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Review of the Theoretical Mechanism of Human Capital Investment Affecting the Enterprise Innovation Output

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Abstract

With the intensification of global competition and the accelerated advancement of technological transformation in enterprises, enterprises are confronted with the problem of insufficient innovation ability and urgently need to enhance their core competitiveness. Human capital promotes the development of enterprises through the accumulation of knowledge and ability, the improvement of technical level, and the stimulation of workers' creativity, exerting a positive incentive effect on enterprises. The investment in enterprise human capital is mainly made through means such as education and training, career development, and health security, ultimately achieving the goal of enhancing the core competitiveness of the enterprise. This paper sorts out and analyzes the relevant literature, and elaborates on the mechanism and path of how enterprise human capital investment catalyzes enterprise innovation output from four aspects: theoretical basis, mechanism of action, empirical conclusion and future outlook, respectively, providing certain references for related research and practice.

Keywords

Human Capital Investment, Innovation Output, Education and Training, Career Development, Innovative Performance

1. Introduction

With the intensification of globalization and the accelerated advancement of technological changes in enterprises, enterprises are confronted with the problem of

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insufficient innovation capabilities and urgently need to enhance their core competitiveness. Human capital promotes the development of enterprises through the accumulation of knowledge and ability, the improvement of technical level, and the stimulation of workers' creativity, exerting a positive incentive effect on enterprises. The investment in enterprise human capital is mainly made through means such as education and training, career development, and health security, ultimately achieving the goal of enhancing the core competitiveness of the enterprise. Based on the relevant literature in the China National Knowledge Infrastructure (CNKI) database from 2001 to 2025, this paper adopts the literature research method and conducts a systematic search with the keywords of enterprise human capital investment, training and development, innovation output, and innovation performance, so that the review comprehensively covers the research topics. This review elaborates on the mechanism and path of how enterprise human capital investment catalyzes enterprise innovation output from four aspects: theoretical basis, mechanism of action, empirical conclusion, and future outlook, providing certain references for related research and practice.

2. Core Concepts and Theoretical Basis

2.1. Definition of Core Concepts

Enterprise human capital investment refers to the developmental investment made by enterprises in terms of funds, time and technological innovation, such as on-the-job training and development of employees, introduction of highly skilled talents, acquisition of vocational qualification certificates and conducting research and development activities, etc. It is the behavior of investing in the quality of the enterprise itself and its members to improve efficiency (Li et al., 2010).

Innovation output refers to the products completed by an enterprise's innovation activities, specifically including several aspects such as technological innovation (such as the number of patents, new product research and development), management innovation (such as process optimization, organizational change), and institutional innovation (such as the design of incentive mechanisms). Generally, indicators such as the number of patent applications, sales of new products, and the conversion rate of research and development achievements are commonly used for measurement (Dai et al., 2012).

2.2. Relevant Theoretical Basis

The human capital theory proposed by Schultz in 1961 and Becker in 1964 holds that human capital is the most important resource among the production factors of an enterprise. Only when it is invested in employees, and when knowledge and skills are transformed into their own skills can it truly be transformed into the ability to enhance productivity (Zhong, 2025).

The innovation theory proposed by Schumpeter in 1912 holds that innovation is the combination of various production factors in a certain pattern. Human capital, as an "active element", plays a crucial role. The amount of knowledge people

possess, the degree of their mastery of technology and their innovative consciousness are the key factors determining whether an enterprise can integrate resources and break through technological bottlenecks (Dai et al., 2012).

The organizational learning theory proposed by Agilis in 1978 holds that enterprise organizations create learning organizations through human capital investment, thereby achieving the goals of absorbing knowledge, transforming knowledge and creating knowledge (Liu, 2020a). The experience gained by individuals through learning will be transformed into the organizational innovation ability of enterprises through the knowledge-sharing mechanism of enterprises.

3. The Influence Path of Human Capital Investment on the Innovation Output of Enterprises

Human capital mainly affects the innovation output of enterprises through the following four paths (**Figure 1**). They are respectively the path for accumulating knowledge and improving skills, the path for motivating innovative thinking and behaviors, the path for teamwork and resource integration, and the path for cultivating dynamic capabilities in organizations.

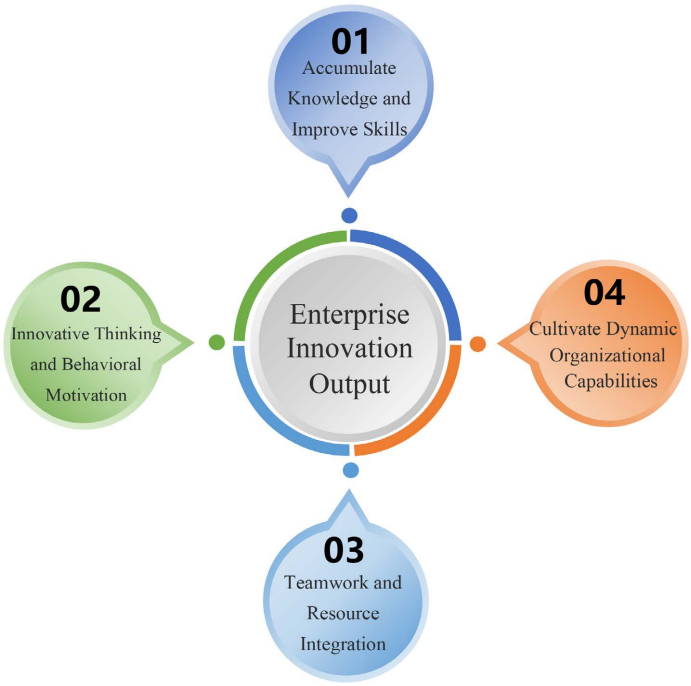

Figure 1. The influence path of human capital investment on the innovation output of enterprises.

3.1. Accumulate Knowledge and Improve Skills

Enterprises can enhance the professional level and knowledge accumulation of their employees through forms such as investing in training or increasing investment in research and development. For example, the enterprise holds the research and development of R&D personnel, which is helpful to improve the understand-

ing, mastery, application and transformation of new knowledge and technology for new people and developers. The stock of technical knowledge provides an endless supply of "raw materials" for the continuous innovation of enterprises. If enterprises are the main body of innovation, then knowledge is the foundation of innovation. Knowledge has now become the most important source of an enterprise's innovation ability. The accumulation and level of knowledge in technology or market of enterprises in relevant fields play an important role in the continuous innovation ability of enterprises (Liu, 2020b). Meanwhile, technological innovation achievements will bring certain knowledge spillover and sharing effects. During the operation of an enterprise, knowledge transfer will occur among employees. Under the knowledge economy, knowledge transfer is crucial for reducing the problem of information asymmetry that occurs in the process of enterprise innovation.

3.2. Innovative Thinking and Behavioral Incentives

Encouraging measures in enterprise human capital investment play an important role in promoting innovation. Among them, there are innovative performance bonuses, fast track for career promotion, etc. These are not simply material incentives. These measures also publicize the enterprise goal of "encouraging innovation" to the majority of employees and greatly stimulate the innovation willingness of the majority of employees (Ju, 2002). Meanwhile, relevant training specifically targeting innovative methods, such as design thinking and agile development, reshaping employees' thinking and enabling them to learn to think proactively and respond quickly. This helps employees break through the original and traditional thinking patterns and build a systematic innovative thinking mode. Existing empirical research results show that employee innovation can generate a very strong sense of self-efficacy, which further gives employees more motivation to innovate. This was significantly positively correlated with the investment level of enterprise research and training (Tierney & Farmer, 2002).

3.3. Team Collaboration and Resource Integration

For enterprises, by introducing leading talents in the industry and conducting cooperation and exchanges among positions in different departments, the overall talent structure level of the enterprise and the sharing and integration of heterogeneous knowledge can be improved (Zhang, 2013). The participation of industry leading talents can bring cutting-edge knowledge and advanced concepts to the development of enterprises. Cross-departmental cooperation can break down information barriers and provide enterprises with more development space in multiple dimensions. For instance, if certain R&D personnel with strong market experience and technical backgrounds are added to the enterprise's R&D team, then when the enterprise is making products, it will better understand how to start from the user's perspective and bring more user-friendly products to the market. In addition, strengthening investment in the human capital of enterprise employ-

ees can also improve their communication skills, execution ability, teamwork ability, etc. Improving communication skills can reduce errors in information transmission, enhancing execution ability enables the efficient implementation of plans, and good collaboration ability enables the coordinated utilization of resources. This can reduce collaboration costs, better achieve resource integration, and also lower innovation costs.

3.4. Cultivate Dynamic Organizational Capabilities

Investment in human capital is conducive to cultivating the dynamic capabilities of enterprises. The dynamic capability of an enterprise (Teece et al., 1997) refers to the ability of an enterprise to integrate, construct and reconfigure internal and external resources in a rapidly changing market environment to cope with uncertainties, seize opportunities and maintain competitive advantages. "Dynamic" refers to the fact that enterprises constantly update their capabilities to adapt to the constantly changing competitive environment. After making human capital investments, employees will receive training and be able to apply methods in new technological fields such as AI and big data analysis to provide innovative research and development applications for new scenarios in the process of the enterprise's digital transformation. For instance, conducting blockchain technology training for employees of financial enterprises has given rise to numerous new businesses such as digital currency trading platforms (Fang, 2024). Furthermore, the improvement of the dynamic capabilities of enterprises brought about by human capital investment can also promote innovative reforms in aspects such as organizational structure and business processes of enterprises. This will enable enterprises to continuously adapt to market changes and thereby achieve sustainable development (Liu et al., 2002).

4. Differences and Consensus in Multi-Perspective Conclusions

4.1. The Connection between Different Capital Inputs of Labor Force and Innovation Output

Many studies have found that the more an enterprise invests in training and development, the more conducive it is to innovation output. For instance, a study by some scholars on Chinese manufacturing enterprises shows that for every 1 percentage point increase in employee training expenses by enterprises, it can lead to an increase of 0.8 percentage points in patent output rate (Wu, 2006). However, some studies have shown that basic skills training has little effect on enterprise innovation. The reason is that the content of basic skills training focuses on basic operations and lacks the cultivation of advanced abilities, such as cutting-edge technologies and creative thinking required for innovation. It focuses on enhancing efficiency and reducing errors rather than driving technological breakthroughs, process reengineering, or product iterations and other innovative behaviors. Higher-level skills training, such as R&D management and technological frontiers, will

have a more positive effect on the innovation of enterprises (Alegre & Chiva, 2008).

Introducing talents means bringing high-end individuals with overseas working experience and learning experience from renowned institutions into enterprises, which brings new concepts and technologies to the enterprises and plays a positive role in enhancing the innovation output of the enterprises. Research has found (Li & Wang, 2015) that the higher the proportion of doctoral students in the R&D team, the more invention patents the enterprise produces. Employees with postgraduate degrees have a stronger influence on the independent innovation of enterprises than those with bachelor's and associate's degrees, and this effect intensifies over time. Technological innovation with bachelor's and postgraduate degrees brings higher profits to enterprises than that of employees with associate's degrees (Du et al., 2024). The salary level and salary calculation method show a positive correlation with the incentive effect on innovative talents (Zhang & Wang, 2012). However, if only talents are introduced without cultivating them, it is easy to cause knowledge conflicts. While introducing them, attention should also be paid to the construction of the internal cultivation mechanism (Wang et al., 2019). For such investments aimed at ensuring the health of employees, such as physical examinations, psychological counseling, and health guidance, they can all enhance the work efficiency of employees. In the long run, they will promote the improvement of the enterprise's innovation ability and creativity. You (2023) pointed out that the higher the health investment of an enterprise, the more frequently innovative behaviors occur among its employees, and the higher the high-end R&D position of the enterprise, the more significant this effect becomes. There are also studies indicating that after making ergonomic modifications to the office environment and other investments, the positive impact on R&D positions is 1.8 times that on production positions. The reason is that a comfortable environment can effectively extend the deep working hours of R&D personnel, increasing the average daily concentration time by 45 minutes, thereby achieving innovative breakthroughs for employees (Alegre & Chiva, 2008).

4.2. Different Investment Subjects of Human Capital Will Bring about Different Effects

The human capital quality of the executive team, including professional background, educational level, industry experience and innovative consciousness, will affect the enterprise's innovation strategy. Executive teams with a strong technical background are more likely to enhance the innovation intensity of enterprises by increasing R&D investment and transform the innovation form of enterprises into radical innovation (Zhang et al., 2020). Gu and Hu (2008) pointed out that the heterogeneity of the professional background of the executive level has a relatively positive and significant impact on enterprise technological innovation. A senior management team with rich industry experience can guide enterprises to precisely layout the direction of innovation with their acute insight into market trends. Empirical analysis shows that the higher the average educational attainment of the executive team, the more it can help enterprises improve the quality of patents

(Chen, 2022).

Enterprise R&D personnel and technical backbones are the main executors of innovation activities carried out by enterprises. There is an inverted U-shaped relationship between the proportion of technical personnel in enterprises and the development speed of new products. When the proportion of technical personnel is 20% - 30%, the development speed of new products in enterprises is the fastest (Zhang et al., 2016). Certain equity incentives should also be given to technical personnel, and restricted stock plans should be implemented, etc., in order to retain these core technical personnel. For instance, Li and Wang (2015) found in their research on enterprises listed on the Growth Enterprise Market that for every 1% increase in the intensity of equity incentives, the intensity of R&D investment increased by 0.3%, and the effect of long-term incentives (such as restricted stocks) was better than that of short-term incentives (such as stock options).

4.3. Differences in Roles under Different Industries and Institutional Environments

Due to the different natures and operation methods of each industry, different industries themselves have different levels of technological intensity. Among them, in high-tech industries represented by information and biomedicine industries, the investment of human capital has a stronger promoting effect on enterprise innovation (Wang & Liu, 2016). Compared with manufacturing or services, the industry that has a greater marginal effect on the input and output of training for enterprise R&D personnel is the former rather than the latter. In other words, in the high-tech industry, more attention should be paid to improving the knowledge update speed of workers, and continuous human capital investment should be made to maintain the demand for the continuous innovation and development of enterprises (Cheng, 2025). Continuous investment in human capital, such as regularly organizing training on cutting-edge technologies and academic exchange activities, can ensure that R&D personnel keep up with technological trends and continuously inject vitality into the enterprise's innovation.

Due to the different institutional environments in various industries, the stronger the protection of intellectual property rights in an industry, the more likely it is to prompt enterprises to make higher long-term human capital investments. Studies have shown that when the patent protection index increases, the connection between enterprise training investment and innovation output will be strengthened (Li et al., 2023). Policy tools such as government subsidies can also indirectly enhance the innovative role of human capital by reducing the investment risks of enterprises' human capital.

5. Disputes That Still Exist in Certain Fields

5.1. Endogenous Disputes over Causality

The core of the endogeneity controversy lies in the fact that human capital investment and innovation output may be "mutually causal" or "driven by common

factors", rather than a simple one-way causal relationship. If this issue is ignored, it may lead to policy suggestions, such as blindly encouraging enterprises to increase training investment, deviating from the actual effect. Therefore, rigorous research needs to strip away endogenous interference through quantitative method innovation, such as causal inference models, or data design, such as follow-up surveys, in order to accurately answer the proposition of "whether human capital investment can truly drive innovation". Therefore, there should be more exploration in the future for research on tracing back to the source.

5.2. Blind Spots in Identifying Investment "Weaknesses"

Most of the existing achievements focus on explicit investments such as training input and salary expenditure, while paying insufficient attention to the mechanism of implicit investments such as corporate culture construction and career development channel design on innovation output. For instance, a flat organizational design can effectively enhance communication efficiency and reduce communication costs. Compared with simply increasing training investment, it can provide better incentives for the innovation of grassroots employees (Li & Wang, 2015). In corporate culture, not only integrity, innovation, responsibility and win-win cooperation are emphasized, but more importantly, more efficient decision-making can be advocated in practice, and employees can execute more quickly. This can effectively improve the efficiency of employees' work (Wang, 2024). To make up for the shortcomings in investment, it is first necessary to focus on supplementing the shortcomings in concepts, emphasizing cultural concepts, so that the company's employees can understand the company's development concepts and always work in accordance with them (Huang et al., 2017). To make up for the shortage of capital, capital investment should be more diversified. In addition, it is necessary to make up for the shortcoming of scale and continuously increase the intensity of resource integration to enable the company to form a scale effect (Lu et al., 2024).

5.3. New Challenges in the Digital Age

With the advent of the digital age, digital technologies such as artificial intelligence and remote working have been continuously popularized. The effectiveness of traditional human capital investment methods, such as offline training, is facing a reduction. The cultivation mechanisms and systems for new capabilities such as communication, collaboration, execution, and digital literacy improvement in virtual teams have not received sufficient attention and research. In addition, the mechanism by which the integration model of external human capital formed by the gig economy, such as part-time experts and freelancers, exerts its influence on the innovation output of enterprises remains to be explored. In today's era, which is characterized mainly by information and the Internet, in the context of digitalization, if an enterprise wants to survive, it should strive to keep up with The Times. For instance, the enterprise's philosophy, operation mode and manage-

ment mode should all undergo changes. The economic benefits of information are reflected in the production, operation and management activities of enterprises. Attention should be paid to the timeliness and accuracy of information resources. We should make good use of the convenience of the information age to make employees' work more efficient and convenient, and thereby achieve higher economic and social benefits. Enterprise human resource management has new demands in the context of the digital age (Xu, 2001). Recruit and select talents by leveraging digital platforms, cultivate talents through new technological tools, and enhance the quality and professional capabilities of employees. Employees should also actively participate in the transformation of the digital age, constantly stimulating their innovation capabilities, thereby enhancing the innovation capacity of the enterprise (Zhou, 2024).

6. Research Prospect

6.1. Methodological Innovation: Integrating Micro-Behavior with Macro-Performance

Experimental economics and behavioral methods were adopted to record, track and study the changes in individual innovation behaviors of employees after human capital investment, such as the number of individual innovations, innovation frequency, the number and frequency of working together with other departments, and a chain-oriented model of "human capital investment—innovation behavior—innovation performance" was established, which has solved the endogeneity problem.

6.2. Contextualized Research: Refine the Industry and Institutional Environment

Green and digital creative talents provide the source of human resources, finance and materials for achieving carbon neutrality and entering cutting-edge fields such as the metaverse. We can start with talents and make breakthroughs in the research of green technologies or digital creative technologies that lead. Meanwhile, comparative studies can also be conducted with developed countries and developing countries, or regions with a high degree of marketization and regions with a low degree of marketization, to analyze the different impacts of institutional comparative advantages under different institutional effects on the innovation conversion rate caused by human capital input.

6.3. Exploration of Emerging Topics: The Reconstruction of Human Capital Caused by Digital Transformation

In the digital age, there are still many research directions that need to be developed, and there is much content worth studying. Such as studying how to enable online learning platforms and AI training systems to better exert their effectiveness and improve the efficiency of human capital investment. Study how to improve the marginal contribution to the innovation output of enterprises under the

"human-machine collaboration" working mode. Study how various new working models, such as the gig economy and remote working, affect the innovation capacity of enterprises, etc.

6.4. Ecosystem Perspective: Make Collaborative Investments beyond the Boundaries of Enterprises

Based on the perspective of the ecosystem, the expansion of the spillover scope in cross-border collaborative investment of enterprises starts from aspects such as building joint laboratories and setting up talent sharing plans to explore the coexisting human capital investment methods between enterprises and universities, research institutes, and upstream and downstream industrial partners. And analyze the influence mechanism of cross-organizational knowledge and ability on the diffusion of enterprise innovation achievements in the background of open innovation. On this basis, construct the theory of human capital investment in the background of "open innovation".

7. Conclusion

Human capital investment is innovative output formed by accumulating knowledge and technology, stimulating innovative thinking and behavioral patterns, enabling teams to exert synergy effects, and promoting organizations to create adaptive methods and apply dynamic capability mechanisms based on different conditions. For instance, in these four aspects, the close integration of the four innovative paths with human resource policies can be promoted respectively by implementing a hierarchical training system, establishing an innovative reward mechanism, promoting cross-departmental project-based management, and setting up a talent rotation and reserve system. In the future, there should be more exploration in focusing on and promoting the implementation of enterprise innovation paths.

There are abundant studies related to enterprise human capital investment, and some relatively complete research conclusions have been obtained in aspects such as different investment forms, heterogeneity of different investment subjects, industries and institutional contexts. However, relevant research on causal relationship identification, implicit investment in human capital, and the integration of exogenous human capital investment in the context of the digital age still needs to be strengthened. In the future, further theoretical research and empirical analysis of enterprises should be carried out by combining the characteristics of the digital economy era and starting from the three aspects of micro behavior, meso organization and macro ecology of enterprises. In an environment of differentiation and uncertainty, it provides more precise guidance for enterprises to adopt human capital investment behaviors to enhance their own innovation capabilities and innovation outputs.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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