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A Study on the Teaching Model for Undergraduate Public Administration -Based on the Drive-Participation-Experience (DPE) Framework

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Abstract

Purpose –In the context of the development of new liberal arts, it is crucial to explore innovative practices and pathways for talent cultivation in the field of public administration.
Design/Methodology/Approach – Addressing key challenges in public administration education, this paper proposes a teaching model based on the "Drive-Participation-Experience" (DPE) theoretical framework.
Findings – The model is conceptualized as a “one-centre, two-integration” approach, specifically focusing on the construction of a “pre-class, in-class, post-class” process-based learning model. This model fully integrates both online and offline components and fosters a collaborative, co-creative environment between teachers and students.
Research Implications – It provides new theoretical support and practical guidance for the innovation of the teaching mode of public management talent cultivation.

Keywords: Public administration,Talent cultivation, Teaching model
JEL Classifications: I20,I21,H70

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I. Introduction

With the ongoing advancement of higher education reform, deepening teaching reform has become an essential path for achieving the talent development goals of universities. To promote the comprehensive development of undergraduate education, the Ministry of Education launched the "Double Ten Thousand Plan" in April 2019. This initiative adheres to the core principle of student-centeredness, calling for continuous innovation in teaching concepts, methods, and tools to deepen educational reforms. It provides clear guidance for enhancing professional development quality and optimizing high-level talent cultivation mechanisms in higher education institutions.

Promoting integrated development is an inevitable choice for the construction of new liberal arts. In October 2020, the Ministry of Education issued the "Declaration on the Construction of New Liberal Arts," advocating for interdisciplinary integration between the humanities and fields such as science, technology, engineering, agriculture, and medicine. It also emphasized the incorporation of modern information technologies into liberal arts education as a key strategy for improving the overall level of new liberal arts construction. Universities are encouraged to optimize talent cultivation models based on emerging technological trends, thereby improving the quality of talent development and providing strong support for the growth of new productive forces.

The Public Administration program has produced a large number of applied, interdisciplinary, and high-level professionals for social development. However, the rapid changes in the public governance environment have raised higher demands for the skills and capabilities of public administration professionals, establishing new standards for talent development in the field. Teaching reform is a critical aspect of improving the quality of public administration education. Innovative teaching models can enhance students' sense of historical mission and social responsibility, stimulate enthusiasm for independent learning, foster creative thinking, and improve both professional expertise and practical skills. These innovations provide a strong response to the goals of new liberal arts construction and the cultivation of new talent.

Against this backdrop, this paper proposes an innovative practice teaching model for undergraduate public administration education based on the "Drive-Participation-Experience" (DPE) theoretical framework. This model, centred on student development, incorporates a hybrid teaching approach combining online and offline learning, and encourages co-creation between teachers and students. It explores pathways for optimising talent development in public administration to support students' comprehensive development and meet the evolving needs of China's high-quality development and future discipline growth.

II. A Review of Teaching Models in Public Administration

Traditional teaching models focus on passive knowledge delivery, a method that is not conducive to stimulating students' creative thinking(WEIMER M,2013). In order to enhance the quality of teaching and talent cultivation in public administration, scholars have engaged in extensive theoretical and practical explorations centered on a student-centric approach. Innovative teaching models, such as case-based teaching, experiential learning, and blended learning, have been proposed to encourage effective interaction between teaching and learning, guiding students to actively engage in the learning process and expanding and deepening the course content.

The development of talent in the field of public administration emphasizes strong practical and applied

aspects, requiring in-depth analysis of real-world cases to accumulate experience in solving related issues and improve the necessary skills. As a result, case-based teaching has become a distinctive and effective method in public administration education. Case teaching takes rich practical experience and real situations in real examples as case materials(W ELLET,2007),case analysis in simple terms can help students realize systematic understanding and acquire a more comprehensive understanding of knowledge(GUMMESSON V,1999). Zhang Liang(2016) developed a case-based teaching model for Master of Public Administration (MPA) students based on cognitive learning theory. This model, through scenario creation and guiding students towards self-directed learning, strengthens MPA students' depth of understanding of public administration issues, analytical skills, and problem-solving techniques. Li Yanling(2016) emphasized that in the process of case-based teaching, students can extract general management principles or rules through the analysis, comparison, and exploration of various cases. She also highlighted the three key elements of implementing case-based teaching: selecting appropriate teaching cases, designing interactive classrooms, and creating teaching scenarios.

Practical skills courses, serving as a bridge between theory and practice, allow students to apply their theoretical knowledge to solve real-world problems, thereby enhancing their practical skills and overall quality(AEBERSOLD M,2018). Wei Hongzheng(2013) conducted an in-depth analysis of the limitations and shortcomings of practical teaching in public administration talent development in Chinese universities. Based on this, he proposed that universities should construct a practical teaching system that integrates "from classroom to laboratory, on-campus to off-campus" based on their own educational resources and characteristics. In the context of the new era, Liu Xiufeng(2023) conducted a thorough exploration of laboratory development in public administration programs. She proposed suggestions for updating experimental teaching systems, reforming experimental teaching models, building open and shared platforms, and fostering collaborative team support to enhance the practical abilities of public administration students.

Public administration professionals need to possess an interdisciplinary knowledge base and comprehensive abilities to address the complex and ever-changing demands of public governance. To cultivate up-to-date, cross-disciplinary talent, Yang Jing(2022) developed a "cross-boundary integration" talent development mechanism combining "electronic information + public administration." This approach explores how leveraging strengths from other disciplines can enhance liberal arts programs, responding to the talent development goals of new liberal arts construction. Chen Yumei(2017) innovatively incorporated computer-simulated scenario teaching into public administration education, significantly enhancing students' comprehensive analytical abilities, cognitive judgment, organizational coordination, scientific decision-making skills, and problem-solving capabilities.

Driven, participatory, and experiential teaching models have emerged as key strategies for improving education quality. Each of these models brings unique teaching philosophies and implementation strategies, all aimed at stimulating students' interest, increasing their learning initiative, and enhancing practical skills. The task-driven teaching method, grounded in constructivist learning theory, uses engaging tasks closely linked to course content to motivate students and foster autonomous learning(LLACH M.C,2023). Wu Zhiwei(2023) designed a task-driven flipped classroom model, which shifts the simpler knowledge transfer outside of class, allowing students to learn independently, while facilitating dynamic interaction between students and teachers in class. This model aims to develop students' problem research skills, advanced reasoning, and critical thinking abilities.

The participatory teaching model encourages students to actively engage in the learning process, emphasizing the central role of students and fostering cooperation, communication, and negotiation between

teachers and students, as well as among peers. The goal is to achieve a symbiotic and communicative teaching environment(Ran Yuanmao,2023). Boppps teaching mode is widely used in classroom practice. It divides the teaching process into six links: Bridge in(B), Objective (O), Pre-assessment (P), Participatory learning(P), Post assessment(P), and Summary(S) (Chung C,2015).Liu Yiqing(2024) implemented participatory teaching in the "Public Relations Practice" course and observed that this teaching model exhibited multiple characteristics such as situationality, proactivity, differentiation, interactivity, process-orientation, and reflectiveness. Practical evidence shows that participatory teaching significantly enhances learning outcomes and improves teaching efficiency. Xue Yongji(2021) analyzed the practical application of participatory teaching in rural public administration courses, discussing the integration of technical innovations in areas such as software and equipment development, alongside educational innovations in teaching content, strategies, organization, and evaluation.

Effective experiential teaching models focus on the central role of students in the learning process. By constructing contextualized teaching environments and using open and flexible teaching strategies and methods, the aim is to achieve predefined educational objectives(Gemmell R M,2013). This approach places teachers, students, and peers in an interactive and dialogic state, gradually stimulating students' entrepreneurial motivation(Gao Xuesheng,2022). Luo Baoyong(2022) and others explored the experiential learning models in American archival education, including project-based learning, internships, community service, and workshops, arguing that experiential teaching effectively stimulates student motivation, develops comprehensive competencies, and enhances students' competitive edge in the job market.

The aforementioned studies focus on the innovative exploration of public administration teaching models, providing an explanation and summary of the principles and practices of driven, participatory, and experiential teaching. These studies lay a solid theoretical foundation and offer rich practical experience for reforming public administration education. However, there remain certain shortcomings in the existing literature. First, the understanding and application of various teaching models are still largely independent, with little systematic integration or collaborative progression towards their organic fusion. Second, public administration education has not sufficiently introduced methods and mature experiences from other disciplines, such as information technology, which would facilitate interdisciplinary integration and mutual learning. To address these gaps, this paper proposes a student-centered, integrated teaching model for public administration under the "Driven-Participation-Experience" theoretical framework. This model combines online and offline teaching, and emphasizes co-creation between teachers and students throughout the entire learning process—before, during, and after class. The integration of modern digital technologies and teacher-student interaction aims to enhance the quality of talent development in public administration education.

III. Issues in Public Administration Education

1. Fragmented Knowledge Content and Difficulty in Constructing a Knowledge System

The curriculum structure of public administration follows a "spiral ascent" approach, starting with general education courses in the first year, followed by more specialized courses in the second and third years, and culminating with practical courses in the fourth year. The theoretical depth and complexity of these courses gradually increase. The curriculum includes theoretical courses such as Public Policy, economics courses like

Western Economics, statistical and practical courses such as Big Data Analysis, and social research courses. While the variety and abundance of courses present students with different types of knowledge, this diversity demands that students employ various modes of thinking and learning methods. This presents a significant challenge to students' ability to transition between different subjects and methods of learning. As a result, many students struggle when faced with shifting between courses, finding it difficult to establish connections and build logical frameworks between different areas of knowledge.

Additionally, since each course syllabus is independently developed, there is a lack of coordination and communication between adjacent courses, potentially leading to redundancy or disconnection in the content delivery. This can result in gaps in the students' knowledge system. The main principle of undergraduate courses is to deliver complete knowledge, but due to the extensive content and numerous complex concepts involved, the presentation of knowledge tends to be fragmented. With a fixed number of teaching hours, students face a heavy burden in mastering all the necessary content. If foundational knowledge is not solidified, students may experience confusion and pressure in the subsequent stages of knowledge deepening and progression, making it difficult to understand the overall structure and context of the curriculum. As a result, the effectiveness of learning is significantly reduced.

2. Weak Student Motivation and Insufficient Classroom Participation

Currently, the teaching of public administration courses largely remains within the traditional lecture-based, passive learning model, with the dominant approach being "instructional" in nature. Teachers focus on delivering content to fulfill the teaching objectives, often leaving insufficient time for students to reflect, discuss, or question the material. Furthermore, there is little opportunity for students to express themselves, and the student's central role is frequently overlooked.

With the advancement of modern educational technology and the integration of multimedia teaching tools, online education has become a primary mode for incorporating digital resources into public administration education. Many universities have adopted a blended learning model that combines online and offline teaching, aiming to leverage online resources and platforms to enhance students' self-directed learning abilities and promote teacher-student interaction. However, in practice, this model often remains superficial. Students tend to treat pre-class materials and platform interactions as routine assignments, displaying a passive attitude. In the classroom, traditional teacher-centered instruction persists, making it difficult to break free from the conventional teacher-dominated teaching model. To foster more positive and dynamic interaction between teachers and students, educators have experimented with innovative teaching models such as flipped classrooms, case-based teaching, and extracurricular activities. While these approaches have achieved some success in boosting student engagement and interaction, a single teaching design is often insufficient to truly stimulate students' intrinsic motivation for learning and to develop their self-driven learning capabilities.

3. Insufficient Practical Training and Disconnect Between Theory and Practice

Public administration is an emerging interdisciplinary field that draws on political science, management, sociology, economics, psychology, and statistics to study public affairs, particularly the general principles of government operations. This field has a clear practical orientation. However, there is a significant gap between the practical skills of public administration graduates and the objectives of training talent to address the

complex, integrated issues of modern public affairs.

In practical training, many universities have introduced the teaching of statistical software such as SPSS and Stata. However, these software training sessions often involve simple tasks and outdated data, meaning that theoretical teaching remains limited to basic operations, failing to keep pace with the development of modern big data analysis and processing in government affairs. The transition from knowledge acquisition to practical application is a difficult process, requiring complex steps of knowledge internalization and skill development.

Due to constraints of time and space, many practical teaching activities are confined to classroom settings, leaving students less attuned to the dynamic complexities of social issues in the real world. This limits their ability to connect theoretical knowledge with practical contexts and hinders deep reflection on case studies, preventing effective knowledge transfer. Although some institutions have proposed reforms in student social practice, practical engagement is often restricted to basic activities like visiting demonstration bases, due to limitations in funding, faculty, and platform collaboration. More hands-on activities such as field visits to government agencies, community interviews, or public service initiatives are often absent, leading to a disconnect between theoretical knowledge and its real-world application.

4. Single Evaluation Criteria and the Need for an Improved Assessment System

Students' learning outcomes are influenced by multiple factors. However, teacher assessments predominantly focus on final examinations, with limited diversity in evaluation methods. Public administration courses often rely on traditional written exams or report submissions as the primary mode of assessment. While formative assessments account for 30%-40% of the final grade, these are typically based on attendance, in-class participation, and homework. As a result, students with low levels of participation may not be accurately assessed in terms of their learning abilities and overall competencies. Moreover, assignments are often paper-based, failing to capture the students' actual learning process and outcomes.

This approach can lead to a lack of differentiation in formative assessments, thus undermining the purpose of continuous evaluation. Ultimately, final grades rely heavily on the summative evaluation of end-of-term exams. Furthermore, the evaluation system is dominated by the teacher as the sole authority, with little room for self-assessment by students or peer feedback. This one-directional assessment structure does not highlight the students' role as active participants in the learning process and lacks comprehensive, multidimensional evaluation. As a result, it is less effective in fostering self-improvement and enhancing students' overall development and competencies.

IV. Constructing the "One Center, Two Integrations" Teaching Model Based on the DPE Theoretical Framework

1. Design of the "One Center, Two Integrations" Teaching Model Based on the DPE Framework

Traditional teaching methods are often one-dimensional, failing to effectively engage students' initiative and interest. Moreover, given the limited class time, students' acquisition of course knowledge is typically confined to the physical classroom, restricting their ability to develop expansive thinking and practical skills.

To address the challenges posed by the traditional teaching model in public administration, which lacks student-driven learning and practical engagement, the teaching team has designed a comprehensive "One Center, Two Integrations" model based on the DPE framework (see Figure 1). This model is centered on student development and incorporates a blended learning approach, combining both online and offline learning, as well as collaborative creation between teachers and students. The goal is to enhance teaching efficiency and quality, strengthen the development of diverse talent in public administration, and advance innovation and entrepreneurship in teaching reforms.

Fig. 1. "One Center, Two Integrations" model based on the DPE framework
Source: Self organized

Firstly, in terms of educational philosophy, the model emphasizes the concept of "student-centered development." This approach is embedded throughout the training process in public administration, guiding the reform and development of teaching methods. After thoroughly understanding students' diverse learning abilities and objectives, the teaching team adopts various tailored teaching methods to support classroom learning. The role of the teacher gradually shifts from a controller to that of an organizer and facilitator, with students actively participating in classroom interactions, thus asserting their central role in the learning process(BARR R B,1995).

Secondly, in the teaching process, the model establishes an integrated approach of "pre-task-driven learning, in-class participation, and post-class experiential learning." During the pre-class phase, the course team sets learning tasks that promote independent learning, encouraging students to engage in autonomous thinking and inquiry under task and problem-driven frameworks, thereby fostering self-discipline and a spirit of exploration. In the in-class phase, the model incorporates flipped classroom strategies to enhance student participation and deepen learning, fully engaging students and facilitating positive teacher-student interaction and improved learning outcomes. In the post-class phase, the teaching team organizes thematic seminars and collaborates with government departments and social organizations to establish public administration practice bases. This enables students to actively engage in practical learning, translating classroom knowledge into real-world applications, thereby ensuring the consistency and systematization of both in-class and out-of-class learning, and promoting

deeper integration of theory and practice.

Finally, in terms of implementation, the model integrates online learning resources with offline classroom activities, creating an interactive and collaborative learning environment. The teaching team leverages internet technologies to provide students with a diverse, multi-layered, and personalized range of learning resources. Through online platforms, the team strengthens effective interaction between teachers and students both inside and outside the classroom, breaking down time and space constraints, and extending the learning experience beyond the traditional classroom setting(Nollenberger K,2017). This approach motivates students to develop intrinsic learning drives, catering to their individual learning needs, and ensuring that they experience well-rounded and comprehensive development.

2. DPE-Based "One Center, Two Integrations" Teaching Practice

2.1 Task-Driven Learning: Constructing the Knowledge System and Task-Driven Learning Objectives

The student-centered teaching philosophy requires the teaching team to have a thorough understanding of students' professional foundations and learning abilities in order to guide them toward clearly defined learning objectives. The teaching team employs tools such as the Holland Occupational Interest Inventory and the SMART goal management method to assess students' learning interests and motivations, helping them set learning goals and provide necessary guidance in a timely manner.

When designing the course syllabus, the team sets learning objectives across three key dimensions—cognitive, emotional, and skill-based—while also outlining the course content and timeline. Each chapter's characteristics are carefully analyzed, and the teaching content is reorganized. The team reinterprets the content based on the knowledge progression model of "low-level memorization, intermediate-level theory consolidation, and high-level value formation", innovating the teaching structure accordingly. This approach includes customized lesson plans and handouts tailored to the specific needs of students. Furthermore, the team utilizes the sequence of course chapters to summarize and map out the knowledge for each lesson using mind maps, helping students better understand and construct a coherent knowledge system, ensuring they can grasp key concepts and the logical relationships between different chapters.

Task-driven learning operates on the central principles of "task orientation, student-centeredness, and teacher guidance," facilitating knowledge acquisition while enhancing students' ability to engage in self-directed learning and cultivate a spirit of exploration. To support students' pre-class autonomous learning, the teaching team leverages resources such as high-quality MOOCs and online teaching platforms, offering a wealth of teaching materials and setting learning tasks that encourage students to engage in task-driven learning aligned with the course objectives. Students participate in initial shallow learning through viewing resources, completing online tests, and identifying areas of difficulty. During this process, students summarize existing problems for further focus in class. After watching online videos, students complete pre-class online quizzes to assess their understanding of the material. This pre-assessment helps students gauge their own grasp of the content, while enabling the teaching team to monitor student progress, identify potential issues, and adjust the teaching design as needed.

2.2 Participatory Learning: Project-Based Group Training and Flipped Classroom to Promote Classroom Co-creation

Participatory learning emphasizes collaborative student engagement. The teaching team constructs an interactive classroom environment through methods such as question-and-answer sessions, group discussions, and project-based group work. This approach encourages students to actively participate in the learning process, breaking away from the traditional teacher-dominated teaching model, and fostering deeper student enthusiasm and exploration.

The classroom is divided into two segments: a teacher-led lecture phase and a student-led discussion phase. During the lecture segment, the teaching team provides key insights into the foundational theories and complex concepts of the course, while simplifying basic knowledge points through random questioning using smart classroom tools to engage students actively in the discussion. More challenging concepts are introduced through the integration of case studies, video-based teaching, and contextual learning techniques, which help students better understand and absorb difficult topics.

In the discussion phase, students are divided into groups based on project tasks. Each group focuses on a specific topic discussed in class and conducts a group discussion, where each member contributes their opinions. The group then synthesizes its discussions into a collective output, which is presented in class by a representative. The teacher and other students then engage in a discussion of each group's presentation, providing feedback and critiques. This peer-to-peer and student-teacher interaction helps students internalize the knowledge and enhances their understanding.

In real-world scenarios, students collaborate within their groups to complete project tasks. This dynamic fosters new insights through the clash of ideas and perspectives, leading to a deeper exploration of the issues at hand. As a result, students can better integrate and absorb course material while also improving their teamwork and collaboration skills. The teacher also gains insight into each group's understanding of the course content and skill development through their presentations, allowing for timely clarification of doubts and guidance. This interaction ultimately increases student participation, performance, and comprehension in the classroom.

2.3 Experiential Learning: Conducting Teaching Seminars and Participating in Practical Research and Study

To assess student learning outcomes and deepen relevant knowledge and skills, the teaching team designs after-class exercises on the online learning platform. Students complete these exercises and submit their assignments via the online community. The teaching team then grades the assignments and provides timely feedback. Each month, the Public Administration program organizes mock exams that do not adhere strictly to traditional formats. These exams are based on the content taught that month, and flexible assessment methods are employed to evaluate students' mastery of the material through follow-up testing.

In addition, the teaching team actively organizes academic exchange seminars in the form of project-based discussions. These seminars focus on the challenges and difficult topics that students encounter in their learning, and serve as a platform for expanding and reconstructing course content. The seminars guide students to explore current research trends and hot topics in the field. Before the seminar, students are tasked with gathering materials related to the topic, and during the seminar, both teachers and students engage in thorough discussions. Students present their viewpoints, while the teacher offers guidance and supplementary insights,

fostering deeper exploration of the topic and stimulating students' innovative thinking. This process facilitates a mutual enrichment of teaching and learning(SENGE P,1994).

The enhancement of students' practical skills is a crucial aspect of their development. Practical training enables students to apply knowledge and skills to solve real-world problems. In this model, the teaching team leads students to visit grassroots government offices or corporate collaboration bases for field visits, research, academic exchanges, or internships, implementing 36 hours of off-campus practice education each semester. Furthermore, students are required to conduct group social research or community work during the summer. Each group, after several discussions both inside and outside the classroom, finalizes their project plans, assigns tasks, and prepares for the activity. The results are submitted as practical reports.

Building on the findings from these practical research activities, the teaching team encourages students to participate in innovation and entrepreneurship competitions, such as the University Innovation and Entrepreneurship Competition, the Public Administration Case Competition, and the Challenge Cup. These activities promote the interdisciplinary integration of knowledge, theory, methods, and technology, enhancing students' ability to solve complex problems and improving their overall practical skills.

V. Conclusion

Against the backdrop of the development of the new liberal arts, advancing the reform of the Public Administration curriculum is a key approach to improving undergraduate education quality and will have a profound impact on the broader educational reform. By constructing a comprehensive "pre-class drive – in-class participation – post-class experience" teaching model and integrating online resources, digital technologies, and diverse student-teacher interactions, we can transform the teaching approach to be more student-centered and promote a deeper integration of theory and practice. This will improve the quality of talent development in public administration and enhance teaching effectiveness. In future development, the Public Administration program will continue to strengthen teaching capabilities, expand educational resources, and improve institutional support to ensure the effective implementation of this teaching model.

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The impact of investment in research and development on the development capacity of electronic companies

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Abstract

Purpose – The purpose of this paper is to examine the impact of research and development (R&D) investment on the development capacity of electronic companies. Given the rapid technological advancements and competitive nature of the industry, this study investigates how R&D spending influences asset growth and innovation-driven development.

Design/Methodology/Approach – Based on the Theory of Endogenous Growth, this study employs a quantitative research approach using panel data from 39 listed electronic companies in China over a five-year period (2019–2023). Key variables include the proportion of R&D personnel, the ratio of R&D investment to revenue, and the proportion of capitalized R&D investment. A linear regression model was constructed to analyze the relationship between R&D investment and total asset growth rate. Additional statistical tests, including multicollinearity, autocorrelation, and heteroscedasticity tests, were conducted to ensure the robustness of the findings.

Findings – This paper finds that the proportion of R&D personnel has a significant positive impact on asset growth, while the ratio of R&D investment to revenue and the proportion of capitalized R&D investment show no significant effects in the short term. The results suggest that human capital is a critical driver of enterprise development, whereas financial investment in R&D requires longer-term observation to capture its full impact.

Research Implications – In management and policy-making, the findings highlight the importance of talent investment in R&D strategy, suggesting that firms should prioritize skilled personnel to drive innovation and long-term development. The study also recommends future research on the non-linear effects of R&D investment and enterprise life-cycle factors.

Keywords: R&D investment, electronic companies, asset growth, innovation, development capability, human capital

JEL Classifications: O32, L25, L63,G31

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I. Introduction

1. Introduction

In today's highly competitive global market, electronic enterprises must continuously innovate to stay ahead. One of the most critical investments a company can make to sustain its competitive edge is in Research and Development (R&D). R&D investment enables businesses to develop new products, improve existing ones, and streamline processes, leading to better operational efficiency and profitability. This investment is particularly vital for industries where technology rapidly evolves, such as the pharmaceutical, automotive, and information technology sectors. For example, companies like Google and Apple allocate significant portions of their revenues to R&D, which has enabled them to maintain their leadership positions by continuously introducing innovative products and services (Jones & Smith, 2017). Similarly, the pharmaceutical industry relies heavily on R&D to develop new drugs and treatments, making it one of the most R&D-intensive sectors globally (Brown & Davis, 2019). So the paper choose electronic industry as it has fast technological iteration and high R&D requirements.

While the advantages of R&D investment are well-known, it is essential to investigate how this investment directly influences an enterprise's development capability. Development capability refers to a company's ability to innovate, adapt to changing market conditions, and improve its operations. R&D investments provide the tools and knowledge necessary to explore new technologies, enter new markets, and reduce costs through process innovations. However, R&D efforts are often costly and come with inherent risks, including the uncertainty of successful outcomes and long payback periods. Hence, understanding how R&D investment translates into tangible development capabilities is crucial for strategic decision-making (Shan, 2020).

This study aims to explore the relationship between R&D investment and the development capability of enterprises, offering insights into how companies can optimize their R&D strategies to foster long-term growth and innovation. By analyzing both quantitative and qualitative data from multiple industries, this research will provide a comprehensive understanding of the impact of R&D investment on enterprise growth and sustainability (Wilson & Green, 2021).

2. Background of the Study

R&D investment is widely recognized as a key driver of both innovation and industrial advancement. In today's highly competitive and rapidly evolving business environment, enterprises are increasingly allocating significant resources to R&D activities. These investments are directed toward developing cutting-edge technologies, products, and services that not only meet but also anticipate market demands. According to Davis and Roberts (2018), firms that prioritize R&D are more likely to witness marked improvements in productivity, market share, and overall competitiveness over time. This is particularly true in industries where innovation cycles are short, such as technology and pharmaceuticals, where companies must continuously innovate to stay ahead of their competitors (Johnson & Lee, 2020). However, while the benefits of R&D investments are well-documented, the precise relationship between R&D expenditure and an enterprise's development capability remains unexplored.

The development capability of an enterprise refers to its capacity to create long- term value through

innovation, adapt to rapidly changing market conditions, and enhance operational efficiency. R&D plays a critical role in fostering this capability by enabling businesses to innovate, create unique products, and differentiate themselves in highly competitive markets. As businesses face increasing pressure to innovate faster and more efficiently, R&D investments are becoming more strategically important than ever.

This study aims to investigate how enterprises can leverage R&D investments not only to foster innovation but also to enhance their overall development capability and achieve sustainable long-term growth (Smith & Zhang, 2021). By examining the factors that influence the success of R&D efforts, this research will provide insights into the best practices for maximizing the impact of R&D on enterprise development.

3. Problem Statement

R&D investment is widely regarded as a crucial factor for driving technological innovation and enhancing an enterprise's market competitiveness. Higher R&D expenditure is often associated with greater technological breakthroughs, which in turn can result in stronger competitive advantages in the market. This technological edge enables businesses to differentiate their products and services, thereby improving their market position and long-term profitability. However, while it is generally understood that increased R&D spending can contribute to these positive outcomes, the specific relationship between R&D investment and an enterprise's asset growth capability remains underexplored. In theory, increased R&D investment and the successful conversion of technological achievements into marketable products should expand a company's competitive advantage, ultimately boosting its asset growth rate (Johnson & Lee, 2020).

On the other hand, higher R&D investments can lead to financial challenges, including the need to adjust cash flow and manage rising costs. These financial pressures may impact the enterprise’s liquidity and operational flexibility, potentially hindering short-term growth (Smith & Zhang, 2021). Therefore, this study seeks to take a more granular approach to understanding the impact of R&D investment by analyzing its components, such as the number of R&D personnel, the proportion of investment in relation to total revenue, and the allocation of capital. By exploring these specific elements, the research aims to uncover how enterprises can strategically balance their R&D efforts to achieve sustainable asset growth without overburdening their financial resources.

4. Research Questions

4.1 Does the proportion of R&D personnel have an impact on the total asset growth rate

Understanding the influence of R&D personnel on total asset growth rate is particularly relevant as firms increasingly prioritize innovation to stay competitive. As R&D often entails high costs and resource commitments, many firms seek evidence that these investments in human capital translate into measurable growth outcomes, such as an increase in assets. This research addresses whether a higher proportion of R&D personnel, indicating a stronger focus on innovation within the workforce, contributes to asset expansion.

4.2 Does the ratio of R&D investment to revenue have an impact on the total asset growth rate

Investigating this question is critical because the ratio of R&D to revenue serves as an indicator of how

much a company reinvests its revenue back into innovation and development. Higher R&D investment relative to revenue can signal a commitment to long-term innovation strategies, which could lead to competitive advantages, product differentiation, and enhanced organizational value over time.

Focusing on the R&D-to-revenue ratio provides insight into the effectiveness of revenue reinvestment into innovation, capturing the balance between maintaining profitability and committing resources to future growth. Analyzing the impact on total asset growth rate allows the study to assess whether increased innovation spending directly corresponds to asset expansion, thus meeting the objective of evaluating key factors that contribute to a firm's development capability.

4.3 Does the proportion of capitalized R&D investment to total R&D investment have an impact on the total asset growth rate

Capitalized R&D reflects management's belief in the probable success of R&D activities in generating future revenue streams. While immediate R&D expenses might reduce short-term profitability, capitalized R&D investments are intended to strengthen a company's asset base over time. Understanding whether a higher proportion of capitalized R&D positively impacts total asset growth provides insight into the efficacy of this accounting treatment in capturing the long-term value of innovation investments.

5. Research Objective

To explore the relationship between R&D investment and the asset growth capability of enterprises. This study aims to understand how higher R&D investment leads to greater technological achievements, which in turn enhance a company's competitive advantage and contribute to increased asset growth rates. Drawing from the Theory of Endogenous Growth, which posits that technological progress and knowledge accumulation are the internal drivers of economic growth, the research will investigate how R&D spending directly impacts technological innovation, improves productivity, and fosters long-term asset growth (Romer, 1994).

Specifically, there are three research objectives for this paper.

To explore the relationship between the proportion of R&D personnel and total asset growth rate.

To explore the relationship between the ratio of R&D investment to revenue and total asset growth rate.

To explore the relationship between the proportion of capitalized R&D investment to total R&D investment and total asset growth rate.

6. Significance of the Study

The findings of this study will have important implications for both academic research and practical applications. Academically, it will enhance existing literature by offering a thorough analysis of how R&D investments affect the development capabilities of enterprises. This research will provide a deeper understanding of the mechanisms through which R&D investment drives technological innovation and asset growth, contributing to broader economic growth theories. Practically, the study will offer valuable insights for managers and policymakers on optimizing R&D resource allocation. By examining the relationship between R&D investment, innovation, and asset growth, the research will help guide strategic decisions that improve operational efficiency and strengthen market competitiveness. These insights will be

particularly useful for industries where R&D plays a crucial role, helping businesses achieve long-term growth while effectively managing financial pressures associated with R&D spending.

This study aims to bridge the gap between theory and practice by offering both theoretical contributions and actionable recommendations for enterprises.

7. Scope of the Study

This study aims to explore the relationship between R&D investment and the asset growth capability of enterprises, with a focus on how increased R&D spending may lead to greater technological achievements and enhanced market competitiveness. The hypothesis suggests that higher R&D investment can result in more innovations, thereby strengthening a company's competitive edge and leading to increased asset growth rates.

However, with increased R&D spending comes adjustments in cash flow and rising operational costs, which may impose financial pressures on companies. Therefore, this research will take a more detailed approach, examining R&D investment through factors such as personnel, investment proportion, and capital allocation (Johnson & Lee, 2020).

The research is rooted in the Theory of Endogenous Growth, which posits that technological progress and knowledge accumulation are the internal drivers of economic growth. R&D investment directly impacts innovation, which in turn enhances productivity and market competitiveness (Romer, 1994).

The study will collect data from 53 companies in the electronics industry listed under the 2014 Shenwan Industry Classification within the China securities market. A regression analysis will be conducted over a three-year period to examine the relationship between asset growth rates and key factors such as R&D personnel, investment proportion, and capital allocation. The results will assess the significance and weight of these factors in driving asset growth.

8. Definition of Terms

In this study, several key terms are essential for understanding the relationship between R&D investment and asset growth capability in enterprises.

R&D investment refers to the resources allocated by an enterprise towards research and development activities, with the aim of creating new technologies, products, and innovations. Higher R&D investments are expected to lead to greater technological achievements and stronger market competitiveness.

The proportion of R&D personnel refers to the ratio of employees dedicated to research and development (R&D) activities relative to the total workforce of a company, organization, or industry. This metric indicates the emphasis placed on innovation and technological advancement within the entity. A higher proportion suggests that a significant portion of the workforce is engaged in developing new products, improving processes, or advancing scientific research, which can be essential for maintaining competitiveness and fostering long-term growth.

The ratio of R&D investment to revenue measures the proportion of a company's revenue that is invested in research and development activities. This ratio expresses how much of each dollar (or unit of currency) earned as revenue is reinvested into R&D. A higher ratio indicates that the company is allocating a significant portion of its revenue toward innovation and future development, which can be crucial for sustaining competitive advantage and growth in technology-driven industries.

The proportion of capitalized R&D investment to total R&D investment measures the percentage of research and development (R&D) expenditures that a company capitalizes on its balance sheet compared to the total R&D spending. Capitalizing R&D means recording certain R&D costs as an asset, rather than expensing them immediately, under the belief that these costs will generate future economic benefits.

Asset growth capability refers to a company's ability to increase its assets over time, often as a result of improved efficiency, innovation, and competitive advantages gained through R&D efforts.

Endogenous Growth Theory is a theoretical framework that emphasizes technological progress and knowledge accumulation as internal drivers of economic growth. It posits that an enterprise's R&D investment directly influences the occurrence of technological innovation, which enhances productivity and asset utilization (Lucas, 1988).

Regression analysis refers to a statistical method used in this study to analyze the relationship between asset growth rates and specific factors, such as R&D personnel, investment proportion, and capital allocation (Greene, 2012). This study will collect data from 53 companies in the electronics sector of the A-share market under the 2014 Shenwan Industry Classification, and will use regression to determine the significance and impact of these factors on asset growth.

9. Organization of the Paper

This study is structured into five key chapters, each building on the last to offer a comprehensive understanding of the relationship between R&D investment and enterprise asset growth. The first chapter introduces the background, identifies the problem, formulates the research questions, and outlines the study's objectives. The second chapter dives into a detailed literature review, exploring existing research on the role of R&D investment in enhancing enterprise development and competitiveness. Chapter 3 focuses on the research methodology, detailing the design, data collection methods, and analytical techniques used to rigorously investigate the research questions. In chapter 4, the results and analysis are presented, offering in-depth interpretations of the data to reveal insights into the impact of R&D investment. Finally, the fifth chapter concludes the study, summarizing the key findings and offering practical recommendations for businesses and policymakers to strategically leverage R&D investments for sustained growth and competitiveness.

II. Literature Review

1. Introduction

This study aims to investigate the impact of R&D investment on the development capability of enterprises. Specifically, this paper will quantify the relationship between research and development investment and enterprise development capabilities. Through research, it can be found that there are several vital indicators that can describe the R & D investment from the different dimensions. There are three important measurement angles for R&D investment: personnel quantity, investment ratio, and capitalization ratio. Specifically, the paper will choose the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment as three factors to measure the R&D

investment and to set as independent variables.

As for the development capability of enterprises, to have an overall overview of the comprehensive development capability of the enterprise, the paper will choose total asset growth rate to measure the development capability. It reflects the degree and magnitude of changes in all assets of the enterprise. The development and expansion speed of enterprises can be described by this indicator from a historical perspective. In this way, the paper set the total asset growth rate as dependent variables.

This paper will build a quantitative relationship between the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment and total asset growth rate. With this model, this article will address the lack of research on the impact of R&D investment on the development capabilities of enterprises. Meanwhile, the model can refine the quantitative impact of each specific aspect of R&D investment on the development capability of the enterprise. The model can help predict the expected impact of R&D investment on changes in corporate assets from different perspectives, thereby assisting decision-makers in making better resource planning and adapting to market changes.

2. literature review

2.1 The proportion of R&D personnel

The human capital of R&D personnel plays a key role in generating tacit knowledge, which is harder to replicate and offers long-term competitive advantages. R&D personnel bring specialized skills and expertise, which are essential in solving complex problems, fostering innovation, and pushing technological frontiers. A study by Hall and Oriani (2006) found that firms with more R&D personnel tend to experience faster growth rates due to their enhanced ability to innovate and respond to market demands. This empirical study shows the positive impact of R&D intensity (including R&D personnel) on firm growth and financial performance.

The involvement of highly skilled R&D staff enables firms to create new products, enhance production processes, and improve technologies, which in turn boosts productivity and growth potential. With more R&D staff, the enterprise can be expected to master market dynamics and closely follow market demand to occupy a leading position. In this case, Enterprises will acquire more excellent technologies and products, occupy a larger market share, and obtain good operating income, which will have a positive effect on the asset size of the enterprise (Cohen & Levinthal, 1989).

Generally, R&D personnel are an important factor in R&D capability. Considering that many enterprises have different scales, the proportion of R&D personnel can better reflect a company's resource allocation in R&D personnel.

2.2 The ratio of R&D investment to revenue

A higher R&D investment to revenue ratio generally signals a stronger focus on innovation and technological advancement, which are critical for enhancing a firm’s development capability. Firms that invest more in R&D relative to their revenue are more likely to create innovative products and services, improve operational processes, and adapt to changing market environments.

Scientific research and product development often require a large amount of materials and repeated experiments, which will require favorable and sustained financial support. In other words, enterprises require a significant amount of capital to absorb theoretical knowledge and commercialize the production of products. Cohen and Levinthal (1990) introduced the concept of absorptive capacity, arguing that firms with higher R&D intensity can better understand, assimilate, and apply external knowledge.

Hirsch-Kreinsen et al. (2008) suggested that in sectors with rapid technological change, the ratio of R&D investment to revenue is a strong predictor of a firm's ability to keep up with innovation cycles. This, in turn, enhances a firm's capacity for sustained development. Therefore, higher R&D capital investment can promote the long-term sustainable development of enterprises and have a positive effect on the overall assets of the enterprise.

2.3 The proportion of capitalized R&D investment to total R&D investment

Capitalizing R&D investment typically reflects the firm's expectation that these expenditures will provide long-term benefits and contribute to future economic growth. By treating R&D as an asset rather than an expense, the firm signals confidence that its innovations will result in commercially viable products or technologies.

Lev and Sougiannis (1996) found that firms capitalizing R&D expenditures tend to experience stronger financial performance in subsequent years, as they expect these investments to contribute to future revenue generation. This capitalization can positively impact a firm's development capability by allowing it to better align resources with long-term growth strategies.

The resource-based view suggests that capitalized R&D investment represents valuable, firm-specific resources that contribute to sustained competitive advantages (Barney, 1991). Firms that invest more in R&D and capitalize a greater proportion are likely to leverage their innovative capabilities to achieve superior growth. In this case,A higher capitalization ratio represents a positive expectation of the enterprise for the transformation of innovative achievements, and also represents the driving force for the growth of enterprise assets.

2.4 Enterprise development capability

R&D investment often leads to the creation of intangible assets, such as patents, proprietary technologies, and intellectual property, which significantly contribute to firm growth. The expansion of intangible assets as a result of R&D activities plays a critical role in increasing a firm's total asset base, especially in knowledge-intensive industries.

Czarnitzki and Kraft (2004) provided evidence that R&D-intensive firms not only grow faster in terms of sales and market value but also in terms of assets. They argued that this asset growth reflects the firm's ability to utilize its R&D investments effectively in generating future revenue and capital expansion.

The total asset growth rate reflects the firm's ability to expand its asset base, which can indicate better utilization of resources and future growth potential. R&D investments, for instance, often lead to growth in intangible assets that are not immediately visible in short-term profit figures but significantly contribute to long- term development. Total asset growth thus captures a broad and comprehensive view of the firm's expansion efforts, including its innovation capability. In this case, total asset growth rate is a suitable indicator

to measure enterprise development capability when study the impact of R&D investment on development capability.

3. Contribution

Academically, understanding the quantitative relationship between R&D investment and firm development provides valuable empirical evidence for theories of innovation-driven growth. R&D investment is widely recognized as a key driver of innovation, productivity improvement, and firm growth. By quantifying how R&D investment impacts metrics such as total asset growth rate, revenue growth, and profitability, this research adds precision to the understanding of how firms evolve through innovation.

By examining the impact of R&D investment on firm development, decision- makers can better understand the trade-offs between investing in R&D and other business areas, such as marketing or operational efficiency. Meanwhile, the model can elucidate the contribution of R&D personnel, R&D investment ratio, and capitalization ratio to the development capability of enterprises. By clarifying the contribution of different independent variables, enterprises can scientifically and efficiently adjust the allocation ratio of resources within the R&D department and determine effective R&D strategies.

From a managerial perspective, understanding the relationship between R&D investment and development capability provides actionable insights for corporate decision-makers. R&D investment often involves substantial risk and uncertainty, but it is crucial for driving innovation and long-term firm growth. This research can help decision-makers evaluate the potential returns on R&D investments and optimize their innovation strategies based on empirical evidence.

4. Summary

Firms with a higher R&D intensity are more likely to experience enhanced development capabilities, as R&D investment leads to innovation, productivity improvements, and sustained competitiveness. By investing in R&D, companies can strengthen their capability to generate new knowledge, develop unique products, and improve their competitive positioning, all of which contribute to firm development capability. This relationship is well-supported by both theoretical and empirical literature.

This research will strengthen the empirical understanding of the relationship between R&D investment and firm development. Previous studies, like those of Cohen (1989) and Czarnitzki and Kraft (2004), demonstrated that R&D investment significantly boosts firm productivity, asset growth, and market value. This research builds on these findings by quantifying how R&D affects development indicators such as total asset growth rate, providing more precise models for understanding firm growth.

The research provides valuable insights for corporate decision-makers who face uncertainty in R&D investments. It supports better evaluation of R&D's potential returns and offers guidance on strategic innovation investment. Research will help companies allocate their resources more scientifically, adjust the funding and human resources of R&D departments based on models, and formulate long-term sustainable development and R&D strategies.

III. Research Methodology And Expected Outcomes

1. Introduction

This paper aims to investigate the impact of R&D investment on development capability of enterprises. The firms with higher R&D investment can be expected to have better absorptive capacity, and better understand, assimilate, and apply external knowledge. Based on that, the paper will further quantify the relationship between R&D investment and development capability by building an accurate model. R&D investment will be measured from three dimensions: human capital, finance investment, and capitalization rate. Specifically, the paper will choose the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment as three independent variables to measure the R&D investment. And for the development capability of enterprise, total asset growth rate will be selected as dependent variable as it takes both intangible and tangible asset into consideration.

The Theory of Endogenous Growth emphasizes that technological progress and knowledge accumulation are the intrinsic driving forces of economic growth.

Enterprises investing research and development funds in the development of new products and technologies can bring innovation and intangible assets, enhance their market competitiveness and development capabilities. Therefore, it can be expected that R&D investment will boost the development capability of enterprise. Therefore, the hypothesis of this paper is proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment has a significant relationship with total asset growth rate.

And the data will be collected from Hithink RoyalFlush iFinD, a financial data terminal database. Furthermore, regression model will be used to estimate the change of total asset growth rate as the three independent variables change. T test will be used to evaluated the significance of the impact of independent variable upon dependent variable and reliability test will also be used. The expected data result of this paper is a significant relationship between the independent and dependent variables.

2. Research Design

2.1 Variables

2.1.1 Total Asset Growth Rate (Dependent Variable)

To measure the development capability of an enterprises, this paper will choose total asset growth rate as dependent variable. The total asset growth rate reflects the firm's ability to expand its asset base, which can indicate better utilization of resources and future growth potential. R&D investment contributes to firm growth by enhancing both productivity and innovation, which ultimately increases the firm's asset base. Higher R&D spending is often associated with the acquisition of new technologies and the expansion of physical and intellectual assets, resulting in overall asset growth. Specifically, R&D investment will cultivate patents and copyrights, as well as advanced equipment or products which are important intangible asset. These intangible asset can significantly give enterprises stronger competitiveness and development capabilities. Total asset growth rate is a comprehensive indicator that takes both intangible and tangible asset into consideration.

2.1.2 The Proportion of R&D Personnel (Independent Variable)

The proportion of R&D personnel refers to the ratio of employees dedicated to research and development (R&D) activities relative to the total workforce of a company, organization, or industry. This metric indicates the emphasis placed on innovation and technological advancement within the entity. In the field of research and development, personnel investment is an important criterion for evaluation. Scientific talents are important reserves for enterprise scientific research and play a crucial role in the field of technological breakthroughs. A higher proportion suggests that a significant portion of the workforce is engaged in developing new products, improving processes, or advancing scientific research, which can be essential for maintaining competitiveness and fostering long-term growth.

2.1.3 The Ratio of R&D Investment to Revenue (Independent Variable)

The ratio of R&D investment to revenue captures the financial commitment a firm makes toward innovation relative to its earnings. A higher R&D investment to revenue ratio generally signals a stronger focus on innovation and technological advancement, which are critical for enhancing a firm's development capability. Firms that invest more in R&D relative to their revenue are more likely to create innovative products and services, improve operational processes, and adapt to changing market environments. In the field of research and development, personnel training, equipment maintenance, and experimentation all require significant and sustained financial support. R&D and conversion cannot be separated from a large amount of upfront capital investment, therefore capital investment is an important assessment indicator.

2.1.4 The Proportion Of Capitalized R&D Investment To Total R&D Investment (Independent Variable)

Capitalizing R&D investment typically reflects the firm’s expectation that these expenditures will provide long-term benefits and contribute to future economic growth. By treating R&D as an asset rather than an expense, the firm signals confidence that its innovations will result in commercially viable products or technologies. Firms that invest more in R&D and capitalize a greater proportion are likely to leverage their innovative capabilities to achieve superior growth. The proportion of capitalized R&D investment has implications for how investors perceive the firm's value and potential for growth.

2.2 Theory

The Theory of Endogenous Growth, developed primarily by economists like Paul Romer and Robert Lucas in the 1980s, emphasizes the idea that economic growth is largely driven by internal factors—specifically, investments in human capital, innovation, and knowledge—rather than external factors. endogenous growth theory argues that technological progress and innovation are results of deliberate investment in research and development (R&D), education, and skill enhancement within the economy (Romer, 1986). The more a society invests in these areas, the higher its long-term growth potential. Technology, skills, and experience improve the productivity of the workforce. The theory suggests that policies encouraging the accumulation of R&D investment can have a lasting impact on economic growth.

One of the unique features of endogenous growth is the idea that innovation and knowledge are partly "non-rival" goods, meaning that once they are developed, they can benefit others without being depleted. For instance, a breakthrough in technology by one firm or country can improve productivity for others. Knowledge spillovers help explain why economies with robust innovation systems can sustain high growth rates.

In summary, the Theory of Endogenous Growth highlights how growth is perpetuated by internal factors, such as investment in human capital and technological innovation, and implies that policy can significantly influence long-term economic outcomes by fostering these areas. Therefore, under this theory, internal investment is crucial for the long-term growth and competitiveness of enterprises. Internal R&D investment is also an important driving force and source of innovation and technological progress for enterprises. Generally, according to this theory, R&D investment can be expected to make a positive impact on development capability of enterprises.

2.3 Conceptual framework

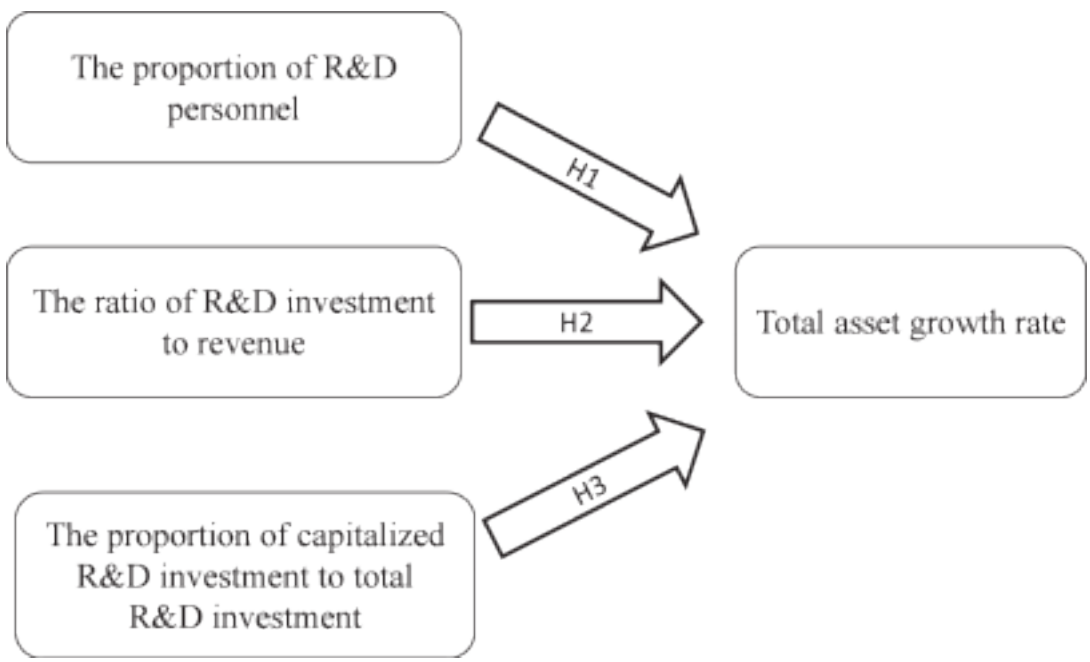

Fig. 1. Conceptual framework

The main objective of this paper is to investigate the impact of R&D investment on development capability. The R&D investment is measured from three perspectives: human capital, financial support and capitalization proportion. Therefore, the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment are selected as independent variables. And for the development capability, total asset growth rate is selected as the dependent variable.

2.4 Hypothesis

Hypothesis (H1): The proportion of R&D personnel has a significant relationship with total asset growth rate.

Hypothesis (H2): The ratio of R&D investment to revenue has a significant relationship with total asset growth rate.

Hypothesis (H3): The proportion of capitalized R&D investment to total R&D investment has a significant relationship with total asset growth rate.

3. Population and sample

The population of this study is all companies in electronic industry listed on the major stock exchanges in China. The conclusion the study discussed is expect to apply all the listing company of electronic industry on major stock exchanges in China. Meanwhile, the industry classification standard is based on Shenwan Industry Classification Standard 2014 which is a well accepted standard in the China fiance industry. And electronic industry is one of the primary industry. And according to the Ifind financial data terminal database, there are 370 listing companies in electronic industry.

And for the samples, the samples will be selected from the same industry, electronic industry. Among listed electronics companies, excluding those that have not disclosed relevant data, the remaining companies that disclose relevant data are examples. There are !!! listed electronic companies in Chinese Mainland that disclose relevant data that are selected as samples.

4. Types of Data Use

The data used are panel data. Specifically, the data comes from 39 different companies in the electronic industry. Besides, all the data of variables are from 2019 to 2023. Therefore, the data are from 39 entities and each entities are observed over several 5 years. Panel data helps in studying how variables change over time within an entity, facilitating analyses of causality and temporal effects.

5. Data Collection Method

All the data related to the listed electronic companies is collected by Hithink RoyalFlush iFinD. It is a financial data terminal that provide investors with massive structured data and rich characterized unstructured data in an accurate and timely manner, and can be conveniently viewed through in-depth data. The author uses the data browser to collect the data of listed companies in the electronics industry, which is classified as a first level industry in Shenwan Industry Classification Standard 2014. At the same time, the author extracted data of indicators including the proportion of R&D personnel, the ratio of R&D investment to revenue, the proportion of capitalized R&D investment to total R&D investment and total asset growth rate over 5 years. Finally, all data is exported in Excel format.

6. Measurement of Variables

6.1 Independent variables:

To investigate the impact of R&D investment, R&D investment will be evaluated by three perspectives: the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment. The following are the formula to calculate the specific value of the independent variables:

The proportion of R&D personnel:

The proportion of R&D personnel is a metric that measures the share of a company's workforce dedicated to research and development activities. Calculated as the ratio of R&D personnel to total employees, this proportion indicates a firm's focus on innovation and can serve as a proxy for the intensity of R&D activities within the organization. It's commonly used to assess the level of human capital investment in R&D and is often associated with a firm's capacity for innovation and long-term growth.

$$\text{The proportion of R\&D personnel} = \frac{\text{The amount of R\&D personnel}}{\text{Total amount of employees}}$$

The ratio of R&D investment to revenue:

The ratio of R&D investment to revenue is a financial metric that indicates how much a company invests in research and development relative to its total revenue. This ratio helps assess the commitment a firm has toward innovation and development.

$$\text{The ratio of R\&D investment to revenue} = \frac{\text{R\&D expense}}{\text{Gross revents}}$$

The proportion of capitalized R&D investment to total R&D investment

The proportion of capitalized R&D investment to total R&D investment is a financial metric that indicates the share of research and development expenditures that are capitalized on the balance sheet, as opposed to being expensed in the current period. This ratio provides insight into how much of a company's R&D spending is treated as a long-term investment.

$$= \frac{\text{The proportion of capitalized R\&D investment to total R\&D investment capitalized R\&D investment}}{\text{Total R\&D investment}}$$

6.2 Dependent variables

Total asset growth rate

The total asset growth rate measures the percentage change in a company's total assets over a specific period. It is an important indicator of a firm's growth and can reflect its ability to generate resources for future expansion.

$$\text{Total asset Growth rate} = \frac{\text{Total Assets at End of period} - \text{Total Assets at Beginning of period}}{\text{Total Asset at Beginning of period}}$$

7 .Proposed Data Analysis

7.1 Regression model

This paper will use regression model to build an accurate quantitative relationship between R&D investment and development capability. Through the large amount of data obtained, we can determine the quantitative impact of various R&D investment indicators on the company's asset development capability. Specifically, the significance of the influence of each independent variable in the model can be determined by conducting a t-test on each independent variable. Test each coefficient's significance using p-values. If the p-value is below a threshold (commonly 0.05), the independent variable is statistically significant. And the coefficient of the independent variables reflects the magnitude of the dependent variable changing with this independent variable. Through regression models, we can determine whether a certain factor of R&D investment has a significant impact and the degree to which it affects the development capability of the enterprise.

7.2 Multicollinearity Test

Multicollinearity refers to a situation in regression analysis where two or more independent variables are highly correlated, meaning they contain similar information. When independent variables are highly correlated, the regression model finds it difficult to attribute unique effects to each variable. This can cause instability in coefficient estimates, meaning small changes in the data can lead to large changes in the coefficients. This can pose challenges in accurately estimating the coefficients of each variable and can make interpreting the model difficult.

Multicollinearity Test is to tell whether there is multicollinearity problem. Specifically, the VIF quantifies how much the variance of a regression coefficient is inflated due to multicollinearity with other variables. If VIF is less than 10, the regression model is acceptable. Meanwhile, if VIF is larger than 10, it may suggest high multicollinearity.

7.3 Autocorrelation Test

Autocorrelation in regression analysis refers to a situation where residual error from one observation are correlated with residuals from another. Detecting autocorrelation is essential because it can lead to incorrect conclusions about the significance of the model, as it violates the assumption of independence of errors in ordinary least squares (OLS) regression.

The Durbin-Watson statistic is a widely used test for detecting first-order autocorrelation in the residuals.It tests the null hypothesis that there is no autocorrelation. The test statistic ranges from 0 to 4. A Durbin-Watson statistic close to 2 indicates no autocorrelation, while values go out of the range of 1.8 to 2.2 suggest the presence of autocorrelation.

7.4 Heteroscedasticity Test

Heteroscedasticity occurs in regression analysis when the variance of the residuals (errors) is not constant across all levels of the independent variables. This violates one of the assumptions of ordinary least squares (OLS) regression and can lead to inefficient estimates and unreliable hypothesis tests.

White's test is a more flexible test that does not require the form of heteroscedasticity to be specified. It involves regressing the squared residuals on the independent variables, their squares, and their cross-products. When the Chisquare is larger than 0.05, it indicate that there is no heteroscedasticity problem.

8. Expected Outcomes

For the regression model, the expected outcomes are that the P-values of all independent variables are less than 0.05 and demonstrate significant influence on the dependent variable. Meanwhile, the sign of all independent variable coefficients in the model is expected to be positive. In this case, it can be proven that the proportion of R&D personnel, capital investment, and capitalization ratio all have a positive effect on the company's development capability.

For the multicollinearity test, the expected VIF is less than 10. In this case, there will be no multicollinearity problem.

For the autocorrelation test, the Durbin-Watson statistic is expected to located between 1.8 and 2.2. In this situation, the statistic indicates that there will be no autocorrelation problem.

For the heteroscedasticity test, the p-value of Chi-square is expected to larger than 0.05 so that there is no heteroscedasticity problem.

9. Summary

To investigate the impact of R&D investment on development capability of enterprise, this paper measures R&D investment from three aspects: personnel, funding, and capitalization ratio. Specifically, three indicators were selected: the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment. And the total asset growth rate is selected to measure development capability.

The panel data is selected from Ifind financial terminal which will be used to build a regression model. With the regression model, the paper can tell the significance of the relationship between interdependent variables and dependent variables. Besides, the coefficient of independent variables indicates the magnitude of the influence of the independent variable on the dependent variable. The model will help establish an accurate quantitative relationship between R&D investment and enterprise development capabilities, which will aid in decision-making by management and supplement literature.

According to literature and theory, the author expects that the effects of each independent variable are significant and the coefficients are positive. Meanwhile, the model also does not exist multicollinearity problem, autocorrelation problem and heteroscedasticity problem. In this case, The proportion of R&D personnel, the ratio of capital investment and capitalization, and the development capability of the enterprise are positively correlated, which is also in line with the theory and expectations mentioned earlier.

IV. Data Analysis And Discussion

1. Introduction

This chapter will conduct linear regression analysis on the collected data from electronic industry to explore the relationship between R&D investment and development capability of enterprises.

Firstly, the paper will discuss the characteristics of data. The mean and the standard deviation will be discussed in the summary of the data. Then relationship between interdependent variables and dependent variable will be evaluated. Specifically, the author imported the data into SPSS software and established a regression model. With the regression model, the significance of impact of specific R&D indicator on development capability can be evaluated. That can help explain the significance of the impact of the R&D impact based the P-value of the overall model. Specifically, it can tell that which indicator has a significance impact on development capability.

Besides that, reliability tests will be conducted to test the whole model, including multicollinearity test, autocorrelation test and heteroscedasticity test. These tests will help detect the key assumptions of regression and the reliability of the model.

Based on the regression result and reliability test, the paper will discuss the specific relationship between R&D investment and development capability. Low R square may be caused by the market influence. The influence of the R&D investment may be more significant in longer time period. Besides, the data and the regression result also confirm the significance of the proportion of R&D personnel which proves the experts is precious treasure for the enterprises to research and apply the innovation and knowledge.

Lastly, the paper uses heteroscedasticity test and stepwise regression model to do the robustness test. The absence of the heteroscedasticity and the same results from different regression model indicates the stability and robustness of the model.

2. Statistic Summary of Data

The paper selected 39 listed companies in the electronics industry. The data includes the proportion of R&D personnel, the ratio of R&D investment to revenue, the proportion of capitalized R&D investment to total R&D investment and total asset growth rate, covering a period of nearly five years from 2019 to 2023.

The author imported these data into SPSS and conducted descriptive analysis. The analysis results are as follows:

Table 1. Descriptive Statistic Results

Descriptive Statistic						
	N	**Range**	**Min**	**Max**	**Mean**	**Standard deviation**
The proportion of R&D personnel	194	85.74	.44	86.18	27.0653	18.44540
The ratio of R&D investment to revenue	195	45.9000	1.5800	47.4800	11.261880	8.5689794
Total asset growth rate	195	351.6054	-67.1702	284.4352	13.104816	32.0722705
The proportion of capitalized R&D investment to total R&D investment	195	81.4600	.0300	81.4900	23.333926	18.4898373
Valid cases	194					

According to the table, there are 194 valid cases as195 cases in total and one company did not disclose the proportion of R&D personnel.

For the independent variables, the proportion ranges from 0.44 to 86.18 with the mean of 27.07. And the standard deviation is 18.44. There are significant differences in R&D personnel and employee structure among different companies. As for the capitalized ration, it ranges from 0.03 to 81.49 with the man of 12.33. The standard deviation is 18.48. There are significant differences in the proportion of R&D capitalization among different companies, which may be related to their different R&D progress.For the ratio of R&D investment to revenue, it ranges from 1.58 to 47.48 with the mean of 11.26. The standard deviation is 8.58. Relatively, the investment ratios of different enterprises are relatively similar, with small differences.

For the total asset growth rate, it varies from companies. Total asset growth rate ranges from -67.17 to 284.4 with the mean of 13.10. It has the standard deviation of 32.07. The development speed of enterprise assets varies greatly, and each company faces different market and product research and development speed conditions.

3. Regression Results

After importing the data into SPSS and conducting linear regression analysis, the following table is obtained.

Table 2. Regression Result

Model summary					
Model	R	R ^2	Adjusted R^2	Standard error	Durbin-Watson
1	.258a	.067	.052	31.2868549	1.844

a. IV: (C), the proportion of capitalized R&D investment to total R&;D investment, the ratio of R&D investment to revenue, The proportion of R&D personnel

b. DV: Total asset growth rate

According to R, it can be seen that in the collected samples, the degree of change in the development speed of company assets is actually relatively small caused by changes in R&D investment.

ANOVA[a]

Model		Square sum	Degree of freedom	Mean square	F	Sig.
1	Reg	13294.909	3	4431.636	4.527	.004b
	Residual error	185984.785	190	978.867		
	Sum	199279.694	193			

a. DV: Total asset growth rate

b. IV: (C), the proportion of capitalized R&D investment to total R&D investment, the ratio of R&D investment to revenue, The proportion of R&D personnel

The significance level of the overall equation is 0.004, which is less than 0.05. The overall regression equation is effective. This means that the R&D investment truly has a significant impact on the development capability of company.

Table 3. Regression Result

Coefficient a

Model		Unstandardized Coefficients		standardized Coefficients	t	Significance	Collinearity	
		B	standard error	Beta			Error	VIF
1	(C)	3.604	5.499		.655	.513		
	The proportion of R&D personnel	.538	.151	.309	3.571	.000	.658	1.520
	the ratio of R&D investment to revenue	-.563	.324	-.147	-1.736	.084	.687	1.457
	the proportion of capitalized R&D investment to total R&D investment	.055	.131	.032	.423	.673	.861	1.162

a. Dependent variable: Total asset growth rate

In terms of specific independent variables, the P-value of the proportion of R&D personnel is 0.00 which is less than 0.05. In this case, the data can tell that the proportion of R&D personnel has a significant impact on total asset growth rate. The coefficient of the proportion of R&D personnel is 0.538 which means that the total

asset growth rate increases 0.538 as the proportion of R&D personnel increases one unit.

But as for other independent variables, the P-value of the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment are both larger than 0.05. In this case, the impact of the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment on total asset growth rate is not significant.

4. Reliability Test

Multicollinearity test

Coefficient a

Model		Unstandardized Coefficients		standardized Coefficients	t	Significance	Collinearity	
		B	standard error	Beta			Error	VIF
1	(C)	3.604	5.499		.655	.513		
	The proportion of R&D personnel	.538	.151	.309	3.571	.000	.658	1.520
	the ratio of R&D investment to revenue	-.563	.324	-.147	-1.736	.084	.687	1.457
	the proportion of capitalized R&D investment to total R&D investment	.055	.131	.032	.423	.673	.861	1.162

a. Dependent variable: Total asset growth rate

From the table, it is obvious that the VIF of three independent variables, the proportion of R&D personnel, the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment are respectively 1.52, 1.457 and 1.162. All the VIF are less than 10 so that the regression model is acceptable. It does not indicate a problematic level of multicollinearity.

Autocorrelation Test

Model summary

Model	R	R ^2	Adjusted R^2	Standard error	Durbin-Watson
1	.258a	.067	.052	31.2868549	1.844

a. IV: (C), the proportion of capitalized R&D investment to total R&;D investment, the ratio of R&D investment to revenue, The proportion of R&D personnel

b. DV: Total asset growth rate

From the table, we can see that the Durbin-Watson statistic is 1.844 which locates between 1.8 and 2.2. As the Durbin-Watson statistic is between 1.8 and 2.2, it indicates no autocorrelation problem.

Heteroscedasticity Test

White Heteroscedasticity Test[a,b,c]		
Chi Square	**Degree of freedom**	**Sign.**
3.086	9	.961

a. IV: Total asset growth rate

b. The null hypothesis that the variance of the test error does not depend on the independent variable values

c. Design : C + The proportion of R&D personnel + the ratio of R&D investment to revenue + the proportion of capitalized R&D investment to total R&D investment + The proportion of R&D personnel * The proportion of R&D personnel + The proportion of R&D personnel * the ratio of R&D investment to revenue + The proportion of R&D personnel * the proportion of capitalized R&D investment to total R&D investment + the ratio of R&D investment to revenue * the ratio of R&D investment to revenue + the ratio of R&D investment to revenue * the proportion of capitalized R&D investment to total R&D investment + the proportion of capitalized R&D investment to total R&D investment * the proportion of capitalized R&D investment to total R&D investment.

From the table, the P-value of significance is 0.961. It is quite larger than 0.05 so that the heteroscedasticity problem is not significant. In this case, variance of the residuals (errors) is constant across all levels of the independent variables.

5. Discussion of Result

As for the regression model, the overall P-value is 0.04 which is less than 0.05 so that the overall model or equation is effective or significant. So the impact of R&D investment on development capability is significant. The enterprises can grow their asset by investing in research and development. However, the influence of R&D is not big. Only the 6.7% change of the total asset growth rate can be explained by the model. The model still has the room to improve. Besides research and development, other variables can also affect the speed of asset development for a company. Research and development is only one perspective that affects asset development, resulting in a relatively low degree of impact.Market changes and company strategic adjustments can both affect changes in company assets.

For the specific dependent variable, the P-value of proportion of R&D personnel is less than 0.05 which means that the proportion of R&D personnel can make a significant difference to the total asset growth rate. Meanwhile, the coefficient of the proportion of R&D personnel is 0.538. In this case, every unit increase in proportion of R&D personnel can bring 0.538 increase in total asset growth rate. This indicates that the proportion of R&D personnel is crucial for the development of enterprise assets. Talents are an important driving force for enterprises to invent and apply innovative technologies. However, the P-value of other independent variables is lager than 0.05 so that the the ratio of R&D investment to revenue and the proportion of capitalized R&D investment to total R&D investment. The actual conversion of R&D investment and

capitalization ratio into the development capability of the enterprise still requires time. Perhaps at a longer time scale, the significance of the two variables will increase.

For the multicollinearity test, VIF is less than 10, so that independent variables are not highly correlated. In this case, the regression model is acceptable. And as for the autocorrelation test, the Durbin-Watson statistic close to 2 which indicates no autocorrelation problem. So residual error from one observation are not correlated with residuals from another. Lastly, for the heteroscedasticity test, the P-value of White test is lager than 0.05 so there is no significant heteroscedasticity problem.

6. Robustness analysis

6.1 Heteroscedasticity Test

White Heteroscedasticity Test[a,b,c]		
Chi Square	Degree of freedom	Sign.
3.086	9	.961

a. IV: Total asset growth rate

b. The null hypothesis that the variance of the test error does not depend on the independent variable values

c. Design : C + The proportion of R&D personnel + the ratio of R&D investment to revenue + the proportion of capitalized R&D investment to total R&D investment + The proportion of R&D personnel * The proportion of R&D personnel + The proportion of R&D personnel * the ratio of R&D investment to revenue + The proportion of R&D personnel * the proportion of capitalized R&D investment to total R&D investment + the ratio of R&D investment to revenue * the ratio of R&D investment to revenue + the ratio of R&D investment to revenue * the proportion of capitalized R&D investment to total R&D investment + the proportion of capitalized R&D investment to total R&D investment * the proportion of capitalized R&D investment to total R&D investment

Based on this table, the P-value of White test is less than 0.05 so that the heteroscedasticity problem is not significant.

The absence of heteroscedasticity problem proves that The estimation of standard error is reliable. In classical linear regression models, if the error term satisfies the assumption of homoscedasticity. The model does not exhibit significant bias due to differences in volatility. When there is no heteroscedasticity, the significance of variables will not be amplified or weakened due to extreme fluctuations in individual sample points. Homoscedasticity is a key assumption of classical linear regression models. Its satisfaction means that the variance structure of the error term is reasonable and the regression coefficient estimation is more robust. (Wooldridge, 2016; Greene, 2018).

6.2 Stepwise Regression

Stepwise Regression is a regression analysis technique used for variable screening and model optimization, which can further validate the robustness of the model and the significance of variables by gradually adding or

removing variables.

The test results using stepwise regression are shown below.

ANOVA[a]

Model		Quadratic sum	dof	Mean square	F	significance
1	regression	10338.080	1	10338.080	10.505	.001b
	residual	188941.614	192	984.071		
	total	199279.694	193			

a. Dependent variable: Total asset growth rate

b. Independent variable, The proportion of R&D personnel

Coefficient a

Model		Unnormalized-coefficent		Standardization-coefficient	t	Significance	collinearity	
		B	Standard error	Beta			tolerance	VIF
1	(constant)	2.451	4.006		.612	.541		
	The proportion of R&D personnel	.397	.122	.228	3.241	.001	1.000	1.000

a. Dependent variable: Total asset growth rate

Based on this table, we can see that the P-value of the proportion of R&D personnel is 0.001 which is less than 0.05. It indicates that the impact of the proportion of R&D personnel on total asset growth rate is significant which is same as the previous regression model.

This paper uses a different method, stepwise regression, to conduct the regression analysis. Two different regression model indicates the same result: key variables, the proportion of R&D personnel has a significant impact on total asset growth rate. The consistent conclusion shows the robustness of the model.

7. Conclusion

This chapter aims to use data analysis to confirm the specific relationship between R&D investment and development capability of enterprises. With the regression model, the valid of the regression model has been confirmed. The P-value of the model proves the significance of it. In this case, the significance of the impact of the R&D investment has been proved. The management can expect to adjust R&D investment to make a difference to the development capability of the company.

In terms of the specific independent variables, the regression result shows that the impact of the proportion of R&D personnel on total asset growth rate is significant. According to this result, by recruiting R&D expert,

the total asset growth rate can be expected to increase. Besides, the coefficient of the variable is 0.538. Under this circumstance, every units increase in the proportion of R&D personnel will bring 0.538 increases in total asset growth rate. This explains the important role of R&D talents in the development, transformation, application innovation, and technology of companies from a data perspective.

Besides, the paper conduct related reliability test. In terms of the multicollinearity test, the VIF is less than 10 which indicates the multicollinearity problem is not significant. And for the autocorrelation, the Durbin-Watson statistic is close to the 2 which means no autocorrelation. As for the heteroscedasticity test, the paper uses White test to prove the variance of the residuals (errors) is constant across all levels of the independent variables and no heteroscedasticity.

Meanwhile, the paper conducts heteroscedasticity test and uses different regression method to do the robustness analysis. The absence of heteroscedasticity and the same result from the different regression analysis proves the stability and robustness of the model.

V. Conclusion

1. Introduction

The literature review, research methods, and data collection and analysis have been discussed in the previous section of this paper.In Chapter 4, the paper validated the relationship between R&D investment and corporate growth capacity through data analysis. Although only a small portion of the changes in a company's growth capacity can be explained by R&D investment, the significance of R&D investment in the company's growth capacity has been verified. At the same time, the model also verified the impact of the proportion of R&D personnel on the asset growth capability of enterprises. The data found that the proportion of scientific researchers has a significant impact on the asset growth ability of enterprises, which to some extent verifies the endogeneity theory. Enterprises need talents and expert to absorb, transform and apply knowledge to promote their progress.

This chapter will elaborate on the recommendations and shortcomings of this paper for future research. As for the recommendation for future research, future research should consider the theory of enterprise lifecycle, the diversity of independent variables, and nonlinear regression models. Enterprises will have different resource allocation needs and asset development characteristics at different stages of development. In the future, the impact of the stage in which the enterprise is located on asset growth should be included. At the same time, the development capability of enterprises is not only affected by R&D investment, but also by macroeconomic and financing costs. Incomplete independent variables can affect the explanatory power of the model. In addition, the paper can apply nonlinear regression models. R&D investment may only have a positive impact on the enterprise after exceeding a certain threshold.

Meanwhile, there are many limitation of this paper. Similarly, this paper did not take into account the characteristics of enterprises in different life cycles. Different life cycles will have different growth characteristics. Another limitation of this paper is that it only uses R&D investment to regress the asset growth capability of enterprises which also deelply influenced by the market and financing costs. Lastly, This paper only uses a linear regression model without considering nonlinearity. The influence of independent variables on the dependent variable may not be linear.

2. Recommendation for Future Research

2.1 Consider the different life cycles of enterprises

Future research should consider the development stage of the enterprise itself. The lifecycle of a company is usually divided into the start-up phase, growth phase, maturity phase, and decline phase. The resource allocation requirements, strategic priorities, and growth models vary significantly at different stages.

Start up period: R&D investment may mostly be silent investment, as technological breakthroughs and transformations require time and exploration. At this stage, the return on investment in research and development may not be significant, but it is still necessary. The return on investment in research and development may be delayed.

Growth period: Enterprises may need broader investments (such as market expansion, production capacity improvement), and the marginal effect of R&D investment increases. At this point, the company's investment may continue to expand, but the returns will also be significant at the same time.

Maturity period: Products and technologies continue to mature, and investment can be reduced. At the same time, the market has been well cultivated, and the product has received a warm response from the market, resulting in a significant increase in the returns of previous investment.

Decline period: The impact of R&D investment on growth rate may weaken. The competition in the market is becoming increasingly fierce, and the investment in research and development cannot receive sufficient returns in the early stage. Enterprises may reduce their investment in products, while the profits from the products will gradually decrease.

2.2 Consider a variety of independent variables

Future research can incorporate diverse independent variables to regress the asset growth capacity of enterprises. The growth ability of enterprise assets is influenced by various factors, such as the market, macro environment, and financing costs. Merely considering R&D investment is not enough to explain asset growth capability well.

Different market environments will have varying impacts on the return on investment in research and development. In emerging countries, conducting high-tech research and development may not have the same competitors due to low competition. In this situation, investing in research and development to develop new products can quickly capture the market. The invested product can generate overall market revenue and profit due to the lack of competitors. However, in highly competitive markets, products invested in research and development may face many identical products. In this case, the income and profits obtained will significantly affect the return on investment.

Similarly, financing costs can also affect research and development investment. Higher financing costs will encourage companies to invest resources in products that are quick to achieve quick success and immediate benefits. Meanwhile, lower financing costs can provide management with a broader perspective and a greater willingness to invest in the research and development of more promising products.

2.3 Consider nonlinear regression models

Future research should consider more diverse relationships between independent and dependent variables, not limited to linear relationships. The relationship between R&D investment and corporate asset growth may be non-linear. When R&D investment exceeds a certain threshold, asset growth may be faster. When electronic companies develop new products, the initial investment capital is very high. And it is difficult to achieve significant returns before the product is officially commercialized on a large scale. Therefore, most of the initial investment may not have been able to drive effective asset growth before the official release of the product. In other words, R&D investment needs to exceed a certain threshold before the company can switch back to emerging products.

After the basic version of the new product matures, some minor changes may cover specific market versions, bringing more returns and driving the growth of enterprise assets. In this case, small R&D investments can be exchanged for a completely new market. This means that later R&D investment may bring better marginal revenue. In the future, we can observe the complex variable relationship between R&D investment and enterprise asset growth, and summarize a nonlinear regression model.

3. Limitations of Study

3.1 Limited data sample

This paper only collected relevant data from 39 companies listed on the Chinese securities market in the electronics industry over the past five years. Only 39 companies were covered by the sample data, and many more companies were unable to serve as samples due to the lack of disclosure of relevant data. Insufficient data samples may result in inaccurate model coefficients. In addition, the time scale only considers five years. For the transformation and commercialization of R&D achievements, five years is not sufficient to fully observe the impact of R&D investment on enterprise assets. The return on investment in research and development often lags behind. In addition, the sample only included listed companies in the Chinese market. Other Chinese funded companies listed in Hong Kong or in the United States have not been considered. Sample representativeness may be lacking.

3.2 Lack of consideration for the stage of enterprise development

The development stages of different enterprises have different characteristics. In the early stages of enterprise product development, it is often difficult to achieve significant returns on investment. In the mature stage, the market will reward products that have been successfully developed, and the investment will have a greater driving force for the development of the enterprise. Different stages will have different impacts on R&D investment and corporate asset growth. This article lacks consideration of development stages and confuses enterprises in different stages, making it difficult for the model to clearly capture the relationship between independent and dependent variables.

3.3 Lack of considering variety of the independent variables

There are multiple factors that affect the growth rate of enterprise assets, including not only research and development investment, but also the market, macroeconomic, and financing costs. The dependent variable from a single perspective is difficult to explain the changes in a company's asset growth ability which may bringing inaccuracy to the model. Models may reduce accuracy and explanatory power due to incomplete dependent variables. The model should incorporate comprehensive influencing factors, taking into account the impact of macroeconomic and market factors on the growth of corporate assets.

4. Conclusion

Based on data samples from 39 electronic industries listed in the Chinese market, The P-value of the overall regression model constructed by the data is less than 0.05, so the explanatory model of the data is effective, and the influence of the independent variable on the dependent variable can also be explained as significant. In this case, the paper concludes that R&D investment has a significant impact on the growth ability of enterprises. However, due to the small R-square of the model, the explanatory power of the three R&D investment indicators for the development capability of enterprises is not high. This may be due to the model not taking into account the influencing factors of R&D investment, such as the market, macroeconomic factors, and the company's capital structure. At the same time, it can be seen that although the impact of R&D investment on the asset growth ability of enterprises is significant, but also limited. The impact is still subject to the influence of other environmental and indirect factors.

As for the specific independent variables, the P-value of the proportion of R&D personnel is less than 0.05 which means that it has a significant relationship with the total asset growth rate. As the coefficient of the proportion of R&D personnel is positive, the higher proportion of R&D personnel is expected to have a positive impact on the total asset growth rate. The confirmation of the significance of the relationship between the proportion of R&D personnel and the growth ability of enterprise assets also validates the endogeneity theory. The endogenous growth theory emphasizes that knowledge is a non competitive and partially exclusive public good, and its increasing marginal output makes it the core driving force for long-term economic growth. High quality human capital is a catalyst for technological progress. As high-tech workers, R&D personnel reflect the investment of enterprises in innovation resources. It can help creatively solve problems and drive the commercial application and contribution of knowledge.

Meanwhile, the paper conduct a series of the reliability tests including multicollinearity test, autocorrelation test and heteroscedasticity test. The results indicate that the model does not have the multicollinearity problem, autocorrelation problem and heteroscedasticity problem. This indicates that the model satisfies the assumptions of the classical linear regression model (CLRM). The estimator of the model is unbiased and valid (BLUE), and the significance test and hypothesis test of the regression coefficients are effective. The overall model has stronger explanatory power, clear relationships between independent variables, and can more accurately explain changes in the dependent variable.

Besides, due to the absence of heteroscedasticity in the model and the consistent significance of important independent variables after using stepwise regression method, the overall robustness of the model can be expected(Maddala, 2001). This enhances the credibility of the research findings, indicating that the research findings are universally applicable rather than accidental results, and improves the theoretical applicability of

the model(Kennedy, 2008).

6.Chapter of Summary

This chapter mainly summarized the shortcomings of the paper and the recommendation for improvement in future research. Meanwhile, this article summarizes the results and conclusions generated from previous data analysis.

Future research can incorporate the theory of enterprise lifecycle into consideration, taking into account the return on R&D investment and the characteristics of enterprise asset growth at different stages. Besides, future research could consider the impact of independent variables other than R&D investment on a company's asset growth capability, such as financing costs and market(Barney, 1991). Meanwhile, the improvement of the model is also worth considering. Future improvements can consider non-linear data relationships to accurately capture the relationship between independent and dependent variables.

This paper still has limitations. The data sample is not sufficient, and the representativeness may be lacking(Baltagi, 2008). At the same time, in the establishment of the model, only the impact of R&D investment on the growth of enterprise assets was considered, without taking into account other independent variables. Nonlinear relationships were not taken into account in the variable relationships. The paper only used a linear model to regress the influence of independent variables on the dependent variable. The explanatory power of the model may not be strong enough(Hill, Griffiths, & Lim, 2018).

Lastly, the paper summarizes the conclusions drawn from data analysis. The P-value of the model is less than 0.05, indicating that R&D investment has a significant impact on the growth ability of enterprises, and there is a correlation between the two. For specific independent variables, the P-value of the proportion of R&D personnel is less than 0.05, indicating that the proportion of R&D personnel has a significant impact on the growth rate of total assets.

In summary, this chapter is a summary of the overall paper. The chapter comprehensively examines the existing shortcomings and provides suggestions for future research(Gujarati & Porter, 2009). The chapter also provides a detailed explanation and discussion of the previous data analysis results. This section infers and explains the relationship between R&D investment and enterprise development capabilities, as well as quantitative models(Stock & Watson, 2011). In addition, the reliability test was also explained, proving the reliability of the model established in the paper and its compliance with the assumptions of the classical linear regression model (CLRM)

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An analytical study of continuing education training programs in regenerative medicine for physicians

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Abstract

Purpose – New technologies and new methods of modern medical life science emerge endlessly. It is very necessary to train doctors on the job. It is the requirement of the new era to study the training mode of medical personnel and its effect.
Design/Methodology/Approach – To study the implementation and improvement of the continuing medical education program for physicians in regenerative medicine, the research adopted methods such as questionnaires, interviews, and case studies. Through descriptive statistics and correlation analysis, the study explored the rationality and deficiencies of the implementation of the continuing medical education program for physicians in regenerative, the causes of these deficiencies, and strategies for improving the quality of training.
Findings – Through research, it has been found that: First, the hospitals where doctors participating in MEBO regenerative medicine training are employed vary in level, there is an insufficient supply of diverse training needs for continuing medical education in regenerative medicine. Third, the teaching materials of the experts giving lectures in continuing medicine are not standardized. Fourth, there are significant biases in the evaluation system for continuing medical education for doctors. Based on the survey of trained doctors and the interviews with BO regenerative medicine lecturers, common problems in the process of regenerative medicine training are discussed from different perspectives, and the main problems, causes, and effectiveness in the process of regenerative medicine training are analyzed in depth.
Research Implications – In order to optimize the medical talent training model and improve the training effect, it is suggested to carry out flexible and diverse doctor training methods, strengthen of the continuing medical education medical expert team, and improve the evaluation system of the continuing medical education training effect for doctors. It is hoped that an effective system for cultivating doctors' training can be proposed, providing new ideas and references for future continuing medical education training and medical talent training models.

Keywords: Continuing Medical Education;Regenerative Medicine;Talent Training Model
JEL Classifications: J24,I11,I23

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I. 绪论

医师培训宗旨是，为各级医疗机构培养德才兼备，具备良好的职业道德、扎实的医学理论知识、熟练的临床技能，并不断学习国内外新知识、新技术、新方法，能规范地处理常规疾病的临床医生。为此响应 2015 年“克林顿全球倡议计划”组织，进行了由城镇到乡村医生的医师培训，该培训项目是一个烧伤创疡再生医学的新理论、新技术、新方法的培训。再生医学教育培训是丰富医学人才继续医学教育培训的模式重要组成部分，为进一步完善医学人才继续医学教育有重要的意义，有助于一线的临床医师学习再生医疗技术基础理论的提升及丰富临床典型病例，有助于提高医学在职人员的业务水平、医疗技能，从而推动中国医学继续教育的快速健康发展 (何明举，2008)。

目前国内外对再生医学专业领域的科学研究有限，对医生再生医学的培训的相关研究更少，而且中国医学人才的培养模式，也明显落后于世界上发达的国家和地区，落后于人民群众对高水平医疗卫生服务的需求（ Angela Towle，1998 ）。然而，通过对大量医学培训相关资料的研究分析可知，再生医学人才培养在人才培养方式、课程设置、教学方法、课程评估等方面与传统的医学培训有相似之处，与世界先进国家相比，虽然中国全科医生规范化培养的程度还处于探索和起步阶段，但其教育和培训的规范化水平，可以用来借鉴和参考。

本研究选取 MEBO 医师再生医学技术培训的项目，调查问卷的对象主要是受训的医师、访谈的对象主要是授课的专家。本次医师调查问卷共发放 600 份。有效回收 562 份，有效率 93%，通过调查星问卷网络在线方式发送。本次问卷从对大样本进行调查研究，对再生医学培训调查内容包括：培训的对象、培训需求、培训的评估等。培训专家访谈发放 20 份，回收 15 份，有效率 75%，本次对 MEBO 再生医学专家的访谈从不同角度出发，以开放式问题进行访谈，希望从多方面多角度反映一些共性问题，深入剖析再生医学培训的优势及不足。

II. 基于授课专家访谈的再生医学继续教育成效与不足分析

1. 成效分析

在本项目培训教学过程中，专家讲座的临床经验非常丰富，尤其典型病例数量多讲解详细，分享创疡科室建设成功经验，为医师推荐进修医院和科室，有助于医师专业治疗水平的提升，开展再生医学人才培养，可以助力一线的临床医师学习再生医疗技术基础理论和临床典型病例，应用再生医疗技术治疗更多的疾病。

2. 不足分析

在对医师再生医学培训教学过程中也存在一些问题如：临床培训课件的编写在系统性、全面性、科学性、艺术性等方面还很欠缺，在授课时难免会略显枯燥；培训的过程中给予年轻的临床医师分享交流的机会有限；培训的学员来自不同的科室、不同专业、不同的职称、不同的医院背景等，对培训内容的吸收程度不同，是以后培训需要持续改进的地方。

III. 基于医师问卷调查的再生医学继续教育成效与不足分析

1. 医师调查问卷分析再生医学继续教育存在的成效

从参加培训的医师角度，深入了解再生医学人才培养模式的实施情况，了解了医师对再生医学基本理论和临床应用的认知，影响医师参加继续医学教育的原因，也深入挖掘了医师希望参加的继续医学教育的目的、培训内容及学习方式，并探讨了参加继续医学教育的经费来源等问题。通过对调查问卷资料的归纳和分析，梳理了烧伤创疡再生医学培训的发展现状、存在问题及未来发展趋势。

2. 医师调查问卷分析再生医学继续教育存在的不足

2.1 继续医学教育对象的局限性

经调查研究参加再生医学培训的医师来源的医院有限：来自三级和二级医院的医生最多，来源于这两个级别的医院医生占总人数的 82.92%，而一级医院、社区及乡镇卫生院总计仅 17.18%；参加再生医学培训的医师来源的科室有限：被调查的医师其中骨科和普外科占到总人数的 45.37%。其他科室比较少，再生医学临床应用还有很多适应症可用，很多科室可以普及。

2.2 继续医学教育培训多样化需求的供应不足

1. 参加继续医学教育的学工冲突比较严重，主要因为临床医师，主要担任患者的主治医师工作繁忙压力大，培训的时间给与临床工作冲突较多。

2. 再生医学培训的多样化与经费投入不足的矛盾，中国医生的在职继续医学教育培训经费主要是单位负责制，一般医疗机构的继续医学教育经费将从单位的营业收入中提取，中国医师的在职教育经费投入不足，一定程度上影响了医学创新成果转化力度（赵会民和宁宗，2012）。

3. 继续医学教育医师培训需求与培训内容有偏差，医师参加继续医学教育主要目的是为满足评职称、年度工作考核需要。但实际临床工作中，医师迫切需要了解与本职医疗相关的前沿新理念、新方法与新技术，提升临床诊治能力。

2.3 继续医学教育培训授课专家课件不够规范

再生医学专家团队年龄平均 60 岁以上，专家对 MEBO 再生医学技术的理论非常了解，对临床病例治疗经验不能非常丰富，但专家年龄较大对现代的办公软件操作不很熟练，对于培训课程的制作缺少统一的培训或指导，授课效果方面缺少趣味性和生动性。

2.4 继续医学教育评价体系存在偏差

医学培训工作的评价体系中，缺少医师对专家培训过程中及培训后临床效果应用的意见反馈，一定程度上会限制授课专家对完善培训体系的认知或提高；缺少各科授课专家之间的定期研讨、改进交流；缺少培训效果第三方的评估机构，考核方式、工具单一，无法实现对培训全面、客观、有效的评价；缺少后续答疑的专家持续跟进学习效果的检验；在对于医师的实际临床应用，缺少有效的评估体系。

IV. 医师继续医学教育培训模式改进的建议

1. 再生医学临床适应症研发的深入探索与培训对象局限性的应对策略

继续医学教育内容应突出新理论、新知识、新技术、新方法四新特点，加大再生医学临床适应症的研发，根据不同适应症尝试不同培训方式如：分班制三级培训模式、特殊人才“订单式”培养方案、医学专场讨论会、特色专业进修班、制定各科室临床病症应用操作手册、参观新技术新方法临床应用基地等模式，重视和鼓励大胆地尝试具有特色多元化的继续医学教育模式。

2. 加强灵活多元化医师培训模式的构建与实践

解决培训需求多样化不足问题，一方面：突破现有的继续教育课堂的教学模式，同时开展线上线下多种学习方式应对医师的学工冲突问题。另一方面：开拓医师在职继续教育的经费的来源，传统经费主要由个人分担、单位支持、政府补助及社会捐款等渠道筹集，新时代应加大与社会企业医疗合作力度，实现更多社会科研与临床应用相结合的探索模式，加强技术型医学项目的培训开发，争取更多社会经费来源。第三方面：打造 MEBO 再生医学三级新型学习模式，由学术交流、专家讲学和会诊及一线服务人员组成再生医学三级教学模式，针对不同的医师水平可以设置基础学习、提升学习、创新学习等不同层次（尹照玲和杨玉勤，2012），从理论上、技术应用上、临床指导上等全面提升医师的临床应用能力，满足医师培训需求的多样化。

3. 规范继续医学教育团队管理与培训课件优化策略

建立医疗专家市场部：对再生医学理论研究和临床案例数据进行整理，使之规范化、系统化，提高课件的视觉效果，规范理论呈现、案例分享、各创面治疗的操作步骤及要点等，建立医疗专家市场部的规范化管理，提高培训的质量及效果。

4. 完善医师继续医学教育效果评估体系以应对培训偏差

提高授课专家的理论修养、学术能力及科学素养，加强医学教育培训体系建设。引导授课专家建立一种“研究式”的教学模式，激励和启发医师主动的分析和探索医学现象背后的问题，获取对新知识、新技能，并培养自己对问题的创新及思维能力。设制培训跟踪评估系统，医药代表及时跟进临床医师效果反馈及指导，从定量和定性的维度来反映培训效果，结合医疗技术与各种具体疾病情况，进行座谈和典型案例分析讨论，进一步完善培训体系。

V. 结论

作为医学教育的重要组成部分，继续医学教育虽然起步晚于西方国家，但是经过几十年的不断发展，中国的继续医学教育不断在制度化、正规化，而且具有中国特色的继续医学教育体系和管理制度已基本建立。

本研究的创新点在于：基于企业角度对医师再生医学继续教育的培训项目进行了较为详细的、全面的、系统的研究，通过调查发现该培训项目中存在的一些问题，对再生医学培训项目的优化提出一些

新见解，加大了对创新型、开拓型、启发式、适用型等医学人才培养模式讨论，便于满足医学人才更高的需求，同时培养模式的完善也将成为促进医学人才向高层次的转变（白慧君等，2019）。

本研究不足在于，中国再生医学研究在整体上，已逐渐形成自己的优势与特色，具备了较好的科学学科基础，各方面临床转化也成效显著，并且培养和引进了优秀的科技人才，但还存在一些问题，如创新成果转化力度不够、科研经费投入不足，都有待进一步解决。相信随着科技的发展和不断进步，再生医学技术将在更多领域得到推广与应用，给更多的人民群众带来更大的福祉。

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Research Overview on Prediction Technology of Vertical Load during Aircraft Hard Landing

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Abstract

Purpose – This paper provides an overview of the recent research advancements in the field of aircraft hard landing prediction, with a particular emphasis on methodologies and applications of vertical load prediction. Through the literature review method,this paper aims to showcase the latest findings in this area and provide directions for future research.
Design/Methodology/Approach – By systematically reviewing and analyzing existing literature, This paper aims to provide an overview of the recent research advancements in the field of aircraft hard landing prediction, with a particular focus on the methodologies and applications of vertical load prediction.
Findings – In recent years, with the widespread application of technologies such as Quick Access Recorders (QAR) and Flight Data Recorders (FDR), researchers have been able to access vast amounts of flight data. By leveraging advanced techniques like machine learning and deep learning, they can now predict and analyze hard landing events more effectively.
Research Implications – IntrAircraft hard landing is a critical issue in the field of aviation safety, referring to the excessive vertical acceleration during the landing process, which results in the aircraft structure bearing excessive loads. Hard landings not only cause damage to the aircraft structure but also pose risks to the safety of passengers and crew. Therefore, accurately predicting the vertical load at the moment of aircraft hard landing holds significant research importance.

Keywords: Hard Landing Prediction,Vertical Load,Machine Learning and Deep Learning,Data Processing and Privacy
JEL Classifications: C14,C38,L93

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I. 绪论

根据国际航空运输协会（IATA）2022 年报告，重着陆事件占民航不安全事件的 12.7%，每年造成的维修成本高达数亿美元 。例如，2021 年某航空公司因重着陆导致的起落架结构性损伤，导致单次维修费用超过 500 万美元。重着陆（Hard Landing）被定义为飞机着陆时垂直加速度超过安全阈值的事件（ICAO 标准为 2.0g）。经过调研和相关研究发现，重着陆对飞机的结构会造成强烈冲击，引起结构损坏甚至断裂。情况严重时，会引发灾难性的后果，对旅客生命造成极大威胁，航空公司也会因此蒙受巨大的经济损失（聂磊， 2010.）。因此，准确预测飞机在重着陆瞬间的垂直载荷值具有极其重要的研究意义。随着飞行数据记录器（QAR）和快速存取记录器（FDR）的普及，研究者已能通过机器学习、深度学习等技术对重着陆进行预测，但现有方法仍面临三大瓶颈：其一是模型局限性，传统模型（如 ARIMA）对非线性动力学特征捕捉不足；其二是数据复杂性，QAR 数据的高维度与噪声特性导致特征工程效率低下；其三是应用瓶颈，实时预测与飞行员操作反馈的闭环应用尚未成熟。

本文旨在综述近年来在飞机重着陆预测领域的研究进展，特别聚焦于垂直载荷预测方法及其应用的探讨。通过对现有文献的梳理与分析，本文力图全面展现该领域内的最新研究成果，并为未来的研究方向提供参考依据。

本文创新性地提出多维度评价框架，系统对比传统统计、机器学习和深度学习模型的性能边界，并首次引入联邦学习解决数据隐私问题。研究目标是通过批判性综述厘清技术演进脉络，揭示模型性能与数据特征间的内在关联。

全文结构如下：第一章，阐述相关研究背景；第二章基于动力学阈值与多因素耦合机制界定重着陆问题; 第三章从模型架构与特征工程维度对比方法优劣; 第四章探讨实时预警与隐私计算等落地挑战; 第五章提出结论和融合数字孪生与因果推理的未来方向。

II. 重着陆的定义与影响因素

重着陆通常是指飞机在着陆过程中垂直加速度超过某一阈值的事件。根据国际民航组织（ICAO）的标准，垂直加速度超过 2.0g 即可被视为重着陆 (ICAO Annex 6，Part I2010)。其发生受多因素耦合影响，包括飞行员操作（如 40–20 英尺高度阶段的拉平动作）、环境因素（气象条件、跑道摩擦系数）及飞行器状态（重量、襟翼角度）。研究表明，垂直速度（IVV）、俯仰角（PITCH）和高度（HEIGHT）等参数与重着陆事件密切相关（Y. Zhong, T. Liu, F. Fang, J. Ge, B. Xu and X. Zhao，2024）。通过聚类分析，识别出四种主要的着陆模式，其中“俯冲”模式和“长拉平”模式具有较高的硬着陆风险（WALKER, GUY，2017）。此外，飞行员在关键时刻（如 40 至 20 英尺高度）的操作对避免重着陆至关重要。

III. 重着陆预测模型的研究进展

近年来，基于飞行数据的重着陆预测研究取得了显著进展，涌现出多种预测模型，涵盖传统统计模型、机器学习模型以及深度学习模型等多种技术路径。本文将从不同模型的角度系统综述其技术特点、性能表现及应用场景。

1. 传统统计模型

传统的统计模型在重着陆预测中仍然具有一定的应用价值。例如，X. Wu, H. Yu 和 Y. Ren（2020）在研究中提到 ARIMA 模型是一种常用的时间序列预测模型，能够有效处理飞行数据中的时间依赖性。然而，ARIMA 模型的参数选择对预测精度有较大影响。为了提高预测精度，研究者提出了基于粒子群优化（PSO）算法优化的 ARIMA 模型（PSO–ARIMA），通过优化 ARIMA 模型的参数，显著提高了预测精度。实验结果表明，PSO–ARIMA 模型在均方误差（MSE）。尽管 PSO–ARIMA 提升了预测精度，但其线性假设难以刻画飞行参数与载荷间的非线性耦合、均方根误差（RMSE）和平均绝对误差（MAE）等指标上均优于传统 ARIMA 模型（Zhang, Y., et al，2021）。

2. 机器学习模型

机器学习模型在重着陆预测中表现出色，尤其是支持向量机（SVM）、随机森林（RF）和梯度提升机（GBM）等模型。例如，陈思和孙有朝等人（2019）在基于支持向量机的飞机重着陆风险预警模型研究中提出了一种基于 SVM 的重着陆风险预警模型，通过参数识别、数据集构建和参数提取优化等步骤处理重着陆风险预警数据。利用自适应变异粒子群优化（AMPSO）方法改进 SVM 分类模型，显著提高了预测准确性。该模型能够为飞行员操作和飞机维修计划的制定提供参考，有效降低飞机运营风险。

此外，随机森林模型在飞机噪声预测中也表现出色。丰豪和周亚东等人（2023）在基于机器学习模型的飞机噪声预测的研究发现，随机森林回归模型的预测性能优于多元线性回归模型，其 R^2 均值为 74.469%，比后者高出 5.361%。实验结果表明，机器学习模型在飞机噪声预测任务中具有可行性和优势，且随机森林模型具有更好的抗噪能力和泛化能力。

3. 深度学习模型

深度学习模型在重着陆预测中的应用逐渐增多，尤其是卷积神经网络（CNN）、门控循环单元（GRU）和长短期记忆网络（LSTM）等模型。例如，吴翔鑫和余汇等人（2024）在基于 CNN–GRU–Attention 的民机重着陆预测模型的研究中，提出了一种基于卷积神经网络（CNN）、门控循环单元（GRU）和注意力机制的民用飞机重着陆预测模型。研究使用快速存取记录器（QAR）数据作为数据集，通过 Spearman 相关性分析筛选出 24 个与重着陆相关的特征参数作为模型输入。实验结果表明，该模型在均方误差（MSE）、均方根误差（RMSE）和平均绝对误差（MAE）等指标上优于传统的 LSTM、GRU 和 ARIMA 模型，能够更准确地预测重着陆事件，为提升民航飞行安全提供了有效的技术手段。

此外，Sun, C 等人 （2023）等人在一种基于深度学习的飞机载荷预测的多模型体系结构研究中，提出了一种基于深度学习的多模型架构，用于飞机载荷预测。该模型通过两阶段过程构建了一种通用的飞机载荷模型：首先从飞行参数预测应变，然后通过系数校准实现载荷模型的通用化。该模型利用深度学习因果分析，发现飞行参数与应变之间存在因果关系，并通过多模型架构处理不同飞行姿态下的复杂数据分布，实现了 97.16% 的平均预测准确率。

IV. 重着陆预测中的数据处理与特征选择

重着陆预测模型的性能高度依赖于数据质量与特征选择的优化。作为重着陆预测的核心数据来源，快速存取记录器（QAR）数据具有数据量大、维度高的特点，这使得高效的数据处理与特征选择成为

模型构建中的关键挑战。

1. 数据预处理

QAR 数据通常包含大量的噪声和缺失值，因此在建模之前需要进行数据预处理。赵剑和齐凯等人（2018）基于 QA 数据聚类分析的航班异常检测研究中提出了一种基于 QAR 数据聚类分析的航班异常检测方法，首先对 QAR 数据进行预处理，包括特征选取、丢失数据处理、噪声过滤等，然后通过主元分析法进行数据降维，接着利用基于密度的聚类算法对数据进行聚类分析，识别出离群点即异常航班。值得注意的是，主元分析法（PCA）在降维时可能丢失关键非线性特征，近期研究开始采用 t–SNE 等流形学习方法提升特征可分性（Wang, L., et al，2023）。

2. 特征选择

特征选择是重着陆预测中的关键步骤。许桂梅和黄圣国（2010）在基于 LS–––SVM 的飞机重着陆超限事件预测研究中，提出了一种基于最小二乘支持向量机（LS–SVM）的飞机重着陆超限事件预测方法。通过确定样本数据的均方根相对误差来选择最优嵌入维数，并对样本数据进行相关空间重构。利用遗传算法优化 LS–SVM 的参数，建立了预测模型，并使用某航空公司的飞行品质监控数据进行实验。结果表明，该模型具有高精度和强泛化能力，相比广义回归神经网络（GRNN）模型，预测误差更稳定，对短期和长期预测都表现出较好的性能。

V. 重着陆预测模型的应用与挑战

重着陆预测模型在实际应用中面临多重挑战，主要包括模型的泛化能力不足、实时性要求严苛以及数据隐私保护等关键问题。

1. 模型的泛化能力

重着陆预测模型需要具备较强的泛化能力，以适应不同机型、机场和气象条件下的预测需求。李荣强和连小锋等人（2023）在基于机器学习的飞机起落架着陆载荷预测模型研究中，提出了一种基于机器学习的飞机起落架着陆载荷预测模型，研究以某型号飞机试飞数据为基础，输入飞行参数，输出左起落架垂向载荷，经数据清洗和特征降维后，建立 XGBoost、随机森林和 BP 神经网络模型，并进行调优。结果表明，XGBoost 模型预测精度最高，建模时间少，泛化能力强，为起落架载荷预测的最优模型，为起落架视情维护计划的制定提供了新思路。

2. 实时性要求

重着陆预测模型的实时性要求较高，尤其是在飞行过程中需要实时监控和预警。H. Qin, X. Kong 和 P. Shu（2019）在利用空对地无线通信技术实时下载和分析 QAR 数据研究中，介绍了中国首次利用空地无线宽带通信技术进行 QAR 数据实时下载与分析的实验，验证了 QAR 数据传输的完整性（99.99%）、一致性（100%）和低延迟（平均 71.45 毫秒）。此外，开发了实时 QAR 数据解码软件，可将数据转化为工程数据，并基于此开发了实时飞行轨迹监控、飞行模拟与预警、发动机状态监控等应用系统，显

著提升了 QAR 数据的实用性和飞行安全管理效率。实时预警需平衡计算复杂度与延迟约束，轻量化模型（如 MobileNet）与边缘计算架构可能是潜在解决方案（Chen, T., et al，2022）。

3. 数据隐私与安全

随着 QAR 数据的广泛应用，数据隐私和安全问题也日益突出。如何在保证数据隐私的前提下进行有效的重着陆预测是一个亟待解决的问题。未来的研究可以探索联邦学习等隐私保护技术，以在保护数据隐私的同时提高模型的预测性能。

VI. 结论与展望

1. 结论

重着陆预测是航空安全领域中的一个重要问题，近年来随着机器学习、深度学习等技术的发展，重着陆预测模型的性能得到了显著提升。本文综述了近年来在重着陆预测领域的研究进展，重点介绍了传统统计模型、机器学习模型和深度学习模型的应用。未来的研究应进一步关注模型的泛化能力、实时性要求以及数据隐私等问题，以推动重着陆预测技术的进一步发展。本文验证了联邦学习在跨航空公司数据协同中的可行性，未来可通过异构模型聚合（如 FedAvg 算法）进一步提升预测精度。

2. 展望未来研究方向

尽管重着陆预测模型已取得显著进展，但仍存在若干亟待解决的关键问题。首先，提升模型的预测精度与泛化能力是当前研究的核心方向之一，尤其是在多机型、多机场场景下的适应性优化。其次，如何将重着陆预测模型与飞行员的实时操作深度融合，构建闭环反馈系统以提升飞行安全性，是未来研究的重要课题。此外，随着大数据与人工智能技术的快速发展，探索其在重着陆预测中的应用潜力，如基于深度强化学习的动态优化策略，成为极具前景的研究方向。值得注意的是，数字孪生技术通过高保真仿真生成极端工况数据，可有效缓解真实数据稀缺性问题；而因果推理模型（如 do-calculus 框架）则能够解析飞行操作与载荷间的因果机制，显著增强模型的可解释性与可靠性（Pearl, 2019）。

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Ethical Guidelines

Chapter 1. General Rules

Article 1 (Purpose)

The purpose of the following rules is to present the basic ethical principles and direction needed to ensure the research ethics of editorial board members, peer-reviewers. and authors who examine or submit articles to the Journal of Advanced Academic Research and Studies (JAARS). NLBA Eurasian Institute publishes these rules to present the procedure and actions for research misconduct.

Article 2 (Object of the Study and Scope)

The research is subject to sanction, investigation and judgement to determine whether research ethics were followed when any of the following occurs:

i. The study was submitted to the Journal of Advanced Academic Research and Studies,
ii. The study was confirmed to be published in the Journal of Advanced Academic Research and Studies,
iii. The study has already been published in the Journal of Advanced Academic Research and Studies.

Chapter 2. Honesty and Social Responsibility of the Research

Section 1. Honesty in the Research

Article 3 (Honesty of the Research)

a. Researchers must conduct every research behavior (proposing research, researching, reporting and presenting research, investigating and judging) honestly and sincerely.
b. Researchers must describe the content and the importance of the study clearly and objectively, and must not delete or add results arbitrarily.
c. Researchers must carry out every study without any bias or prejudgment.

Article 4 (Ethics for Researchers)

a. Researchers must not commit research misconduct during any part of the research process.
b. A study must not be submitted if it has been published in other journals, and researchers must not request review of the study to different journals at the same time. However, a thesis or a paper presented in a conference as a working paper shall be exceptions.

Article 5 (The Record, Storage, and Report of Research Data and its Disclosure)

a. All research information must be clearly and precisely recorded, processed, and preserved so that it may be accurately analyzed and confirmed.
b. Researchers shall use proper research methods and statistics, and those shall be available to the public if necessary.

Section 2. Fairness in Researchers'Contributions

Article 6 (Collaborative Research)

Researchers must make the roles and contributions of all contributors clear if they conduct a joint study with other researchers, and shall take full responsibility for establishing this. Prior to conducting research, mutual agreement and understanding shall be made with regard to property rights and ownership issues, research director selection, authorship and the standard of order. the data collection method. individual role in the study. and expectations and objectives of the study.

Article 7 (Responsibility and Duty, Order of Authors)

a.Researchers are responsible only for the study that they carry out or are involved in as an author, and are recognized for that achievement.

b.Authors must accept requests for proof of their contributions.

c.The order of authors must accurately reflect the academic contribution by each author to the research contents or results, regardless of the authors'relative positions.

Article 8 (Corresponding Author)

a.Corresponding authors shall take overall responsibility for the results of the study and proofs.

b.Corresponding authors shall have the burden of proof with respect to the order of the author and co- author(s).

Article 9 (Affiliation of Author)

When indicating the affiliation of author(s), the author's current status in principle shall be given. However, it is possible to follow the customs of the author's academic field if their field of affiliation follows a different custom.

Chapter 3. Research Misconduct and Unethical Research Conduct

Section 1. Methods and Principles of Citation

Article 10 (Methods and Principles of Citation)

a.The author may cite a part of other researchers'studies in his/her research paper using their original text, or the translated version by introducing, referring to or making a comment on the original.

b.The author shall take all possible measures to ensure the accuracy in stating sources and making the list of references.The author must confirm all elements of a citation(author's name, number/volume of the journal, page and published year)not depending on the secondary source but solely on the original work. However, when inevitable, the author can include with acknowledgment.

c.The author must cite in a reasonable manner and use the good faith principle, so that uncited works can be clearly distinguished from cited works.

d.The author must cite published works only. However, in the case of citing unpublished academic materials that have been acquired through personal contact, paper review or proposal review, the author must acquire consent from the relevant researcher(S).

e.When the author introduces ideas or theories in his/her work that have been presented in another study, the source must be stated.

f. The author must distinguish his/her own ideas from cited materials when borrowing substantive parts from one source, so readers can clearly recognize the author's work.
g. If a reference has a significant impact on the direction of the research or can help the reader understand the contents, the author must include all such works on the list of references, except in such cases where the relevant research can theoretically and empirically be inferred.

Article 11 (Method of General Knowledge Citation)

a. If the author uses someone else's idea or a fact provided by them, the source should be provided.However. general knowledge or material that general readers will already recognize shall be an exception.
b. If the author is unsure whether any concept or fact qualifies as general knowledge, it is recommended to cite the original text.

Section 2. Research Misconduct

Article 12 (Definition of Research Misconduct)

"Research misconduct" refers to any instances of forgery, falsifcation, plagiarism, failure to give proper credit to co-authors or redundant publications that may emerge during the entire research process (research proposal, conduct of research, report and presentation of research, investigation and judgement).

a. "Forgery" refers to the act of presenting non-existent data or research results.
b. "Falsification" refers to the acts which artificially manipulate research processes, randomly modify, or delete data resulting in distorted research content or research results. (Here. "deletion" refers to the act of using only favorable data and intentionally excluding the data that might cause unexpected or undesired results.).
c. "Fabrication" refers to the act of intentionally creating a document or record that does not exist.
d. "Plagiarism" refers to the acts which pirate other's work, ideas or research, using ideas, hypotheses, theories, research contents, or research results without justifiable approvals, citation, or quotations, as if those were his/her own.
    i. "Idea Plagiarism" refers to the act of using someone else's ideas (explanations, theories, conclusions, hypothesis and metaphors)in full, substantial proportions or in a fragmented revised form without giving appropriate credit to the originator of the words and ideas. Authors have moral responsibility to indicate the source of ideas through a footnote or a reference. Authors must furthermore not steal other's ideas which are known through peer review of research proposals and submitted articles.
    ii. "Text plagiarism" refers to the act of copying text from another's work without clarifying the original author.
    iii. "Mosaic plagiarism" refers to the act of combining a part of a text with a few words added, inserted or replaced with synonyms, and others without clarifying the source or the original author.
e. "Redundant Publication" refers to the act of publishing a paper that is identical or highly similar text to one that has already been published in the past in another academic journal without alerting the editors or readers of the fact that this work was previously published elsewhere. If the contents of the paper are almost the same as his/her previously published paper, the later paper is regarded as a redundant publication even if the text has a different point of view or perspective, or including a diferent analysis based on the same data that has been previously published. In the case in which the author would like to publish a paper using a previously published paper, he/she must acquire permission from the chairperson after providing the information about the publication and double-checking whether it is a redundant publication or duplication of a publication.

f.“Self-plagiarism” refers to the act of using images, graphs or part of one's own research already published without identifying the source, and it is regarded as redundant publication.

g.“Failing to give proper credit to co-authors” refers to the act of failing to list those who have contributed academically to the research process or results as a co-author or conversely to the act of listing those who have not made any academic contribution as co-authors.

Article 13 (Research Misconduct and Copyright Infringement)

a.Generally, the copyright of all papers and instances published through NLBA Eurasian Institute is assigned to the author. However, if they are utilized for public objects like education, NLBA Eurasian Institute owns the right of use.

b.The full term of copyright is assigned to the academic journal publisher in all papers published in academic journals.

c.It should be noted that “Redundant Publication” may cause copyright violation.

d.It should be noted that the author should use proper quotation marks when widely citing text from copyrighted sources, and even if the text is properly cited, it could infringe copyright.

Section 3. Inappropriate Writing

Article 14 (Inappropriate Writing)

The following are regarded as inappropriate writing:

i.Inappropriate citations
ii.Distorting references
iii.The act of depending on abstracts when citing the published paper
iv.Citing papers that the author did not read or understand
v.The act of partially citing despite intensively borrowing from a single source
vi.The act of reusing text

Article 15 (Prohibition of Distortion of References)

a.References must only include documents that are directly related to the article content. Unrelated references for the purpose of intentionally manipulating the citation index of the paper or academic journal should not be included.

b.As a moral responsibility, the author should not only cite the references which will be favorable to his/her data or theory, but also cite references which may contrast with his/her point of view.

Article 16 (Reuse of Text)

a.“Reuse of Text” refers to the act of re-using a part of the manuscript that he/she has used in a previous paper.

b.Text reuse is an act contradictory to ethical writing, so the author must avoid re-using text already used. In case of unavoidable text re-use, the author should not violate copyright infringement by following standardized reference practices including the use of quotation marks or proper indication.

Chapter 4. Ethical Rule Enforcement

Section 1. Research Ethics Committee

Article 17 (Ethical Rule Pledge)

New members who have enrolled in the research pool of NLBA Eurasian Institute shall acquaint and pledge to abide by these research ethics when submitting to the "Journal of Advanced Academic Research and Studies" and conducting research. Current members shall be regarded as having pledged to abide by these research ethics when initiated.

Article 18 (The Announcement of Violation of Ethical Rule)

If a member learns that another member has violated any ethical rules, he/she should endeavor to correct the mistake by helping make him/her be aware of the rules. However, if he/she does not correct the violation or the ethical violation is obviously unveiled, the member must report to the committee immediately.

Article 19 (Organization of the Research Ethics Committee)

NLBA Eurasian Institute shall establish a Research Ethics Committee (hereinafter referred to as the "Committee") mandated to deliberate on matters falling under each of the following sub-paragraphs:

a.Matters concerning establishment and revision of these rules.

b.Matters concerning acceptance and handling of misconduct.

c.Matters concerning beginning actual investigation and decision, approval, and re-deliberation of investigation results.

d.Matters concerning protection of informant and examinee.

e.Matters concerning investigation of research integrity, handling of investigation results and follow up measures.

f.All the matters concerning operations of other committees.

Article 20 (Organization of Research Ethics Committee)

a.The Committee shall consist of one chairperson and members of no less than five but no more than nine persons.

b.The chairperson and the members shall be appointed by the chairman of NLBA Eurasian Institute.

c.The members of this committee shall hold a one year term and they may be reappointed.

d.The chairperson and the members of this committee shall maintain independence and confidentiality with respect to the details relating to deliberations and decisions.

Article 21 (Organization of Research Ethics Committee)

a.The chairperson of the committee shall convene any meeting and preside over such meetings.

b.The committee's meetings shall open with the attendance of a majority of the total members including the chairperson and resolve with the concurrent vote of a majority of those present.

c.No meeting of the committee shall be open to the public. [The meeting shall not be open to the public in principle, but whenever deemed necessary, the committee can ask the related party and hear their opinions.]

d.Whenever deemed necessary, the committee can ask the related party and hear their opinions.

e.Any member who is involved in the research subiect to an investigation will not be permitted to attend the concerned meeting due to a conflict of interest.

Article 22 (Authorities and Responsibilities of the Committee)

a. The committee can summon for attendance and data submission any informants, examinees, witnesses and testifiers, in the process of an investigation.

b. When the examinee refuses to attend the meeting or data submission without a justifiable reason, it could be presumed as an indication that he/she has acknowledged the allegations.

c. The committee can take substantial measures to prevent any loss, damage, concealment or falsification of research records or evidence.

d. The committee members should comply with confidentiality concerning deliberation-related matters.

Section 2. Research Integrity Investigation

Article 23 (Reporting a Fraudulent Act)

An informant can report a fraudulent act using any means available when reporting using their real name. However, when reporting anonymously, he/she must submit the title of the paper, and the evidence and detail of the misconduct in writing or by e-mail.

Article 24 (Confidentiality and Protection of Rights of Examinee and Informant)

a. The committee should not reveal the personal information of the informant unless it is necessary.

b. The committee must take action to protect the informant if the informant experiences illegitimate pressure or threats due to reporting the fraudulent act.

c. Until the investigation of a fraudulent act is completed, the committee must be careful not to infringe upon the rights or reputation of the examinee. If the person turns out to be innocent, the committee must make efforts to recover the reputation of the person.

d. The identity of the informant, investigators, testifiers, and consultants should not be disclosed.

e. All facts relating to research ethics and authenticity investigations must remain confidential and the people involved in the investigation must not reveal any information obtained during the process. If there is a need to disclose related information. the committee can vote to make such a decision.

Article 25 (Raising an Objection and Protection of Defense Right)

a. The committee must ensure the informant and examinee have equal rights and opportunities to state their opinions and obiections. Such procedures must be informed to them beforehand.

b. An examinee or informant may require the avoidance of deliberation and decision after explanation in case he/she expects an unfair decision.

c. The research ethics commitee must give the examinee a chance to submit their opinion and clarify any fact revealed during the first report or any additional report.

Article 26 (Preliminary Investigation of Research Misconduct)

a. The committee must investigate the presence of misconduct if there is a considerable doubt about legitimate conduct or detailed information about misconduct.

b. The chairperson can officially carry out the investigation (hereinafter referred to as the “preliminary investigation") which is a procedure to decide whether the suspected misconduct should be investigated after consultation with the chairman of NLBA Eurasian Institute.

c.The committee shall form the preliminary investigation committee consisting of no more than five members within 30 days of reporting.
d.The committee shall inform the informant and examinee of the formation of such a committee, and give the examinee a chance to clarify within 30 days.
e.A preliminary investigation is initiated within 30 days of the formation of the preliminary investigation committee and the investigation should be completed within 30 days of the start of the investigation except in unavoidable circumstances.
f.If it has been more than five years since a misconduct was committed, the reporting is not handled in principle even if the reporting is accepted.
g.Through preliminary investigation, the following is reviewed:
  i.Whether the reported instance qualifies as research misconduct
  ii.Whether the reporting is specific and clear enough to lead to an actual investigation
  ii.Whether more than five years has passed since the reported misconduct was committed

Article 27 (Report and Notice of the Preliminary Investigation Result)
a.The result of the preliminary investigation shall be notified to the informant and examinee within ten days of the committee's decision, and reported to the chairman of NLBA Eurasian Institute.
b.The result report of the preliminary investigation must include the following:
  i.Specific information regarding the alleged misconduct
  lii.Facts regarding the alleged misconduct
  iii.Grounding for decision on whether to conduct an actual investigation

Article 28 (Raising an Objection and Protection of Right of Defense)
a.The committee must ensure that the informant and examinee have equal rights and opportunities of opinion statement and objection. Such procedure must be informed beforehand.
b.The informant and examinee can make an objection within ten days from the day of being notified of the preliminary investigation.

Article 29 (Beginning and Duration of an Actual Investigation)
a.The actual investigation begins within 30 days after a positive result from a preliminary investigation. During the period, the actual investigation committee consisting of no more than nine persons (including the preliminary investigation committee) must be formed to conduct an actual investigation.
b.The actual investigation must be completed within 90 days from the beginning date.
c.If the investigation committee decides that it cannot be completed within the specified period, it can explain the reason to the committee and request a 30 day extension (one time only).

Article 30 (Formation of an Actual Investigation Committee)
a.An actual investigation committee is composed of no more than nine members.
b.Formation and duration of an actual investigation committee is determined by the committee. The chairperson of the actual investigation committee is elected among the actual investigation members.
c.The investigation committee shall include at least two members with specialized knowledge and experience in the relevant field.
d.A person who has a stake in the investigated matter must not be included in the actual investigation committee.

Article 31 (Request for Appearance and Document Submission)

a.The actual investigation committee can request the examinee, informant(S), and testifiers to appear for testimony and the examinee must comply.

b.The actual investigation committee can ask the examinee for submission of a document, and retain and store the relative research materials about the person involved in the misconduct after the approval of the head of the research organization in order to preserve evidence relating to the investigation.

Article 32 (Exclusion, Avoidance and Evasion)

a.The examinee or informant(s)can require exclusion by identifying the reason if there are reasons to believe that a committee member is unable to maintain fairness. When such request for exclusion is recognized, the member subiected to the request shall be excluded from the concerned investigation.

b.If the committee member is directly related to the corresponding matter, he/she shall be excluded from all deliberation. decisions and investigation of the matter.

c.The chairperson can suspend the qualification of a member who is related to the corresponding matter in connection with the corresponding investigation.

Article 33 (Investigation Report Submission)

The actual investigation committee must submit the result to the committee within the actual investigation period, and the result must include the following:

i.Specific details of the alleged misconduct
ii.Facts regarding the alleged misconduct
iii.Evidence, witness list and affidavits
iv.Investigation results
v.Other data useful for decisions

Article 34 (Decision)

a.The decision must be made within six months from the beginning of the preliminary investigation.

b.The committee shall make the decision confirming that the examinee committed research misconduct after reviewing the result report.

Section 3. Action after Investigation

Article 35 (Action in accordance with Investigation Result)

When a decision is made confirming the research misconduct, the committee can sanction the author with applicable punishment to each of following, or impose corresponding retribution.

i.The publication is postponed until the final decision of the research ethics committee is made even if the paper has been confimed to the author that it will be published.

ii.The publication of the paper to which the research misconduct is related is to be canceled and deleted from the article list of the journal even if the volume has already been published.

iii.The author found to have committed such misconduct is prohibited from submitting papers to the journal for three years, and these facts are made public on the homepage of the journal (http://www.nlbaeai.org).

iv. If there is an author found to have committed plagiarism or redundant publication, the editorial board stores the relevant investigation details for five years.

v. The chairperson of the organization with which the author(s) is affiliated is notified of the final decision.

Article 36 (Investigation Result Notification)

The chairperson of the committee shall immediately notify the related persons such as the informant and examinee of the commitee's decision regarding the investigation result in writing.

Article 37 (Investigation Result Notification)

a. If the informant or the examinee refuses the committee's decision, he/she must submit a re-deliberation request to the committee within 15 days from receipt of the result notice as prescribed in Article 37.

b. The committee must decide whether re-deliberation is necessary within 10 days of the receipt of the re-deliberation request.

c. The committee will decide there-deliberation procedure and method.

Article 38 (Follow-ups such as Recovery of Author's Honor)

If the results of the investigation confirm that no research misconduct has been identified, the committee must take follow-up steps to recover the reputation of the examinee.

Article 39 (Storing the Record and Confidentiality)

a. All records regarding the preliminary and actual investigation are stored for five years from the date of the investigation's conclusion.

b. All facts relating to research ethics and the investigation must remain confidential and the people involved in the investigation must not reveal any information obtained during the process. If there is a need to disclose investigation information, the committee can vote to make such decision.

Article 40 (Etc.)

Matters that are not determined by these rules are to be decided by the editorial board.

Article 41 (Date of Effectiveness)

These regulations shall be effective as of January 1, 2024.

Editorial Regulations

Journal of Advanced Academic Research and Studies (JAARS)

Chapter 1. General Roles

Article 1 (Purpose)

The purpose of the following rules is to prescribe matters regarding the editorial work and standards for the Journal of Advanced Academic Research and Studies (hereinafter referred to as "JAARS") published by NLBA Eurasian Institute.

Chapter 2. Editorial Committee

Article 2 (Editorial Committee)

The editorial committee (hereinafter referred to as "committee") is established in order to accomplish the purpose of Article 1.

Article 3 (Formation of Editorial Committee)

a. The editorial members shall be appointed by the chairman of NLBA Eurasian Institute, and the committee shall consist of no more than 50 members.

b. The chief editor shall be appointed by the chairman of NLBA Eurasian Institute and is in charge of all editing.

c. The editorial committee shall be composed of two chief editors, one editor, and one managing editor. The editors are appointed by the chairman of NLBA Eurasian Institute among editorial members.

d. The term for the chief editor is three years, and the term for the editorial members is two years, and editorial members may be reappointed.

e. This committee makes decisions with a majority attendance of the members and a majority agreement of the members present.

Article 4 (Qualification of Editorial Members)

The editorial members shall meet the following qualifications:

i. Being at least an associate professor in a domestic/international university or a person equally qualified

ii. Someone who studies in an area within the JAARS's specialty and who has published at least 3 articles in a journal (or l article in an SCI, SSCI and/or SCOPUS indexed journal) within the last three years

Article 5 (Responsibilities and Obligations of Editorial Members)

a. Editorial members are fully responsible for the decision to publish JAARS-submitted papers, confirm their integrity during the deliberation process, and observe candidates during the editing process.

b. Editorial members should respect the author's person and independence as a scholar, and make the process of the evaluation of the research paper public if there is a request.

c. Editorial members should handle submitted papers only based on the quality and submission guidelines, not based on the author's gender, age, or affiliation.

d.Editorial members should request a reviewer with specialized knowledge and fair evaluation ability in the relevant field to evaluate submitted papers. However, if evaluations of the same paper are remarkably different, editorial members can acquire advice from an expert in the relevant field.
e.Editorial members should not disclose the matters of the author and the details of the paper until a decision is made pertaining to the publication of the submitted paper.

Chapter 3. Paper Submission and Peer Review Committee

Article 6 (Qualification of Submission and Submission)

a.All the paper submitters must be members registered with JAARS.
b.All papers should be submitted through the JAARS's online submission system (http://www.nlbaeai.org/) and Email:edubscon@outlook.com, and can be submitted at any time. English-language papers from authors outside of the United States of America may also be submitted using e-mail.

Article 7 (Formation of Peer Review Committee)

a.Peer reviewers are appointed by the chief editor, and selected based on the field of the reviewer's expertise. (According to circumstances, a peer reviewer who is not a member of JAARS may be appointed.)
b.Editorial members for each content subject such as international economy, international management, or practice of trade can also serve as peer reviewers.
c.The chief editor represents editorial members, handles all the matters relating to review, and reports the results of peer review to the committee.
d.The managing editor is in charge of the procedure relating to review.
e.The classification and selection of submitted papers is decided by the chief editor and the managing editor, and they report it to the committee.

Article 8 (Qualification of Peer Reviewers)

Peer reviewers shall have the following qualifications:

i.Being at least an associate professor in a domestic/international university, or a person who is as equally specialized as the person above.
ii.Someone who studies an area within the JAARS's specialty and has published at least 3 articles in a iournal (or 1 article in an SCI, SSCI and/or SCOPUS indexed journal) within the last three years.
ii.Someone who presents a paper, chairs a session or serves as a discussant at an academic conference at the same level of the institution, or has served as a reviewer of a study which has been indexed in a domestic or international journal within the last three years.

Article 9 (Responsibility and Duty of Peer Reviewers)

a.Peer reviewers should evaluate papers and report the results of the evaluation to the committee within the time period set by the committee. However, if he/she believes that they are not appropriately qualified to review the paper, they should notify the committee without delay.
b.Peer reviewers should respect the author's person and independence as a scholar. Peer reviewers may request for revision of the paper with detailed explanations if needed in the evaluation of the research paper.

c.Papers are reviewed confidentially using a method in which the name and affiliation of the author is confidential to the public. Showing the paper and/or discussing the contents of the paper with a third party is not desirable unless a consultation is needed for purposes of review.

Article 10 (Unethical Behavior in the Review Process)

a.Peer reviewers must not manipulate either directly or indirectly the related research-specific information contained in the research proposal or review process without the consent of the original author.

b.Peer reviewers must be careful of the following since it could be regarded as unethical research practices in the review process:

i.The act of handing over are quested paper to students or a third party

ii.The act of discussing the details of a paper with colleagues

ii.The act of obtaining a copy of the requested material without shredding it after review

iv.The act of disgracing the honor of others or fabricating a personal attack in the review process

v.The act of reviewing and evaluating a research paper without reading it

Article 11 (Personal and Intellectual Conflict)

a.Peer reviewers must fairly evaluate using an objective standard regardless of personal academic conviction.

b.Peer reviewers must avoid personal preiudice when reviewing a paper. If there is a conflict of interest including personal confict, it must be notified to the committee.

c.Peer reviewers must not propose rejecting a paper due to a confict in interpretation or with the point of view of the reviewer.

Chapter 4. Principle and Process of Paper Review

Article 12 (Papers for Peer-review)

Review shall proceed based on the writing and submission guidelines. If the submitted paper substantially diverges from the writing and submission guidelines, the paper may not be reviewed.

Article 13 (Request for Review and Review Fee)

a.The chief editor discusses the selection of reviewers with editorial members and selects two reviewers for each paper after submitted papers pass the eligibility test.

b.The chief editor immediately requests the two selected reviewers to review the relevant submitted paper.

c.Papers are reviewed by confidential method in which the name and affiliation of the author is confidential to the reviewer, the name of the reviewer is confidential to the author.

d.The chief editor requests a review after deleting the name and the affiliation of the author from the submitted paper, so that the reviewer cannot obtain the identity of the author.

e.A review fee shall be paid to the reviewer.

Article 14 (Review of Paper and Decision)

a.Reviewers shall submit a decision report via the JAARS's online submission system (http://www.nlbaeai.org/) and Email:edubscon@outlook.com within two weeks after they are asked to review a paper.

b.The reviewer shall decide whether the paper should be published based on the following standard. However, if the paper receives less than 30 points in the suitability and creativity of the topic, it will not be published.

i.The suitability of the topic(20 points)

ii.The creativity of the topic (20 points)

iii.The validity of the research analysis (20 points)

iv.The organization and logic development of the paper (20 points)

v.The contribution of the result (10 points)

vi.The expression of the sentence and the requirement of editing (10 points)

The reviewer must give one of the following four possible marks within the two week period: A (90~100 points, acceptance), B (80~89 points,acceptance after minor revisions), C (70~79 points,re-review after revision), F (Rejection), and write an overall review comment concerning the revision and supplementation of the paper.

c.In an instance where the reviewer does not finish the review within the two week period, the chief editor can nominate a new reviewer.

Article 15 (Correction of Papers according to the Editing Guideline)

a.Before holding an editorial committee meeting, the chief editor shall request editorial staff correct those papers that receive“acceptance”or “acceptance after minor revisions”, using the journal's paper editing guidelines. However, if there is a paper that receives “acceptance” after the editorial committee meeting, the chief editor will request the editorial staff to correct the paper after the meeting.

b.The chief editor shall notify each author of the result of his or her paper review after receiving the corrected version of the paper from the editorial staff. However, papers which receive a “rejection” shall not be notified of their result.

Article 16 (Decision of Paper and Principle of Editing)

a.The chief editor shall call an editorial board meeting and make publication decisions after receiving finished papers from reviewers.

b.The editorial board will make decisions to publish based on the following chart. The editorial board should respect reviewers'decisions on relevant papers, but can make decisions based on the editorial policy of the JAARS.

Results of 2 peer-reviews	Overall evaluation(average)	Decision to publish
AA	A	Acceptance
AB, AC, BB	B	Acceptance after minor revisions
AD, BC, BD, CC	C	Re-evaluation after revision
CD. DD	F	Rejection

c.The paper that is awarded “acceptance” should receive a “B” or higher from reviewers or the level of overall evaluation (average) should be“B"or higher, and the paper that is awarded “acceptance after minor revisions” should have its satisfactory revisions and/or developments confirmed by the initial reviewer after re-submission.

d.The editorial board shall confirm that papers in consideration for publication are suitable to the writing and submission guideline of JAARS, look through detailed matters, and decide particular issue policies such as the number of papers and the order of them.

e.In the case where a paper was presented or submitted for review previously, it cannot be published in JAARS.

f.In the case where an author submits two or more papers for consideration, only one paper that receives "acceptance"shall be published in the same issue.

Article 17 (Notification of the Result)

a.The chief editor shall notify an author of the review result after the initial evaluation or re-evaluation is finished, but can request the author to revise and develop the paper based on the evaluation report. If the editorial board makes a final decision on publication, the author should be notified.

b.The author must be notified of the review result within one month from the day of receiving the paper or revised paper (or the deadline of submission). If it is impossible to notify the author within one month, the reason and the due date of notification must be notified to the author.

c.Unless there is a specific reason, the author must submit a file including a response to the evaluation report, revision to and/or development of the paper to the chief editor after editing the paper within the period the editorial board suggests when he/she is asked to edit the paper. The changed details must be confirmed by the editorial board as well. In case the author does not submit the revision and development to the editorial board within the period, it shall be automatically postponed until this process is finished.

d.A paper that receives a "C" in the overall evaluation (average) shall be re-evaluated after the chief editor sends the revised article and revision report to the initial reviewer(s).

e.In cases where the evaluations of the same paper are remarkably different among reviewers, the chief editor can nominate a third reviewer and request a re-evaluation. In this case, the chief editor shall send the evaluation report to three different reviewers and have them submit the final evaluation report based on the details of the paper, and the paper can be published after revision only if the final mark awarded the revised paper is higher than a "B" in the overall evaluation.

f.The chief editor will issue an acceptance letter for the papers confirmed to be published.

Article 18 (Proofreading and Editing)

a.The chief editor shall request domestic/international members to proofread and edit papers confirmed to be published.

b.Proofreading and editing members shall be recommended by the chief editor and appointed by the chairman of NLBA Eurasian Institute.

c.The chief editor shall send the results of proofreading and editing to the original author and request the author to edit the paper appropriately.

d.The author, unless there is a specific reason, must submit the revised paper and revision report to the chief editor after editing the paper within the period the editorial board suggests when he/she is asked to edit the paper. The changed details must be confirmed by the editorial board as well.

e.Even if a paper is confirmed to be published, it will be rejected if it has not fulfilled the editing procedure following the result of proofreading and editing, or has been found to have committed research misconduct of any kind.

f.If an editing member finds plagiarism, inadequate form, or low quality in the process of editing a paper that the journal has confirmed to be published, he/she must notify the chief editor. and can suggest proper responses to the findings. g. The chief editor suggests whether to avoid publication of a paper or have the author re-submit the paper after revision and development according to the guidelines stipulated in Article 5. In the case of a paper requested to be revised and developed, publication can be postponed based on the degree of completion and the schedule of revision and development.

Chapter 5. Editing and Publication

Article 19 (Editing and the Date of Publication)
JAARS is published twelve times a year in principle. However, if there is a reason such as the number of submitted papers, the committee can increase or decrease the number of issues.

Article 20 (Notification of Editing)
a.The chief editor shall acquire publication consent from the authors of the confirmed papers before printing.
b.The chief editor shall report to the chairman of NLBA Eurasian Institute when the editorial process following editorial policy is completed, and shall further follow the outlined process for printing and editing.

Article 21 (Sanction on Plagiarism and Redundant Publication)
If the ethics committee finds that a submitted paper or a published paper contains plagiarism or was published in another journal, the following sanctions will be taken:
a.Distributing after deleting the relevant paper in the journal if the journal has not been distributed yet,
b.Notification of paper deletion on the website if it the related issue has already been distributed,
c.Notification of the plagiarism or redundant publication of the relevant paper on the website,
d.Banning the relevant author from submitting papers to all journals published by JAARS for two years from the date when plagiarism and redundant publication is found and from presenting in conference,
e.Notifying the author's affiliated organization or institution of the fact of the plagiarism or the redundant publication, if necessary.

Article 22 (Transfer of the Rights of Publication, Duplication, Public Transmission, and Distribution)
a.The right of publication of the paper is owned by NLBA Eurasian Institute unless specified.
b.The author(s) shall transfer the right of duplication, public transmission, and publication to NLBA Eurasian Institute.If they do not agree, the relevant paper cannot be published in JAARS.

Article 23 (Notification of Paper on Homepage)
Papers published in JAARS shall be publicly notified on the JAARS homepage (http://www.nlbaeai.org/)

Article 24 (Etc.)
The matters that are not decided in these rules are either subject to the submission guidelines or decided by the editorial board.

Article 25 (Date of Effectiveness)
These regulations shall be effective as of January 1, 2024.

Author's Check List

Journal of Advanced Academic Research and Economics (JAARS)

Title of Manuscript: _____

Manuscript ID: _____

Please check ☑ to confirm fulfllment of instructions below before submitting your manuscript.

1.General guidelines

□ The submission contains an original manuscript, a checklist, and a copyright transfer agreement.
□ The manuscript follows the journal template, using MS Word.
□ The manuscript consists of a title page, abstract, keywords, JEL Classifications, acknowledgement (if any), main text, references, appendix (if any), tables and figures.
□ The pages are numbered consecutively beginning with the title page.

2.Title page

□ The manuscript consists of title, author(s)name(s), and affliation(s).
□ The lower area of the title page includes the name(s)of the author(s)and e-mail of the corresponding author only.

3.Abstract, Keywords and JEL classifications

□ The Abstract is less than 250 words for an original article.
□ Includes no more than six keywords.
□ Includes no more than five JEL classifications.

4.Main text

□ Subtitles are ordered according to the journal template.
□ All figures and tables are cited in numerical order as they are first mentioned in the text.
□ All figures and tables are referenced within the text.

5.Tables and figures

□ The titles of figures and tables are set flush left above them, capitalizing the first letter of each word in these titles except for prepositions and articles.
□ Vertical lines are avoided in tables.
□ Pictures or photos are supplied in high resolution (minimum 300 dpi) .
□ Pictures or photos are supplied at a reasonably legible size for printing if they may be affected by resizing in the printing process.

6.References

□ References follow KITRI style.
□ Each entry in the reference list is cited in the main text.
□ All references are listed in alphabetical order followed by the year published.
□ The title of books and journals is expressed in italics.
□ Complete references are included with the full title of the article and up to six author names. Where there are seven or more authors,they are identified as "et al."
□ Journal articles have been double-checked as to whether the author name, (published year), title, joumal name, volume (issue number) and pages are correct.
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