Intellectual Capital and Technological Innovation

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It is not assumed that intellectual capital is significantly associated with technological innovation. Most of the time, intellectual capital promotes technological innovation, but that is not the whole truth. At some point, some elements of intellectual capital can also have a negative impact on innovation.

Keywords: intellectual capital ; technological innovation

1. Introduction

In the era of the knowledge-based economy, intellectual capital based on knowledge has gradually become a vital strategic resource for enterprises to gain competitive advantages and realize value appreciation [1], which has a profound impact on their financial performance and technological innovation. Technological innovation is the core element for the long-term development of enterprises. In order to survive and progress in the highly competitive and unpredictable market environment, enterprises must obtain sustainable competitive advantages through technological innovation [2]. Promoting technological innovation has become the key for enterprises to achieve the goal of becoming bigger and stronger. However, for most enterprises, technological innovation based on R&D activities means facing the uncertainty of results and the instability of cycles in the innovation process. They need to invest many R&D resources and take the high intensity of innovation risks [3]. Therefore, if enterprises want to improve their innovation performance, it is even more necessary to carry out technological innovation activities by strengthening their talent pool and building innovative organizations. Intellectual capital is an important strategic resource for enterprises, which helps alleviate the insufficient investment in R&D resources and enhances the motivation of technological innovation [4]. Based on the division of intellectual capital structure by Pulic [5], there are differences in the degree of influence of different types of intellectual capital on technological innovation. Among them, human capital can promote technological innovation by providing core resources such as employees' knowledge and skills [6], while structural capital can promote technological innovation by building an organizational structure that drives innovation, developing a standardized innovation system, and creating a positive innovation culture [7]. Therefore, it is essential to explore the impact of intellectual capital and its components on enterprise technological innovation.

The mechanism of the effect of intellectual capital on enterprise technological innovation has increasingly become a hot topic of academic research. While scholars have contributed very many research results, they have also developed very many debates. Some scholars argue that intellectual capital and its elements can motivate enterprises to carry out technological innovation and positively affect technological innovation. For example, Harrison and Sullivan [8] pointed out that intellectual capital can enhance the returns of strategically important businesses across the board while enhancing enterprises' innovation capabilities. Furthermore, Hayton's [9] empirical study of 237 high-tech companies in the United States showed that intellectual capital is a source of technological development that can significantly increase innovation performance by reducing risk. Meanwhile, Chahal and Bakshi [10], through an empirical study of the banking industry, confirmed that intellectual capital could positively affect technological innovation and improve the competitive advantage of enterprises.

Of course, other scholars argue that intellectual capital and its elements can negatively affect technological innovation. For example, Subramaniam and Youndt [4] studied the impact of intellectual capital and its elements on enterprises' innovation capability with 93 organizations. They found a significant negative relationship between human capital and innovation capability. Cao et al. [11] explored the differences in the effects of intellectual capital and its elements on innovation performance in different life cycles. They found that enterprises' human capital in the growth stage showed a significant negative effect on innovation performance. Zha et al. [12] verified that organizational capital would negatively affect low-cost innovation based on structural equation modeling. Some scholars' studies found that the impact of intellectual capital on technological innovation is not a simple linear relationship. For example, Bejinaru and Bratianu [13] [14] criticized the linearization of the study of intellectual capital in academia. They pointed out that the assumption of a

direct and linear causal relationship between intellectual capital and firm performance is false. Many researchers ignore the intangible nature of intellectual capital and even make it tangible, while all intangible resources are non-linear in nature. Using the usual linear logic not only fails to reflect the value of intellectual capital, but may lead to misinterpretation of the results. Zhan and Li [15] examined empirical data from 39 developing countries using a threshold test model. They found that the effect of intellectual capital on technological innovation showed a significant U-shaped relationship after controlling for variables such as economic level and R&D investment.

2. The Effect of Intellectual Capital on Technological Innovation

Regarding the connotation of intellectual capital, Stewart [16] believed it is distinguished from physical capital and is the sum of a set of intangible knowledge, skills, and experience in an organization. Intellectual capital is closely related to value creation and is a strategic resource that accelerates value creation and increases competitive advantage [17][18]. This view, based on a resource-based theory, is usually less about specific products and services and more about the firm's resources and capabilities, such as how to develop and deploy those intangible assets that can lead to competitive advantage [19]. Gallego et al. (2020) stated that intellectual capital should include strategic design capability, which could influence process and innovation management. The application of strategic design increases the value of intangible assets, promotes enterprise innovation, generates systems that integrate tangible products and intangible services, and triggers changes in organizational structures. AlQershi et al. (2021) [7] argued that by improving structural capital, firms can develop new structures that will contribute to value creation and sustain superior performance. These inferences were supported in the study by Ali and Anwar (2021) [20], who found a significant positive correlation between the elements of intellectual capital and value creation.

Regarding the components of intellectual capital, academics have formed dualistic, triadic, and pluralistic theories. Among them, the dualism proposed by Pulic [5] is widely used by academics. He believes that intellectual capital can be divided into human capital and structural capital. Human capital refers to the individual employee's knowledge reserve, innovation ability, cognitive judgment, experience skills, and work attitude, while structural capital refers to the knowledge management, organizational culture, information system, and institutional norms embedded within the organization. The later emerged triadic and pluralistic viewpoints are not essentially different from the above dualism. They are basically obtained by expanding and extending the concept of structural capital on the basis of dualism. However, the subdivision of the concept does not affect the correctness of various theories of intellectual capital structure classification. Therefore, this study draws on Pulic's [5] dualistic framework, which states that intellectual capital consists of human capital and structural capital, to investigate the impact of intellectual capital and its elements on enterprise technological innovation.

Factor endowment theory suggests that the abundance of production factors can increase firms' incentives to produce. As long as the advantages of factor endowment are greater than the corresponding production costs and high returns can be obtained from factor input, enterprises will accept the corresponding production decisions [21]. Similarly, technological innovation cannot be achieved without the support of intellectual capital and its constituents. Enterprises' motivation to make technological innovation decisions will vary according to the size of the intellectual capital. That is, the intellectual capital of different sizes will exert different effects on enterprise technological innovation. When the increased cost of enhancing intellectual capital is lower than the endowment benefit generated by enhancing intellectual capital, enhancing intellectual capital can stimulate enterprises' enthusiasm for technological innovation and positively impact technological innovation. On the contrary, if the increased cost of enhancing intellectual capital is higher, and even its endowment benefit cannot compensate for the increased cost, the enterprise will lose the incentive of technological innovation. Then, intellectual capital will have a negative impact on technological innovation.

As a special kind of decision, the enterprise technology innovation decision is characterized by high technical requirements, long periods and unstable processes, and the long-term benefits it produces are often greater than the short-term benefits [22]. Enterprise technology innovation is not only difficult to bring direct economic inflow to enterprises in the short term but also requires enterprises to invest much intellectual capital in carrying out technology research, which, to a certain extent, crowds out or constrains enterprises' investment in other operational projects [23]. Because of the high opportunity cost of technological innovation, many enterprises do not have the subjective willingness to implement technological innovation. A study by Niu et al. [24] found that under a supervisory corporate governance mechanism, executives are likely to undermine a firm's motivation to engage in technological innovation in order to achieve their short-term performance and compensation covenants. Cao et al. [11] explored the differences in the impact of intellectual capital on innovation performance under different enterprises' life cycles. They found that the positive effect of intellectual capital on innovation performance is higher in the maturity period than in the growth period. Apparently, companies usually do not initiate technological innovation without sufficient intellectual capital and incentives for innovation effectiveness.

Combining the factor endowment theory and the essential characteristics of enterprise technology innovation, we believe that the relationship between intellectual capital and enterprise technology innovation is not a simple linear relationship but a U-shaped relationship. Intellectual capital has a “double impact” on technological innovation. When intellectual capital is at a low level, weak intellectual capital is usually accompanied by a low willingness and investment in technological innovation. This is because technological innovation involves R&D expenditures, technological upgrading, product renewal, and organizational management. In terms of human capital, companies need not only to increase the number of R&D personnel, and salary expenditures, and increase training; in terms of structural capital, they need to establish information management systems, improve process norms, and create an innovation culture. Increased investment in intellectual capital often leads to higher operating costs for companies [25]. Moreover, a lower level of intellectual capital usually indicates a weaker physical base when the enterprise is mostly in the start-up or growth stage. The risks associated with implementing technological innovation are often higher than those associated with investing in other operational projects [26]. Thus, even if intellectual capital grows within a certain range, firms are still not very motivated to carry out technological innovation for the sake of controlling costs and risks. It can be seen that there is a “regressive” effect of a low level of intellectual capital on enterprise technological innovation. However, when the intellectual capital continues to grow beyond a certain threshold, the human capital (e.g., the number of R&D personnel, training) reaches a high level, and employees expect that they can obtain higher benefits by exchanging their knowledge, experience, and expertise. As a result, the willingness and quality of knowledge-sharing becomes higher, and the flow and updating of knowledge within the enterprise are improved [6]. In terms of structural capital, enterprises also have richer information management systems, complete process specifications, and sufficient intellectual capital to support technological innovation. Moreover, at this time, the increased cost of implementing technological innovation may be much lower than the comprehensive benefits brought by technological innovation, and the company has sufficient capital accumulation and the ability to cope with the risks that may be caused by technological innovation. The company should pursue technological innovation at this time actively [27].

3. Intellectual Capital, Corporate Social Responsibility, and Technological Innovation

According to the stakeholder theory, firms need to consider stakeholders’ expectations and support when making technological innovation decisions. As a typical stakeholder-driven behavior, fulfilling CSR can deepen the intimate relationship between a firm and its stakeholders, thus helping the firm to obtain valuable stakeholder support for technological innovation [28]. This may complement the internal resources that intellectual capital provides for technological innovation, which in turn affects the effectiveness of firms’ use of intellectual capital for technological innovation [29]. For example, Gangi et al. (2019) [30] showed that CSR engagement positively affects intellectual capital. CSR could create trusting relationships, stimulate tacit knowledge sharing, and make it explicit, thus benefiting the entire firm. They also argued that companies actively fulfilling their social responsibility help improve managers’ reputations and recruit more talented employees. A similar opinion appears in the study of Cegarra-Navarro et al. (2021) [31]. They argued that fulfilling the responsibility for the ecological environment contributes to corporate reputation. It also promotes the understanding and sharing of environmental information, which drives companies to improve their technology to meet or improve environmental standards continuously. However, at the stage where an enterprise’s intellectual capital accumulation is relatively weak, excessive fulfillment of CSR can consume the available resources of firms, seriously distract them from technological innovation, and ultimately reduce the efficiency of technological innovation [32]. Therefore, the impact of CSR on technological innovation can be summarized as the incentive effect and crowding-out effect.

The incentive effect of CSR can help alleviate the knowledge dilemma of technological innovation, improve the cooperative relationship between companies and stakeholders, acquire external knowledge and skills to carry out innovation, and improve the efficiency of enterprise technological innovation [33]. The crowding-out effect of CSR can make enterprises bias their resource focus toward stakeholders and seriously crowd out the resource input for technological innovation activities, thus weakening their incentive for technological innovation [34]. As a result, while CSR plays an important role in promoting technological innovation, an impractical CSR performance may have a negative impact on technological innovation by crowding out resources.

When intellectual capital is at a low level, the crowding-out effect of CSR is stronger than the incentive effect, which will enhance the negative influence of intellectual capital on technological innovation. Enterprises with a low level of intellectual capital usually have weak profitability and innovation levels. Most of them are in the start-up or growth stage, facing serious resource scarcity and business risks, with limited human capital to invest in technological innovation. Structural capital such as the organizational process, knowledge management system, and innovation culture are not yet sound, so improving CSR is more likely to crowd out enterprises’ originally insufficient technological innovation resources. Although the incentive effect of social responsibility is conducive to the acquisition of external knowledge and skills from

stakeholders, the fulfillment of social responsibility in the start-up or growth stage of such companies requires the enterprises to invest many resources to maintain the relationship with stakeholders. The investment of these resources will easily make the companies sink into existing customer relationships and distract the enterprises' focus on technological innovation, thus crowding out the enterprises' technological innovation resources. This will have a negative impact on the use of intellectual capital for technological innovation. It follows that CSR enhances the negative effect of intellectual capital on technological innovation when intellectual capital is at a low level.

When intellectual capital exceeds a certain threshold, the incentive effect of CSR is stronger than the crowding-out effect, which can enhance the positive influence of intellectual capital on technological innovation. Enterprises with a high level of intellectual capital have strong human capital, and their structural capital has been improved to a certain extent. The comprehensive benefits of using intellectual capital to carry out technological innovation are greater than the costs, and enterprises are more eager to carry out relevant technological innovation activities in order to enhance their competitive advantages and sustainable development capabilities. CSR as an external mechanism can quickly help enterprises obtain knowledge, skills, and relationships from stakeholders that are beneficial to technological innovation, and improving CSR will have a strong incentive effect on technological innovation. At the same time, the higher intellectual capital means that the internal resources of enterprises are sufficient, and enterprises are no longer limited to the contradiction of resource allocation between fulfilling social responsibility and carrying out technological innovation. Thus, they are less likely to be constrained by the problem of resource scarcity when the crowding-out effect of CSR is greatly reduced. In other words, CSR will enhance the positive effect of intellectual capital on technological innovation after a certain threshold is exceeded.

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