factors such as short product life cycles, rapid customer preferences, and technological changes are unclear (D'Aveni, 1994) to the extent that changes in a company's external environment (market, technology, competitors) cannot be accurately predicted. Ten questions were measured on a five-point scale. The market size of the company's industry, the rate of product technological innovation, the market is the rate of growth, the degree of change in demand, the degree of market saturation, the life cycle of the product, the degree of technological innovation, the rate of change in consumer preferences, the added value of produced products, and the frequency of emergence of new products.

##### **3.1.2 Human Resource Management**

Human resource management was measured in 7 questions (5-point scale) on the evaluation of education and training and job performance of employees of a company using items used by Delery and Doty (1996). The content is the degree to which employees are provided with a wide range of education and training programs, the degree to which employees complete and provide formal education and training programs every year, the degree to which they evaluate the performance of their employees that can objectively and quantitatively, the performance evaluation of a company is the degree to which employees' performance is evaluated with objective figures based on the criteria for achieving objective and quantifiable work performance results, and the results of their work performance.

##### **3.1.3 Technological Innovation**

Technological innovation is introducing new products to improve the competitiveness and profitability of a company by satisfying customer needs by revising the definition of Zahra *et al.* (2000), and the measurement was set as the 'number of new product introductions in the last three years.'

### 3.1.4 Control Variables

Scale was used as a control variable according to the argument that size significantly influenced technological innovation (Cosh & Hughes, 2000). The scale was measured as 'number of employees', and natural logarithms were taken and used for analysis.

In terms of age, young companies are more innovative than old companies (Joltan & Randall, 1997). However, the longer the establishment period, the more active access to external sources (Mosakowski, 1991), and the more new products are introduced and patented (Deeds & Hill, 1996). Therefore, age was introduced as a control variable, and the measurement was set as the 'number of years elapsed from the year of establishment to the present time.'

R&D was introduced as a control variable according to research results showing that R&D has a significant impact on innovation (Lin *et al.*, 2006), and the measurement was set to 'the ratio of R&D investment to sales over the past three years' (Hall & Bagchi-Sen, 2002).

### 3.2 Sample and Data Collection

A survey was conducted on companies with sales of 3 billion won or more as of 2021-2023 among manufacturing companies in Daegu and Gyeongsangbuk-do province. As a result, 203 data were collected, and 172 companies were used for the final analysis, excluding companies judged to have unfaithful or low reliability in the survey response.

The questionnaire was sent and collected by mail, direct visits by research members, fax, and e-mail. In this study, the CEO or middle manager level or higher was asked to respond to the questionnaire (80%). If it was difficult for them to respond, a person in charge of R&D or with sufficient knowledge of technology management work was asked to respond (20%).

### 3.3 Reliability and Validity

In this study, the construct validity of these data was reviewed by performing factor analysis by Varimax, rotating ten items to measure environmental uncertainty and seven items to measure human resource management at the right angles. As a result of the initial factor analysis, the two items that measure environmental uncertainty (whether to produce a product with high added value or high attractiveness in overseas markets) were not significantly loaded anywhere, so factor analysis was conducted again except for these two items. As a result, eight factors were found.

Furthermore, the Cronbach alpha value for each type of the above items was obtained to examine the reliability of the data. As a result, human resource management .943 and environmental uncertainty .898 were found to be reliable.

Table 1. Factor Analysis and Reliability

| Variables                 | Contents   | 1    | 2    | Cronbach's Alpha |
|---------------------------|--|------|------|------------------|
| Human Resource Management | The company provides an extensive education and training program for its employees.  | .753 | .103 | .943             |
|                           | Employees of the company take an education and training program every year.          | .881 | .140 |                  |
|                           | There is a formal education and training program for new employees to acquire skills | .895 | .120 |                  |

|                                   |  |        |        |      |
|-----------------------------------|--|--------|--------|------|
|                                   | necessary for their job performance.   |        |        |      |
|                                   | The company provides formal education and training programs for employees to acquire the skills necessary to perform their upper-level jobs. | .847   | .138   |      |
|                                   | Evaluate the performance of employees with objective and quantifiable job performance results.   | .835   | .203   |      |
|                                   | The company's performance evaluation is based on objective and quantifiable work performance results.  | .862   | .127   |      |
|                                   | The performance of employees is evaluated based on the results rather than the work performance process.                                     | .881   | .126   |      |
| Environmental Uncertainty         | Product technology innovation in your industry takes place quickly.  | -.007  | .789   | .898 |
|                                   | The market for your industry is growing rapidly.   | .054   | .785   |      |
|                                   | Demand fluctuates greatly in your industry.  | .197   | .803   |      |
|                                   | The market in your industry is saturated.  | .280   | .567   |      |
|                                   | The product life cycle of your industry is short.  | .116   | .789   |      |
|                                   | Consumer tastes in your industry change rapidly.   | .178   | .770   |      |
|                                   | The frequency of the appearance of new products in your industry is high.  | .086   | .720   |      |
|                                   | The overseas market of your industry is growing rapidly.   | .157   | .803   |      |
| Eigenvalue                        |  | 6.605  | 3.386  |      |
| Proportion of Variance            |  | 44.033 | 22.576 |      |
| Cumulative Proportion of Variance |  | 44.033 | 66.609 |      |

### 3.4 Hypotheses Test

#### 3.4.1 Correlation Analysis

Table 2 shows the correlation of each variable. As seen from this table, technological innovation was found to be significant in a positive relationship with age, size, R&D, environmental uncertainty, and human resource management. In addition, in the case of multiple regression analysis conducted to verify the hypothesis, the problem of multicollinearity is likely to occur. However, the correlation coefficient between variables was not generally enough to suspect multicollinearity.

Table 2. Correlation Analysis

|                              | Mean   | SD     | 1      | 2      | 3      | 4      | 5      |
|------------------------------|--------|--------|--------|--------|--------|--------|--------|
| 1. Firm Age                  | 15.308 | 9.072  |        |        |        |        |        |
| 2. Firm Size                 | 1.548  | .384   | .224** |        |        |        |        |
| 3. R&D                       | 9.051  | 10.821 | -.122  | -.151* |        |        |        |
| 4. Environmental Uncertainty | 3.840  | .709   | .075   | -.079  | .166*  |        |        |
| 5. HRM                       | 3.649  | .717   | .154*  | .036   | .020   | .334** |        |
| 6. Technological Innovation  | 5.267  | 6.794  | .201** | .103   | .268** | .464** | .521** |

Notes: \* $p < .05$ , \*\* $p < .01$

### 3.4.2 Regression Analysis

In this study, while controlling firm age, firm size (number of employees), and R&D, the relationship between environmental uncertainty and technological innovation and the interaction of human resource management on their relationship are intended to understand the moderating role.

Regression analysis was performed to verify the hypotheses, and the results are shown in Table 3. First, looking at the results of analyzing technological innovation with only control variables (Model 1), the research model was significant ( $F=8.872^{**}$ ), and the explanatory power was 13.7%. Also, firm age, firm size, and R&D were significant in a positive relationship with technological innovation. Model 2, which included environmental uncertainty in Model 1, was found to be significant ( $F=18.573^{**}$ ), and  $R^2$  also increased significantly compared to Model 1 ( $\Delta R^2=.291^{**}$ ). The relationship between environmental uncertainty and technological innovation was also positively significant (Hypothesis 1 is supported).

Second, the result of analyzing the moderating effect of human resource management on the relationship between environmental uncertainty and technological innovation (Model 4), the research model was significant ( $F=33.469^{**}$ ), and  $R^2$  also increased significantly compared to Model 3 ( $\Delta R^2=.533^{**}$ ). In addition, the interaction item between environmental uncertainty and human resource management was found to have a significant positive relationship with technological innovation. In other words, the higher the level of human resource management, the more positive environmental uncertainty has a positive relationship with technological innovation, and human resource management has been found to have a positive moderating effect (Hypothesis 2 is supported).

Table 3. Regression Result

|                           | Dependent Variable: Technological Innovation |                            |                    |                            |
|---------------------------|--|----------------------------|--------------------|----------------------------|
|                           | Model 1<br>[N=172]                           | Model 2<br>[N=172]<br>(H1) | Model 3<br>[N=172] | Model 4<br>[N=172]<br>(H2) |
| Control                   |  |                            |                    |                            |
| Firm Age                  | .216   | .168*                      | .121*              | .041                       |
| Firm Size                 | .101   | .134*                      | .122*              | .139*                      |
| R&D                       | .310   | .239**                     | .245**             | .223**                     |
| Independent               |  |                            |                    |                            |
| Environmental Uncertainty |  | .423**                     | .292**             | -1.273**                   |



|                         |   |   |   |   |
|-------------------------|---|---|---|---|
| HRM                     |   |   | .396**  | -1.344**  |
| Interaction<br>EU * HRM |   |   |   | 2.735**   |
| Regression Result       | F=8.872**<br>R <sup>2</sup> =.137<br>Adjusted<br>R <sup>2</sup> =.121 | F=18.573**<br>R <sup>2</sup> =.308<br>Adjusted<br>R <sup>2</sup> =.291<br>Model 1<br>ΔR <sup>2</sup> =.171* | F=26.554**<br>R <sup>2</sup> =.444<br>Adjusted<br>R <sup>2</sup> =.428<br>Model 2<br>ΔR <sup>2</sup> =.136* | F=33.469**<br>R <sup>2</sup> =.549<br>Adjusted<br>R <sup>2</sup> =.533<br>Model 3<br>ΔR <sup>2</sup> =.105* |

Notes: \*p < .05, \*\*p < .01

#### 4. CONCLUSION

##### 4.1 Summary and Implications

This study investigated the relationship between environmental uncertainty and technological innovation and the moderating effect of human resource management on the relationship between them for small and medium-sized manufacturing companies in Daegu and Gyeongsangbuk-do province. In order to achieve the purpose of the study, the hypotheses derived from the research model were empirically verified through surveys after an in-depth examination of previous studies. The results are as follows.

First, the relationship between environmental uncertainty and technological innovation was positively and significantly found.

Second, the interaction of human resource management on the relationship between environmental uncertainty and technological innovation was significant.

These findings theoretically and practically provide the following significance and implications.

First of all, there may be differences in the ability of companies to respond to the intensity and uncertainty of environmental uncertainty, but the results of this study show that environmental uncertainty is a factor that induces technological innovation in companies (Kim *et al.*, 1993; Miller & Friesen, 1982).

Also, modern companies must adapt to the environment and move actively, which can be regarded as a major principle in the growth and development of a company. Therefore, for a company to survive and achieve its goals, it must respond to changes in the uncertain environment and, in some cases, change the given environment in favor of the company. Therefore, SMEs should recognize changes in the uncertain environment as a very threatening factor and emphasize active corporate movements such as technological innovation caused by environmental changes.

Moreover, human resource management positively moderates environmental uncertainty, inducing technological innovation in SMEs. In other words, companies with a high level of effective human resource management have a higher relationship between environmental uncertainty and technological innovation than companies with a low level of human resource management. Technology is rapidly developing according to radical environmental changes, and the boundaries between basic science and technology and applied development technology are blurring. From this point of view, companies emphasize the need for human resource management, such as educating and training existing human resources and hiring new human resources to develop new technologies or introduce advanced technologies.

As such, human resource management is challenging to apply past actions or experiences in a dynamic environment, so it is important to quickly detect environmental changes and how well they acquire them (Eisenhardt & Martin, 2000). Through this, it is appropriate to use new human resources to create new knowledge when the environment of a company changes rapidly.

In practice, the results of this study can be used to establish strategies for strengthening the competitiveness of SMEs, and it is believed that it will be a starting point for systematic research on factors that have a moderating effect on the relationship between environmental uncertainty and technological innovation.

#### **4.2 Limitations and Future Research Directions**

Despite the above significance, this study has limitations, and studies to supplement them should be conducted in the future.

First, it is known that there are differences in innovation-related research results and significance depending on the selection of the research sample. This is because there are differences in the level of innovation of SMEs by industry type (Hoffman *et al.*, 1998). The sample of this study is limited to manufacturing companies, but in future studies, it is necessary to conduct research by comparing different types of industries.

Second, technological innovation was measured only by the number of new product introductions, and to reflect various innovation results, the number of new process introductions, patent applications, existing product improvements, and existing process improvements should also be measured. Therefore, future studies need to overcome these limitations, and the results of this study are expected to be used as primary data for future studies.

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