The Impact of Personal Knowledge Management on Technological Innovation from the Knowledge Field Perspective: A Case Study of X Enterprise (Postprint)

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Abstract

[Purpose/Significance] Corporate technological innovation is crucial for enterprises to keep pace with the times. Focusing on the individual level and investigating how knowledge management influences technological innovation from the knowledge field perspective, this study aims to overcome the limitations inherent in previous organizational-level research.

[Method/Process] Adopting a case study approach and taking the three stages of the knowledge field—practice field, thematic knowledge community, and social knowledge network—as the logical foundation, this research constructs a framework for investigating the impact of personal knowledge management on technological innovation, and examines how this process influences both breakthrough technological innovation and incremental technological innovation.

[Results/Conclusion] The findings indicate that personal knowledge constitutes the core and foundation of organizational technological innovation. A virtuous cycle of personal knowledge management formed through knowledge accumulation, knowledge radiation, knowledge sharing, and knowledge application can effectively facilitate technological innovation.

Full Text

Preamble

The Impact of Personal Knowledge Management on Technical Innovation from the Perspective of Ba: A Case Study of X Enterprise

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Abstract

[**Purpose/Significance**] Enterprise technical innovation is crucial for firms to keep pace with the times. This study examines how knowledge management influences technical innovation from the perspective of Ba at the individual level, aiming to overcome the limitations of previous organizational-level research. [**Method/Process**] Using case analysis, this paper constructs a research framework for the impact of personal knowledge management on technical innovation based on the three stages of Ba—the practice field, thematic knowledge community, and social knowledge network—and investigates how this process affects both breakthrough and incremental technical innovation. [**Result/Conclusion**] The findings indicate that personal knowledge constitutes the core and foundation of organizational technological innovation. A virtuous cycle of personal knowledge management formed through knowledge accumulation, knowledge radiation, knowledge sharing, and knowledge application can effectively promote technical innovation.

Keywords: personal knowledge management; social exchange theory; social learning theory; Ba; technical innovation; high-tech enterprise

Classification Numbers: C939; G302

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Introduction

In the era of the knowledge economy, innovation has become a core element for sustainable enterprise development. Enterprise technical innovation stems from talent acquisition and knowledge accumulation, and the success of innovation largely depends on existing knowledge [1-2]. Knowledge management has always been a critical internal issue for enterprises, as effective knowledge management enables rational knowledge utilization and promotes innovation across all aspects of the organization. However, how to implement knowledge management at the individual employee level remains a practical challenge. Previous research on the relationship between knowledge management and enterprise technical innovation has predominantly focused on the organizational level. While numerous empirical studies have analyzed various factors affecting technical innovation—such as knowledge accumulation, knowledge absorption, and knowledge sharing—few have explored how knowledge management at the individual level influences technical innovation, or the mechanisms through which such influence occurs.

Therefore, this study focuses on technical personnel in high-tech enterprises, using case research to establish the content of three stages of personal knowl-

edge management and proposing hypotheses regarding the relationships among these components and their connections to technical innovation, which are subsequently supported theoretically. This research breaks through the previous limitation in personal knowledge management studies that concentrated primarily on educational groups such as teachers, students, and librarians [3], while also addressing the relative gap in research on the relationship between personal knowledge management and technical innovation.

The knowledge-based view posits that knowledge possesses characteristics of scarcity and inimitability. Enterprises accumulate and integrate existing knowledge to promote knowledge creation. Furthermore, this perspective conceptualizes the firm as a knowledge-processing system whose core capabilities derive from tacit knowledge [4]; only through continuous innovation can enterprises maintain competitiveness. Perspectives on the relationship between knowledge and innovation fall into two categories: (1) Enterprise innovation depends on knowledge heterogeneity, which involves leveraging inter-firm relationships for innovation, but this view overlooks the firm's own knowledge base and stock; and (2) Enterprise innovation depends on the existing knowledge base, emphasizing independent innovation. The knowledge-based view of the firm considers the enterprise as a collection of knowledge elements, with innovation resulting from the integration and recombination of these elements [4-5]. Knowledge creation involves screening, absorbing, and assimilating existing knowledge, refining it into a foundation for creating new knowledge frameworks that enable enterprises to continuously renew their competitive advantages [6]. Consequently, effective knowledge management is particularly crucial.

Social exchange theory is based on the principle of reciprocity, where interactions between individuals constitute an exchange process. Scholars have found that social exchange theory is closely related to knowledge sharing, viewing knowledge sharing as a form of social exchange behavior [7]. Social learning theory posits that human behavior is influenced by the interaction between environment and individual cognition, primarily acquired through observation and imitation. Individual behavioral norms and standards can be conveyed to employees through social learning processes. Employees shape their behavioral patterns by perceiving phenomena within the organization [8], and knowledge sharing among employees is also influenced by the organizational environment [9].

Literature Review

2.1.1 Current Research Status of Personal Knowledge Management

P. A. Dorsey first proposed a preliminary concept of personal knowledge management, defining it as a set of problem-solving methods and techniques encompassing both logical conceptual and practical exploratory dimensions, including information retrieval, evaluation, organization, analysis, and information collaboration. J. Frand and colleagues defined personal knowledge management

(PKM) as a system designed for individual learning that transforms potentially random information into usable information, thereby expanding our knowledge reserves [10]. This aligns with the framework proposed by P. A. Avery, where maintaining communication and building trust with peers constitutes the core of personal knowledge management. Subsequently, K. Wright' s research indicated that PKM is even a natural and unconscious process—the ability to acquire and apply information, knowledge resources, and processes to enhance individual efficiency, productivity, and innovation capacity [11].

Some scholars tend to view personal knowledge management as an interactive process among individuals, others, and ideas—a method to support knowledge worker productivity from the perspective of knowledge workers. For example, L. Effimova proposed a personal knowledge management framework that maps three dimensions of knowledge worker activities: individual, community and network, and ideas [12]. R. K. F. Cheong and E. Tsui conducted a classified analysis of previous scholars' research and offered relevant insights: the main purpose of personal knowledge management is to provide a framework for managing new information and integrating it to enrich people' s personal knowledge databases in an effective manner, enabling them to use personally acquired knowledge to handle old and new problems, learn from experience, create new knowledge, and maintain a continuous interactive process. The four core components of personal knowledge management are personal information management (PIM), personal knowledge internalisation (PKI), personal wisdom creation (PWC), and interpersonal knowledge transferring (IKT). Among these, inter-personal knowledge transfer plays an important role in personal knowledge management, maximizing each other' s knowledge and providing individuals with a knowledge collaboration environment [13]. PKM is a two-way transfer conducted through different social activities in both face-to-face and virtual models, diverting knowledge work from being individual-centered to being community and society-centered, with technology becoming the most critical enabling factor.

Domestic research on personal knowledge management primarily includes: early personal knowledge management systems were processes triggered by individuals as the core, without involving communication and knowledge sharing with others, such as using literature management, electronic notes, and electronic concept mapping systems to help people form orderly knowledge. In later stages, people achieved knowledge exchange, sharing, and collaboration through online conversations and literature annotations. Chinese scholar Kong Dechao [14] divided personal knowledge management into three components: (1) individuals managing acquired knowledge; (2) learning from each other' s experiences to compensate for knowledge gaps and continuously build a unique knowledge base; and (3) elevating existing knowledge through one' s own knowledge reserves and unique thinking patterns to stimulate knowledge innovation. Yang Helin [15] argued that personal knowledge management is human-centered, open learning aimed at knowledge innovation, treating knowledge as a developable resource. Its purpose is to consciously manage personal knowledge, gradually establish and improve one' s professional knowledge system, and ultimately achieve knowledge

innovation through interaction with others. Yang Yuxi and Deng Shengli categorized personal knowledge management motivations as coping with personal information and knowledge overflow, enhancing personal core competitiveness, meeting knowledge sharing needs, and effectively learning fragmented knowledge [16].

Through reviewing and analyzing relevant domestic and international research on personal knowledge management, this study defines personal knowledge management as an individual-centered process of identifying, acquiring, and storing needed knowledge, engaging in inter-individual communication, internalizing external explicit knowledge as one' s own, and thereby creating new knowledge.

2.1.2 Ba (Knowledge Field)

I. Nonaka defined Ba as a shared space for emerging relationships, which can be physical, virtual, or even mental—a platform provided to advance individual or collective knowledge [7,17]. Ba is divided into four types: originating, dialoguing, systematizing, and exercising. According to the Chinese context, domestic scholar Xu Hongcai [18] classified personal knowledge management learning fields into three stages: practice field, thematic knowledge community, and social knowledge network. The practice field is the specific stage where individual learners solve problems as tasks and independently complete knowledge management. The thematic knowledge community is a knowledge field formed by multiple learners gathering around common learning themes to interact and collaborate. The social knowledge network involves all learning subjects actively participating in learning based on sociocultural contexts. A knowledge network is a social network that provides knowledge and information, while personal knowledge represents specific nodes on this network. Personal Ba plays a crucial role in the acquisition, digestion, and sharing of personal knowledge. In the practice field, employees internalize external knowledge to create corresponding new knowledge. The thematic knowledge community involves employees gathering around common learning themes, where employees' autonomous learning is stronger than in the previous learning field, enabling them to obtain information beyond problem-solving orientation. Employees exchange and cooperate with each other to screen and identify needed information while compensating for weaknesses in personal thinking and skills, thereby improving their knowledge frameworks and generating more new knowledge. The social knowledge network expands the learning subject to the societal level, with the previous two types of Ba nested within it. Each individual' s knowledge serves as connection points in the network, linking together to form a knowledge network. The essence of a knowledge network is cooperative relationships [19], where individuals interact and implement cooperation based on mutual trust and internal drive. From the functional processes at each level, Ba influences sequentially and positively promotes knowledge creation.

Enterprise Technical Innovation Research

Schumpeter first introduced "innovation" into economic theory, summarizing it in his work *The Instability of Capitalism* as a process, and later used the concepts of "creative destruction" and "new combinations" in his 1934 *Theory of Economic Development*, arguing that the essence of innovation is the recombination of production factors or conditions to create new value and benefits [20]. According to R. L. Daft' s 1978 classification, innovation is divided into technical innovation and management innovation, where technical innovation concerns the organization' s core technology, including adopting advanced production processes, optimizing raw material utilization, and efficient manufacturing and packaging [21]. Li Zhen defined technical innovation as a dynamic process of utilizing existing technology combinations, absorbing external new knowledge, transforming it into commodities, and achieving commercial value [22]. Since the late 1990s, technical innovation has entered a stage centered on knowledge and learning [23]. From a knowledge-based perspective, R. D. Dewar classified technical innovation into incremental and breakthrough technical innovation based on intensity [24]. The former focuses on utilizing internal knowledge accumulation, continuously improving technology along existing technical routes to meet dynamically changing customer needs; the latter requires extensively using internal and external information and knowledge, integrating and creating them to form entirely new technologies and market them [25]. Therefore, from the perspective of technical innovation sources, technical innovation originates from knowledge, making effective management of knowledge resources an inevitable requirement for enterprise technical innovation development [26].

Previous research on the relationship between knowledge management and technical innovation indicates that enterprise knowledge management in dynamic environments helps improve innovation capability, where knowledge accumulation has increasing marginal benefits for innovation capability, and knowledge sharing has an inverted U-shaped relationship with innovation capability [27]. The accumulation of internal technical knowledge and the quantity and quality of knowledge mined by enterprises are primary factors affecting technical innovation performance [28]. Knowledge sharing positively influences technical innovation both within and across organizational contexts [29-30], while social networks also promote technical innovation through knowledge sharing, highlighting the important role of knowledge sharing in knowledge management and technical innovation. From the perspective of knowledge management as a whole, the synergy between knowledge management and human resource management can effectively enhance technical innovation capability [31-34]. From the viewpoint of knowledge management' s effect on technical innovation, knowledge management expands knowledge breadth and depth through effective management; at the organizational level, knowledge sharing accelerates knowledge accumulation, and different thinking patterns improve problem-solving efficiency, promoting innovation generation and increasing success rates.

However, both technical knowledge accumulation and independent innovation

depend on individuals. Personal knowledge management forms the foundation of organizational knowledge management [35]. Compared with enterprise knowledge management, personal knowledge management adopts a bottom-up approach to knowledge management. Individuals combine acquired and accumulated knowledge with personal experience to form unique personal knowledge, which is then shared among knowledge subjects to effectively transform unique individual knowledge into unique organizational knowledge, thereby driving organizational benefits through personal benefit enhancement [36]. Therefore, research on the relationship between personal knowledge management and technical innovation is highly necessary.

This chapter preliminarily establishes the specific content of personal knowledge management corresponding to the three Ba: practice field, thematic knowledge community, and social knowledge network. Given the limited previous research on the relationship between personal knowledge management and technical innovation, this study conducts a case analysis of technical personnel, theoretically exploring the relationships among personal knowledge management elements and their impact on technical innovation to establish a relevant theoretical framework.

Methodology

This study employs semi-structured interviews, designing the main interview outline in advance while allowing for adjustments and refinements during the interview process. The entire process includes interview preparation, contacting interviewees, conducting interviews, and organizing and analyzing data.

Three technical employees from a high-tech enterprise in Zhejiang were selected for interviews. The basic information of the respondents is shown in Table 1 .

Table 1 Basic Information of Respondents

Respondent	Profile
A	Male, 34 years old, Technical Sales Deputy Manager, 7 years of experience
B	Male, 41 years old, Design Engineer, 18 years of experience
C	Male, 36 years old, Technical Manager, 14 years of experience

Excerpts from the respondents' answers are as follows:

Respondent A: "I am mainly engaged in technical sales work, requiring me to use my technical background to correctly identify customer needs, formulate test plans and design products for customers, and provide technical services···

At work, I search for relevant information based on tasks assigned by superiors and continuously accumulate knowledge based on previous experience, forming my own knowledge base. When similar problems arise next time, I can quickly retrieve corresponding solutions···I also feel that knowledge updates quickly and need to continuously acquire and accumulate similar knowledge related to my work through the internet, books, consulting experts, and practice. I set aside specific time each month to organize and summarize newly learned knowledge, making document records on my computer. When encountering technical difficulties, I first engage in autonomous learning, and if problems remain unsolved, I consult colleagues. My usual interactions with colleagues mostly revolve around discussing problems, but I also acquire heterogeneous knowledge during casual conversations. When colleagues ask me for advice, I am very willing to share what I know, and we subsequently collaborate. Sharing and communicating with colleagues can sometimes stimulate new ideas. I can also apply professional knowledge well to practical work, generally using theory as guidance to solve real-world problems, which gives me a great sense of achievement when I can apply what I' ve learned. I believe enterprise technical innovation is related to personal knowledge management. As the ancients said, 'Reviewing the old to learn the new,' only when knowledge is continuously accumulated and effectively managed can innovation be stimulated. For example, after understanding the conditions under which nylon 66 customers use the product and based on my understanding and knowledge of PET, I created a PET product that mimics nylon 66 under specific conditions."

Respondent B: "I am engaged in product design and development work. The main process involves collecting information and products from the market through sales, combining them with existing production line processes, and developing new products. The workflow includes: (1) New product development: following the Advanced Product Quality Planning (APQP) process; (2) Change management process: following change application—change feasibility assessment—change execution—change verification—change approval; (3) Tooling management: daily inspection, annual inspection, and incoming inspection. Generally, starting from receiving a task, I follow the Plan-Do-Check-Act (PDCA) approach to collect information and historical similar case experiences to make task plans, check and compare goals during implementation, and after task completion, summarize and standardize work, promptly sharing it with team members to form collective memory and enhance the team' s problem-solving capabilities. However, I feel that knowledge in both technical and management aspects updates and iterates very quickly. Technically, customers have increasingly higher requirements for conventional products and urgent needs for differentiated products. I actively communicate with and consult colleagues, customers, and suppliers, and acquire more in-depth similar knowledge from paper websites and technical journals to improve products. In terms of management, I acquire heterogeneous knowledge from management books and online paid audio courses to expand my knowledge scope, particularly to understand the thinking patterns of the post-2000 generation to better manage the team. Additionally,

I take both paper and electronic notes, then imagine the connection points between this knowledge and daily work, transform it into my own language, and explain the knowledge to team members. This not only improves my mastery of the knowledge—knowledge that can be taught to others is definitely firmly mastered—but also brings team members closer and enhances their capabilities. When encountering problems, I ask colleagues if they have encountered similar issues and how they handled them, generally obtaining useful information to accelerate problem resolution. If no one has prior experience, we form a task force to search for information, conduct experiments, create group chats for communication until the problem is solved or a temporary alternative measure is found, and then share the experience summary with team members. Interactions with colleagues generally revolve around solving new problems, sharing and exchanging knowledge together. In-depth communication and idea collisions enable me to master heterogeneous knowledge. Experience in collaborating with them and developing new products are both conducted in APQP team form. Knowledge sharing allows me to grasp knowledge more deeply and firmly and generates opportunities for innovative ideas. Subsequently, applying knowledge to practical work gives me a great sense of achievement and value realization. In daily work, I consciously theorize and standardize problem-solving experiences guided by theory and share them with the team. Effective personal knowledge management promotes the generation of technical innovation. Senior professionals in this industry can lead product technical transformation and upgrading, which they can only achieve after years of experience. We must also do well in personal knowledge management to promote knowledge innovation at the team and organizational levels, thereby accelerating technical innovation."

Respondent C: "My job content roughly includes: (1) New product development: following the APQP process; (2) Change management: change application—change feasibility assessment—change execution—change verification—change approval; (3) Tooling management: daily inspection, annual inspection, and incoming inspection. Generally, starting from receiving a task, I follow the PDCA approach to collect information and historical similar case experiences to make task plans, check and compare goals during implementation, and after task completion, summarize and standardize work, promptly sharing it with team members to form collective memory and enhance the team' s problem-solving capabilities. However, I feel that knowledge in both technical and management aspects updates and iterates very quickly. Technically, customers have increasingly higher requirements for conventional products and urgent needs for differentiated products. I actively communicate with and consult colleagues, customers, and suppliers, and acquire more in-depth similar knowledge from paper websites and technical journals to improve products. In terms of management, I acquire heterogeneous knowledge from management books and online paid audio courses to expand my knowledge scope, particularly to understand the thinking patterns of the post-2000 generation to better manage the team. Additionally, I take both paper and electronic notes, then imagine the connection points between this knowledge and daily work, transform it into my own language, and

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Interview Analysis

Respondent A, engaged in technical sales, recognizes that effective personal knowledge management can stimulate technical innovation. He outlined the necessity of personal knowledge accumulation, sharing, and application in his work, as well as how to manage personal knowledge. Regarding personal knowledge accumulation, A mentioned collecting information based on assigned tasks and combining it with personal experience to transform it into his own knowledge. He also accumulates heterogeneous knowledge through autonomous learning and communication and cooperation with colleagues, documenting it systematically. In terms of personal knowledge sharing, he is willing to share knowledge with colleagues and collaborate to stimulate new ideas. For personal knowledge application, he uses theory to guide practical problem-solving, achieving the application of learning.

Respondent B, a design engineer engaged in product design and development, proposed that personal knowledge management enables employees to consider problems more comprehensively in practice. He noted differences in knowledge reserves among employees, which this study refines as "knowledge radiation."His statement that "whenever new products and processes are developed, summaries are formed. When similar problems reoccur, previous solutions are referenced and adjusted to meet needs" fully demonstrates the necessity of information

processing and transformation into personal knowledge for work. He classifies and organizes acquired knowledge into documents, and when developing new processes, interactions with colleagues mostly revolve around problem-solving to understand market orientation and collaboratively complete product design and development. He also communicates with colleagues based on shared interests. He emphasized the importance of accumulating both similar professional knowledge and heterogeneous knowledge, as well as deepening and broadening knowledge for problem-solving. He noted that innovation cannot occur without teamwork or personal knowledge reserves. After knowledge application, parameters are set according to existing production processes, trial spinning is conducted on machines, and data is tested—all of which are processes for innovation implementation.

Respondent C, a technical manager, recognizes the indispensable role of autonomous learning in personal knowledge management and that personal knowledge management forms the foundation for team and organizational-level knowledge management. He emphasizes that personal knowledge management significantly influences technical innovation. C actively engages in interpersonal interactions, conducts autonomous learning through both online and offline channels, and combines knowledge with work to transform it into his own language for internalization. His statements– "after task completion, summarize and standardize work, promptly share with team members to form collective memory" and "take good notes and electronic notes, then imagine the connection points between this knowledge and daily work, transform it into your own language, explain knowledge to team members···to close relationships" – demonstrate the cross-level impact of personal knowledge management: gradually enhancing team members' capabilities to improve enterprise knowledge management effectiveness. Using personal leadership to drive team members to solve problems together, knowledge sharing promotes deeper knowledge mastery. His work content includes change feasibility assessment, change trial implementation, and change verification. When new technologies are tested and problems arise, adjustments must be made according to these steps to promote technical innovation implementation. Meanwhile, these long-accumulated experiences can provide guarantees for product technical transformation, upgrading, and innovation.

Interview Conclusions

The three respondents from this enterprise unanimously agreed that: (1) The organization frequently proposes many methods to improve product processes or operational procedures and introduces new technologies that can improve processes or operational procedures; the organization can develop products or services that meet market trends, with relatively high profits coming from newly developed products or services; (2) Compared with peer enterprises, the organization obtains more science and technology awards, and adjusts service items and improves service methods according to changes in market and customer

needs, or changes research concepts, methods, and models according to social, technological, and management development needs; (3) The organization has certain rules, procedures, and methods to identify, summarize, organize, and disseminate employees' personal knowledge; (4) The organization can integrate employees with various knowledge expertise to work together, and employees solve problems through mutual coordination and cooperation.

These interview results regarding the relationship between personal knowledge management and technical innovation can also be verified from the company' s annual reports for the past three years: enterprise R&D investment has shown an upward trend, correspondingly, the enterprise has continuously generated new products or processes. In 2018, it developed high-barrier high-low modulus shrinkage fiber products; in 2019, the enterprise independently developed and successfully created polyester-based automotive airbag yarn to replace nylon, and also developed six new products (such as "SPC ultra-wear-resistant flooring"); in 2020, it completed acceptance work for upgraded new products and technologies, including the development of processes for polyester replacing nylon 66. The overall revenue trend of this high-tech enterprise has also increased.

Theoretical Framework

Based on the above theoretical foundation, case analysis, and Xu Hongcai' s three Ba, this study proposes a research framework for the impact of personal knowledge management on technical innovation (see Figure 1 [Figure 1: see original paper]). The practice field includes information processing and knowledge accumulation; the thematic knowledge community includes autonomous learning and interpersonal interaction; and the social knowledge network includes knowledge radiation, knowledge sharing, and knowledge application. The three Ba respectively promote professional knowledge accumulation, stimulate new ideas through heterogeneous knowledge accumulation, and facilitate innovation implementation through the above personal knowledge management content.

The Impact of Personal Knowledge Management on Technical Innovation

Practice Field Stage In the practice field stage, knowledge subjects conduct personal knowledge management oriented toward problem-solving. Employees first complete their own tasks, then invest certain energy and time into knowledge management activities, such as establishing documents to record past experiences in dealing with problems. According to resource conservation theory, resources are limited. When energy and time are considered limited resources, investing substantial effort in personal knowledge management creates greater expectations for achieving the direct goal of knowledge creation.

Information Processing Employees first need to search for required information based on assigned tasks—finding as much information as possible while possessing the ability to evaluate information to filter out what is useful. In addition to existing information, they need to trace effective information back to its source to continue finding valid information. Next, they encode and transform the searched effective information, reprocessing it during this period, and finally represent it in propositional form, combining theory with practice to form a grasp of the regularities of work, social, and thinking activity patterns, storing it in the brain as meaningful knowledge for employees [15]. Subsequently, individuals organize knowledge—that is, after fully understanding acquired knowledge, they combine it with actual work to codify and order it. Employees also need to classify knowledge for future retrieval and utilization. When individuals receive external stimuli again—that is, when similar problems arise—they can promptly search their constructed knowledge base for solutions matching the problem, which is the assimilation process.

Knowledge Accumulation Enterprises achieve independent innovation or promote innovation through alliances by acquiring, accumulating, and integrating knowledge at their own level. Incremental technical innovation in technological innovation has continuity characteristics and requires prior knowledge accumulation [37]. Yang Fei divided knowledge accumulation into personal knowledge accumulation and organizational knowledge accumulation. Personal knowledge accumulation is completed through learning, communication, cooperation, and imitation [38], with internal individual accumulation methods including the process of knowledge internalization and externalization, learning through practice, and training [39]. Enterprise internal knowledge accumulation mainly refers to individuals forming knowledge-creating abilities through learning to promote better application of new knowledge to improve and expand products, processes, and management methods.

This study analyzes the role of knowledge accumulation and its mechanisms for promoting technical innovation from the individual level. Knowledge accumulation primarily promotes incremental technical innovation through application and absorption mechanisms [39]. On one hand, scholars believe that knowledge is an important source of innovation, but achieving innovation must rely on knowledge application—only through application can knowledge play its role [40]. On the other hand, the stronger employees' absorptive capacity, the stronger their ability to identify new opportunities, analyze market opportunities, and digest external knowledge, thereby promoting technical innovation generation. Zhang Zhengang compares individuals to "gatekeepers" and "transformers" in the knowledge absorption process—the former screens acquired external knowledge, while the latter transforms external knowledge into more easily understandable forms [41]. Since knowledge internalized by individuals is often closely connected with personal experiences, habits, and contexts, it is difficult to express like other explicit knowledge. However, this unique knowledge is the fundamental source of innovation. People are more willing to accumulate knowledge

related to their tasks to form core competitiveness and maintain their position in the organization. This aligns with the view that "highly related knowledge flows faster under network growth strategies than knowledge with low relatedness" [42].

It is worth noting that knowledge accumulation involves not only quantitative accumulation but also qualitative improvement. Enterprises can provide employees with corresponding professional knowledge and skills training to keep them informed about the frontiers of development in their fields and acquire high-quality knowledge. When knowledge workers accumulate high-quality knowledge, their absorptive capacity also strengthens, enabling such knowledge workers to quickly identify new opportunities. Only by obtaining new opportunities from the external environment to stimulate individuals to generate new ideas can existing technical deficiencies be continuously improved, making technical innovation possible. Even when external environmental changes cause previous knowledge to become obsolete and reduce available organizational knowledge, employees who have accumulated sufficient high-quality knowledge can quickly identify new market demands and promptly adjust the organization' s current trajectory due to improved accuracy in obtaining external information. While effectively responding to threats posed by environmental turbulence to the enterprise, knowledge subjects can also invest their held knowledge into technical innovation, combined with the application of already mastered technical principles, jointly driving technical innovation.

In the practice field stage, employees should cultivate good learning habits and awareness of information utilization. Therefore, after knowledge individuals draw experience from completed tasks and absorb and internalize it as their own knowledge, when similar problems arise again, employees can efficiently respond, reducing time spent on problem-solving and thus investing more energy into innovation work.

Thematic Knowledge Community Stage Compared with the previous stage, the thematic knowledge community adds interaction steps among employees, and knowledge management shifts from problem-solving orientation to shared interest orientation. When related activities align with employee interests, group members have higher willingness to engage in knowledge exchange [43]. Employees share and exchange their own knowledge, thereby increasing the heterogeneity of individual knowledge and effectively "learning from others' strengths to compensate for one' s weaknesses," while also making employees aware of their deficiencies in professional fields. They absorb other basic knowledge within the organization and exchange knowledge with like-minded internal employees, which facilitates knowledge subjects to draw valuable knowledge from different fields, thereby stimulating the generation of new ideas and leveraging the advantages of cross-domain integration to produce breakthrough innovations in technology.

Autonomous Learning In the thematic knowledge community, employees tend toward autonomous learning, which is mainly reflected in three aspects: "self-reliance," "self-action," and "self-discipline." The core of autonomous learning is "self-reliance,"meaning that learning individuals are relatively independent people whose psychological cognitive systems have uniqueness and differences. When individuals receive external information stimuli, they do not merely react mechanically to environmental stimuli but form perceptions of the external environment through unique personal cognition. For example, the internal enterprise environment includes unstable factors such as position changes and personal reputation, which make employees, especially knowledge workers, realize that failing to update knowledge in a timely manner threatens their own status. Additionally, individual beliefs and motivations strongly govern behavior, with resulting outcomes reacting back on individuals, stimulating emotional responses and affecting their thinking patterns. Due to cognitive differences among individuals, even when facing the same information, they will selectively absorb it, combining it with past experiences to produce their unique knowledge.

Compared with the previous stage, the thematic knowledge community provides knowledge workers with sufficient basic knowledge to stimulate technical creativity. Employees identify product service object needs, seize new opportunities, generate new ideas, and form the primary fuzzy form of technical innovation. Employees then evaluate the feasibility, input costs, expected benefits, and substitutability of innovations based on existing knowledge bases to determine whether development can proceed.

The social learning process is explained by social learning theory, where triadic reciprocal determinism explores the dynamic relationships among environment, individual, and behavior—each independent yet interacting. First, behavioral subjects do not merely make mechanical responses to environmental stimuli but form perceptions of the external environment through personal unique cognition. The internal enterprise environment includes unstable factors such as position changes and personal reputation, which make employees, especially knowledge workers, realize that failing to update knowledge in a timely manner threatens their own status. Additionally, individual beliefs and motivations strongly govern behavior, with resulting outcomes reacting back on individuals, stimulating emotional responses and affecting their thinking patterns. Due to cognitive differences among individuals, even when facing the same information, they will selectively absorb it, combining it with past experiences to produce their unique knowledge.

If the proportion of basic knowledge is too large while professional knowledge proportion is too small, it will lead to employees not having refined professional skills to support technical innovation. Therefore, a reasonable personal knowledge structure enables employees to recognize their deficiencies and find suitable personal knowledge management methods to improve management effectiveness [44]. In this stage, individuals not only possess stable professional knowledge accumulated in the practice field but also acquire sufficient basic knowledge

through autonomous learning. A scientific and reasonable knowledge structure helps knowledge individuals become proficient in their professional fields.

Interpersonal Interaction Compared with the previous stage, the thematic knowledge community adds interaction steps among employees. When related activities align with employee interests, group members have higher willingness to engage in knowledge exchange [43]. Employees share and exchange their own knowledge, thereby increasing the heterogeneity of individual knowledge and effectively "learning from others' strengths to compensate for one's weaknesses," while also making employees aware of their deficiencies in professional fields. They absorb other basic knowledge within the organization and exchange knowledge with like-minded internal employees, which facilitates knowledge subjects to draw valuable knowledge from different fields, thereby stimulating the generation of new ideas and leveraging the advantages of cross-domain integration to produce breakthrough innovations in technology.

When some employees receive stimulation from other employees' knowledge management and see their own professional skills improved, they will also react by learning, promoting collective learning and generating synergistic benefits. When the above stimuli from external information and colleagues act on personal cognition, the balance of individuals' original cognitive structures is broken. To achieve cognitive structure balance again, knowledge subjects need to internalize new stimuli. When encountering completely new problems, employees cannot retrieve matching knowledge and experience from existing knowledge bases, requiring them to adjust their cognitive structures to adapt to challenges posed by external environmental changes—the accommodation process. This stage aligns with the behaviorist learning theory's view that "the connection formed between stimulus and response constitutes learning."

Social Knowledge Network Stage The social knowledge network stage emphasizes knowledge radiation, knowledge sharing, and knowledge application among various knowledge subjects. Knowledge radiation helps those who master more knowledge resources to flow knowledge to other employees, placing all employees in an environment of knowledge flow. Knowledge sharing among knowledge subjects compensates for individual deficiencies and absorbs others' advantages. Applying the theoretical knowledge obtained through the above processes can better identify existing technical gaps and improve deficiencies in existing technologies, thereby achieving incremental technical innovation.

Xiao Dongping defines a knowledge network as a network system composed of multiple knowledge chains with functions such as knowledge sharing and knowledge creation [45]. Research on internal enterprise knowledge networks from a social network perspective focuses on how knowledge flows and is shared among knowledge subjects and the process of promoting technical innovation. This study's research objects are internal enterprise employees, aligning with the social network perspective's focus. The knowledge network in the social

network perspective is a social network composed of knowledge participants, through which knowledge flows, is shared, and created at different levels by these knowledge workers. Unlike cooperation networks, knowledge networks solve "technology selection" problems by analyzing relationships among technical elements [46]. This stage requires members to actively participate and exchange knowledge with each other, similar to interpersonal knowledge transfer, one of the four cores of the personal knowledge management model proposed by R. K. F. Cheong et al. The motivation for knowledge network formation is to find complementary knowledge, with the main task being to promote knowledge sharing behavior among knowledge workers and inhibit knowledge hiding behavior, strengthening knowledge application. Therefore, this section first analyzes the characteristics of knowledge networks, then examines how personal knowledge management affects technical innovation from three aspects influenced by it: knowledge radiation, knowledge sharing, and knowledge application.

Knowledge Network Characteristics According to the structural dimension of knowledge networks, they can be divided into knowledge network size, knowledge network centrality, knowledge network openness, and network density, while the relational dimension generally refers to tie strength.

(1) Structural Dimension. Knowledge network size: The larger the internal knowledge network scale, the more knowledge workers participate. Individuals' knowledge acquisition channels increase with the number of knowledge subjects, enabling employees to combine knowledge according to current needs or future career planning. Therefore, larger knowledge network scales increase the probability of individuals contacting different types and depths of knowledge, thereby generating new ideas and promoting technical improvement and innovation. Network centrality refers to the degree to which knowledge subjects are at the center. Centrality means having more knowledge acquisition channels and knowledge control rights, with faster knowledge acquisition speed compared to other knowledge subjects. However, employees at the center of knowledge networks may develop territorial awareness, reducing cooperation with other employees, which may negatively affect technical innovation to some extent. Higher knowledge network openness reflects higher organizational culture openness, making it easier to form a more inclusive and knowledge-sharing-motivating organizational atmosphere within the organization. This facilitates knowledge subjects to broaden their horizons, absorb new knowledge from other employees within the organization, and also acquire knowledge from outside the enterprise—from peer enterprises or other technical alliances—allowing different types of knowledge to permeate each other. Knowledge networks continuously renew themselves and expand boundaries to achieve technical innovation. Enterprise knowledge network density and stability increase as knowledge accumulates from the individual level to the organizational level. Wu Jiebing argues that overly dense knowledge networks weaken enterprises' knowledge acquisition capabilities, causing network closure [47]. Xie Hongming [48] believes that network density promotes technical innovation through positive regulation of

learning ability, and subsequent research found that in large and medium-sized enterprises, network density significantly positively affects technical innovation [49]. However, for small enterprises, network density' s impact on technical innovation performance is not obvious. Based on previous research, this study argues that overly dense knowledge networks lead to poor knowledge absorption within enterprises, reducing external knowledge absorption efficiency and instead hindering enterprise knowledge creation. Tie strength and network density are positively correlated; high density is not conducive to new heterogeneous knowledge entering the enterprise. Therefore, this study argues that relatively low-density knowledge networks can promote the entry of heterogeneous knowledge, enriching knowledge diversity within the network and laying the foundation for different viewpoints and ideas.

(2) Relational Dimension. Knowledge network relational characteristics refer to tie strength—that is, communication frequency, distance, trust, reciprocity, and cooperation among knowledge subjects. Tie strength can promote the establishment of trust and reciprocity among subjects, especially facilitating the sharing of tacit knowledge. However, other scholars propose that strong ties weaken knowledge subjects' adherence to their own viewpoints, thereby reducing individual creativity [50].

This study argues that greater tie strength represents closer communication among subjects, higher knowledge sharing frequency, and frequent interaction that generates knowledge spillover and diffusion for acquisition by other employees within the knowledge network. As a strategic resource, knowledge has complexity and uniqueness. Only when solid trust foundations are established among knowledge subjects will knowledge helpers show willingness to share knowledge to supplement others' knowledge gaps when knowledge seekers request technical assistance. However, since tie strength and knowledge network density are positively correlated, when tie strength is too strong, external differentiated knowledge cannot easily enter, and different opinions are difficult to emerge internally because viewpoints converge, tolerance decreases, and thinking becomes rigidified. Therefore, moderate tie strength is conducive to external knowledge entry.

Knowledge Radiation Economic radiation theory was originally applied in regional economics, referring to the exchange of capital, talent, technology, and other elements between regions with higher and lower economic development levels, as well as the dissemination of culture and living habits, aiming to improve the allocation efficiency of economic resources [51]. Foreign scholar G. Myrdal proposed the circular cumulative causation theory, arguing that economic development is not uniformly diffused but simultaneously involves backwash effects and spread effects [52]. As a strategic resource, knowledge also needs efficient utilization. One structural dimension of knowledge networks—centrality—reflects knowledge subjects' control over knowledge and possession of multiple knowledge acquisition channels. Therefore, knowledge subjects in central positions

have central radiation effects. Similarly, backwash effects and spread effects occur during knowledge radiation. On one hand, knowledge subjects in central positions have priority access to various types of knowledge and opportunities, with external diffused knowledge flowing toward the center along knowledge chains—knowledge backwash. Compared to other nodes, these central subjects have more significant knowledge richness and depth. On the other hand, spread effects manifest as knowledge from central positions flowing to other nodes, generally from knowledge-rich to knowledge-scarce directions. Due to the authority held by central knowledge subjects, individuals at other network nodes are influenced by this authority on a large scale and to a deep degree, causing them to regulate their behavior and engage in positive emulation—that is, continuously and actively participating in learning, timely updating knowledge reserves, and promoting knowledge innovation to maintain their core competitiveness. Meanwhile, employees' willingness to contribute new ideas gradually increases, and the frequency of idea collisions in the social knowledge network stage also rises accordingly. Therefore, knowledge subjects in central network positions should fully exert knowledge radiation effects, actively transmitting acquired frontier explicit knowledge and self-summarized tacit knowledge to other members to achieve knowledge diffusion and stimulate the potential of various knowledge subjects.

Knowledge Sharing Knowledge flow is knowledge sharing within organizations [53]. Knowledge sharing is the source of new knowledge generation, a pathway to improve knowledge utilization efficiency, and a key element in social knowledge networks. According to social exchange theory, knowledge sharing behavior among knowledge workers is controlled by sharing motivations, which include economic, reputational, reciprocal, and altruistic aspects. Personal knowledge sharing motivation is also influenced by economic factors—when employees realize the connection between sharing behavior and incentives, they are more inclined to selflessly participate in knowledge sharing. Employees with high concern for personal reputation typically expect positive evaluations from others and try to avoid negative evaluations, thus having stronger willingness to cooperate and share knowledge with others. Meanwhile, since sharing one' s own knowledge may threaten one's core competitiveness, knowledge workers use this as motivation to continuously acquire new knowledge, thereby alleviating concerns about knowledge outflow. When facing knowledge seekers, individuals choose to provide knowledge assistance based on reciprocal motivation, hoping their efforts can achieve benign interaction with the other party and receive corresponding returns [54]. Altruistic motivation is the opposite of the reciprocity principle—if employees frequently help others, they derive self-satisfaction from it and are willing to help seekers and share knowledge in interpersonal interactions. However, reasons for employees not engaging in knowledge sharing include insufficient individual knowledge reserves, lack of conditions for sharing, and knowledge hiding behavior to prevent others from acquiring unique knowledge that might threaten their status after obtaining it.

In addition to the above interactions among knowledge subjects, various departments within the enterprise should also actively communicate and propose effective suggestions for technical innovation from different perspectives. During technology development and improvement, timely feedback from various departments must be collected, including market department estimates of commercial value and technical department progress status. Since the "new" in technical innovation implies initial technological immaturity, continuous testing is required from development to launch, with improvements made to potential defects. The essence of knowledge networks is cooperation, achieved through interaction based on the principle of reciprocity. Organizations should form an organizational atmosphere that incentivizes knowledge sharing, allowing knowledge workers whose core competitiveness is knowledge to reduce psychological ownership of knowledge, align personal goals with organizational goals, actively transform personal knowledge into organizational knowledge, and reduce knowledge hiding. Only through mutual cooperation between individuals and between departments can technical innovation be realized and implemented.

Knowledge Application Merely acquiring knowledge through storage and sharing to build a knowledge base cannot realize knowledge value—knowledge application is essential for maximizing knowledge value. Only by implementing ideas into practice can the space for technical improvement be identified, and a more adequate and scientific understanding of technical principles and product manufacturing processes be achieved. For example, when technical problems occur, experienced employees can quickly and accurately identify and solve them. Individual knowledge application ability is measured by the following aspects: problem-solving ability, research ability, transformation ability, induction ability, and transfer ability [48]. Employees accumulate sufficient professional knowledge in the practice field, and in the subsequent thematic knowledge community stage, they adjust personal cognitive structures according to new external stimuli, generating more knowledge matching external problems. Through good interpersonal interaction, they become knowledge network centers. Individuals at knowledge network centers have multiple information acquisition channels, often mastering first-hand information and understanding knowledge application purposes, problems to be solved, possessed knowledge and solutions, gaps with implementation goals, and exploration of unknown factors, possessing strong knowledge application capabilities. They can not only solve a series of procedural and non-procedural problems but also deeply analyze the causes of technical problems and actively apply knowledge reserves to practice, testing solution feasibility. After technical problems are solved, they are categorized into documents and general rules are summarized for sharing with other employees. Additionally, employees at network centers possess knowledge transfer ability—that is, they can draw inferences about other cases from one instance in different contexts. In practical application, they can identify deficiencies, thereby searching for new knowledge to support subsequent improvements through channels such as consulting materials and communicating with

peer technical personnel, and conducting practical operations and experiments. Technical personnel discover and solve problems in practice, apply mastered relevant principles in different contexts, enhance professional skills, and improve existing technical deficiencies to achieve incremental innovation.

Conclusions

Based on the logic of personal Ba and case analysis, this study constructed a research framework for the impact of personal knowledge management on technical innovation, explored the content included in personal knowledge management and how it affects technical innovation, and reached the following conclusions:

(1) In the practice field stage, knowledge subjects consolidate professional knowledge through information processing and knowledge accumulation, laying the foundation for technical innovation. Knowledge accumulation mainly promotes incremental technical innovation through application and absorption mechanisms. On one hand, knowledge is an important source of innovation, but achieving innovation must rely on knowledge application —only through application can knowledge play its role. On the other hand, the stronger employees'absorptive capacity, the stronger their ability to identify new opportunities, analyze market opportunities, and digest external knowledge, thereby promoting technical innovation generation.

(2) In the thematic knowledge community, knowledge subjects leverage learning autonomy to broaden basic knowledge, and interpersonal interaction promotes the absorption of heterogeneous knowledge, combining cross-domain knowledge and internalizing it into their own unique knowledge to stimulate new ideas, positively impacting breakthrough technical innovation.

(3) In the social knowledge network, knowledge subjects in central network positions exert radiation effects, driving other knowledge subjects to actively participate and promoting the transformation of personal knowledge into organizational knowledge. Individuals complement each other' s strengths and weaknesses through knowledge sharing, cultivating new viewpoints and ideas. Applying these ideas in practice helps employees identify existing technical problems and improve them, thereby promoting the realization of incremental technical innovation.

At the theoretical level, this study breaks through the previous limitation of predominantly exploring how knowledge management affects technical innovation from the organizational level, to some extent compensating for the research gap in the relationship between personal knowledge management and technical innovation, while enriching the connotation of personal knowledge management. At the practical level, this research has theoretical guiding significance for enterprises to enhance technical innovation. High-tech enterprises can encourage employees to manage knowledge well at the personal level, achieving a virtuous cycle of knowledge management within the organization through knowledge ac-

cumulation, sharing, and application, thereby promoting both incremental and breakthrough technical innovation. Enterprises should cultivate employees' autonomous learning habits, incentivize members to actively discuss problems and ideas, build personal knowledge management platforms that fit organizational contexts, facilitate employees to effectively categorize acquired knowledge in a timely manner, maintain communication with team members, transform personal knowledge into organizational knowledge, and accelerate enterprise technical innovation.

Limitations and Future Research

(1) This study used case analysis with a small sample size, which cannot comprehensively reflect personal knowledge management situations in the high-tech industry, limiting the universality of conclusions.

(2) This study only selected employees from a high-tech enterprise in Zhejiang as research objects. Employees in different regions and industries have varying willingness and actual operations regarding personal knowledge management, and the degree of impact on technical innovation also differs. Therefore, future research needs to investigate more enterprises and verify findings through empirical methods.

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Author Contributions

Liu Yiling: Collected interview data, conducted literature review, and wrote the paper;
Xiao Dongping: Guided the research process, revised and finalized the paper.

Note: Figure translations are in progress. See original paper for figures.