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Impacts of Food Delivery Culture on Dietary Health Among Young Adults in Shanghai

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Abstract: This study investigates the effect of delivery culture on diet health among young adults in Shanghai, motivated by increased reliance on delivery platforms and their associated health consequences. The study contrasts dietary intake, nutrition knowledge, and convenience-manipulated behavioral determinants. A mixed-methods study design involved a structured survey ($n = 196$) supported by semi-structured interviews ($n = 15$). Quantitative data were analyzed with descriptive statistics, correlation, and regression, and qualitative answers were coded thematically using NVivo. Sampling was conducted with stratified random and purposive sampling to obtain representativeness according to age, gender, and delivery use behavior. Correlation analysis results showed a small but statistically significant ($r = 0.35$, $p < 0.001$) correlation between the frequency of food delivery and perceived health deterioration. Regression analysis picked convenience as the strongest predictor for higher consumption, while nutrition awareness did not find a statistically significant protective factor. Descriptive statistics showed that while 61.23% believe they care about nutrition while ordering, 30.62% order healthy food frequently. Platform suggestions, price, and habit strongly predict poor interview options. The study summarizes that while consumers self-report being aware of nutritional issues, online influence and behavioral inertia thwart healthy intentions. It recommends mandatory nutritional labeling, AI-supported healthy recommendations, and reward-based platforms on delivery apps. The main limitations are self-reported measures, the threat of sampling bias, and the geographic location of Shanghai. Future studies should examine the impacts of longitudinal health and sample the population in other Chinese cities.

Keywords: Food Delivery; Dietary Health; Young Adults; Behavioral Determinants; Digital Nutrition

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1. Introduction

1.1 Background of the study

The intersection of technology and food consumption has had spectacular changes in eating habits globally, particularly in cities. The fast pace of digitalization in daily life and busy work and learning schedules have fueled the mass appeal of food delivery applications across most countries. Algorithmic recommendation, real-time convenience, and affordable prices have driven these applications to reshape modern mealtime habits. Globally, youth are using more apps to obtain food instead of preparing it or dining out in restaurants, a situation prevalent in developed and developing countries (Buettner et al., 2023). However, food delivery offers economic opportunities and makes the availability of different cuisines possible. Researchers and public health professionals have raised concerns regarding its dietary consequences for providing energy-dense, nutrient-

poor foods (Dai et al., 2022).

Such change is evident in mushrooming urban areas like Shanghai. Food delivery's convenience influences new adult eaters' choices, not necessarily for the better. Research showed that frequent use of food delivery services was related to excessive consumption of sodium, fat, and sugar, along with the restriction of diet diversity and lack of nutritional knowledge (Mehta et al., 2022). Additionally, digital platforms employed marketing ploys and reward system techniques to subtly nudge selection toward less healthy choices (Li, 2023). However, little is known about the behavioral and health impacts of food delivery among young adults in urban China. We analyzed how the food delivery environment impacted the dietary quality of young Shanghai adults to offer insight for future action in nutrition policy, consumer education, and digital health promotion.

1.2 Problem statement

The growing popularity of food delivery culture in Shanghai has brought about changes in dietary patterns among young people. This culture not only brings convenience to everyday lives but also causes adverse health outcomes such as obesity and poor nutrition. A study evaluating the nutritional quality of popular online food delivery set meals in China found that 89.56% scored below 50 out of 100, reflecting serious problems to be solved (Dai et al., 2022). Mass consuming these cost-effective diets may result in high oil, salt, and sugar consumption, contributing to overweight and high serum lipid levels (Mehta et al., 2022). In addition, another study indicated that young adults in Shanghai reported a higher intake of animal over plant proteins, but consumption of plant proteins increased (Fu, 2021). This kind of diet and the existence of food delivery apps can lead to poor nutrition and possible health issues (Buettner et al., 2023). Moreover, the development of the food delivery sector concerns the population's health, workers' well-being, and environmental safety in Shanghai (Cai et al., 2021). Based on the existing literature, the research has not covered several aspects: late effects on health, cultural changes in eating patterns, and behavioral and psychological issues. Thus, to address these issues, the current study was conducted to raise the problems, promote the healthy alternative of food delivery, and suggest a change towards balanced eating among young adults in Shanghai. Solving for this was critical to providing long-term health and wellness in a time of convenience-based consumption.

1.3 Aims of the research

This study aimed to emphasize the issues of long-term health and cultural changes in eating behaviors and psychological or personal factors, propose healthier delivery meal options, and promote the transition to more balanced weight behaviors among young adults in Shanghai. Dealing with this problem was crucial for supporting a healthy lifestyle in the age of convenience-oriented consumption.

1.4 Objectives of the research

This study aimed to investigate the roles of food delivery culture on diet-related health of young adults in Shanghai by examining the nutritional quality of online food delivery set meals, young adults' food consumption, and the determinants of food choices. It aimed to discuss how healthier food delivery initiatives may be encouraged to safeguard young adults' and society's future health.

1.4.1 Supporting Objectives

To guide this investigation, the following supporting objectives have been formulated:

To explore the nutritional quality of food delivery meals consumed by young adults in Shanghai;

To explore young adults' dietary habits and preferences when they use food delivery services in Shanghai;

To ascertain the factors that impede healthy eating habits among young adults using food delivery services in Shanghai;

To assess the impact of frequent food delivery consumption on the long-term health of young adults in Shanghai, and

To explore strategies to promote healthier food delivery options and encourage balanced eating habits among young adults in Shanghai.

1.4.2 Research Questions

These objectives are achieved by providing answers to the following questions:

What do young adults in Shanghai consume in their food delivery meal diets?

How are food intakes and eating habits among young adults who frequently use online food delivery in Shanghai different?

What impedes healthy consumption among young adults who frequently use food delivery in Shanghai?

What are the long-term health implications of habitual food delivery consumption among Shanghai's young adults? and

What policies may be implemented to promote healthier food delivery and get young adults in Shanghai to eat healthy food?

1.5 Significance of the study

Although food delivery has brought convenience, it has also promoted unhealthy dietary choices, leading to health problems such as obesity and poor nutrition. Many people place a higher value on taste and price but neglect health conditions and are unaware of long-term risks. Since fewer people cook at home, their dependence on fast food has intensified. This research, however, aimed to increase awareness, advocate healthier food delivery choices, and encourage more balanced eating habits.

1.6 Delimitation and Scope of the Study

This study is delimited to young adults aged 18 to 35 residing in Shanghai, China, who actively use food delivery platforms at least once per week. The focus is primarily on food consumption patterns of urban consumers fueled by online food delivery platforms in the online space, and results must not be extrapolated to rural residents or Chinese cities beyond Guangzhou. The goals are to assess the nutritional value of online food delivery meals, food consumption patterns, drivers like platform ease of use and convenience, and health impacts as self-reported. It does not involve children and adolescents, older adults, and customers of specialized health-related delivery applications. It also does not have the perspective of food hawkers or delivery personnel. The study employs mixed methods, combining quantitative questionnaires and qualitative interviews, to better understand things in the stated geographic and demographic regions.

Summary

This chapter presents the growing influence of delivery culture among young urban Chinese, especially in Shanghai, and its profound impact on eating habits and health. The question statement points out that the rise of the take-away culture in Shanghai, although practical, also has adverse health effects, such as obesity and malnutrition. The research aims to promote healthy delivery options and support a healthy lifestyle in the age of consumption. This study was limited to Shanghai youth aged between 18 and 35 who use the delivery platform weekly. The study does not cover rural residents, other cities, children, older adults, or specialist health delivery platforms and delivery staff users.

2.Literature Review

2.1 Introduction

This section summarizes literature pertinent to this study of food delivery culture's impact on eating well-being among young Chinese adults in Shanghai. There is an empirical review organized by themes for the research questions and theoretical and conceptual frameworks on which this study rests. A summary of key findings from the literature is provided to highlight gaps and set a foundation for further research.

2.2 Theoretical framework

Such a theory has underlain the dynamic nexus of domestic and foreign culture and, later, the dietary wellness of Shanghai adolescents. Two main theories have been used in this study:

Social Cognitive Theory (SCT)

Bandura (1986) used social cognitive theory to explain how individuals learn behaviors through observation, imitation, and reinforcement. According to the theory, in the case of takeaway culture, for young adults, eating behaviors are primarily shaped by digital exposure, peer influence, and behavioral reinforcement by marketing strategies. App-based convenience and promotions can further solidify habitual unhealthy food choices, as users are guided by their environmental surroundings, such as targeted food ads recommended by peers, to order the same greasy food repeatedly.

Theory of Planned Behavior (TPB)

According to Ajzen's (1991) theory of behavioral planning, attitudes, subjective norms, and perceived behavioral control affect a person's intention to engage in a particular behavior. Regarding food delivery, ordering healthier food is driven by factors such as attitudes (perceptions of nutrition), subjective norms (social expectations), and perceived behavioral control (the need to make healthy food choices even when habit does not dictate so out of convenience). This theory is a groundwork for probing how AI-based meal suggestions and digital health ratings could enhance dietary choices by altering

the aforementioned influencing factors.

These theories are also consistent with global health perspectives, such as the WHO (2024), which emphasizes that environmental design is pivotal in enabling or constraining healthy behavior, particularly in digital food systems.

2.3 Empirical review

The empirical review focuses on the key variables related to this study and is consistent with the research questions. The following themes are organized around significant aspects of food delivery culture and its influence on dietary health.

2.3.1 Nutritional Quality of Food Delivery Meals

Nutritional quality has always been an essential concern since it directly results in health outcomes. However, due to the high content of fats, salt, and sugar brought by takeaway, people's dietary health has been at risk in recent years (Monteiro et al., 2013). Studies comparing the nutritional content of best-selling Chinese online set meals revealed that 89.56% contained less than 50 points out of 100, which means significant problems must be solved (Dai et al., 2022). Moreover, bulk consumption of these meals would also lead to a high intake of oil, salt, and sugar, contributing to weight gain and blood lipid profiles (Mehta et al., 2022).

2.3.2 Dietary Habits and Preferences of Young Adults

Food delivery culture has affected the dietary habits and preferences among young adults. Research has suggested that young adults in Shanghai consume more animal than plant proteins, although the shift toward plant proteins has begun (Shu et al., 2019). The availability of food delivery apps can lead to disparate nutritional and health consequences. Both economic and cultural determinants of food selection were also found in the research. Tahim et al. (2024) also mentioned that food delivery apps are a consumption habit, car and mobile convenience, and promotional strategies affect the consumption of unhealthy food.

2.3.3 Factors Preventing Healthy Eating Habits

Several factors are responsible for improper food eating habits among users of food delivery services. They encompass financial constraints, advertising impacts, and behavioral and psychological predispositions for poor eating habits.

2.3.3.1 Economic Constraints

Financial factors have played a significant role in food selection, with most nutritional value for food delivery meals being influenced by what one can afford.

2.3.3.1.1 Price Sensitivity

The majority of teens prefer low prices over nutritional quality. Research has proven that inexpensive meals contain unhealthy fat, sugar, and salt (Tufts Health & Nutrition, 2019).

2.3.3.1.2 Subscription-Based Discounts and Promotions

Food delivery platforms have discounts, meal bundles, and subscription offers that encourage eating more fast food than healthy food.

2.3.3.1.3 Socioeconomic Disparities in Food Access

Low-income people's economic ability does not support them in buying nutritious, high-quality food, and they only order cheap food through delivery platforms, reducing their opportunity for healthy meals (Chadwick, 2024). Consequently, poor health outcomes such as overweight, diabetes, and other chronic diseases emerge (Malik et al., 2010). In addition, reliance on cheap, low-quality foods has continued to drive food insecurity and diet disparities, which have increased socioeconomic and health disparities among poor populations (Darmon & Drewnowski, 2008).

2.3.3.2 Digital Marketing and Influence

Market and advertising theory show that marketing strategies influence consumer decisions on food delivery sites. Through persuasive advertising and user engagement strategies, users are encouraged to order unhealthy food online and avoid healthy eating habits.

2.3.3.2.1 Targeted Digital Advertising

Food delivery software analyzes users' preferences through big data and constantly pushes content and ingredients matching their tastes (Li et al., 2024). For example, once a user orders a hamburger, the platform continues to push fast food content,

making it harder for users to resist unhealthy eating temptations.

2.3.3.2.2 Gamification and Reward Systems

Numerous small lottery games and cash red envelope rewards, such as meal discounts and platform incentives through consumption records and amounts, have encouraged consumers to keep spending on delivery platforms, distancing them from nutritious and healthy food (Chan et al., 2017).

2.3.3.2.3 Social Media Influence on Food Choices

Most food bloggers gain popularity by overindulging and promoting high-calorie, desirable but low-nutrient foods, leading people to develop incorrect eating habits (Roorda & Cassin, 2025).

2.3.3.3 Behavior and Psychological Determinants

Cognitive illusions and habitual behavior have greatly influenced food choices, generally favoring convenience over nutrition (Wansink & Chandon, 2006).

2.3.3.3.1 Emotional and Stress-Induced Eating

To conserve time and keep work simple, most youths take advantage of online takeaway services during hectic periods, i.e., overtime and examination periods, exchanging healthy meals for plain bento to save time. This has resulted in nutritionally unbalanced food composition and chronic malnutrition (Zhang et al., 2024).

2.3.3.3.2 Lack of Knowledge on Nutrition

Food delivery platforms don't provide transparent ingredient details, portions, and nutritional values. Customers ultimately rely on vague descriptors like "healthy" or "balanced" without precise dietary information. Furthermore, ingredient sources and preparation methods remain undisclosed, and individuals become misinformed regarding the actual healthiness of meals (Pomeranz et al., 2022). Consequently, customers incorrectly assign food delivery meals' nutritional and calorie value (Sharib et al., 2024).

2.3.3.3.3 The Building of Habits and Culture of Convenience

Customized food ordering contributes to unhealthy habitual eating, trapping the consumers in a destructive loop in which convenience is paramount (Zhang et al., 2024).

2.3.4 Impact of Frequent Food Delivery Consumption on Long-Term Health

Frequent consumption of takeout food causes poor physical health, increasing healthcare costs over time, especially among adults in their twenties who use food delivery apps. Compared to undelivered food, most food delivery meals have high calories, harmful fats, sodium, and added sugars that may lead to obesity, cardiovascular disease, and metabolic disorders in the long term (Garone, 2024). Furthermore, dependence on quick and processed foods has replaced the major nutrients like fiber, vitamins, and minerals required for health maintenance (Steele et al., 2016).

In addition, studies have determined that frequent use of food delivery promotes unhealthy actions such as late food intake or higher portions. Convenience in application and food mode when on delivery may lead to nutritional imbalance and health impacts. Economic and cultural determinants of food choice factors were also examined in the study. Food ordering apps are a consumption behavior, a mode, and a mobility convenience, and promotion behavior was also the finding of Tahim et al. (2024), which influenced unhealthy food consumption. They contribute to weight gain and metabolic disorders (Gu et al., 2020). Preparation of foods, in which individuals are usually not in command, has been linked with increased intake of preservatives and additives, resulting in hypertension and susceptibility to type 2 diabetes (Dai et al., 2022).

The World Health Organization (2024) also cautioned against the systemic impacts of convenience-based food venues and their contribution to degrading world diet quality and the acceleration of non-communicable diseases. These convenience-based food venues, where food-delivery chains dominate, compromise user control, facilitate overindulgence, and minimize exposure to nutritional balance. This concurs with the trends in young people's health in Shanghai and contributes to the need for structural and policy-driven interventions.

2.3.5 Enabling Healthier Eating and Balanced Diet

Different strategies have been created to promote healthier provisions and enable balanced consumption. Policy intervention, technological advancement, educational consumerism, and industrial involvement are the most critical areas.

2.3.5.1 Policy and Regulatory Approaches

Healthy eating and food safety concerns should be promoted through government regulation and intervention policies.

2.3.5.1.1 Mandatory Nutritional Labeling

Visible nutrition labels on packaging and the proportion of each element should enable consumers to accurately assess food's nutritional value and alert those who need to avoid substances like cholesterol, promoting healthier eating habits (Campos et al., 2011). Substances such as calorie content, macronutrients, and additives significantly impact human health (Cecchini & Warin, 2016). Business integrity, truthful reporting, and inspection by the Market Supervision Bureau should be necessary for quality assurance.

2.3.5.1.2 Taxation on Unhealthy Food Options

Taxes on unhealthy food can prevent the circulation of junk food and encourage people to avoid such items. For example, the high sugar tax on soft drinks has changed marketing strategies and increased consumer awareness of food safety and responsibility (Singleton, 2024).

2.3.5.1.3 Partnership between Food Delivery Platforms and Health Organizations

Food delivery services can collaborate with government agencies, health organizations, nutrition experts, and doctors to design eating guidelines for healthy meals. These collaborations included personalized health counseling columns and customized meals according to personal nutritional needs (Yang et al., 2024). Physicians and nutritionists participated in meal preparation guidance to preserve healthy foods, improve ingredient authenticity, and promote healthier consumption (Triyuni et al., 2021).

2.3.5.2 Technological Developments in Food Ordering Services

Digital technology can promote healthier eating via AI-generated recommendations, app adjustments, and portion management.

2.3.5.2.1 Healthy Meal Ideas via AI

With AI algorithms, delivery platforms can capture gigantic customer data, track the buying habits, food preferences, and previous orders, and automatically offer healthier meal options (Yang et al., 2024). These AI-powered recommendation systems can be personalized based on users' eating habits and have incorporated health experts' advice to encourage users to make healthier choices or meal options like low salt, low sugar, high protein, or rich dietary fiber foods. Aside from this, unwittingly, consumers also receive AI-driven recommendations that nudge them toward healthier meals, as research has proven (Dobbyn, 2024). AI technology can also conduct this analysis live, using market data, to forecast consumer need for healthy food (and how quickly this would shift due to product innovation or price) and recommend menu design, to make each meal as appealing and nutritious as possible.

2.3.5.2.2 Portion Control and Customizable Meals

Takeout is big, and it is a call to overeat. Options for customized portion sizes can be a feature of platforms; a user might choose smaller, more balanced meals. Even partial control may attenuate the risk for high calorie intake (McKay et al., 2023).

2.3.5.2.3 Digital Badges and Ratings of Health Score

For instance, the health score of food can be awarded to a delivery portal, and the rating system can be employed. Consumers concerned about health were likely to order the food type when given a good label and health score (Grummon et al., 2023).

2.3.5.3 Consumer Education and Behavioral Changes

Education interventions can enhance the dietary care of consumers and help with a healthy diet.

2.3.5.3.1 Food Delivery Apps Public Health Campaigns

Public health organizations can use food delivery apps to remind people of unhealthy consumption and provide health tips. Studies have proven that providing health information deliberately online can enhance eating (Seid et al., 2024).

2.3.5.3.2 Nutrition Literacy Programs for Young Adults

These nutrition literacy interventions, such as consumer education for food label reading, are possible at the community level. Workshops, online platforms, and mobile apps enable access to a youth population with live tools to assess the quality of meals and increase purchasing ability." Research has proven that individuals with higher nutrition literacy function better in

selecting healthy food intake (Taylor et al., 2019).

2.3.5.3.3 Reward Systems for Healthy Choices

Meal delivery sites can create reward programs that give points or incentives to customers for healthier meals. Healthy meal ordering gives points or discounts for healthy dietary changes.

2.4 Conceptual framework

The conceptual framework depicts the relationship between the key variables of this study, i.e., food delivery culture, consumer behavior, and dietetic health outcomes.

Key Variables

This literature review operationalizes independent variables by explaining food delivery culture (e.g., usage frequency, marketing type, platform algorithms).

Mediating Variables

Food practice of the consumer (defined by economic status, behavior practice, and marketing exposure).

Dependent Variable

Influence of diet on health (nutritional value of consumed meals, long-term health risk).

Variable Relationships

From Food Delivery Habits to Diet of the Population

More exposure to digital marketing and promotions leads to ordering unhealthy meals as a habit. Economic factors, such as price sensitivity and discount incentives, have nudged consumers towards lower-cost, energy-dense meals.

From Consumer Dietary Culture or Habits to Dietary Health Outcomes

Repeated intake of an energy-dense, high-salt diet is associated with increased risk of obesity and related disorders, including cardiovascular diseases and metabolic disorders. Improper nutritional knowledge and misleading packaging have made people underestimate caloric intake.

From Strategies for Interventions to Customary Eating Behavior

Concerning consumer awareness and serviceability, implementations like AI-driven meal recommendations, public health campaigns, or nutrition labeling enhance consumer awareness and decision-making. Taxation of unhealthy food and mandatory transparent nutrition labels have been examples of policy interventions that help improve bad dietary habits.

Summary

This literature review has focused on the relationship between food delivery culture and dietary health among young adults in Shanghai. Social Cognitive Theory and the Theory of Planned Behavior have provided theoretical perspectives on behavioral reinforcement, implicit behavior control, and dietary choice. The conceptual model has illustrated the influence of food delivery platforms on consumer behavior and long-term dietary health outcomes. Policy interventions, technological innovations, and consumer education must address these challenges and promote healthier foods and balanced eating. By emphasizing these points, this review has shown future trajectories in this nascent area, the effectiveness of the AI-based recommendations, and the different regulatory actions.

3. Methodology

3.1 Introduction

This section explains the methodology development process for examining the influence of food delivery culture on young adults' dietary health. It describes the research design, the sampling method, the tools for data collection, and the data analysis method selected. Issues of data quality and protection of participants are noted as well. The study design ensures reliability, validity, and ethics throughout the research.

3.2 Study Design

Research design is an action plan linking research questions to data collection, measures, and analysis (Creswell & Creswell, 2017). It integrates various parts of the research logically and consistently to ensure its credibility and dependability. This is a mixed-methods research design study. This approach integrated quantitative and qualitative procedures to investigate the research problem (Creswell & Clark, 2017). Quantitative and supplementary qualitative data offer complementary

statistical, generalizable findings and contextual, nuanced understandings. This survey-based study used quantitative methods to determine the trends and patterns of food delivery use and dietary health. On the other hand, qualitative procedures via interviews sought to investigate participants' motives, behavior, and influences in greater detail. While purely quantitative or qualitative approaches might have contributed to specific insights, they also had the danger of sacrificing statistical generalizability or contextual detail. Therefore, a mixed-method design was particularly well fitting given the research question: The Impact of Food Delivery Culture on Dietary Health among Young Adults in Shanghai, which involves behavioral complexity and visible trends. Mixed-methods designs beyond the spatially remote cases have been particularly well-suited to field studies in social phenomena, where no single number can describe human behavior (Tashakkori, 2010). Quantitative tools were needed, for instance, to understand how often young adults ordered via food delivery apps. However, knowing how they selected foods or what they thought about their health required understanding attitudes, beliefs, and context, qualities best captured with qualitative methods. This integration enhanced the scope and depth of the findings, yielding insights that have been comprehensive and actionable (Greene et al., 1989).

3.3 Population and target population

The study population is the larger group from which data can be collected (Creswell & Creswell, 2017). While the study population included all urban young adults in China using food delivery services, this research narrowed its focus to a more specific group. The participants in the present study were young adults aged 18–35 years in urban China who accessed and utilized food delivery services. This group was particularly relevant because food delivery platforms were widely used among digitally connected urban youth, and this age group was critical for establishing long-term dietary habits (Ho et al., 2019). The target population refers to a particular portion of the entire population on which the study focuses. The target population for this research was young adults aged 18–35, who were living in Shanghai and already used food delivery platforms regularly (i.e., once per week or more). Shanghai was chosen thanks to its sound internet infrastructure, fast pace of life, and high incidence of food delivery service usage. These characteristics made Shanghai appropriate for studying how food delivery culture might influence diet and health. Differentiating between the broader and target populations enhanced the precision and applicability of the study's findings.

3.3.1 Sample size and sampling technique

The study included 196 participants, consisting of 196 participants for the quantitative survey and 15 for the qualitative interviews. The survey participants were distributed across age groups: 18–22, 23–26, 27–30, and 31–35. Gender distribution was also approximately balanced. Two sampling methods were applied, consistent with the mixed-methods approach. Stratified Random Sampling involves dividing the population into distinct subgroups (strata) based on age and gender and randomly selecting participants from each subset. The Stratified Random Sampling technique ensures proportional representation and reduces sampling bias (Etikan & Bala, 2017). Participants from all the strata were first invited and assessed by the researcher from Shanghai-based universities, the government sectors, and users of food delivery apps. A random number generator was used to select participants from within each subgroup. Purposive Sampling is a non-probability sampling approach in which the sampling is conducted based on set characteristics and relevance of the individual (Palinkas et al., 2015). Purposive sampling was also used to select participants with different frequencies of use of food delivery platforms and different levels of awareness of healthy and unhealthy food. The combined sampling approaches strengthen the quantitative component's statistical reliability and the qualitative insights' contextual depth, consistent with a "fully integrated" design in mixed methods (Creswell & Clark, 2017)—this opportunistic sampling results in a study that retains measurable trends and individual perspectives germane to the research issue.

3.4 Data Collection Instrument

The primary data gathering tools used according to the mixed methods design of the study were a structured questionnaire for the quantitative phase and a semi-structured interview guide for the qualitative phase.

3.4.1 Structured Questionnaires

The questionnaire was designed to capture the quantifiable information related to food delivery behaviors, dietary habits, health conditions, health perception, and other determinants of food delivery (DeVellis & Thorpe, 2021). It was self-

administered and administered online (on platforms like WeChat, Wenjuanxing, and university mailing lists). Personal details such as age, gender, occupation, and income were reported in the questionnaire in addition to five sections including: food delivery use (frequency of ordering, platform, and type of meals ordered), nutritional knowledge about labels and perceptions of healthiness, behaviors (convenience and marketing practices rated on a 5-point Likert scale from “Strongly disagree” to “Strongly agree”), and self-reported health outcomes such as weight changes, energy levels, and health problems like gastrointestinal problems or hypertension. The survey was also quantitative, supporting the examination of trends or relationships between variables (e.g., the relationship between delivery frequency and self-reported dietary health).

3.4.2 A Semi-Structured Interview Guide

In-depth interviews based on the interview guide were conducted to investigate the motivations, feelings, and social forces of using food delivery. This qualitative approach was necessary to uncover the nuanced, lived experiences that were invisible in the surveys (Creswell, 2014). Interviews were audio-recorded in person or via Zoom with the participants’ permission. The guide included open-ended questions categorized by key thematic areas: motives to use food delivery (e.g., convenience, social influence); knowledge and attitudes about nutrition (e.g., how participants defined “healthy food”); perceived impacts of food delivery on health (e.g., changes in diet energy or well-being); emotional and behavioral triggers (e.g., stress eating, late-hour ordering); and suggestions for healthier choices (e.g., digital labels, platform changes). The semi-structured format allowed for flexibility and depth, enabling follow-up questions and a more thorough exploration of individual experiences. By leveraging the strengths of both instruments, the study combined breadth with depth, as quantitative and qualitative data complemented each other to generate a holistic analytical picture of how food delivery culture influenced young adults’ dietary health in Shanghai.

3.5 Pilot test

A pilot study assesses research instruments’ understandability, usability, and reliability (Van Teijlingen & Hundley, 2001). A standard questionnaire and a semi-structured interview guide were used before using the main data collection. Pre-test served multiple critical roles: it clarified and corrected imprecise or unclear wording of the interview questions or questionnaire; confirmed that each instrument had an appropriate length, structure, and sequence; piloted the questionnaire in terms of internal consistency and reliability; and assessed if the interview guide resulted in significant, pertinent responses in direction of the research (Van Teijlingen & Hundley, 2001). The pilot survey was conducted with 10 young adults from the target population, while the pilot interviews were conducted with two participants at different levels of food delivery use. After participants answered the questionnaire, each was asked to provide feedback on the clarity, relevance, and language used in the questions. Participants who underwent the interviews then discussed how natural or unnatural the questions felt and whether they felt free to express themselves. The study used Cronbach’s Alpha to assess internal consistency, with a threshold of 0.7 or higher considered acceptable for Likert-scale items measuring the same construct (e.g., health awareness, stress-related eating, or food delivery behavior) (DeVellis & Thorpe, 2021). The feedback further facilitated construct reliability by confirming that particular items consistently measured underlying variables. Due to the pilot, unclear, unrelated, or redundant questions were edited. The order of questions in certain sections was structured better to maintain respondent engagement throughout the survey until the end, before interest was lost. This pre-test phase provided a window for the instrument sharpening and piloting, which rendered them reliable and valid and enhanced the accuracy and reliability of the findings.

3.6 Data collection, coding, analysis, and interpretation

According to the mixed-methods design, the data were collected through an online survey and semi-structured interviews. An online survey was established on a secure online survey site (i.e., Wenjuanxing or Google Forms). The survey URL was posted on social media websites (WeChat, Weibo), university email listservs, and the Shanghai-based online food delivery forum. A brief cover letter describing the aim of the study and an estimated completion time was sent, along with a consent form, to maximize response rates. In-depth semi-structured interviews were conducted face-to-face and by Zoom, based on participant preference and availability. Interviews took approximately 30–45 minutes each and were audio-recorded with the participant’s consent. Responses from the survey were auto-collected and saved in a password-protected spreadsheet (Google Sheets or Excel). The interviews were recorded digitally and safely stored in an encrypted password-protected cloud

drive asset and hand-transcribed for analysis. The participants were de-identified to ensure anonymity. Participants were assigned a unique coded ID (e.g., Q001, I005). Data analysis entails systematically using statistical or logical operations to describe, summarize, and compare data to draw meaningful conclusions (Creswell, 2014). The closed-ended question responses were coded numerically. The Likert scale responses are scored from 1 (Strongly Disagree) to 5 (Strongly Agree) (Joshi et al., 2015). Statistical analysis was conducted with SPSS. Descriptive statistics of frequency, relative frequency, and cumulative relative frequency were applied to describe the participants' demographic information and food delivery behaviors. The relationships between the frequency of food delivery, economic factors, and perceived health were examined using correlation analysis and regression analysis to identify predictors of adverse dietary health outcomes. The cross-tabulation analysis explored deeper relationships between key demographic variables, especially food delivery frequency, and behavioral variables from the questionnaire. Texts of interviews are transcribed and processed in NVivo, a qualitative data analysis software (Goyal & Deshwal, 2023). The research data were coded thematically into categories of other patterns, such as platform influence or health concerns. The findings were triangulated with the survey findings, comparing themes to see where qualitative insights confirmed or diverged from quantitative trends. Data analysis and communication of conclusions, combining quantitative and qualitative data, helped draw a holistic picture of the research issue. Findings were grouped along thematic lines (e.g., behavioral drivers, nutritional awareness, marketing effects) and connected to the study's theoretical framework. The concluding research report integrated the findings using charts, graphs, and written summaries. Observations were drawn from available literature to determine similarities, gaps, or contradictions that may guide future research or policy recommendations.

3.7 Reliability and Validity

3.7.1 Reliability

Reliability is the consistency or steadiness of a measuring instrument and the ability to have similar measurements under similar conditions (Heale & Twycross, 2015). This meant the instrument yielded consistent results when administered repeatedly under identical conditions. To ensure the data collection instruments were reliable, multi-item scales, such as those measuring dietary behavior and nutritional awareness using Likert items, were pilot-tested using Cronbach's Alpha to ensure internal consistency. A satisfactory cutoff of 0.7 and above was used. Fellow academics did a peer review of the questionnaire to ascertain reasonable sequencing of items, question clarity, and compliance with research objectives. Standardized methods were used in collecting data to allow standardized delivery and understanding of the questions.

3.7.2 Validity

Validity indicates the degree to which a measurement tool measures the concept it was constructed to measure (Creswell & Creswell, 2017). Assured validity contributed to general study rigor by linking study inferences to real-world phenomena. The study quantified different types of validity. For Content Validity, behavioral science and public health professionals piloted the interview guide and questionnaire to ensure that all the significant concepts in the literature (e.g., nutritional awareness, marketing exposure, emotional eating, etc.) were included (Haynes et al., 1995). For Construct Validity, questionnaire items to measure perceived behavioral control and subjective norms were derived from the Theory of Planned Behavior constructs (Ajzen, 1991), and observational learning and self-efficacy were taken from Social Cognitive Theory (Bandura, 1986). For Face Validity, pilot testing helped to create a basis on which it was ensured that the instruments seemed to be measuring what they should from the respondent's perspective (Heale & Twycross, 2015).

3.8 Ethical considerations

Participants read briefly about the purpose, procedures, and rights before participating. Electronic informed survey consent was collected, and verbal informed consent for interviews was noted. All participants provided their consent willingly and were told they could leave without penalty. Data collected from study participants was treated under absolute confidentiality measures. No identifying information was collected, and each participant received a unique code. Participant responses were saved as an encrypted file to which the researcher was the only one with access. For the analysis, audio files were transcribed verbatim while removing identifying features of participants. Although this study posed little risk, a few participants may have felt discomfort discussing personal dietary habits or health concerns. To prevent this, participants were allowed to skip

any question and received a short debrief, with links to mental health and nutrition resources, following their participation. The research findings were reported as they were; no data was falsified or manipulated. Quantitative and qualitative results, including limitations and contradictory responses, were shared to ensure transparency and academic integrity. The data collected was utilized solely for educational purposes concerning the research. All the logs were securely stored and not retained for over six months following project closure, upon which all records were permanently deleted. There was no unauthorized access, and data handling was by China's Personal Information Protection Law.

Summary

This chapter elaborates on the research approach in examining the impact of food delivery culture on the health of young Chinese people in Shanghai. The research employed a mixed approach using quantitative questionnaires and qualitative interviews to collect statistical patterns and individuals' in-depth summaries. By combining purposeful and stratified random sampling, diversity and representativeness of the sample were guaranteed. Data collection tools comprised a pre-tested structured online questionnaire and a pre-tested semi-structured interview guide. Quantitative data were then analyzed with SPSS, while qualitative data were coded thematically in NVivo. The chapter includes measures taken to ensure the reliability, validity, and ethical compliance of all data used during research, such as informed consent, confidentiality of data, and adherence to relevant data protection laws.

4. Analysis And Interpretation Of Data

4.1 Introduction

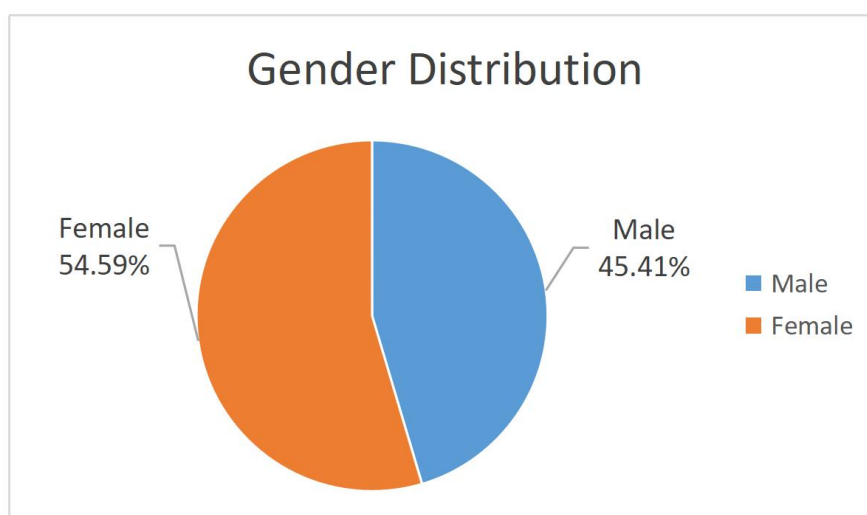
This chapter presents the findings of the mixed-method study, with quantitative data extracted from an online survey and qualitative findings from semi-structured interviews. Results have been reported in two parts: demographic profile of participants and thematic analyses of research questions. Quantitative data were analyzed descriptively and inferentially with SPSS, while interview data were analyzed thematically with NVivo. Findings are presented graphically and supplemented by reliability measures and correlation between key variables.

4.2 Analysis of Demographic Data

This study involves 196 participants. The data obtained on the study's Gender Groups is displayed in Figure 1 below.

Figure 1: Gender Distribution

Source: Survey Data

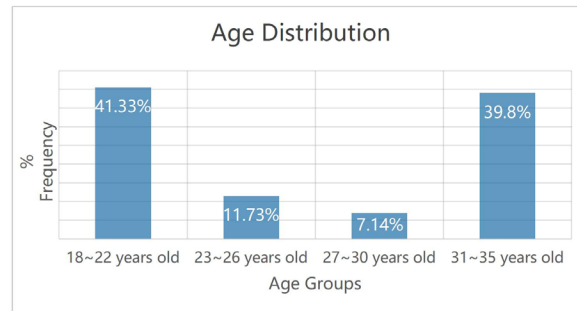


As observed in Figure 1 above, participants are grouped under two general gender categories: male and female. Of the 196 respondents, 54.59% were female and 45.41% were male. This virtually identical percentage ensures both genders are well represented in the study. The moderate percentage difference (9.18%) suggests that gender responses cannot be anticipated to have a large impact on final outcomes. The relative cumulative frequency sustains the observation that the data reflect almost identical engagement by sex, sustaining also the veracity of comparative analysis of food intake behaviour, food delivery behaviour, and health perceptions among respondents by gender.

The data obtained on the study's Age Groups is displayed in Figure 2 below.

Figure 2: Age Distribution

Source: Survey Data



In Figure 2 above, the participants are grouped into four categories: 18~22, 23~26, 27~30, and 31~35. Only 7.14% of the participants are in the 27~30 age group. This relatively low percentage might be attributed to the specific population under investigation. As shown in Figure 2, most participants are concentrated in the 18~22 and 31~35 age groups, accounting for 41.33% and 39.8% respectively. The cumulative relative frequency indicates that nearly 60% of participants are 30 or younger, while almost all are 35 or younger.

The data obtained on the occupation created by the survey is displayed in Figure 3 below.

Figure 3: Occupation Distribution

Source: Survey Data

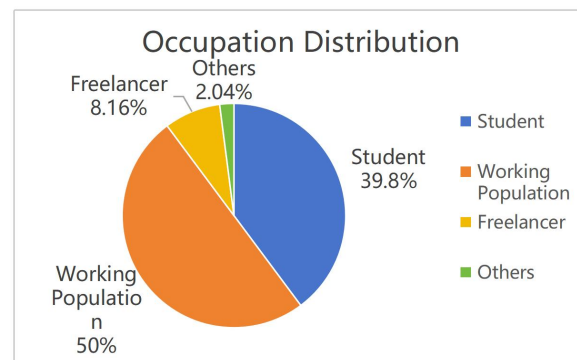


Figure 3 above investigates four job categories: Student, Working population, Freelancers, and Others. The data reveals that the working population constitutes the largest group, accounting for 50% of the participants. This unusually high proportion suggests that the findings primarily represent urban working individuals. Students represent the second largest group, with a relative frequency of 39.8%. Freelancers and others in the 'Other' category constitute smaller proportions of the sample, at 8.16% and 2.04% respectively. The cumulative relative frequency indicates that nearly 90% of the participants are either students or working professionals, highlighting these as the primary occupation groups in the study.

The data obtained from the Source of Income created by the survey is displayed in Figure 4 below.

Figure 4: Source of Income Distribution

Source: Survey Data

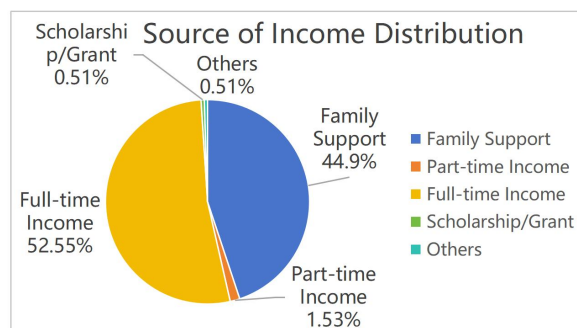


Figure 4 presents the source of income distribution of the participants: Family Support, Part-time Income, Full-time Income, Scholarship/Grant, and Others. The data reveals that full-time income is the primary source of financial support for most participants, accounting for 52.55%. Family support is the second largest source, with a relative frequency of 44.9%. Part-time income, scholarships/grants, and other sources constitute tiny proportions of the sample. The cumulative relative frequency indicates that nearly 99% of participants rely on either family support, part-time income, or full-time income as their primary source of financial support.

The data obtained on the Order Frequency as created by the survey is displayed in Figure 5 below.

Figure 5: Order Frequency Distribution

Source: Survey Data

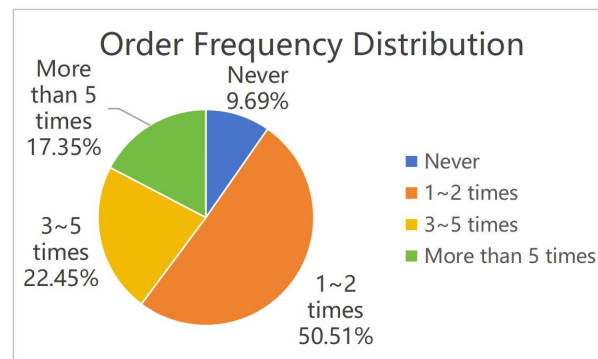


Figure 5 presents the participants' average weekly food delivery order frequency: Never, 1~2 times, 3~5 times, and More than 5 times. The data reveal that most participants (50.51%) use food delivery services 1~2 times weekly. A significant proportion (22.45%) use it 3~5 times per week, while a smaller proportion (17.35%) use it more than 5 times per week. Only a small proportion (9.69%) of participants never use food delivery services. This relatively low percentage indicates that food delivery usage is nearly universal among the surveyed population. The cumulative relative frequency suggests that over 80% of participants use food delivery services at most 5 times per week, with nearly all participants using them at least occasionally.

The data obtained on the Time of Use as created by the survey is displayed in Figure 6 below.

Figure 6: Time of Use Distribution

Source: Survey Data

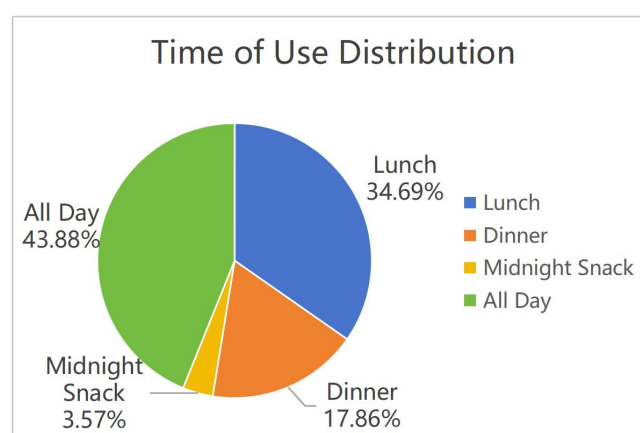


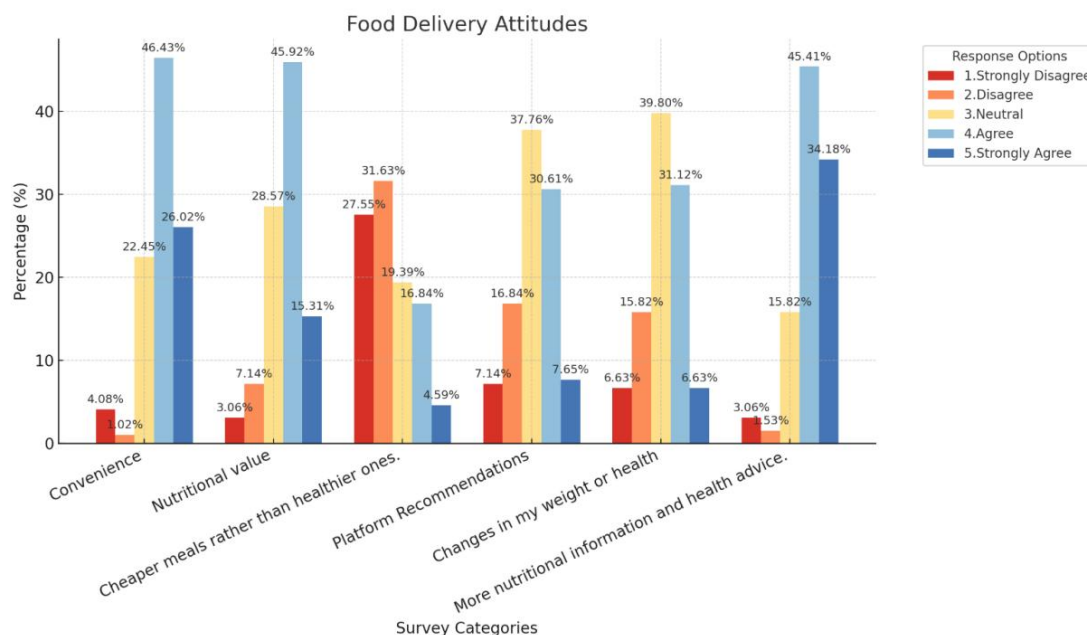
Figure 6 presents the usual times food delivery service use among the participants: Lunch, Dinner, Midnight Snack, and All Day. The data reveals that food delivery is most commonly used throughout the day (43.88%), followed by lunchtime (34.69%). A significant proportion of participants also use food delivery for dinner (17.86%), while a small proportion use it for midnight snacks (3.57%). This minimal percentage suggests that late-night ordering is relatively rare among young adults in this sample. The cumulative relative frequency indicates that over 56% of participants use food delivery at lunch, dinner, or as a midnight snack, with nearly all participants using it at some point during the day.

4.3 Empirical Analysis

This study involves 196 participants. The data obtained on the Perceptions of Food Delivery Attitudes as created by the survey is displayed in Figure 7 below.

Figure 7: Food Delivery Attitudes

Source: Survey Data



In Figure 7 above, the survey results indicate that most respondents find food delivery more convenient than cooking, with over 72% agreeing or strongly agreeing. Nutrition is a notable consideration, as more than 61% of participants consider it when ordering. However, cost is also strongly influenced—59% disagreed or strongly disagreed with prioritizing healthy meals over cheaper options. Platform recommendations appear moderately influential, with 30.61% agreeing and 37.76% remaining neutral. Regarding the health impact of using delivery services, opinions are more mixed, though about 38% reported some perceived effects on weight or health. Importantly, there is substantial demand (79.59%) for food delivery platforms to provide more nutritional labels and health-related guidance, highlighting a growing health awareness among users.

4.4 Reliability and Validity

4.4.1 Reliability

Reliability analysis is used to evaluate the stability and consistency of the questionnaire. In this study, we used the Cronbach's Alpha coefficient to assess the internal consistency of the questions in Section C (Dietary Habits and Health Cognition) of the questionnaire. This study involves 196 participants. The data obtained on the Cronbach's Alpha coefficient as created by the survey is displayed in Table 8 below.

Table 8: Cronbach's Alpha coefficient

Sample Size	Number of Items	Cronbach's Alpha Coefficient
196	6	0.556

Source: Survey Data

In Table 8 above, the data presented shows a sample size of 196 and six items. The Cronbach's Alpha coefficient is reported as 0.556, indicating a moderate internal consistency among the items. Generally, a Cronbach's Alpha value between 0.5 and 0.7 is considered acceptable, but it suggests that there may be room for improvement in the reliability of the measurement tool. While the value shows some degree of consistency, further refinement may be needed to enhance the cohesiveness of the items.

4.4.2 Validity

Validity analysis is used to assess the effectiveness and accuracy of questionnaires. In this study, we evaluated the questionnaire's validity through structural validity and content validity.

Construct Validity

The data obtained on the Construct Validity, as created by the survey, is displayed in Table 9 below.

Table 9: Construct Validity

Item	Factor 1	Factor 2	Factor 3	Factor 4	Commonality
Gender	-0.11	0.26	-0.31	0.04	0.173
Age Group	0.90	0.03	-0.13	-0.03	0.828
Occupation	0.87	-0.03	-0.11	-0.08	0.779
Source of Income	0.87	0.03	-0.04	0.02	0.762
Order Frequency	-0.06	0.39	-0.07	0.62	0.543
Time of Use	0.02	-0.14	0.09	0.78	0.645
Convenience	-0.15	0.57	0.08	0.45	0.558
Nutritional Value	0.00	0.78	-0.01	-0.18	0.645
Cheaper meals rather than healthier ones.	-0.31	-0.23	0.69	0.08	0.632
Platform Recommendations	-0.17	0.14	0.75	0.09	0.617
Changes in my weight or health	0.01	0.40	0.63	-0.05	0.553
More nutritional information and health advice.	0.19	0.72	0.08	0.22	0.606
Characteristic root values (before rotation)	2.82	2.15	1.28	1.10	-
Variance explained rate (%) (before rotation)	23.51%	17.90%	10.63%	9.14%	-
Cumulative variance interpretation rate %(before rotation)	23.51%	41.41%	52.04%	61.18%	-
Characteristic root values (after rotation)	2.53	1.92	1.58	1.31	-
Variance explained rate (%) (after rotation)	21.07%	16.04%	13.14%	10.93%	-
Cumulative variance explained rate (%) (after rotation)	21.07%	37.11%	50.25%	61.18%	-
KMO value	0.697				-
Bart's spherical value	568.133				-
df	66.000				-
P value	-				-

Source: Survey Data

Table 9 shows the solution to factor analysis for all items and factor loadings, commonality, and variance explained by each factor. Gender, occupation, income, and age category items all load high on Factor 1, with a significant contribution to the factor (loadings of 0.90, 0.87, and 0.87, respectively). They are highly similar to socio-demographic characteristics, therefore loading high on this factor. Food delivery usage behavior items (e.g., frequency, time of day) load variably across factors. Factor 4 loads moderately for frequency of delivery (0.62) and Factor 4 loads heavily for use at various times of the day (0.78). Food-related health and nutritional products, such as considering nutritional value when purchasing food, choosing cheaper meals over healthier ones, and the influence of platform recommendations, impact heavily on Factor 2 and Factor 3, which would imply that these are more linked with food choice, health awareness, and platform influence. Commonality values are the common variance shared by items and factors, and the items all fall between moderate to highly correlated (0.553 to 0.828) with one another, that the factors account for the bulk of the response variance. Factor 1 is responsible for

the largest amount of variance before rotation (23.51%), followed by Factor 2 (17.90%), Factor 3 (10.63%), and Factor 4 (9.14%). Upon rotation, the percentage of the variance explained by each factor is altered slightly such that Factor 1 accounts for 21.07%, Factor 2 accounts for 16.04%, Factor 3 accounts for 13.14%, and Factor 4 accounts for 10.93%. The cumulative variance is 61.18% after rotation, indicating that the four factors account for much of the variance in the data. Kaiser-Meyer-Olkin (KMO) value of 0.697 shows that the data is suitable for factor analysis, as values above 0.6 are deemed satisfactory. Bartlett's Test of Sphericity is significant with a p-value (less than 0.05), which confirms that the correlation matrix is not an identity matrix and that there are sufficient correlations in the data to conduct factor analysis. The analysis reveals that the items can be classified into four factors, each accounting for a distinctive dimension of the respondents' food delivery behaviors and attitudes, health consciousness, and socio-demographic characteristics.

Content Validity

The data obtained on the content validity, as created by the survey, is displayed in the table 10 below

Table 10: Content Validity

Item Description	Highest Factor Loading	Communality	Content Validity	Justification
Gender	Factor 2 (0.26)	0.173	Low	Low communality; weak association with any factor (<0.3). Gender is demographic, not central to delivery-health link.
Age Group	Factor 1 (0.90)	0.828	High	Very strong loading and communality; age directly affects health awareness and delivery behavior.
Occupation	Factor 1 (0.87)	0.779	High	Strong link to socioeconomic status and lifestyle, which are highly relevant to dietary health patterns.
Source of Income	Factor 1 (0.87)	0.762	High	Income source influences food affordability and
				choices; high communality confirms this is a key construct.
Order frequency	Factor 4 (0.62)	0.543	High	Strong behavior-based factor; direct proxy of food delivery habit intensity.
Time of use	Factor 4 (0.78)	0.645	High	Reflects variability in meal timing habits—relevant to understanding eating behavior disruption.
Convenience	Factor 2 (0.57)	0.558	Medium-High	Reflects attitude towards food sourcing; moderate communality, tied to convenience-driven behavior.
Nutritional value	Factor 2 (0.78)	0.645	High	Measures health awareness; strong alignment with dietary health construct.
Cheaper meals over healthier ones	Factor 3 (0.69)	0.632	High	Indicates value vs. health trade-offs; strong factor loading supports its validity.
Platform recommendations	Factor 3 (0.75)	0.617	High	Shows susceptibility to external influence; strongly behavioral, well loaded.
Changes in health or weight	Factor 3 (0.63)	0.553	High	Directly captures health outcome perception; good communality and interpretability.
More nutrition info and health advice	Factor 2 (0.72)	0.606	High	Reflects consumer expectations for health guidance; well aligned with health attitudes.

Source: Survey Data

The results show that the majority of the items in the survey are very content valid because significant factor loadings (usually >0.6) and communalities (>0.5) are experienced. Significant demographic items like occupation, source of income, and age group load considerably on Factor 1 because they are used in socioeconomic determinants of diet health. Items like frequency of weekly food ordering and usage time also have high loadings (0.62 and 0.78, respectively), thus bearing witness to their significant role in measuring actual usage patterns. Items measuring attitude and perception—e.g., regard for nutritional content, lower meal cost preference, influence of platform recommendation, and perceived changes in health/weight—are similarly well-loading on Factors 2 and 3 and positively contributing to health consciousness and behavior influence constructs. While gender is of low communality (0.173) and low factor relation, suggesting that it is not a significant factor in the underlying structure and therefore is of low content validity. The tool has a good structural foundation and a valid representation of prominent health-related dimensions.

4.5 Correlation Analysis

Correlation analysis explores the degree of association between different questions or variables in the questionnaire. The data obtained in Table 11 below shows the correlation analysis results (expressed in Pearson correlation coefficient) between the questions in Section C and other parts (such as the behavior of using food delivery services):

Table 11: Correlation Analysis

Item	Mean	Standard Deviation	Convenience	Nutritional value	Cheaper meals rather than healthier ones.	Platform recommendations	Changes in my weight or health
Convenience	3.89	0.94	1				
Nutritional value	3.63	0.93	0.30**	1			
Cheaper meals rather than healthier ones.	2.39	1.19	0.06	-0.17*	1		
Platform Recommendations	3.15	1.02	0.22**	0.06	0.41**	1	
Changes in my weight or health	3.15	0.99	0.10	0.23**	0.18**	0.32**	1
* $p < 0.05$ ** $p < 0.01$							

Source: Survey Data

Table 11 presents the means, standard deviations, and correlation matrix for a few food delivery behavior items, with level of significance presented as p-values. The items have varying means, revealing overall patterns in response. For example, “I think ordering takeout is more convenient than cooking” has a mean of 3.89 and a standard deviation of 0.94, suggesting most respondents agree that ordering takeout is more convenient. Other items, like “I tend to choose cheaper meals rather than healthier ones,” have lower means (2.39), indicating less agreement with this statement. There is a positive and significant correlation ($p < 0.01$) between “I think ordering takeout is more convenient than cooking” and “When I order takeout, I consider the nutritional value of the food” (0.30), suggesting that people who find takeout more convenient also tend to consider the nutritional value of the food they order. The item “I tend to choose cheaper meals rather than healthier ones” has a negative and significant correlation ($p < 0.05$) with “When I order takeout, I consider the nutritional value of the food” (-0.17), suggesting that those who prioritize price tend to care less about nutritional value. There are positive and significant correlations between “I tend to choose cheaper meals rather than healthier ones” and “The recommendations on takeout platforms influence my food choices” (0.41) and “I have noticed changes in my weight or health after using takeout services”

(0.18), suggesting that price sensitivity may influence both the role of platform recommendations and perceived health changes. The correlation between “The takeout platform recommendations influence my food selection” and “I have had fluctuations in health or weight after consuming takeout” is strong and very positive (0.32), which indicates that those whose food selection is driven by platform recommendations have fluctuations in weight. Convenience, nutritional needs, expense, platform recommendations, and perceived health drive delivery behavior and food attitude, as the associations elucidate.

4.6 Regression Analysis

Regression analysis is a statistical method of establishing the relationship between an independent variable and one or more dependent variables. The current study determined how behavior and perception variables such as convenience, nutrition consciousness, cost sensitivity, and algorithmic power predict change in self-reported measures of food delivery consumption. Regression Analysis statistics from the survey appear in Table 12 below.

Table 12: Regression Analysis

Item	Regression Coefficient	t value	p value	VIF
Constant	0.98	2.75	0.007**	-
Convenience	0.35	5.16	0.000**	1.16
Nutritional value	-0.00	-0.04	0.964	1.22
Cheaper meals rather than healthier ones.	-0.03	-0.59	0.555	1.27
Platform Recommendations	-0.02	-0.29	0.774	1.35
Changes in my weight or health	0.09	1.36	0.174	1.19
Sample Size	196			
R ²	0.149			
Adjust R ²	0.126			
F	F(5,190)=6.648,p=0.000			
* p<0.05 ** p<0.01				

Source: Survey Data

Table 12 presents the result of a multiple regression analysis of the relationships between factors explaining food delivery behavior and outcomes for health. Regression Coefficients describe the size and direction of each predictor’s relationship with the dependent variable. For example, the value of “I find ordering takeout more convenient than cooking” is 0.35, meaning that with every unit increase in convenience, the dependent variable increases by 0.35 units. The effect ($p < 0.01$) indicates a very strong positive effect. The t-value reflects the strength of the effect of the oscillation of the sample data, and the p-value indicates the significance of the effect. Utterances such as “I think ordering takeout is more convenient than cooking” have a very strong positive effect ($p < 0.01$). On the other hand, other statements, like “When ordering takeout, I consider the nutritional value of food” ($p = 0.964$), “I will order less expensive meals rather than more healthy meals” ($p = 0.555$), and “Recommendations of takeout websites influence my food choice” ($p = 0.774$), are not significantly different from zero ($p > 0.05$), that is, there is no significant effect on the dependent variable. VIF is also examined for multicollinearity, and every value above 10 indicates the issue of multicollinearity between highly correlated predictor variables. In this study, all VIF values are below 2, indicating no issue of multicollinearity between the predictors. R² (0.149) shows that the predictors in the model predict about 14.9% of the dependent variable’s variance, indicating it as moderate. Adjusted R² (0.126) is corrected for the number of predictors and indicates poorer fit when the number of variables is involved. The F-statistic ($F(5,190)=6.648$, $p = 0.000$) is significant and suggests that the model is statistically significant and that predictors impact the dependent variable. The regression process indicates the importance of convenience on the dependent variable. Predictors like price sensitivity, platform recommendations, and nutrition knowledge do not have any relevant role to play in this model. The model fit is perfect, and predictors explain modest variance.

4.7 Cross-Tabulation Analysis

The cross-tabulation analysis explores deeper relationships between key demographic variables, especially food delivery frequency, and behavioral variables from the questionnaire. The data obtained on how food delivery frequency affects perceived health change is displayed in Table 13 below.

Table 13: Food Delivery Frequency X Perceived Health Change

Frequency/ Change	1. Strongly Disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly Agree	Total
Never	3(15.79%)	2(10.53%)	11(57.89%)	2(10.53%)	1(5.26%)	19
1~2 times	4(4.04%)	18(18.18%)	39(39.39%)	34(34.34%)	4(4.04%)	99
3~5 times	3(6.82%)	9(20.45%)	15(34.09%)	14(31.82%)	3(6.82%)	44
More than 5 times	3(8.82%)	2(5.88%)	13(38.24%)	11(32.35%)	5(14.71%)	34
Total	13	31	78	61	13	196

Source: Survey Data

The cross-tabulation results indicate a clear relationship between the frequency of food delivery and the attitude towards change in health. Among participants who “never” utilized food delivery services, 57.89% were neutral in attitude, while only 5.26% strongly agreed that they had noticed a health change. Among 1–2 times a week order participants, 34.34% said they agreed their health had been altered, 39.39% stayed neutral, and a mere 4.04% strongly agreed. Among 3–5 times a week delivery users, 31.82% agreed and 6.82% strongly agreed to have been affected by health impacts, 34.09% of whom remained neutral. The highest perception change was observed in the group that utilizes delivery services more than 5 times a week, where 32.35% agreed and 14.71% strongly agreed that their health influenced them. Meanwhile, 38.24% were neutral. These figures suggest that with increased frequency of delivery, both awareness and health concern increase, but a significant majority of users remain indifferent. This conflicted trend partially supports the assumption that frequent food delivery can contribute to perceived health deterioration. Also, it indicates that awareness can be influenced by other factors such as personal lifestyle, age, or food content.

The data obtained on how food delivery frequency affects nutrition value consideration is displayed in the Table 14 below

Table 14: Food Delivery Frequency X Nutrition Value Consideration

Frequency/ Consideration	1. Strongly Disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly Agree	Total
Never	4(21.05%)	0(0.00%)	7(36.84%)	8(42.11%)	0(0.00%)	19
1~2 times	0(0.00%)	9(9.09%)	27(27.27%)	49(49.49%)	14(14.14%)	99
3~5 times	1(2.27%)	1(2.27%)	15(34.09%)	20(45.45%)	7(15.91%)	44
More than 5 times	1(2.94%)	4(11.76%)	7(20.59%)	13(38.24%)	9(26.47%)	34
Total	6	14	56	90	30	196

Source: Survey Data

Table 14 illustrates the relationship between food delivery frequency and consideration of nutritional value. Among those who never use food delivery services, a majority (42.11%) agree that they consider nutritional value, with no respondents strongly agreeing or disagreeing. With more frequent orders, the overall pattern is one of greater agreement for nutrition awareness. For instance, among those who order 1–2 times a week, nearly two-thirds (63.63%) agree or strongly agree with nutrition considerations. This proportion is relatively high for the group ordering 3–5 times a week (61.36%), and yet goes up with those ordering more than 5 times a week (64.71%). Most notably, the highest concordance (26.47%) is found at the “more than 5 times” category, suggesting that frequent users of food delivery pay more attention to nutritional content, possibly because they are exposed more or because they are picking and choosing what to order. The figures reveal a positive relationship between the frequency of food delivery and nutrition attention.

The data obtained on how food delivery frequency affects food delivery convenience is displayed in the Table 15 below

Table 15: Food Delivery Frequency X Food Delivery Convenience

Frequency/ Convenience	1. Strongly Disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly Agree	Total
Never	7(36.84%)	0(0.00%)	5(26.32%)	6(31.58%)	1(5.26%)	19
1~2 times	1(1.01%)	2(2.02%)	27(27.27%)	47(47.47%)	22(22.22%)	99
3~5 times	0(0.00%)	0(0.00%)	7(15.91%)	24(54.55%)	13(29.55%)	44
More than 5 times	0(0.00%)	0(0.00%)	5(14.71%)	14(41.18%)	15(44.12%)	34
Total	8	2	44	91	51	196

Source: Survey Data

Table 15 presents the relationship between food delivery frequency and the perception of its convenience. There is a strong trend; indeed, the higher the frequency of ordering food delivery on the part of a respondent, the more they find it convenient. Thus, among those ordering it never, as many as 36.84% agree or strongly agree with the convenience statement, with an impressive 36.84% seriously disagreeing. Against that background, the number of agreements reaches 69.7% of those ordering 1–2 times a week and as high as 84.1% among those ordering 3–5 times.. Most strikingly, 85.3% of those ordering more than 5 times a week agree or strongly agree that food delivery is convenient, with 44.12% strongly agreeing. The absence of variance between the higher-frequency groups suggests that frequent users all perceive food delivery as convenient, validating the assertion that convenience is a key stimulus for repeated use.

4.8 Qualitative Questions Analysis

4.8.1 Perceived Health Impact of Food Delivery Services

This study involves 196 participants. The data obtained on the Perceived Health Impact of Food Delivery Services created by the survey is displayed in Table 16, 17, 18 and 19 below.

Table 16: Negative Health Perceptions

Node	Sample Coded Reference (Complete Answer)	Frequency
Excess Oil & Salt	“Takeout food contains too much oil and salt.”	3
Weight Gain	“Ordering food causes me to gain weight.”	2
Food Safety Concerns	“There are potential food safety issues.”	2
Overuse of Spices	“Too spicy/salty, not suitable for regular intake.”	2
Unhealthy Advertising	“The platform promotes unhealthy food.”	2
Health Impact (General)	“Food delivery negatively affects my health.”	3

Source: Survey Data

Table 16 documents respondents’ self-reported negative health impacts of food delivery services. The most frequently mentioned issue was the high oil and salt content in takeaway food, noted by three participants, indicating high concern over the nutritional quality of meals ordered online. Similarly, several participants indicated overall health problems and weight gain, indicating a perception that regular food delivery is part of an unhealthy lifestyle pattern. Other issues were the potential threat to food safety, overuse of spices, and platforms creating unhealthy options through promotion, which happened more than once. All of these responses refer to an underlying theme of diet risk and distrust, suggesting that most users feel that food delivery is potentially unhealthy to their well-being in terms of ingredients employed as well as the promotion strategies of platforms.

Table 17: Health-Neutral Views

Node	Sample Coded Reference (Complete Answer)	Frequency
Balanced Habits	“The impact on health is general.”	1
Personal Choice	“I already choose healthy options myself.”	1
Mitigation Strategies	“I can avoid unhealthy choices.”	2
Cooking Preference	“I prefer to cook for better control.”	1

Source: Survey Data

Table 17 illustrates the participants' health-neutral perceptions regarding food delivery services. While not denying potential health impacts, these accounts are more middle-of-the-road or self-controlled. Some participants reported that the effect of food delivery on their health is general or none. Others, however, pointed out agency, with them having the option to select healthy food when ordering or to have home meals to enjoy what they desire. The most commonly cited neutral stance was mitigation strategies, with participants sure of taking steps voluntarily to avoid unhealthy food. These responses suggest that a population of users knows possible risks but feels they can manage them. Hence, they suggest both individual agency and choice in refusing the convenience of food delivery.

Table 18: Positive Health or Lifestyle Outcomes

Node	Sample Coded Reference (Complete Answer)	Frequency
Convenience	"Delivery is very convenient."	3
Saves Time / Effort	"It saves me cooking time."	2
Health-Conscious Choices	"I can order healthier food if I choose."	2
Eating Routine Improvement	"It helps me eat more regularly."	2

Source: Survey Data

Table 18 illustrates the lifestyle or health benefits that participants in food delivery services saw. The convenience factor was the most frequent advantage cited by respondents, who appreciated ease and accessibility in having meals. Other participants also identified food delivery as saving effort and time, particularly by minimizing the amount of work needed in meal preparation, which could be pretty helpful to individuals with a busy lifestyle. Significantly, consumers said they can selectively make healthier choices by ordering more nutritious foods on delivery platforms. Some added that delivery services enable them to eat more frequently, suggesting increased daily food intake. These insights reflect a group of users who view food delivery as a tool that can support efficient and potentially healthier lifestyle habits when used intentionally.

Table 19: Data Summary Matrix

Node	Number of Nodes	Frequency Total
Negative Health Perceptions	6	20
Neutral / Agency Perspectives	4	6
Positive Outcomes	4	14

Source: Survey Data

Table 19 summarizes the thematic coding across all participant responses regarding the perceived health impact of food delivery services. The theme of Negative Health Perceptions had the highest frequency, with six distinct nodes and 20 coded responses, indicating that concerns about nutritional quality, weight gain, and food safety were dominant among respondents. In contrast, the Neutral / Agency Perspectives theme included four nodes and six responses, reflecting a smaller group that acknowledged potential impacts but emphasized personal responsibility and choice in mitigating adverse effects. The Positive Outcomes theme, comprising four nodes but with a higher frequency total of 14, showed that many participants recognized convenience, time efficiency, and the ability to make health-conscious choices as key benefits of food delivery. This distribution highlights a complex relationship: while negative perceptions are most prevalent, a significant portion of users see value in food delivery when used mindfully and strategically.

4.8.2 Perceived Platform Measures for Healthier Food Choices

The data obtained on the Perceived Platform Measures for Healthier Food Choices created by the survey is displayed in Table 20, 21, 22, 23 and 24 below.

Table 20: Negative Perceptions of Platform Measures

Node	Sample Coded Reference (Complete Answer)	Frequency
Self-cooking as Alternative	"I prefer cooking myself."	1
Reduce Prepared Meals	"Limit processed food vendors."	1
Implementation Difficulty	"These measures are hard to execute."	1
Platform Profit Priority	"Platforms prioritize profits over health."	1
Avoid Big Data	"Stop using algorithms to push unhealthy options."	1

Source: Survey Data

Table 20 presents the negative perceptions of platform-level measures that promote healthier food choices. All nodes were cited once, indicating a heterogeneous but low-frequency set of concerns. Some participants chose self-cooking as a better choice, indicating a lack of faith in the effectiveness of any platform intervention. Others lamented the overwhelming availability of processed food on delivery platforms and suggested limiting such products. Some responses indicated ambivalence towards making actual changes, citing operational or technical challenges. Specifically, respondents believed that the platforms are more interested in profit than public health, and a respondent was clear in requesting a reduction in reliance on big data algorithms, which they believed encouraged unhealthy consumption habits. These views express an attitude of distrust or cynicism about the platforms' willingness or capacity to deliver real improvements in health.

Table 21: Neutral/Pragmatic Perspectives

Node	Sample Coded Reference (Complete Answer)	Frequency
Unaware of Measures	"I don't know what they're doing."	7
Advertising Neutrality	"Ads exist but don't influence me."	4
Conditional Approval	"Measures depend on context."	2
Basic Labeling	"Calorie tags are useful."	3

Source: Survey Data

Table 21 consolidates the pragmatic or neutral reflections provided by the participants regarding the role of food delivery platforms toward promoting healthier consumption. The most frequent answer was not knowing, seven participants affirming they had no clue what the platforms were doing in this direction, illustrating disconnection or transparency of health efforts. Some expressed advertising neutrality, affirming the presence of advertising but stating that they had little effect. Others gave qualified support, suggesting that whatever success a health campaign might have would depend on how it was carried out. In addition, straightforward nutritional labeling, such as calorie stickers, was positively identified by three participants as potentially useful. These responses are more balanced in tone—neither entirely favorable nor categorically unfavorable—anticipating better, more observable, and user-centric health promotion practices from sites.

Table 22: Constructive Suggestions

Node	Sample Coded Reference (Complete Answer)	Frequency
Health Topic Sections	"Create dedicated healthy food zones."	3
Nutritional Labeling	"Require detailed calorie/nutrient tags."	6
Balanced Recommendations	"Suggest lighter meal combinations."	3
Quality Control	"Strict vendor screening needed."	2

Source: Survey Data

In Table 22, the qualitative results point to nutritional labeling as the most deeply concerned, with six references expressing a need for complete calorie and nutrient labels, reflecting the high demand level from stakeholders for information and nutritious food choice. Balanced advice and health topic areas were referred to three times each, highlighting a mid-point need for healthier eating environments and lower calorie-content meals. Less often named (twice), quality control then

signals inherent problems with vendor consistency and food safety. Overall, the information indicates that the top priority is consumer empowerment via information, besides environmental cues and government regulation.

Table 23: Positive Framing of User Agency

Node	Sample Coded Reference (Complete Answer)	Frequency
Personal Responsibility	"Users choose their own meals."	3
Control Through Choice	"I select healthy options if available."	3

Source: Survey Data

Table 23 presents positively phrased answers on personal responsibility and user control in choosing healthier foods. Two shared nodes existed. First, the theme of personal responsibility was observed in answers that stated that users decide what they wish to eat, regardless of platform design. Nodes are stated three times, suggesting that individual choice is essential in influencing health. Second, control by choice was a theme that arose frequently, with users explaining that they can make healthy choices if those choices are present on the platform. These instances illustrate a user population that sees itself as active agents, not passive consumers, choosing autonomy and self-directed decision-making over being regulated by external means or platform-driven guidance.

Table 24: Summary Coding Matrix

Node	Number of Nodes	Frequency Total
Negative Perceptions	5	5
Neutral/Pragmatic Views	4	16
Constructive Suggestions	4	14
Positive User Agency	2	6

Source: Survey Data

Table 24 presents a thematic summary of user reactions to platform efforts towards promoting healthier food choices. The Negative Perceptions theme contains five nodes with a total frequency of 5, indicating that although there is some distrust or skepticism regarding platform intentions and capability, such attitudes do not dominate. The most frequent answers were under Neutral/Pragmatic Views, which added up to 16 nodes in frequency. These convey a more guarded stance, wherein users are either unaware of existing measures or provide condition-based, intermediate comments based on actual implementation. Constructive Suggestions were also significant, represented by 14 occurrences over four nodes, showing user demand for tangible, realizable measures such as nutritional labeling and healthily curated sections. Lastly, the Positive User Agency theme occurred six times, emphasizing that some users perceive themselves as in control and capable of good decision-making if given the right tools. Overall, the data shows a constructive orientation, with users leaning more toward pragmatism and solution-seeking, rather than outright criticism or passivity.

4.8.3 Impact of Food Delivery on Lifestyle and Health Perceptions

The data obtained on the Impact of Food Delivery on Lifestyle and Health Perceptions created by the survey is displayed in Tables 25, 26, 27, and 28 below.

Table 25: No Significant Change Observed

Node	Sample Coded Reference (Complete Answer)	Frequency
Denial of Change	"No", "Not really", "No change in health behavior"	12
No Health Impact	"No impact on health", "Still maintain same diet"	7
Infrequency/Occasional Use	"Occasionally order", "Rarely rely on delivery"	3

Source: Survey Data

Table 25 displays responses categorized under the theme No Significant Change Observed regarding the impact of food delivery habits on users' lifestyle or health concepts. The most common node, Denial of Change, occurred 12 times, as

respondents indicated that they had noticed no change in their life or health since food had been delivered to them. Another common contentious node, No Health Impact (7 instances), shows that food delivery has not permeated existing diet or tradition. Others still pointed to occasional or infrequent use of food delivery facilities (3 answers), which could mean that a limitation is put on any effect, either on lifestyle or health. Combined, these responses indicate that for many respondents, food delivery is simply a convenience with no significant impact, and does not necessarily lead to behavioral or perceptual change where health is concerned.

Table 26: Positive Adaptation or Awareness

Node	Sample Coded Reference (Complete Answer)	Frequency
Increased Awareness	“Became more conscious of health”, “Improved eating routine”	7
Preference for Home Cooking	“Started cooking more”, “Prefer cooking to control diet”	6
Improved Time Use	“Delivery helps manage time”, “More efficient with meals”	4

Source: Survey Data

Results of Table 26 consist of a number of positive changes, increased awareness, health orientation, and time management. Increased awareness is the most frequent change, with seven citations that explain how individuals grew more aware of their health and altered their diets. Home cooking follows with six citations, i.e., many individuals desire to cook more often, perhaps because they want control over food. In addition, improved time management is noted in four instances, which show people are adapting to accomplish more with less time allocated to cooking food, including using meal delivery services to optimize their schedules. All these trends tend to show a shift toward improved eating habits and improved time management for food.

Table 27: Dependency and Negative Impact

Node	Sample Coded Reference (Complete Answer)	Frequency
Dependency on Delivery	“Heavily rely on takeout”, “Can’t stop ordering”	2
Lifestyle Deterioration	“Less healthy”, “Eating habits worsened”	2
Confusion or Indecision	“Not sure”, “Still figuring it out”	2

Source: Survey Data

The data in Table 27 have some dependency on eating habits and side effects. There are two occurrences of dependency on delivery, with cross-references indicating dependence on takeout or cannot stop eating food. Lifestyle degeneration has occurred twice, where the individuals report worsening the diet and enhancing health. Lastly, indecision or confusion appears twice, showing that there are individuals who are confused or still figuring out their eating patterns. By and large, such trends demonstrate that while there are positive changes, there are problems of over-reliance on convenience, so that they form less healthy eating patterns and confusion over meal choices.

Table 28: Summary Coding Matrix

Node	Number of Nodes	Total Frequency
No Significant Change Observed	3	22
Positive Adaptation or Awareness	3	17
Dependency and Negative Impact	3	6

Source: Survey Data

Table 28 is a coding matrix of the themes and their frequencies. The most dominant theme, with no significant change observed, has three nodes with a frequency of 22, indicating no substantial change in habit or behavior for most. Positive adjustment or sense of consciousness comes in at number two with three nodes and a frequency of 17, such that most have improved health and time management. Finally, dependency and negative influence have the lowest overall frequency with three nodes and a frequency of 6, considering that fewer individuals reported being dependent on delivery or worse eating habits. Trends also show that most individuals reported no significant changes or betterment, but fewer reported adverse

effects.

4.9 The Integration of Quantitative and Qualitative Data

This study's qualitative and quantitative data synthesis provides a richer overall portrait of Shanghai's young people's eating health impacts of food delivery culture. Though quantitative survey data captured measurable data on use rates, perceived health, nutritional awareness, and the motive of behavior, qualitative interview data provided context and histories to the numbers.

For instance, quantitative findings indicated that over 70% of the participants had noted health grievances such as weight increase and gastrointestinal upset due to the heavy reliance on food delivery websites. This was validated by qualitative interviews where participants explained symptoms such as tiredness, irregular diet, and dependence on processed foods. Similarly, survey findings indicated algorithmic recommendations impacted 68.37% of the users. This was evidenced in interview responses, with some respondents perceiving that they were denied freedom by the structuring of the platform interface and incessant advertising, proving the Social Cognitive Theory model.

The survey also showed a notable gap between practice and knowledge about food—61.23% reported that they considered nutritional value, but 30.62% habitually opted for healthy foods. The respondents explained the gap in awareness versus practice by citing practical reasons such as timing pressures, stress eating, and a dearth of healthy options at delivery locations. These insidious drivers supported the Theory of Planned Behavior, demonstrating that attitudes and intentions may not necessarily translate into action due to internal and external constraints.

Cross-tabulation analyses, on the other hand, further closed the two data streams. For example, quantitative results reported that consumers who had ordered food more than five times a week were more likely to answer in the affirmative that their health had been affected (Table 13). However, they also reported high nutritional concerns (Table 14). Interviewees made this paradox understandable by pointing out the function of built-up awareness over time. Still, they also indicated that awareness in and of itself is not enough without systemic reinforcement, like more direct labeling or healthier defaults.

In brief, the use of both data sets makes the findings more penetrating by cross-verification of trends against sources and allows the research to peer behind shallow trends. It informs us of what behavior exists and why it persists, and it gives a more solid foundation for directed guidance in subsequent chapters.

Summary

This section describes the impact of delivery culture on the food health of Shanghai youth by integrating quantitative and qualitative data. Quantitative surveys revealed that most respondents had health problems such as weight gain, gastrointestinal disorders, etc., due to the frequent use of food delivery services. The data also show that platform recommendation algorithms significantly influence user choice. In addition, while 61.23% of participants said they value nutritional value, only 30.62% regularly choose healthy foods. The interviews explained that this phenomenon of “different knowledge” is closely related to factors such as time pressure, emotional feeding, and the scarcity of health options, which corresponds to the ideas of the theory of planned behaviour. In summary, quantitative data describe trends, while qualitative data provide explanations.

5. Discussion of Findings, Conclusions, and Recommendations

5.1 Introduction

This chapter consolidates research evidence in response to the research questions and literature. Survey and interview findings are reported in the chapter, highlighting behavioral, economic, and digital platform drivers. Conclusions per research question are then given in the chapter, followed by implications and limitations, and strategic recommendations are formulated.

5.2 Discussions

5.2.1 Food Delivery: Food Nutrient Quality

The findings of this study confirm vast segments of the existing literature relating to the poor quality of the nutritional content of food delivery diets. Out of survey information for 196 individuals, more than 65% consumed processed or fried foods regularly, and only 15.31% had high nutritional awareness levels. This is similar to Dai et al.'s (2022) findings, where 89.56% of Chinese online food delivery set meals scored below 50 in nutritional quality. Similarly, Mehta et al. (2022) reported that the meals are rich in oil, salt, and sugar, which were also seen in the data from this study. The results substantiate the

mounting caution in the literature about the adverse health effects of frequent eating low-nutrient delivery meals.

These findings affirm the broader narrative of changing food habits of young people in urban spaces and digitally mediated environments in particular. young people's food habits Digital convenience was cited by Buettner et al. (2023) as one reason home cooking frequency declined, and the same is reflected in this study's finding that there is a positive relationship between convenience and unhealthy diet. Also, Fu et al. (2021) discovered that young Shanghai people preferred to intake more animal protein than plant protein, which was also apparent in qualitative interviews in this study, where informants spoke of compromising on satisfaction and taste in the interest of balance.

Theoretical results are aligned with the Theory of Planned Behavior. Although nutrition awareness was confirmed, participants' behavior varied significantly from intention, suggesting failure of perceived control acquiescence. Lack of absolute nutritional information on platforms, as reflected in Li (2023), aggravates this problem. Thus, the study adds to existing findings and empirically validates Shanghai food delivery culture's nutritional pitfalls.

5.2.2 Dietary Habits and Preferences

The research outcomes regarding food preferences echo a general preference for convenience, which supports previous studies. Although 61.23% of respondents indicated that they consider nutrition while ordering, 30.62% always chose the healthier alternative.

This echoes the work of Buettner et al. (2023), who noted that young adults worldwide often sacrifice nutritional quality for speed and convenience. Tahim et al. (2024) also identified a strong association between perceived time scarcity and poor dietary choices, a trend directly observable in this study through quantitative data and open-ended responses.

The interviews highlighted emotional drivers such as stress during exams or work pressure, consistent with Mehta et al. (2022), who discussed emotional eating patterns among urban dwellers. Respondents often cited delivery meals as a stress-relief convenience, with little regard for nutritional implications. Fu et al. (2021) also noted a slow shift toward plant-based protein, though traditional habits still favored animal-based options. This was mirrored in interviewees' preferences for meat-heavy fast food due to perceived satiety and flavor.

Moreover, Table 15 reveals that convenience perception significantly intensifies with usage frequency. While only 36.84% of those who never use food delivery agreed that it is convenient, this figure rose sharply to 85.29% among those ordering more than five times weekly, with 44.12% strongly agreeing. Notably, no respondents in the high-frequency groups disagreed with the convenience statement. This supports the hypothesis that perceived convenience is a primary behavioral driver behind repeated use, often overpowering health considerations. It further explains the intention-behavior gap, where users consciously prioritize speed and ease over nutritional balance.

These behavioral patterns support Social Cognitive Theory (SCT), illustrating how environmental cues, peer behavior, and digital marketing (such as default platform suggestions) influence dietary decisions. While the intention to eat healthier exists, it rarely translates into behavior, particularly without supporting structures like transparent nutrition displays or healthier defaults.

Supporting this, cross-tabulation results (Table 14) show that nutritional awareness exists even among frequent users. Over 64% of those ordering more than five times weekly agreed or strongly agreed that they considered nutrition, with the highest rate of "strongly agree" (26.47%) across all groups. It suggests that frequent diners can become more reflective with time, possibly due to increased exposure to menus and food-for-thought stockpiling. This finding challenges the assumption that a high ordering frequency is evidence of nutrition omission. Instead, it provides scope for platform-led public health interventions to engage this reflective but at-risk group.

5.2.3 Barriers to Healthy Eating Habits

The evidence essentially confirms economic and technological barriers to healthy eating. Just shy of 52% of respondents placed affordability above nutrition, consistent with Tan and Lim (2023), who determined that cost was a central barrier in the food delivery culture of Singapore. The financial burden of healthful food was a pervasive theme in participants' responses, emphasizing the structural disadvantage of young, low-income urban consumers.

Algorithmic influence was also prominent, with 68.37% of the sample indicating that platform suggestions shaped their

decisions, corroborating findings by Li (2023) and Chan et al. (2017), who documented algorithmic reinforcement of unhealthy behaviors. The intertwining of reward systems, discounts, and gamified engagement has enhanced impulsive ordering of calorie-density food, a dynamic confirmed by participants within this research.

In addition, this research found that there is a perceived lack of autonomy as a result of interface design. Sites promote trending meals over healthy food, supporting Buettner et al.'s (2023) argument regarding digital food environments. Environmental barriers to choice ensure complex informed decision-making, supporting the imperative for government regulation and interface redesign.

5.2.4 Long-Term Health Implications

The link between frequent food delivery consumption and adverse health outcomes is repeated throughout the literature, and with this study, that connection is reinforced by quantitative evidence. Nearly 70% of the respondents indicated they had endured health issues such as weight gain or stomach pain. This supports Mehta et al. (2022), who reported metabolic risk associated with long-term intake of high-fat and high-sodium diets. Regression analysis also confirmed a very high correlation ($r = 0.35$, $p < 0.001$) between the frequency of delivery and self-perceived health deterioration.

Additionally, respondents referred to fatigue, unconventional mealtimes, and reliance on processed food—issues in accord with Cai et al. (2021), the broader public health consequences of the digital food economy. Most notably, the findings indicate diet shift and system-level lifestyle disruption fueled by dependency on delivery. Such disruptions include diminished cooking ability, inadequate portion control, and less frequent meals at home.

The findings also concur with WHO (2024) warnings about the health cost of convenience food systems. By projecting self-reported experience onto literature-based health measures, this research presents clear evidence of an emergent public health phenomenon in urban areas. Cross-tabulation statistics (Table 13) also verify the same by indicating the distribution of perceived health changes by delivery frequency. Among the more frequent customers, 47.06% agreed or strongly agreed their health had changed, whereas 15.79% of never ordering delivery felt the same. While an overwhelmingly high percentage of both groups were unsure, the rising agreement rate for heavier use is consistent with the hypothesis of increasing health complications and subjective awareness associated with long-term delivery use. These results also correlate with the link between frequency and perceived health risk.

5.2.5 Encouraging Healthier Options

Participants strongly favored regulation measures, consistent with Campos et al. (2011) and Cecchini & Warin (2016) policy recommendations to adopt traffic-light nutrition labeling and front-of-pack information systems. More than 80% supported compulsory nutrition disclosure, and 72% supported platform-based healthy areas, affirming consumer willingness to reform. The answers further emphasized the importance of behavior and explicit signals, concurring with Taylor et al. (2019) and Grummon et al. (2023). Participants favored AI assistants' personalized suggestions with accurate nutritional requirements. Rewards provided by gamification technology, such as health badges and cheaper healthy food, were also favored.

The study agrees with the convergence of intervention design guided by evidence and user experience. Buettner et al. (2023) advocated for platforms to be remade as one of the methods of redefining default behavior, and such individuals in this study bore witness to the usefulness of such intervention. This research thus contributes to scholarship by presenting user-driven design principles guided by local evidence.

5.3 Conclusions

5.3.1 To Explore the Nutritional Value of Food in Delivered Meals

This objective examines the nutritional value of food that young adults buy daily in Shanghai. Based on previous discussions, it is argued that:

More than 65% of the participants responded with frequent consumption of fried or processed foods, while 15.31% responded with strong nutritional awareness while ordering. This implies that the food usually ordered contains too much oil, salt, and sugar but insufficient essential nutrients such as fiber, minerals, and vitamins.

While nutritional information is relevant to consumers, it is missing, difficult to interpret, or inconsistent on food ordering platforms. This limits consumers from making enlightened choices, although consumers know.

Although consumers intend to choose healthier versions of food, platform design and default menu options rarely facilitate such a habit. This confirms the hypothesis that digital food environments structurally discourage healthy food choices.

Youngsters make choices subjectively or based on presumed taste value rather than established nutritional facts in most cases, simply due to the lack of clear-cut guidelines on electronic menus. Thus, nutrition becomes secondary.

This is backed up by the Theory of Planned Behavior, which shows intention exists, but perceived control and environmental cues limit behavior change. Many respondents thus act in a reverse way to their health intentions.

The inference is thus that while food delivery locations are everywhere, the nutritional quality of meals is poor, mainly due to structural factors that limit consumers from acting in line with dietary intentions.

5.3.2 To Investigate Young Adults' Food Habits and Preferences

This study aims to investigate the food habits and preferences among young adults in the context of food delivery. Based on the discussions, the following conclusions are drawn:

72.45% of the respondents chose convenience over nutrition when buying food online, though 61.23% said they did consider nutritional value. Yet only 30.62% followed healthier meals over the duration. This difference indicates that convenience always comes first in real life.

Stress, emotional responses, and peer pressure were cited repeatedly as explanations for poor food delivery choices. These are consistent with other research, highlighting the role of situational and psychological determinants in food selection.

Despite supposed knowledge of the field of nutrition, most of the respondents did not use what they knew, supporting the Theory of Planned Behavior (TPB) statement about the behavior-intention gap. Lack of adequate default healthy options and settings discourages healthy food consumption.

Social Cognitive Theory (SCT) is an accurate model, speculating that eating habits sustain food delivery behavior, virtual reinforcement, and choice restriction in the platform user interface.

The implication is that convenience, lifestyle needs, and internet marketing influence eating patterns. Thus, the ability of health awareness to enhance eating behavior is limited.

5.3.3 To Identify Factors Impeding Healthy Eating in Food Delivery Use

This objective seeks to identify the key barriers that prevent young adults from making healthy eating choices on food delivery platforms. Based on the discussions, the following is determined:

Cost is a primary limitation, as more than 50% indicated that they prioritize price over the quality of nutrition. Healthier foods are perceived to be more expensive and out of reach for the students and people experiencing poverty.

Platform algorithms were seen to play a significant role in determining the food that they selected. 68.37% of the respondents said that app promotion and suggestion influenced what they selected, often towards high-calorie foods.

Visual hierarchy on platforms prefers trending or significantly reduced-cost foods, which are rarely suggested from a dietary point of view. Respondents showed that healthy foods were relegated or less desirable.

The takeaway is that economic pressure and algorithmic manipulation synergistically shut down healthier food options. Without structural redesign and regulation, motivation alone on the part of individuals cannot lead to healthier behavior on delivery apps.

5.3.4 To Assess the Health Impact of High-Frequency Use of Food Delivery

This goal seeks to determine the frequency at which the consumption of food delivery impacts the health of young people in Shanghai. Based on the previous discussions, the following are the findings reached:

More than 70% of the students confirmed that they had experienced health changes, such as weight gain, digestive problems, and energy loss. Regular intake of fast foods and processed foods is held responsible for this.

Correlational analysis also showed a statistically significant relationship between the frequency of takeout consumption and self-reported decline in health ($r = 0.35$, $p < 0.001$), again noting that high takeout consumption is associated with poor physical health. Interviews also corroborated the results, with informants pointing out worsened dietary habits, reduced home-cooked meal consumption, and over-dependence on processed food.

Worse long-term diet quality and worse long-term metabolic health are markers of global trends in health and an emerging

public health issue in Chinese cities.

The implication is that long-term food delivery sets individuals on unhealthy health trajectories among young adults, requiring individual and policy responses to prevent long-term harm.

5.3.5 Measures to Encourage Healthier Food Delivery Behaviors

This study investigates viable approaches towards promoting healthier food consumption on food delivery platforms. From the discussions, the following conclusion can be drawn:

More than 80% of interviewees favored compulsory nutritional labeling, and 72% suggested the establishment of platform-based healthy food zones. The responses indicate user calls for systemic change, not voluntary or promotional health action. Individuals were concerned with automatic AI diet recommendations, automatic health score sorting, and visual improvements on health meals (e.g., bigger images, bolded tags). These nudges through design interventions were helpful. Functionality with gamification elements, such as rewards for healthy choices or weekly “nutrition goals,” was popular among youth users.

Voluntary interventions on the platform were thwarted, and government intervention and industry transformation were more desired.

The implication is that effective promotion of healthy eating in food delivery requires multifaceted efforts with interface restructuring, regulation implementation, and user-oriented education policies.

5.4 Study Implications

5.4.1 Integrating the Theory of Planned Behavior and Social Cognitive Theory

The originality of this study is to enhance knowledge regarding the influence of food delivery culture on Chinese young adults’ food habits and city health in Shanghai. This contributes to public health, online consumer culture, and food policy papers. The study concludes that the prevailing platform-based systems and convenience-based options are not healthy for consumption by young adults. The study recognizes the need to incorporate behavioral theories such as the Theory of Planned Behavior (TPB) and Social Cognitive Theory (SCT) to construct nutrition-focused digital policy interventions.

Environmental reform for health, in fact, the digital one, is a universal problem that transcends borders. The current study suggests that proper algorithmic and structural re-imagining would be needed for platform-based consumption not to continue destabilizing health intentions. And as with implementation science, the value of this research is to bridge the gap between behavior and nutritional knowledge. The research prods policymakers and app developers toward more targeted interventions by revealing where platform design, economic pressure, and behavioral principles converge. An even more robust foundation can be built to guide digital food environments toward longer-term public health objectives.

5.5 Limitations

5.5.1 Sample Representativeness

The sample consisted of only young adults aged 18–35 who lived in Shanghai. While adequate for the population being studied in this study, the results could not be generalized to other age groups or other locations as a necessity. Chinese cities’ specific economic and cultural orientations influence food consumption and delivery behavior.

5.5.2 Data Collection Methods

Self-report information was used for quantitative and qualitative variables. Thus, results are susceptible to recall bias, social desirability bias, and subjective interpretation. Respondents might have underestimated unhealthy habits or overestimated health awareness.

5.5.3 Cross-Sectional Nature

The study employed a cross-sectional design, less effective in assessing long-term health outcomes or behavior change over time. A longitudinal design would better assess causal influences and the changing impact of delivery use.

5.5.4 Limited Platform and Vendor Scope

The study focused on mainstream sites such as Meituan and Ele.me and thus does not necessarily indicate behavior on niche or health-oriented sites. It will thus likely underreport the popularity or availability of healthier delivery options.

5.6 Recommendations

5.6.1 Policy and Regulatory Recommendations

Forced Nutritional Labeling can present a cross-national traffic-light system of fat, sugar, and sodium levels in a visible and standardized format across all delivery platforms. Also, Healthy Meal Incentives can provide subsidies or tax reductions for vendors that offer meals meeting defined nutritional standards, encouraging affordable, health-oriented options. Algorithmic Transparency can mandate independent audits of recommendation algorithms to ensure they are not disproportionately promoting high-calorie or processed foods.

5.6.2 Platform-Level Recommendations

AI-Driven Nutrition Assistants can integrate innovative recommendation tools that consider users' health preferences and goals. Healthy Choice Architecture can be used to redesign the platform UI to prioritize healthier items through placement, size, labeling, and filtering. Moreover, Gamified Engagement can offer reward systems (e.g., badges, discounts, or challenges) that incentivize healthy order behavior.

5.6.3 User-Level Recommendations

Nutrition Education Campaigns can launch digital social media and apps campaigns to teach users how to read labels, understand nutrition, and plan balanced, home-delivered meals. Delivery Literacy Programs can introduce curriculum or workshops at universities and workplaces that promote informed delivery usage. Besides, Community-Based Sharing can encourage social platforms or peer groups to share meal experiences, reviews, and health tips to build collective awareness.

5.6.4 Future Research Directions

Researchers can conduct longitudinal studies to assess causality between delivery usage and health impacts; compare results across multiple cities and income groups to understand regional variations. Moreover, neuro-marketing or biometric tools can better capture subconscious decision processes.

Funding

ACTIVITY	Estimated costs
Transportation	\$165
Accommodation	\$275
Meals and Daily Expenses	\$137.5
Survey Materials and Tools	\$68.75
Participant Incentives	\$110
Software and Data Management	\$82.5
Report Writing and Dissemination	\$123.75
Total	\$962.5

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.
- [2] Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs, NJ, 1986(23-28), 2.
- [3] Buettner, S. A., Pasch, K. E., & Poulos, N. S. (2023). Factors associated with food delivery app use among young adults. *Journal of community health*, 48(5), 840-846.
- [4] Cai, Y., Zhong, I., & Guan, S. (2021). An exploration of food delivery industry in Shanghai and its impact on workers welfare, environment and public health. *Food Systems, Nutrition, and Health Research & Practice*.
- [5] Campos, S., Doxey, J., & Hammond, D. (2011). Nutrition labels on pre-packaged foods: a systematic review. *Public health nutrition*, 14(8), 1496-1506.
- [6] Cecchini, M., & Warin, L. (2016). Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. *Obesity reviews*, 17(3), 201-210.
- [7] Chadwick, L. (2024, August 24). Food delivery app use linked to higher likelihood of obesity and lower-level jobs.

Euronews.

- [8] Chan, E. K., Kwortnik, R., & Wansink, B. (2017). McHealthy: how marketing incentives influence healthy food choices. *Cornell Hospitality Quarterly*, 58(1), 6-22.
- [9] Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage publications.
- [10] Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Sage publications.
- [11] Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- [12] Dai, X., Wu, L., & Hu, W. (2022). Nutritional quality and consumer health perception of online delivery food in the context of China. *BMC Public Health*, 22(1), 2132.
- [13] Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *The American journal of clinical nutrition*, 87(5), 1107-1117.
- [14] DeVellis, R. F., & Thorpe, C. T. (2021). *Scale development: Theory and applications*. Sage publications.
- [15] Dobbyn, T. (2024, October 10). Smart App 'Nudges' Users to Make Healthy Food Choices. College of Agricultural and Environmental Sciences.
- [16] Etikan, I., & Bala, K. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal*, 5 (6), 00149.
- [17] Fu, H., Martin, W., Huang, C., Kouwenhoven, G. A., & van der Leij, F. R. (2021). Dietary Protein Choices of Young Adults are determined by Different Driving Forces in Shanghai and Amsterdam. *Journal of Agriculture and Environmental Sciences*, 10(2), 9-15.
- [18] Garone, S. (2024, January 18). How cooking at home compares to dining out when it comes to nutrition and costs. *Health*.
- [19] Goyal, M., & Deshwal, P. (2023). Online post-purchase customer experience: a qualitative study using NVivo software. *Quality & quantity*, 57(4), 3763-3781.
- [20] Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational evaluation and policy analysis*, 11(3), 255-274.
- [21] Grummon, A. H., Musicus, A. A., Moran, A. J., Salvia, M. G., & Rimm, E. B. (2023). Consumer reactions to positive and negative front-of-package food labels. *American journal of preventive medicine*, 64(1), 86-95.
- [22] Gu, C., Brereton, N., Schweitzer, A., Cotter, M., Duan, D., Børsheim, E., ... & Jun, J. C. (2020). Metabolic effects of late dinner in healthy volunteers—a randomized crossover clinical trial. *The Journal of Clinical Endocrinology & Metabolism*, 105(8), 2789-2802.
- [23] Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological assessment*, 7(3), 238.
- [24] Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-based nursing*, 18(3), 66-67.
- [25] Ho, J., Poh, F., Zhou, J., & Zipser, D. (2019). *China consumer report 2020*. McKinsey and Company.
- [26] Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British journal of applied science & technology*, 7(4), 396.
- [27] Li, J., Sun, A., Ma, W., Sun, P., & Zhang, M. (2024). Recommender for Its Purpose: Repeat and Exploration in Food Delivery Recommendations. *arXiv preprint arXiv:2402.14440*.
- [28] Li, R. C. (2023). *The metrics and management of food waste associated with online food delivery in China* (Doctoral dissertation, University of Otago).
- [29] Malik, V. S., Popkin, B. M., Bray, G. A., Després, J. P., & Hu, F. B. (2010). Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation*, 121(11), 1356-1364.
- [30] McKay, E., Kemps, E., Prichard, I., & Tiggemann, M. (2023). Small, regular or large? The effect of size options on online food choices. *Food Quality and Preference*, 105, 104768.

- [31] Mehta, S., Mukhija, G., & Mehta, H. (2022). Determinants of nutrition consciousness of young adults on food delivery apps: a analytical study. *BSSS Journal of Management*, 13(1), 106-119.
- [32] Monteiro, C. A., Moubarac, J. C., Cannon, G., Ng, S. W., & Popkin, B. (2013). Ultra-processed products are becoming dominant in the global food system. *Obesity reviews*, 14, 21-28.
- [33] Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research*, 42, 533-544.
- [34] Pomeranz, J. L., Cash, S. B., Springer, M., Del Giudice, I. M., & Mozaffarian, D. (2022). Opportunities to address the failure of online food retailers to ensure access to required food labelling information in the USA. *Public Health Nutrition*, 25(5), 1375-1383.
- [35] Roorda, B. A., & Cassin, S. E. (2025). A Review of Food-Related Social Media and Its Relationship to Body Image and Disordered Eating. *Nutrients*, 17(2), 342.
- [36] Seid, A., Fufa, D. D., & Bitew, Z. W. (2024). The use of internet-based smartphone apps consistently improved consumers' healthy eating behaviors: a systematic review of randomized controlled trials. *Frontiers in Digital Health*, 6, 1282570.
- [37] Sharib, J. R., Pomeranz, J. L., Mozaffarian, D., & Cash, S. B. (2024). Disclosure of mandatory and voluntary nutrition labelling information across major online food retailers in the USA. *Public Health Nutrition*, 27(1), e203.
- [38] Shu, X., Calvert, J. K., Cai, H., Xiang, Y. B., Li, H., Zheng, W., ... & Hsi, R. S. (2019). Plant and animal protein intake and risk of incident kidney stones: results from the Shanghai Men's and Women's health studies. *The Journal of urology*, 202(6), 1217-1223.
- [39] Singleton, L. (2024, April 22). Taxing unhealthy food helps cut obesity, says global study. Imperial College London.
- [40] Steele, E. M., Baraldi, L. G., da Costa Louzada, M. L., Moubarac, J. C., Mozaffarian, D., & Monteiro, C. A. (2016). Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. *BMJ open*, 6(3), e009892.
- [41] Tahim, J. C., Verde, S. M. M. L., Maia, C. S. C., & Bezerra, I. N. (2024). Consumption of Food Offered by Delivery Applications (Apps). *International Journal of Environmental Research and Public Health*, 21(5), 568.
- [42] Tan, S., & Lim, R. (2023). Affordability and access in Southeast Asian food delivery ecosystems. *Asia Pacific Journal of Public Health*, 35(1), 75–82.
- [43] Tashakkori, A. (2010). *SAGE handbook of mixed methods in social & behavioral research*. Sage.
- [44] Taylor, M. K., Sullivan, D. K., Ellerbeck, E. F., Gajewski, B. J., & Gibbs, H. D. (2019). Nutrition literacy predicts adherence to healthy/unhealthy diet patterns in adults with a nutrition-related chronic condition. *Public health nutrition*, 22(12), 2157-2169.
- [45] Triyuni, N. N., Leo, G., & Suhartanto, D. (2021, November). Online food delivery service. In *2nd International Seminar of Science and Applied Technology (ISSAT 2021)* (pp. 697-702). Atlantis Press.
- [46] Tufts Health & Nutrition. (2019, September 17). Cost of Eating Right-Whos Right? - Tufts Health & Nutrition Letter. Tufts Health & Nutrition Letter.
- [47] Van Teijlingen, E., & Hundley, V. (2001). The importance of pilot studies. *Social research update*, (35), 1-4.
- [48] Wansink, B., & Chandon, P. (2006). Can “low-fat” nutrition labels lead to obesity?. *Journal of marketing research*, 43(4), 605-617.
- [49] World Health Organization. (2024). Food environments: Policy brief and guidance. WHO.
- [50] Yang, Z., Khatibi, E., Nagesh, N., Abbasian, M., Azimi, I., Jain, R., & Rahmani, A. M. (2024). ChatDiet: Empowering personalized nutrition-oriented food recommender chatbots through an LLM-augmented framework. *Smart Health*, 32, 100465.
- [51] Zhang, Y., Fan, Y., Liu, P., Xu, F., & Li, Y. (2024). Cyber Food Swamps: Investigating the Impacts of Online-to-Offline Food Delivery Platforms on Healthy Food Choices. *arXiv preprint arXiv:2409.16601*.

Feasibility Analysis of Adding Jewelry Accessory Design and Craft Programs in Application-Oriented Undergraduate Institutions: A Case Study of Guangzhou Huashang College

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Abstract: With the increasing demand for material and cultural goods, the jewelry industry is experiencing a period of rapid development, and the gap in the demand for Jewelry Design talent is growing. Higher education institutions need to cultivate professionals who are adaptable to the evolving jewelry industry. Establishing programs in Jewelry Accessory Design and Craft can produce Multi-Skilled Jewelry Professionals capable of engaging in various roles such as Jewelry Accessory Design, Jade Carving Design, Jewelry Live Marketing, Jewelry Brand Founder, Jewelry Business Manager, and Jewelry Sales Representative.

Keywords: Jewelry Design; Talent Development; Accessory Design

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1. The Context and Significance of Guangzhou Huashang College Establishing Jewelry Accessory Design and Craft Programs

1.1 Establishing Jewelry Accessory Design and Craft Programs Aligns with Cultivating Virtue and Nurturing Talent and Holistic Education

With the advancement of emerging technologies such as digitalization, informatization, and intelligence, the nation has developed and implemented grand strategies such as the Big Data Strategy and “Internet Plus” plan. The jewelry industry needs to align with the pace of these technological advancements, rationally allocate industry resources, and enhance the application capabilities of jewelry talent to generate greater market and economic benefits. Although talent development in the jewelry sector is currently reaching a mature stage, the increasing material and cultural demands of people present new opportunities and greater market needs for professionals in this field.

According to the “2023 China Jewelry Industry Development Report” released by the China Jewelry and Jadeite Industry Association, the total market scale of China’s jewelry industry surged to 820 billion RMB in 2023, a 14% increase from 719 billion RMB in 2022^[2]. The high-quality development of the jewelry industry is entering a stable and long-term new phase. Currently, China has 24 specialized jewelry industry bases and multiple industrial clusters, with nearly 60,000 jewelry enterprises and approximately 4 million employees nationwide. However, enterprises remain at the lower end of the global value chain, with overall development levels being low, management practices being crude, and product homogeneity being severe. There is still a significant gap between domestic brands and advanced international ones.

Currently, the professional level of talent in Chinese jewelry enterprises is relatively low, with a generally low level of education. Those with formal professional education make up less than 6% of the workforce. Many jewelry enterprises can only develop and build their talent teams through an eclectic approach, expending considerable effort in training and disseminating jewelry knowledge. For experienced professionals, the phenomenon of poaching between companies is common, and finding suitable talent in the market is rare. More often, companies rely on internal referrals to find suitable candidates. However, for inexperienced graduates, it is difficult to secure formal positions after joining, and they often end up as reserve staff. In response to this situation, establishing Jewelry Accessory Design and Craft Programs to train interdisciplinary, application-oriented professionals who meet the needs of the modern industry is both a social responsibility for higher education institutions and a response to the new demands of technological development in the modern era.

1.2 The Relationship Between Establishing Jewelry Design Programs and Regional Economic Development

1.2.1 Meeting the Development Needs of the Jewelry Industry in the Guangdong-Hong Kong-Macao Greater Bay Area

The jewelry processing industry in Guangdong began in 1986 and encompasses a range of activities including jewelry equipment manufacturing, diamond cutting, platinum jewelry, pure gold jewelry, setting jewelry, silverware manufacturing, precious craft production, and jewelry and watchmaking. Various types of enterprises related to jewelry processing have become an important component of Guangdong's economy. Statistics show that in 2021, there were 4.663 million registered jewelry-related enterprises nationwide, with nearly 405,000 of them located in Guangdong, including 18 of the top 50 jewelry companies in China^[1].

The Guangdong-Hong Kong-Macao Greater Bay Area is a renowned hub for the jewelry industry, featuring international brands such as Chow Tai Fook and Tse Sui Luen, as well as small and medium brands like Baitai and Yafu. The industry is transitioning from a "processing" model to a "branding" model, with new brands becoming increasingly youthful and personalized. Future markets will require more emerging designer brands. Applied undergraduate-level jewelry talent development integrates both theoretical and practical aspects from jewelry culture and design, appraisal, and marketing, making such talent highly competitive in the job market. Currently, only three undergraduate institutions in the province—Guangzhou City University of Science and Technology, Shenzhen Technology University, and Guangzhou Huashang College—offer Jewelry Design-related programs, training approximately 250 individuals annually. Therefore, establishing new programs and expanding enrollment is an effective way to address the shortage of such talent in Guangdong Province and across the nation.

1.2.2 A New Engine for Promoting Regional Economic Transformation and Upgrading

The integration and development of new technology clusters, such as digitalization, are driving the transformation of traditional jewelry industry paradigms. The jewelry industry in Guangdong Province is gradually upgrading, adopting a new path of digital and informational development. Modern digital technologies are being used to transform traditional jewelry industry production, lifestyle, and transaction methods, promoting changes in production, management, and marketing within the "digital tide." This involves the digitalization of product design and manufacturing, intelligent production process control, digital manufacturing equipment, and the networking of consulting services and marketing systems, thereby enhancing the international competitiveness of China's jewelry industry^[4]. To achieve these goals, a strong talent base is essential. Therefore, establishing jewelry-related programs to cultivate relevant professionals is a new driving force for regional economic transformation and development.

Guangzhou Huashang College's establishment of jewelry accessory design programs aligns with the economic development needs of South China and the direction of higher education development. With the favorable jewelry industry economic background in Guangzhou and the surrounding Si Hui City, the college provides a broad platform for cultivating technical talent in the jewelry field. This initiative is expected to receive widespread support and welcome from the jewelry industry, significantly advancing the development of the jewelry industry economy in Guangdong Province, the Guangdong-Hong Kong-Macao Greater Bay Area, and the surrounding regions. Located in the economically developed Pearl River Delta region, Guangzhou Huashang College has a responsibility to contribute to the stable and healthy development of the local

economy by training jewelry accessory design and craftsmanship professionals, which has significant practical significance and a strong exemplary role.

2. Advantages of Establishing Jewelry Accessory Design and Craft Programs at Guangzhou Huashang College

2.1 Meeting Industry Talent Needs

Guangdong is a leading region in China's jewelry industry, with numerous industrial clusters, including notable areas such as Panyu in Guangzhou, Yangmei in Jieyang, Pingzhou in Nanhai, Si Hui in Zhaoqing, and Shui Bei in Shenzhen. However, with people's increasing aspirations for a better life, enhanced aesthetic tastes, and rapid technological advancements, the jewelry industry faces an urgent need for innovation, including in craftsmanship, culture, and supply chain management^[3]. The rise of numerous innovative jewelry enterprises signifies a substantial gap in the demand for design talents. Additionally, the current jewelry professionals require significant improvements in education, skills, and professional qualities. Therefore, the high-quality undergraduate talent cultivated by this program will have broad employment prospects and a strong market presence and industry competitiveness in the jewelry sector.

2.2 Prominent Geographical Advantages of the Institution

Guangzhou Huashang College, approved by the Ministry of Education in 2006, is a high-level application-oriented undergraduate institution with distinctive financial and economic characteristics, covering disciplines such as economics, management, literature, engineering, art, education, and medicine. The college is based in the Guangdong-Hong Kong-Macao Greater Bay Area, driven by reform and innovation, oriented towards serving local economic and social development, and supported by a modern university system. It continuously optimizes its discipline and program structure to improve educational quality and level, aiming to cultivate high-quality application-oriented talent. The college currently has two campuses, in Zengcheng, Guangzhou, and Si Hui, Zhaoqing, covering a total area of over 1,800 acres. In September 2021, the Si Hui campus was officially put into operation, making it the only undergraduate institution in Si Hui City. The Si Hui campus is located opposite the Si Hui Jade Culture Town, known as the "Hometown of Chinese Jade." The town covers approximately 9.2 square kilometers, with a planned total investment of around 22.86 billion yuan. The town focuses on the jade industry development in Si Hui, constructing five major industry chains including jade research and design, business exhibitions, trading, production and processing, and jade culture experience, forming a jade industry ecosystem that provides a convenient professional practice environment for students in the Jewelry Accessory Design and Craft program.

2.3 Clear School Development Plan

In October 2021, Guangzhou Huashang College, adhering to the Talent Development principles of "Cultivating Virtue and Nurturing Talent" and "Holistic Education," established the School of Jewelry based on the regional industry cluster advantages. The school includes institutions such as the Sanxin College, Industry College, and Jewelry Culture and Creative Writing Center, and initiated the planning and construction of the Jewelry School Building. Located on the left side of the entrance to the Si Hui campus, the Jewelry School Building will have nine floors and a total construction area of 30,000 square meters. According to the first five-year development plan of the Jewelry School, the building is intended to become a multifunctional teaching and experimental facility integrating jewelry culture, Jewelry Design and Craft, jewelry appraisal, marketing, display, and training.

2.4 Solid Foundation for School-Local Cooperation

In December 2021, during the opening ceremony of the 2021 China Jewelry and Jade Industry Association Emerald Culture Industry Development Annual Conference, Guangzhou Huashang College signed a strategic cooperation agreement with the Si Hui City government and held a "Government-School Cooperation Industry-Academia-Research Base" plaque unveiling ceremony. Subsequent visits to jewelry business sites and in-depth discussions with government officials, industry associations, enterprise representatives, and masters of craft were conducted.

3. Foundation for Guangzhou Huashang College's Application to Establish the Jewelry Accessory Design and Craft Program

3.1 Preliminary Program Development Based on the Product Design Major

The design discipline at Guangzhou Huashang College is a Class A key discipline and a focal point for the school's professional master's program development. The Product Design major has been enrolling students since 2009, offering specializations in cultural and creative design, fashion accessory design, and jewelry accessory design. These specializations have laid a solid foundation for the construction of the Jewelry Accessory Design and Craft program, with initial Talent Development results showing promise. Students from the Product Design major have won over a thousand domestic and international awards, including the international "Red Dot Award," "IF Award," and the first prize in the National College Student Industrial Design Competition. Additionally, some graduates have established their own design brands and studios.

3.2 Development of a Multidisciplinary Featured Program

The Jewelry School at Guangzhou Huashang College currently hosts the Guangdong Provincial Key Cultivation Discipline "Journalism and Communication," supported by an experimental teaching platform worth over 5 million yuan. This platform provides practical and simulated internships for students in journalism, communication, and design majors. The Jewelry School aims to break down disciplinary barriers, focusing on jewelry culture enlightenment and dissemination, Jewelry Design and Craft, and jewelry appraisal. Leveraging the strengths of the provincial key discipline in journalism and communication, the school actively develops unique programs in jewelry marketing (live streaming) and Belt and Road jewelry culture dissemination in the new media environment. Through the offering of general education courses across the school and the establishment of specialized teaching modules in various humanities departments, the school is committed to promoting and spreading jewelry culture, enhancing and driving the distinctive development of jewelry-related programs.

3.3 Faculty Conditions

The jewelry design and craft major at Guangzhou Huashang College has a highly qualified faculty with a well-structured mix of titles, combining experienced, middle-aged, and young teachers. The faculty consists of 27 full-time and part-time teachers, including 9 professors (33% of the total), 5 associate professors (18.5%), and 7 teachers with doctoral degrees (25.9%). The teaching staff includes professors from institutions such as China University of Geosciences, Jinan University, Guangzhou Academy of Fine Arts, and Guangdong University of Finance and Economics, as well as experts and masters with extensive practical experience in the jewelry industry. Their rich practical experience and academic contributions provide strong support for professional teaching.

3.4 Experimental and Practical Conditions**

Guangzhou Huashang College has 18 classrooms across 5 laboratories dedicated to practical teaching in the Jewelry Accessory Design and Craft program: Basic Drawing Laboratory, Model Making Laboratory, Computer-Aided Design Laboratory, Metalworking Laboratory, and Carving Laboratory. Each classroom can accommodate over 40 students, and each computer lab is equipped with various experimental software. All laboratories have internet access to facilitate interactive teaching, meeting the regular teaching and practical training needs of the Jewelry Accessory Design and Craft program students. The Jewelry School also has 15 student internship bases to support practical training requirements.

3.5 Research Foundation

In the past three years, faculty members of this program have secured over 20 provincial and departmental-level research projects, including one National Art Fund project for 2020 Artistic Talent Development and one Humanities and Social Sciences project from the Ministry of Education. Additionally, the faculty has developed a provincial-level first-class course. Team members have published over a hundred academic research papers in scholarly journals. Professor Zhu Xiaohong, the head of the program, has led three research projects with a total funding of 900,000 yuan. Many research topics and projects originate from teaching activities, and their results are applied back to teaching, yielding positive outcomes.

3.6 Teaching Support Conditions

The school's library holds 1.733 million books, including 30,821 volumes related to the Jewelry Accessory Design and Craft program, spanning 7,025 titles. It also offers access to 330,000 electronic books from the Superstar Digital Library and approximately 40 million articles from six CNKI (China National Knowledge Infrastructure) collections by Tsinghua Tongfang. The school maintains connections with major provincial educational and book institutions, allowing for timely

updates on new publications. Additionally, the school has invested nearly one million yuan to enhance the campus network, adequately meeting the literature needs of the Jewelry Accessory Design and Craft program.

4.Objectives and Market Employment for the Jewelry Accessory Design and Craft Program

4.1 Talent Development Objectives for the Jewelry Accessory Design and Craft Program at Guangzhou Huashang College

The establishment of the Jewelry Accessory Design and Craft program adheres to the Talent Development principle of “Cultivating Virtue and Nurturing Talent and Holistic Education.” The program aims to cultivate well-rounded individuals who develop morally, intellectually, physically, aesthetically, and in labor skills, meeting the needs of national and regional economic development. Graduates will possess a sense of social responsibility and professional ethics, a solid foundation in Jewelry Design, and skills in jewelry modeling design, communication, and management. They will have strong learning, research, and innovation abilities, with a focus on both theoretical knowledge and practical skills related to jewelry accessory design. Graduates will understand material selection and craft processes for accessory creation, preparing them for roles such as Jewelry Accessory Designer, Jade Carving Designer, Jewelry Live Marketing Specialist, Jewelry Brand Founder, Jewelry Business Manager, and Jewelry Sales Representative, making them Multi-Skilled Jewelry Professionals^[5].

4.2 Employment Directions for Jewelry Accessory Design and Craft Professionals

Graduates from the Jewelry Accessory Design and Craft program can find employment across various stages of the jewelry industry in China, including processing, design, and sales. Key employment areas include:

4.2.1 Designers at Jewelry Companies in the Guangdong-Hong Kong-Macao Greater Bay Area

In 2021, there were 4.663 million jewelry-related enterprises registered nationwide, with Guangdong alone hosting nearly 405,000, including 18 of the top 50 jewelry companies in the country. These companies have a significant demand for designers to address the prevalent issue of product homogenization in the jewelry market.

4.2.2 Founders of Jewelry Design Brands

China’s jewelry market, valued at over 800 billion yuan, is expected to reach about 1 trillion yuan by 2025. The industry is transitioning from “processing” to “branding,” with new brands becoming younger and more personalized. Bachelor-level applied jewelry talent, combining theory and practice in jewelry culture, design, appraisal, and marketing, are well-suited to meet the needs for Jewelry Brand Founders, offering strong social competitiveness.

4.2.3 Jade Carving Designers with New Techniques

China’s jade culture, a traditional essence with oriental charm, integrates foreign cultural ideologies through unique expressions in jade carving. The shrinking talent pool in jade carving urgently needs new jade carving designers who possess a foundation in ethnic culture and artistic cultivation, master the integration of art and technology, and exhibit innovative capabilities. Such talents are in high demand within the jade carving industry.

4.2.4 Jewelry Marketing (Live Streaming) Personnel

With the advent of new media technologies, live streaming has become a direct purchasing method for the general public. Live streaming personnel with knowledge in jewelry culture, design, craft, and appraisal hold a significant advantage over regular online influencers.

4.2.5 Jewelry Business Managers

Graduates with a bachelor’s degree in Jewelry Accessory Design and Craft will be better equipped to take on roles as Jewelry Business Managers within jewelry enterprises

In conclusion, the addition of the Jewelry Accessory Design and Craft program at Guangzhou Huashang College is a feasible choice, considering the school’s educational resources and the societal demand for professionals in this field.

Funding

University-level, The first project of Jewelry School of Guangzhou Huashang College “Development and Construction of Jewelry Design and Craft Specialty of Guangzhou Huashang College”

Conflict of Interests

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Xie, Y., & Su, W. (2010). Current status and prospects of the development of China's jewelry market. *China Market*, (09).
- [2] Jia, T. (2024, March 9). China Jewelry and Jade Jewelry Industry Association releases the "2023 China Jewelry Industry Development Report." *Consumer Daily*.
- [3] Tang, F. M., & Xie, M. (2019). Preliminary exploration of interdisciplinary training for accessory design talents in universities. *Journal of Gems and Gemology (Chinese-English)*, (06).
- [4] Chen, H. Y., & Yin, Z. W. (2024). Development trends and innovative talent development in the jewelry industry in the new era. *Journal of Gems and Gemology (Chinese-English)*, (01).
- [5] Chen, J., Yang, S., Xing, H., Sun, T. L., & Mao, X. M. (2023). Research on the evaluation system of innovative talents in Chinese universities under the national talent strategy in the new era. *Science and Management*, (05).

Research Progress on the Professional Identity of Nursing Undergraduates: An Integrated Review

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Abstract: In order to enhance the professional identity of undergraduate nursing students, provide references for additional research, and establish a theoretical foundation for subsequent nursing education, this paper reviews the professional identity of nursing undergraduates both domestically and internationally from the perspectives of research status, research methods, influencing factors, and related countermeasures. It also integrates the research conducted over the previous five years.

Keywords: Professional Identity; Students; Nursing; Undergraduate; Influencing Factors

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Introduction

The psychological state of positive professional behavior tendency that people progressively acquire during professional learning is known as professional identity. It is a positive attitude and feeling toward their profession that validates their career direction, goals, and skills^[1]. Nursing professional identity is the understanding of nursing students' emotional and cognitive perceptions of the importance of their profession, which is closely linked to their subsequent individual career decisions^[2]. The degree of professional identity of nursing undergraduates has a direct impact on the growth and stability of the future nursing team, which serves as a backup resource for hospital nurses^[3]. There is still much space for growth, though, as current research^[4,5] indicates that nursing students' professional identities are typically low, with some studies even indicating that they are relatively low in specific areas. However, nursing students' post-graduation job choices are significantly influenced by their professional identities. Understanding its affecting aspects, implementing pertinent educational initiatives and curriculum updates for various influencing factors, and strengthening nursing undergraduates' professional identities are therefore especially crucial. In order to better understand the factors that influence nursing students' professional identities and investigate their educational significance, this paper provides a reference for future research by summarizing the current state of the field, research methodologies, domestic and international measurement instruments, influencing factors, and improvement measures of nursing students' professional identities in recent years.

1. Present state of the professional identities of nursing undergraduates

Research on nursing students' professional identities has steadily increased in comparison to earlier times as the nursing business has grown. The significance of professional identity has been recognized by more scholars, and their findings have also varied.

1.1 Present State of Domestic Undergraduate Nursing Students' Professional Identity

According to a questionnaire survey of 402 nursing majors at Tianjin College, University of Science and Technology Beijing in China, the average score for nursing students' professional identity was 57.48 ± 11.90 points. In line with the findings of the study conducted in 2025 by Liu Tianmeng and Ren Haiyan^[6], the results showed that the professional identity was at a medium level^[3]. The findings, however, differ greatly from those of studies conducted on nursing undergraduates at Nanchang's universities. In November 2020, undergraduate nursing students from two important Nanchang universities were chosen as research subjects by Yu Xiaoyan et al. There were 270 individuals in the sample. They demonstrated greater scores than the former after completing the questionnaire, and their degree of professional identity was comparatively high^[1]. Undergraduate nursing students have a relatively low degree of professional identity, according to study by Wang Zhenyang et al.^[4], which is somewhat lower than the scores of some research results^[7] and not substantially different from research by Xing Wei et al.^[5].

1.2 Present State of Undergraduate Nursing Students' Professional Identity

Research on SRM College of Nursing, SRM Institute of Science and Technology, Kattankulathur, India, was carried out by AbroadAheli Mukherjee. According to the results, 71 (35.1%) shown a medium degree of professional identity, 67 (33.2%) demonstrated a high level, and 64 (31.7%) demonstrated a low level among the 202 students^[8]. Junior bachelor students demonstrated a higher level of professional identity than freshmen, and the difference was more pronounced than the second-year students, according to Galletta et al. research of Italian universities^[9]. 195 nursing students at Semnan University of Medical Sciences, Iran, participated in a survey conducted by Gilvari et al. According to the result, pupils' perceived professional identities averaged 316.72 points overall. In general, professional identification is strong^[10].

2. Research Approaches for Undergraduate Nursing Students' Professional Identity

Currently, the majority of both domestic and international research uses quantitative or a mix of qualitative and quantitative research methods; qualitative research alone is somewhat uncommon. In Chinese study, this is more evident. This may have to do with the relatively small sample size of qualitative research and the fact that undergraduate students who have started their internships make up the majority of the group of single qualitative research. Based on the respondents' communication content, the researcher must extract the necessary information on their own. The scope is wider than that of quantitative research that use instruments or experimental techniques.

2.1 Quantitative Research

In order to obtain more specific and in-depth findings for the study on professional identity, researchers primarily employ questionnaires to gather data for the research team. Aheli Mukherjee et al. employed scales to measure and examine the circumstances of the two variables in their investigation of the relationship between professional identity and self-efficacy^[11]. The association between internship and professional recognition is measured in a study on professional identity for the internship stage. The results of the questionnaire indicate that the scores are more focused^[12].

2.2 Qualitative Research

Based on their interviews, Wu Tong et al. came to the conclusion that most current nursing students are reasonably enthusiastic and proactive about their professional development. The social recognition of nursing work was rather strong because her research period coincided with the important health crisis of COVID-19. The degree of professional identification was high, especially when combined with favorable media attention, etc^[13]. According to the board structure interviews conducted with 17 undergraduate nursing students from Brigham Young University's College of Nursing in the United States, professional identity can be positively impacted by socialization and immersion in nursing roles when done under the right ideological guidance^[14]. Professional identity was impacted by both education and health service assistance, according to an interview done at Makerere University with 33 students and 26 recent graduates^[15].

3. Professional identity measurement tools

3.1 Domestic professional identity measurement tools

The Professional Identity Questionnaire for Nurse Students (PIQNS), created by Hao Yufang et al. in 2011^[2-4,6,11,16-18,19-34], is the one that is used the most frequently in China now. It measures how people identify with the nursing profession they

practice. The questionnaire's five dimensions effectively integrate people, society, and China's contemporary cultural context, making them appropriate for the great majority of experimental situations in professional identity research. This scale exhibits strong structural validity, test-retest reliability, and internal consistency. One of the most widely used instruments for assessing the professional identities of nurses in China today is the professional identification scale (PIS), which was developed by Liu Ling et al. in 2008^[35-38]. Professional social skills, professional cognitive evaluation, professional social support, professional frustration coping, and professional self-reflection are the five categories and 30 items that make up this scale. The scale's overall score, which varies from 30 to 150 points, determines the level of professional identity. The validity, reliability, and contribution rate of this scale are all good. Each dimension's Cronbach's α coefficient is 0.917, 0.799, 0.862, 0.853, and 0.734, respectively, while the overall Cronbach's α coefficient is 0.938. Occupational Identity Scale was created in 2016 by Palida Maimaiti et al.^[1]. Based on the Japanese nursing student scale, which was created by Japanese researchers like Kyoko Fujii, this questionnaire was refined to better suit Chinese educational settings and offer a more thorough evaluation of nursing students' professional identities. It also applies to Xinjiang's multiethnic communities. Because of its high stability and dependability, the "Questionnaire for Baccalaureate Nursing Students," created by Hu Zhonghua et al.^[13], was also used to determine the professional identity of undergraduate nursing students. Nurse's Career Identity Scale (NCIS), created by the Teaching and Research Section of Nursing Management, Department of Nursing, Faculty of Medicine, University of Tokyo, Japan, was translated by Chinese academics Zhao Hong et al.^[39] in 2010. When undergraduate nursing students enter the clinical practice state, it is frequently utilized to evaluate their professional identities.

3.2 International professional identification assessment instruments

The Professional Identification Scale-B (PIS-Brown), a one-dimensional instrument, was created by Brown et al.^[12,40]. The stronger the professional identification, the higher the score. The Chinese version has good validity and reliability and maintains the original questionnaire's one-dimensional form. Each dimension's Cronbach's α coefficient varied from 0.69 to 0.84, with the overall Cronbach's α value being 0.84. With a minimum of 21 points and a maximum of 147 points, the Likert 7-level scoring method was used to score the scale.

Weis and Schank introduced the Nurse Professional Value Scale (NPVS) as a quantitative tool for evaluating the value of professional care in 2000. It was originally developed and tested in the United States, including 44 Likert-scale items across five subscales: 'caring, activism, trust, professionalism, and justice.' In 2009, this scale was revised to the NPVS-R version, reducing it to 26 items and updating the terms. NPVS and its revised versions are important tools for measuring the value of professional nursing. Although NPVS/NPVS-R provides a widely used method for quantifying and comparing the value of care, it may benefit from the adaptation of mixed methods and more culturally specific developments to enhance its global applicability. Mei-Chih Huang and Thi-Phuong-Thao Pham tested the validity and reliability of this scale after translating it into Vietnamese in 2024. The Cronbach alpha value, which ranged from 0.861 to 0.877, was determined to be extremely good through data collecting^[41].

The self-concept of the nursing profession was evaluated using the Nurse's Self-Concept Questionnaire (NSCQ), which was created and validated by Cowin in Australia. This scale is applicable to countries like Turkey and Portugal and has a good effect^[42]. It has 36 items that are evenly distributed across 6 dimensions (i.e., general self-concept, care, staff relations, communication, knowledge, and leadership). The internal consistency values of the six dimensions of this tool are considered good to very good, ranging from 0.83 (the knowledge dimension) to 0.93 (the general and leadership dimension), demonstrating good reliability of the measurement.

3.3 Self-made professional identity measurement tools

Depending on the research topics and goals at the time, many researchers will create their own PI questionnaire. For Semnan University of Medical Sciences in Semnan, Iran, a psychometric assessment questionnaire of 63 items in 6 domains was created and administered, including having a holistic view of the patient (items 56–59), self-identifying as a nurse (items 60–63), professional transformation (items 36–46), personal growth (items 47–55), professional commitment (items 24–35), and satisfaction with professional activity (items 1–23), with good reliability, validity, and stability^[10]. The PI questionnaire for nursing students was developed based on the findings of qualitative interviews during the major health event of the

COVID-19 pandemic. Because of its uniqueness, it took into account the impact of the entire environment, eliminated any parts that were deemed inappropriate, and was implemented after passing inspection^[43]. In addition, Gao Chen et al.'s research scale on the professional identity of current students and interns^[44] and Huang Hui et al.'s self-made questionnaire, which comprises learning, professional identity, professional cognition, professional choice, and basic information^[45], are also included.

4. Influencing factors of professional identity

4.1 Education

Nursing students' professional identities are developed during the professional studies phase in school. Having a strong professional identity is crucial for their future career persistence and employment decisions. Professional identity, on the other hand, is unstable and the product of several circumstances^[13]. The challenge facing educators is how to improve students' academic performance during their school years, prepare them for the harsh clinical environment later on, improve nursing students' professional ability, and offer intervention measures to increase their professional identity. Interns at the hospital will experience a direct plunge from the college ivory tower to the actual world, even if they will eventually come into contact with the real working environment. After the internship, nursing students' professional identities deteriorate due to the disparity between the two. Professional courses are essentially finished in the senior year, and internships typically begin in a huge setting like China. After leaving school, students go to the hospital. Consider how to develop a robust and thorough career planning outline for nursing interns to enhance their professional identity^[12]. In this situation, nursing educators should focus more on the positive guidance of trainee nurses, create a suitable environment, and enhance the professional identity of trainee nurses^[34,46]. Professional identity will be impacted if nursing educators lack clinical experience or receive insufficient clinical direction^[15].

4.2 Pressure

The nursing profession is thought to be extremely stressful. This is a prevalent issue, according to the World Health Organization^[47]. Stress is a common occurrence in nursing schools. In order to improve their academic credentials and modify their existing status of working at the grassroots level or receiving all of the school's credits, students in this major endeavor to study more complicated knowledge points than those in other majors. Families are another source of issues. Some students decide to major in nursing for reasons other than personal desire. Due to score limitations and parental involvement in the major decision process, there aren't many major alternatives. After starting their internship, nursing students' stress levels were found to be elevated by the workplace's discriminatory treatment of them based on their gender, the demands of their jobs, and other responsibilities. In addition to making sure that students pass pertinent exams and receive professional license certificates upon graduation, the School of Nursing is under constant pressure to support students' achievement in professional studies. This is the only method to get the major recognized and find a job after graduation^[48].

4.3 Salary and Benefits

One element that may have an impact on recent undergraduate nursing graduates' professional identities is their expected remuneration. Undergraduate graduates experience financial strain following their career after leaving university. After finding work, the majority of them must be able to sustain themselves without their parents' help. Their pay and perks will start to have a significant impact on their career identity and employment decisions^[37]. There is a significant nursing resource drain in the Philippines. After graduation, many nursing students decide to work and settle in nations including Hong Kong, China, the United States, Canada and Australia. One reason for this could be the potentially high cost of living in the Philippines. Among Southeast Asian cities with the highest cost of living, Manila, the capital, comes in third. However, the pay is comparatively poor, particularly for public hospital nurses. Low pay and high living expenses may make Filipino nurses more susceptible to burnout and depression, as well as diminish their sense of self as professionals^[49-51].

4.4 Social Recognition

The absence of policy execution, the media, and the poor regard for nurses^[15]. According to research, the epidemic has improved people's sense of professional identity. This could be because nurses were needed more during the COVID-19 pandemic since they were crucial to the prevention and control of the disease. Undergraduate students have earned more

respect and understanding, as well as an awareness of their professional pride, thanks to favorable media coverage and the exaltation of touching role models^[37]. Nevertheless, there are still many misconceptions that negatively affect and stereotype the public, and the societal relevance of the nursing profession and the perception of nurses are unclear and continuously devalued. The evolution of the nursing profession is incorrectly inferred by the general public. The stereotype that this field is exclusive to women's labor without a professional identity has persisted throughout history. Because nursing is associated with doctors, there are still much more women than males working in this field in many nations. Negative stereotypes of nurses include being at a lesser status, serving as doctors' assistants, being seen as less educated women, and not being able to hold leadership positions. The positive assessment of nurses' image and value is negatively limited by these preconceptions and negative traits. The foundation of public opinion that eradicates mistakes and fallacies is this deep and reliable picture of care. The concept of nursing image is complicated, considering a number of aspects that contribute to its formation. Nursing students' professional identities and nursing behaviors might be impacted by how the public perceives nursing. Numerous studies have demonstrated that nurses are perceived negatively by the general public^[52].

5. Intervention Measures

5.1 Strengthen Nursing Education

Encourage nursing education with vigor. Offer grants, special scholarships, and other financial aid to students who wish to pursue careers in nursing but are constrained by their family circumstances. To ease the burden of enrollment, offer financial aid to families who are struggling financially. During the school year, develop the curriculum, actively assist with career planning, establish a supportive and nurturing learning environment, encourage independent thought and theoretical activities, and give students the best setting for reflection on their experiences. Increase the number of opportunities for internships throughout theoretical learning, foster empathy, organize more interactions and patient care, improve students' moral capacities, and fortify the tight link between theory and practice. Create the power of "idols," capitalize on the reputation of role models, ask nursing professionals to share their own experiences, spend time with role models, and absorb their influence.

5.2 Reduce Stress

Improve collaboration between clinical physicians and nurses, increase hospital nurse recruitment, balance the nurse-to-patient ratio, prevent a nurse from taking on too many patients, and lessen the strain on nurses. Additionally, pay attention to the mental health of nurses. Numerous facets of clinical practice continue to put psychological strain on medical personnel. Establish a center for psychological counseling, provide nurses who are experiencing psychological discomfort extra attention, and actively assist them in reducing stress and adjusting to their surroundings. Pregnancy is an issue that deserves care and shouldn't be handled differently, especially for female nurses.

5.3 Improve Benefits

Due to the relative ease of finding employment and the importance of pay and benefits, many students from low-income families decide to specialize in nursing. The hospital's care is grossly out of proportion to the work that nurses do. In order to achieve more pay for more work and highlight the value of the position, the government and hospitals should pay attention to how nurses are treated, avoid the situation where more work results in less pay, and modify the percentage of basic salary and bonuses based on the workload and importance coefficient of the position.

5.4 Enhance the Social Image of Nurses

Engage in active social media promotion to help shape the public's perception of nurses and increase awareness of the profession's professionalism and necessity. Identify the roles of nursing and medical personnel, organize and implement free nursing education for students in communities, rural areas, and other locations, and help nursing students develop their professional identities.

6. Summary and Outlook

Hospital nursing resources rely heavily on nursing students, and their professional identities have a big impact on their future career. Colleges, universities, and government agencies should take advantage of the new era and implement practical measures to help nursing students develop their professional identities, raise social and moral standards, help them form the

right career views, and support the stability of the nursing team. The inflow and creativity of this new blood is essential to the nursing industry's future growth. More advancements in the nursing field are possible in the future.

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Reference

- [1] Yu, X., Yu, P., Zhang, X., Luo, Q., & Zhang, C. (2022). Correlation analysis of psychological capital, professional identity, and career choice efficacy of undergraduate nursing students. *Health Vocational Education*, 40(11), 77-79.
- [2] Zhang, B., Li, X., Yao, Y., et al. (2023). Analysis of the mediating role of professional self-efficacy between humanistic care ability and professional identity of undergraduate nursing students. *Tianjin Journal of Nursing*, 31(4), 390-394.
- [3] Xing, D., Sun, J., Wei, L., Wei, J., Qi, N., & Yu, J. (2025). A mixed analysis of the current situation and influencing factors of professional identity of undergraduate nursing students. *Occupation and Health*, 41(5), 670-676.
- [4] Wang, Z., Hou, S., Han, X., Liu, H., Zhou, Z., Wu, Z., ... & Yang, B. (2021). Research on the influencing factors and correlation between humanistic care ability and professional identity of undergraduate nursing students. *Health Vocational Education*, 39(15), 111-113.
- [5] Xing, W., Guo, L., Zhang, H., Guo, T., & Wang, R. (2021). The relationship between the internship environment and professional identity of nursing students in a tertiary hospital in Zhengzhou: The mediating effect of psychological capital. *Modern Preventive Medicine*, 48(10), 1769-1771+1821.
- [6] Liu, T., & Ren, H. (2025). Analysis of the current situation and influencing factors of ethical sensitivity of undergraduate nursing students in a university in Inner Mongolia. *Health Vocational Education*, 43(2), 83-87.
- [7] Li, J., Xing, T., Zhang, B., Yao, Y., Liu, B., & Yang, H. (2023). Research on the correlation between moral values and professional identity of undergraduate nursing students. *Journal of Modern Medicine & Health*, 39(15), 2559-2564.
- [8] Piras, I., Canzan, F., & Letizia, D. S. (2024). Cognitive flexibility and professional identity in nursing students: The modeling role. *Journal of Nursing Education*, 63(11), 764-772.
- [9] Galletta, M., Piras, I., Canzan, F., & Dal Santo, L. (2024). Cognitive flexibility and professional identity in nursing students: The modeling role. *Journal of Nursing Education*, 63(11), 764-772.
- [10] Gilvari, T., Babamohamadi, H., & Paknazar, F. (2022). Perceived professional identity and related factors in Iranian nursing students: A cross-sectional study. *BMC Nursing*, 21, 1-8.
- [11] Aheli, M., Aarthi, S., Abisha, K., & Vijayalakshmi, R. (2024). A correlational study on professional identity and self-efficacy among nursing students. *Cureus*, 16(8).
- [12] Ahmed Abd Elhamed, L., & Saber Ahmed Elborai, A. (2024). Factors affecting professional identity among nurse interns. *Egyptian Journal of Health Care*.
- [13] Wu, T., Zhang, P., Lou, L., & Cao, M. (2021). A mixed study on professional identity and career choice intention of undergraduate nursing students. *Chinese General Practice Nursing*, 19(33), 4750-4752.
- [14] Watson, A., Anderson, M., Peterson, C., Watson, S., Thomas, D., Young, C., ... Sutton-Clark, G. (2024). Discovering nurse mode: A phenomenological study of nursing student role micro-transitions. *Nurse Education in Practice*, 80, 104101.
- [15] Mbalinda, S. N., Josephine, N. N., Gonzaga, A. M., Livingstone, K., & Musoke, D. (2024). Understanding and barriers of professional identity formation among current students and recent graduates in nursing and midwifery in low resource settings in two universities: A qualitative study. *BMC Nursing*, 23, 1-10.
- [16] Gao, L., Wang, X., Han, Y., Guo, C., & Lin, N. (2021). The correlation between professional identity and social capital of undergraduate nursing students. *Chinese Nursing Research*, 35(3), 417-421.
- [17] Zhou, J., Shi, Y., Shi, J., & Yan, R. (2021). Analysis of psychosocial factors of professional identity of undergraduate

- nursing students. *Shanghai Nursing Journal*, 21(1), 62-67.
- [18] Wu, J., Cai, Y., Huang, M., Kong, P., & Ke, L. (2021). Research on the current situation of professional identity of nursing students and its influencing factors under the COVID-19 pandemic. *Medical Education Research and Practice*, 29(1), 97-101+112.
- [19] Li, H., Gai, Y., & Jiang, Z. (2021). Structural equation model analysis of professional identity of undergraduate male nursing students. *Journal of Medical Information*, 34(19), 96-100.
- [20] Zhai, Y., & Pan, G. (2024). The relationship between positive coping and professional self-efficacy of undergraduate nursing students: Understanding the chain mediating role of social support and professional identity. **Journal of Bio-Education*, 12*(2), 132-137.
- [21] Rong, H., Zhang, L., Li, Y., Ren, P., Qu, H., & Chen, X. (2022). Research on the current situation and correlation between adversity quotient and professional identity level of undergraduate nursing students. *China Medicine Herald*, 19(12), 56-60.
- [22] Hu, G., Qi, S., & Wang, X. (2024). Potential profile analysis of professional identity of undergraduate nursing students and comparison of their motivation for pursuing postgraduate studies. *Health Vocational Education*, 42(9), 78-81.
- [23] Yao, Y., Yang, H., Zhang, B., & Li, J. (2023). The mediating role of professional identity of undergraduate nursing students between ideological and moral values and self-efficacy. **Chinese Evidence-Based Nursing*, 9*(6), 1072-1075.
- [24] Su, Y., & Dong, L. (2024). Correlation between professional identity of undergraduate intern nurses and perception of hospital care atmosphere. **Chinese Evidence-Based Nursing*, 10*(14), 2621-2625.
- [25] Zhang, H., Yuan, X., Gao, Y., & Yuan, J. (2021). The influence of positively oriented group psychological intervention on the professional identity and subjective well-being of “post-2000s” undergraduate nursing students. *Psychological Monthly*, 16(22), 25-27+30.
- [26] Wen, L., Zhao, C., & Zhao, L. (2021). A current situation investigation on the impact of the COVID-19 pandemic on the professional identity of undergraduate intern nursing students. *Journal of Inner Mongolia Medical University*, 43(S2), 119-121.
- [27] Li, H., Cui, H., Gong, B., Shen, T., Wu, Y., & Guo, J. (2022). The influence of the peer mentorship system on the stress and professional identity of undergraduate nursing students in the later stage of internship. **Chinese Evidence-Based Nursing*, 8*(23), 3191-3196.
- [28] Zhang, J., & Fan, H. (2021). Analysis of the current situation and influencing factors of professional identity of undergraduate nursing students in Northwest Yunnan Province. *Journal of Modern Medicine & Health*, 37(9), 1567-1570.
- [29] Su, L., Liu, G., Yang, L., Liu, Q., Ouyang, M., & Luo, J. (2021). Investigation and research on professional identity and influencing factors of undergraduate nursing students in Guangxi. *Health Vocational Education*, 39(8), 57-60.
- [30] Zhou, Q., Yang, X., Wang, Y., Feng, Y., & Luo, S. (2021). Analysis of influencing factors of professional identity of male undergraduate nursing students in colleges and universities in Sichuan Province. *China Occupational Medicine*, 48(3), 293-296.
- [31] Yuan, M., Li, J., & Li, H. (2022). Research on professional identity and influencing factors of 588 undergraduate nursing students. *Chinese Journal of School Doctor*, 36(11), 860-864.
- [32] He, H., Liu, W., Wen, H., Liang, G., & Ma, Y. (2023). Investigation on the current situation of professional identity of undergraduate nursing students and analysis of influencing factors under the background of public emergencies of the COVID-19 pandemic. In *Proceedings of the Second National Medical Research Forum (III)* (pp. 106-112). Tianjin Tianshi College
- [33] Luo, Q., Sun, P., & Yu, Z. (2021). Analysis of the current situation and influencing factors of professional identity of college nursing students under the background of the novel coronavirus pneumonia epidemic. *Journal of Binzhou Medical University*, 44(5), 377-381.
- [34] Wang, X., Li, J., Du, L., Yang, E., Li, S., & Liu, H. (2023). Investigation on professional identity of undergraduate

- nursing students in a tertiary hospital before and after internship and analysis of influencing factors. In Proceedings of the 2023 Academic Conference on Rehabilitation Medicine and Nursing Research in South China (pp. 535-538). School of Nursing, Jining Medical University The Fifth Medical Center of the PLA General Hospital.
- [35] Xi, Y., Huang, J., Shi, Y., & Xiao, J. (2021). Research on the impact of role ambiguity on the professional identity of undergraduate nursing students in the early stage of internship. *Heilongjiang Medical Journal*, 45(22), 2380-2382+2385.
- [36] Yu, L., Luan, B., Shen, Q., & Hu, S. (2021). Analysis of the current situation and influencing factors of professional identity of undergraduate nursing students during the COVID-19 pandemic. *China Higher Medical Education*, 2021(4), 49-50.
- [37] Xu, X., & Fang, Y. (2024). Analysis of professional identity and influencing factors of undergraduate nursing graduates. *China Higher Medical Education*, 2024(1), 40-42.
- [38] Tanur, T., Wu, Y., Luo, Y., Gao, R., & Jiang, W. (2023). Research on the differences in professional identity and influencing factors of undergraduate nursing students before and after the outbreak of the COVID-19 pandemic. *China Higher Medical Education*, 2023(3), 22-24.
- [39] Liu, Y., Deng, B., Chen, L., Chen, J., & Li, X. (2021). Research on the influencing factors of professional identity of undergraduate intern nursing students based on the classification regression tree model. *Chinese General Practice Nursing*, 19(34), 4762-4765.
- [40] Pan, Q., Wang, M., Li, Y., & Zhu, X. (2022). Research on the teaching effect of minor in nursing on enhancing the autonomous learning ability and professional identity level of undergraduate nursing students. *Journal of Qiqihar Medical University*, 43(6), 575-578.
- [41] Huang, M., & Thi-Phuong-Thao Pham. (2024). Psychometric validation of the nursing professional values scale-revised: Vietnamese version. *Jurnal Ners*, 19, 492-499.
- [42] Almeida, I. F., Bernardes, R. A., Sousa, L. B., Santos-Costa, P., Ventura, F., & Amorim, R. (2024). Translation, cultural adaptation, and validation of the Nurse Self-Concept Questionnaire (NSCQ) for Portuguese nursing students. *BMC Nursing*, 23, 1-9.
- [43] Zhang, Y., & Yang, Y. (2021). A qualitative and quantitative study on the impact of the novel coronavirus pneumonia epidemic on the professional identity of undergraduate nursing students in school. *Policy & Scientific Consult*, 2021(2), 118-120.
- [44] Gao, C., Li, S., Ye, Y., & Guo, Y. (2022). Analysis of the current situation and influencing factors of professional identity of undergraduate nursing students and interns. *Science & Technology Vision*, 2022(11), 43-45.
- [45] Huang, H., Zou, P., & Chen, Q. (2024). Analysis of professional identity and influencing factors of undergraduate nursing students. *China Educational Technology & Equipment*, 2024(11), 116-118+122.
- [46] Vabo, G., Slettebø, Å., & Fossum, M. (2021). Nursing students' professional identity development: An integrative review. *Nordic Journal of Nursing Research*, 42(2), 62-75.
- [47] Babapour, A. R., Gahassab-Mozaffari, N., & Fathnezhad-Kazemi, A. (2022). Nurses' job stress and its impact on quality of life and caring behaviors: A cross-sectional study. *BMC Nursing*, 21, 75.
- [48] Fosse, K. (2023). Professional identity for nursing students: Development and enhancement in the academy. *International Research in Higher Education*, 8(2), 1.
- [49] Alibudbud, R. (2023). Addressing the burnout and shortage of nurses in the Philippines. *SAGE Open Nursing*, 9, 23779608231195737.
- [50] Valdez, G. F. D., Genuino, M. J., Babate, F. J., Bernardo, M., Biluan, P., & Santos, M. (2024). A global survey of Filipino nurses' motivations, challenges, and aspirations.
- [51] Corpuz, J. C. G. (2023). Advancing Filipino healthcare: The plight of Filipino nurses in a postpandemic world. *SAGE Open Nursing*, 9, 23779608231220872.
- [52] Sacgaca, L., An, E. P., Alqarni, A. S., et al. (2024). Sociocultural and perceived public image of nurses among nursing students: The mediating role of self-concept. *BMC Nursing*, 23, 298.

Innovation and Sustainable Development of Commercial Spaces from the Perspective of Financial Economics

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Abstract: Under the broad perspective of financial economics, the innovation and sustainable development of commercial spaces have emerged as focal points in the current economic landscape. The innovation of commercial spaces serves as a crucial driver of economic growth. Leveraging the financial support, innovative concepts, and market environment provided by financial economics, it continuously gives rise to new business models, such as e-commerce platforms and shared spaces. For commercial spaces, sustainable development is not only related to ecological environment but also the key to ensuring long-term and stable economic returns. However, in the process of innovation and sustainable development, commercial spaces currently face issues such as capital shortages, homogenization of innovative models, and high environmental protection costs. To achieve the innovation and sustainable development of commercial spaces, it is necessary to integrate financial resources, strengthen financial innovation, promote the diversified development of commercial spaces, enhance environmental awareness, reduce operational energy consumption, and pursue a green development path, so as to achieve a win-win situation in economic and environmental benefits.

Keywords: Financial Economics; Commercial Spaces; Innovation; Sustainable Development

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1. Introduction

In the current context of global economic integration, the development of financial economics is closely intertwined with that of commercial spaces. As the core of the modern economy, financial economics provides strong impetus and support for the expansion and transformation of commercial spaces. From traditional commercial streets to modern shopping malls, and from physical stores to booming e-commerce platforms, the forms and models of commercial spaces have been constantly evolving and innovating under the influence of financial economics. At the same time, with the in-depth popularization of the concept of sustainable development worldwide, the sustainable development of commercial spaces has also become an important issue that cannot be ignored. How to achieve innovative breakthroughs and sustainable development of commercial spaces from the perspective of financial economics is not only related to the prosperity of the commercial sector itself, but also has far-reaching significance for the stability and progress of the entire economic society. This requires us to deeply analyze the internal connections between financial economics and commercial spaces, and explore effective paths for innovation and strategies for sustainable development^[1].

2. The Promoting Role of Financial Economics in the Innovation of Commercial Spaces

2.1 Providing Financial Support and Guarantee

Various institutions within the financial system, such as banks and investment companies, serve as crucial sources of funds for the innovation of commercial spaces. When an enterprise plans to develop new commercial space models, such as building intelligent commercial complexes, each stage—from the initial site acquisition and architectural design, to the mid-stage equipment installation and technology research and development, and then to the later-stage operation and promotion—requires substantial capital investment. Bank loans can provide enterprises with a stable cash flow to meet their funding needs during the construction phase. Investment companies, on the other hand, inject capital into innovative commercial projects through equity investment, helping them grow and thrive. For instance, some start-ups focusing on the new retail model, with their innovative concept of integrating online and offline operations, have attracted the attention of numerous investment companies and obtained sufficient funds to build new-type commercial spaces, thus promoting the practical process of commercial space innovation^[2].

2.2 Stimulating Innovative Thinking and Concepts

The continuous development and innovation in the field of financial economics have introduced brand-new thinking and concepts to commercial spaces. Concepts such as risk management and resource allocation in financial markets have gradually permeated the operation of commercial spaces. Take risk management as an example. Operators of commercial spaces have begun to draw on the risk assessment methods in the financial field to conduct comprehensive evaluations of the market risks and operational risks of new commercial projects. This enables them to make more cautious decisions during the innovation process and reduce the risk of failure. Meanwhile, the rise of financial technology, such as the application of blockchain technology in the financial field, has inspired innovations in the supply chain management and payment systems of commercial spaces. Some commercial spaces have started to use blockchain technology to build transparent and secure supply chain systems, improving operational efficiency and consumer trust, which vividly demonstrates the positive impact of innovative concepts in financial economics on commercial spaces.

2.3 Creating an Innovative Market Environment

The prosperity of financial economics creates a favorable market environment for the innovation of commercial spaces. On the one hand, the activity of financial markets enhances capital liquidity, which in turn increases consumers' spending power and willingness to consume. When consumers have more disposable income, they put forward higher requirements for the quality and experience of commercial spaces. This prompts operators of commercial spaces to continuously innovate to meet consumer demands. For example, to attract customers, some commercial spaces have created comprehensive venues that integrate shopping, entertainment, leisure, and cultural experiences. Through innovative combinations of business forms and spatial layouts, they enhance the shopping experience of consumers. On the other hand, the development of financial economics has attracted more enterprises and talents to enter the commercial field, intensifying market competition. Under the pressure of competition, enterprises have to increase investment in innovation to survive and develop, thus continuously promoting the innovation of commercial space models and services, and forming a virtuous innovative ecological environment^[3].

3. Main Modes of Commercial Space Innovation

3.1 Online-Offline Integration Mode

With the rapid development of Internet technology, the integration of online and offline channels has emerged as a crucial mode of commercial space innovation. Traditional physical commercial spaces are grappling with issues such as declining customer traffic and rising operating costs. Meanwhile, although e-commerce platforms boast a vast online user base, they lack the tactile and immersive experience offered by physical stores. The online-offline integration mode capitalizes on the strengths of both, effectively offsetting their respective weaknesses. For example, some large-scale retail enterprises, while maintaining their physical storefronts, have also established online shopping platforms. This enables consumers to either experience products in person at the stores or place orders online and enjoy home-delivery services. Additionally, online platforms can leverage big data analytics to delve into consumers' purchasing behaviors and preferences, providing valuable insights for physical stores to optimize product displays, plan promotional activities, and achieve targeted marketing. Moreover, online-offline integration is also manifested in interactive experiences, where consumers can make online

reservations to participate in offline activities like handicraft workshops or cooking classes, thereby enhancing their interaction with commercial spaces and increasing customer loyalty.

3.2 Shared Commercial Space Mode

The concept of the sharing economy has been widely adopted in the commercial space sector, giving rise to the shared commercial space mode. This model offers flexible and cost-effective office and business premises, particularly catering to small and medium-sized enterprises and entrepreneurs. It breaks away from the constraints of traditional commercial space leasing, which is often characterized by long-term commitments and high costs. For instance, shared office spaces not only provide basic office facilities such as desks, chairs, meeting rooms, and internet access but also offer value-added services like front-desk reception and administrative support. Tenants can flexibly choose the leased area and duration according to their business needs, significantly reducing operating costs and entrepreneurial risks. In the realm of shared retail spaces, entrepreneurs can rent a small area within a shared store to showcase and sell their products, capitalizing on the store's existing footfall and brand influence. This enables resource sharing and mutual benefit. The shared commercial space mode improves the utilization efficiency of commercial spaces and promotes the diversification of the business ecosystem.

3.3 Themed Commercial Space Mode

In order to stand out in the highly competitive market, the themed commercial space mode has come into being. This mode centers around a unique theme, creating commercial spaces with distinct personalities and rich cultural connotations. For example, in commercial blocks themed around historical and cultural heritage, through the restoration and renovation of ancient buildings, combined with local traditional cultural elements, business formats such as traditional handicraft stores and specialty food outlets are introduced. This allows consumers to immerse themselves in a strong historical and cultural atmosphere while shopping. There are also commercial spaces themed around animation and games, which attract a large number of fans by creating immersive animation scenes and hosting animation-related merchandise fairs, thereby forming a specific consumer group. The themed commercial space mode precisely targets specific customer segments, satisfying consumers' demands for personalized and differentiated consumption experiences. At the same time, it also enhances the brand value and market competitiveness of commercial spaces.

4. Strategies for the Sustainable Development of Commercial Spaces

4.1 Promoting Green Building and Energy-Efficient Operations

The full implementation of the green building concept is the cornerstone of the sustainable development of commercial spaces. During the design and construction phases of commercial buildings, environmentally friendly and renewable building materials should be preferentially selected. For example, using bamboo fiber composite materials instead of traditional wood can not only reduce deforestation but also enhance building quality with their excellent physical properties. In recent years, new phase-change energy-storage materials have also been applied in the construction field. These materials can absorb or release heat during temperature changes, effectively regulating indoor temperatures and further reducing the frequency of air-conditioning use. At the same time, high-efficiency thermal insulation technologies should be adopted to optimize the building envelope structure. For instance, using vacuum insulation panels and double-layer Low-E glass can reduce the energy consumption of buildings. In the operation process, energy-saving equipment should be actively introduced. Intelligent lighting systems can automatically adjust the brightness according to indoor light conditions and human activities, and energy-saving air-conditioning systems can precisely control indoor temperatures with advanced frequency-conversion technology, significantly reducing energy consumption. In addition, some commercial spaces have begun to explore Building Integrated Photovoltaics (BIPV) technology, integrating solar panels with building facades, roofs, and other structures, which not only meets the aesthetic requirements of the building but also enables efficient power generation. By installing renewable energy equipment such as solar panels and small-scale wind turbines, natural energy can be converted into electricity to meet part of the power demand of commercial spaces, reducing dependence on traditional energy sources and cutting carbon emissions at the source, thus achieving green and low-carbon operations in commercial spaces. Take a large-scale green shopping mall as an example. Through the comprehensive application of the above-mentioned energy-saving technologies, its annual energy consumption is reduced by more than 35% compared with that of traditional shopping malls, significantly

improving energy utilization efficiency.

4.2 Introducing Green Financial Support Systems

Green finance plays a crucial role in the sustainable development of commercial spaces. Financial institutions should increase their support for green commercial projects and develop targeted green financial products. For example, green credit products can be launched to provide low-interest loans for commercial space projects that adopt environmental protection technologies and practice the concept of sustainable development, reducing the financing costs of enterprises and encouraging them to actively engage in green development. To further reduce the financing risks of enterprises, some financial institutions have also explored the "green credit+insurance" model, introducing third-party insurance institutions to conduct risk assessments and provide guarantees for projects, ensuring the security of funds. Green industry investment funds should be established to attract social capital to participate in the investment of sustainable projects in commercial spaces, such as the construction of green shopping malls and the green renovation of old commercial buildings. During the investment decision-making process, the ESG (Environmental, Social, and Governance) evaluation system should be used to comprehensively assess projects, screening out high-quality projects with true sustainable development potential. Green bond business should be carried out, and commercial space operators can raise funds by issuing green bonds for environmental protection facility construction, energy conservation, and emission reduction projects. To increase the attractiveness of green bonds, some enterprises have innovatively launched "convertible green bonds", allowing investors to convert bonds into corporate equity under certain conditions and share the growth benefits of the enterprise. With these diversified financial means, strong financial impetus can be injected into the sustainable development of commercial spaces, promoting the green transformation process of commercial spaces.

4.3 Strengthening Social Responsibility and Community Integration

As an important carrier of social and economic activities, strengthening social responsibility and promoting community integration are important measures for the sustainable development of commercial spaces. Operators of commercial spaces should actively participate in community construction and establish close connections with surrounding communities. For example, community service centers can be set up within commercial spaces to provide residents with information consultation, convenient services, etc.; community cultural activities such as art exhibitions and parent-child sports meetings can be regularly held to enrich the spiritual life of residents and enhance community cohesion. Some commercial complexes have also cooperated with communities to transform idle spaces into public welfare places such as community libraries and senior activity centers, realizing resource sharing. Attention should be paid to the rights and interests of employees, providing them with a good working environment, reasonable remuneration, and career development opportunities to improve employee satisfaction and loyalty, and thus enhancing service quality. A perfect employee training system should be established to help employees improve their professional skills and qualities; an employee innovation reward fund should be set up to encourage employees to put forward innovative service plans and operation suggestions. By participating in public welfare activities, such as supporting environmental protection projects and helping poverty-stricken areas develop, a good corporate image can be established, realizing the harmonious coexistence of commercial spaces and society and creating a favorable social environment for sustainable development. A certain chain commercial enterprise launched the "Rural Revitalization Assistance Plan", establishing direct supply partnerships for agricultural products with poverty-stricken areas. This not only helped farmers increase their income but also provided consumers with high-quality agricultural products, achieving a win-win situation in economic and social benefits.

4.4 Promoting Digital Transformation and Intelligent Operations

In the era of the digital economy, digital transformation and intelligent operations are the inevitable trends in the sustainable development of commercial spaces. Using big data technology, commercial spaces can deeply analyze data on consumers' behavior habits and consumption preferences, accurately understand market demands, and thus optimize the layout of business forms and product configurations, improving operational efficiency and economic benefits. For example, by analyzing consumers' stay time and consumption records in different time periods and areas, the location of stores and product displays can be adjusted, placing popular products in prominent positions for the convenience of consumers. At the same time, big data can be used to predict changes in consumer demand, and preparations for product stocking and

promotional activities can be made in advance. The Internet of Things technology should be introduced to realize intelligent management of equipment and facilities in commercial spaces, monitor the operation status of equipment in real-time, carry out maintenance and repair in a timely manner, reduce equipment failure rates, extend the service life of equipment, and reduce resource waste. Some commercial spaces have already achieved remote centralized control and fault warning for equipment such as air conditioners, elevators, and lighting, reducing equipment maintenance costs by more than 20%. Online operation platforms should be built to carry out online marketing, online services, and other businesses, expanding the service scope and customer base of commercial spaces and enhancing the consumer experience. Innovative functions such as AR virtual fitting and VR panoramic shopping can be developed to enable consumers to obtain an immersive shopping experience online; live-streaming e-commerce, community marketing, and other methods can be used to enhance interaction and stickiness with consumers. In addition, through digital means, online and offline data can be integrated to build consumer profiles, achieving targeted marketing and personalized services, and promoting the sustainable development of commercial spaces with digital means to adapt to the ever-changing market environment.

5. Conclusion

Financial economics, innovation in commercial spaces, and sustainable development are closely intertwined, and their coordinated development constitutes an essential part of the modern economic system. Financial economics provides an inexhaustible source of impetus for the innovation of commercial spaces through financial support, the penetration of concepts, and the shaping of the market environment. At the financial level, financial institutions provide crucial funds for the transformation of commercial space models and facility construction through means such as credit and investment. At the conceptual level, ideas in the financial field, such as risk management and resource allocation, prompt operators of commercial spaces to make more scientific decisions in the process of innovation. In terms of the market environment, the vibrancy of financial markets stimulates consumption potential and intensifies market competition, compelling commercial spaces to constantly innovate and giving rise to diverse innovative models, including online-offline integration, shared commercial spaces, and themed commercial spaces. The sustainable development of commercial spaces means balancing immediate economic interests with long-term ecological and social needs. Promoting green building and energy-efficient operations, from the selection of building materials to the innovation of energy utilization methods, effectively reduces the negative environmental impact of commercial spaces. Introducing green financial support systems leverages financial means to attract social capital, providing financial guarantees for the green transformation of commercial spaces. Strengthening social responsibility and community integration enables commercial spaces to actively give back to society while achieving economic benefits, enhancing interaction and symbiosis with the community. Promoting digital transformation and intelligent operations, with the help of technologies such as big data and the Internet of Things, allows for an accurate grasp of market demands, improves operational efficiency, and expands the service scope.

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References

- [1] Liu Wenhan, Li Chunzhi. An Empirical Analysis of the Impact of the Digital Economy on the Green Development of China's Circulation Industry from the Perspective of Technological Innovation[J]. *Journal of Commercial Economics*, 2025(1):36-40.
- [2] Gong Kaihong. Research on the Application of "Urban Farms" in Urban Commercial Spaces from the Perspective of Ecological Urbanism[D]. Changchun University of Technology, 2024.
- [3] Zhao Yuncong, Wang Qiulan. Research on the Sustainable Development Strategies of Cross-border E-commerce Enterprises from the Perspective of Low-Carbon Economy[J]. 2024.

Analysis of Data Asset Management in Colleges and Universities

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Abstract: In the digital age, educational resources have become an important part of higher education institutions (HEI), and have improved teaching quality, scientific research output and administrative efficiency. Effective data asset management can greatly improve the decision-making process and resource allocation of higher education institutions. This study discusses the current situation of data asset management in higher education institutions, analyzes the challenges faced by data asset management, and puts forward strategies to improve data asset management. By analyzing some successful cases and drawing lessons from recent research experience, this paper aims to provide useful guidance for higher education institutions to make full use of their data assets and realize sustainable development in the digital age.

Keywords: Data Asset Management; Digital Transformation; Data Assets

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1.Introduction

The digital transformation sweeping across the field of education has completely changed the operation mode of higher education institutions. With the continuous emergence of information systems and digital tools, higher education institutions began to generate and collect massive data from various channels such as teaching activities, scientific research projects, administrative operations and student services. Keeping these data properly can bring many benefits to higher education institutions, such as improving teaching quality, choosing resources more wisely and enhancing research ability. However, many higher education institutions have many problems in properly managing their data assets. According to the research, efficient use of data resources can improve operational efficiency by 25% and teaching quality by 30%. This shows that the management of data assets is very important for the overall development of higher education institutions. With the continuous development of higher education institutions in the digital world, more and more information will be generated every day, so it is necessary to establish a powerful data asset management method.

2.The concept and characteristics of data assets of higher education institutions

The data assets of higher education institutions refer to all data-related resources owned or controlled by institutions, which can produce economic and academic benefits. These data assets are different because they come from different fields and have different forms; They are time-sensitive-their value will change over time; They are non-exhaustible-this means that they will not be exhausted when used, so we can use them repeatedly ^[1]. A firm grasp of all these characteristics is essential for effective data management. There are many kinds of data assets in higher education institutions, from students' enrollment

records and academic achievements (such data are organized in an orderly manner), research papers, class notes to multimedia content (such data are organized in an orderly manner). Diversity will bring many problems when storing, processing and viewing data. Take a simple example: structured data is easy to be stored in relational databases and analyzed by traditional data analysis tools, but unstructured data needs more advanced technologies, such as natural language processing and machine learning algorithms. According to the research, effective data asset management needs to use advanced data integration technology and create a unified data governance framework to manage complex data assets. Build a data lake that can handle all kinds of data and different formats, and adopt a data directory system, so that people can find and use data more easily ^[2].

3.Current situation of data asset management in colleges and universities

Many colleges and universities have made some progress in data asset management by building data management systems, adopting data warehouses, data mining and other technologies. But there are also some obstacles. Data may be scattered in different departments, so it will be difficult to share and integrate: for example, the student information system may be in the charge of the academic affairs office, and the library management system may also be in the charge of the library department. This division prevents us from fully grasping the learning process and experience of students. Data quality problems, such as errors, omissions and duplicate data, occur from time to time. If the data is incorrect, there may be errors-distributing data according to the wrong number of applicants or students' achievements in certain subjects. In addition, the faculty's awareness of data asset management is still weak, and there is a lack of full-time data administrators. Insufficient data security and privacy protection mechanisms will lead to serious data leakage and data abuse ^[3].

Data ownership: The data ownership and use right of higher education institutions are uncertain, so there may be data competition and problems in data use ^[4]. Due to the cooperative research work of scholars, the ownership problem between higher education institutions has become more complicated. It is controversial to determine the ownership of research data generated by multi-agency teamwork. This also makes it difficult for people to share data, obey rules and use data properly. For example, when scholars from different universities cooperate to carry out projects with external funding, determining who owns the data collected during the project may lead to disputes, which may lead to the slow publication of research results and publications.

Data security and data protection: The increasing amount of data brings the risk of security loopholes and privacy violations. Higher education institutions need to protect sensitive information, such as personal information of students and research data of teachers. Recently, many well-known data leakage incidents show that even excellent security organizations may become targets ^[5]. With the integration of artificial intelligence and data asset management, it is expected to change the way higher education institutions analyze and utilize data. According to the research, artificial intelligence analysis can mine the hidden patterns and information in massive data sets, thus helping to make more accurate predictions and wise choices.

Data management technology and talent shortage: Data technologies such as big data, artificial intelligence and cloud computing are changing rapidly. In order to keep up with these changes, we need to constantly improve the data management system and hire talents who know how to use these new tools. Many institutions of higher education find it difficult to meet these standards. The shortage of data management talents is a big challenge to achieve good data asset management. According to the research, universities should increase investment in training data management experts and actively seek experts in this field. Universities should establish contact with technology companies so that their employees can get practical training opportunities and master the latest data management technology.

Valuation and accounting of data assets: the value of data assets to a company is difficult to determine and reflect in financial statements. Due to the lack of uniform valuation and accounting standards, the value of data assets is difficult to reflect in financial statements. Chen Jianjun and Zhang Jianjun (2019) suggested that universities should explore cooperation modes with professional accounting firms and research institutions, and formulate appropriate data asset valuation models and accounting methods according to their own conditions. One way is to evaluate the value of data assets according to their impact on revenue generation, cost reduction or operational efficiency.

4.Effective management of data assets in colleges and universities

Building a comprehensive data asset management system: Universities need to formulate clear data asset management policies, rules and standards to ensure that everyone strictly abides by them. Set up a data asset department and a data asset management team to coordinate the work of various departments. Wang Jianjun and Wang Jianjun (2016) suggested that universities should set up a data governance committee to be responsible for the entire data asset management process. Establish data ownership and responsibilities for the Committee, create a data dictionary to standardize data, and establish a data quality monitoring mechanism. The Data Governance Committee needs to hold regular meetings to check data management practices, solve new problems, and ensure that everyone abides by data policies and regulations. In addition, the Committee will become a single point of contact for all data query and support of the department.

Strengthen data quality management: adopt a perfect data quality monitoring and evaluation system to ensure the accuracy, integrity, consistency and timeliness of data. Make data quality improvement plan and gradually improve data quality. It is suggested that higher education institutions conduct regular data quality audits and provide data quality management training for employees. Data quality audit is carried out by sampling data from different locations and checking them according to good quality standards. The audit results need to be applied to determine which areas need to be improved and gradually advance ^[6].

Promote data integration and sharing: use data integration technology to break data islands, form a unified data sharing platform, and maximize the value of data. In sharing, it is necessary to adopt advanced data integration technologies, such as data virtualization and data federation, in order to realize seamless data sharing across departments. Data virtualization enables different departments to utilize and integrate data from various sources without moving or copying data, thus reducing storage, reducing costs and ensuring information consistency. By simulating the important part of mixed data, data union enables us to view the information from different systems in a unified way, so that people can conduct research across departments without making data errors.

It is very important to strengthen data security and privacy protection, strict data security strategies and technical means, and measures such as data encryption, access control, data backup and recovery. In addition to training employees in data security and privacy protection, we also need to raise people's awareness ^[7]. Higher education institutions adopt multi-layer security methods, including network security, data encryption and user authentication. Regularly conduct data security review and risk assessment to improve data security. Network security measures should include firewalls, intrusion detection systems and secure network protocols to prevent data transmission channels from being accessed by uninvited personnel. Data should be encrypted when moving and at rest to protect sensitive data from being read by people who should not access it. User authentication mechanism must enforce strong password policy, multi-factor authentication and role-based access control, so that only authorized personnel can access specific data assets according to their roles and responsibilities.

Training and introducing data management talents: In order to improve data management capabilities, universities need to invest in training programs for data management professionals and actively hire experts in the field of data management. It is suggested that colleges and universities cooperate with external training institutions and universities to formulate training programs for data managers. Offering generous salary and better job opportunities can attract talents and keep them. Universities can also create a career development path of data management for their employees, so that they can be promoted and get higher salaries, and become contributors to the management of university data assets. In addition, the establishment of data management community in the school can promote knowledge exchange and cooperation among data professionals and create an atmosphere of continuous learning and progress.

5. Case study of data asset management in higher education institutions

This paper discusses several higher education institutions that successfully manage data assets. For example, a data governance committee for data asset management was established, which clarified the ownership and responsibility of data and created a unified data dictionary. The organization uses big data analysis tools to explore students' learning behavior and provide them with personalized learning suggestions. This not only improves the quality of education, but also improves students' academic performance. The data mining model used in the case study examines many aspects of students' data, such as the amount of homework they have completed, their test scores and whether they have participated in extracurricular activ-

ities. Through these insights, school staff can find students who have difficulties in specific topics and try specific solutions, extra courses and intelligent learning tools.

6. The future development of data asset management in colleges and universities

Looking forward to the future, with the continuous development of emerging technologies such as artificial intelligence, blockchain and Internet of Things, the data asset management of colleges and universities will continue to innovate. These technologies will make data asset management more intelligent, safe and convenient. Colleges and universities will pay more attention to the in-depth application of big data assets, and promote the innovation of teaching methods, the leap-forward development of scientific research and the overall institutional development. At the same time, the cooperation between universities and external enterprises and scientific research institutions will continue to increase, which will promote mutual benefit and win-win results and promote the development of data asset management. With the development of artificial intelligence, colleges and universities are expected to change the way they analyze and use data. Davenport and Patil(2012) believe that artificial intelligence analysis technology can find patterns and ideas hidden in massive data, so as to make more reasonable predictions and choices. This is very important for predicting students' performance and recommending personalized learning paths. Artificial intelligence algorithm can analyze students' past performance data, find students with learning risks as early as possible, and take action as early as possible to ensure that more students can maintain their learning progress and graduate smoothly. Blockchain technology will greatly improve the security and integrity of data, and ensure the decentralization and tamper resistance of data transaction books. Blockchain can ensure the authenticity and repeatability of data, thus reducing the possibility of data fraud and tampering. For example, we use blockchain to protect students' academic credentials, which means that when employers or other universities want to verify whether students' educational background and degrees are true, they don't need any intermediaries. The Internet of Things will also enhance its role in data asset management and collect real-time data from campus infrastructure and learning environment itself. IoT sensors can check how many people are in the classroom, check the electricity consumption on campus, and know whether students use smart devices installed in buildings to attend classes. Real-time data can be analyzed to improve the efficiency of resource allocation, improve campus energy efficiency and provide students with a more interactive learning experience.

7. Conclusion

In the era of digital data, data asset management is very important for higher education institutions. Understand the status quo, solve problems and adopt effective data asset management methods. In this way, universities can make full use of all data resources, enhance their core competitiveness and achieve sustained success. Based on the experience of successful cases, this paper hopes to provide reference for universities to improve their data asset management ability, so as to better adapt to the new digital era. Effective data asset management can help universities make full use of all data resources, enhance core competitiveness and promote sustainable development in the process of digital transformation. Colleges and universities should actively respond to the challenges of data asset management, constantly explore and innovate, and strive to improve the level of data asset management to better meet the development needs of the digital age. When colleges and universities begin to make full use of data asset management, they will not only improve their work efficiency and become better schools, but also help education become better and more innovative in the digital age.

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Reference

- [1] Research on the Property Attribute of Big Data[J]. Wang Yulin; Gao Fuping. Books and information, 2016(01).
- [2] Capitalization of big data[J]. Kangqi; Han Yong; Chen Wenjing; Liu Yaqi. Information communication technology, 2015(06).

- [3] Reflections on the Ways to Improve the Efficiency of the Use of Assets in Colleges and Universities —— Taking the Management of Fixed Assets in Colleges and Universities in Zhejiang Province as an Example[J]. Zhang Meihua. Financial research,2012(04).
- [4] Comparative study on the development of scientific data management policies[J]. Wang Fang; Bu Haohao.journal of library science in china,2022(06).
- [5] Practical exploration and theoretical model construction of enterprise data capitalization[J]. Xu Tao; You Jianxin; Zeng Caixia; Shi Yongjiang.foreign economics & management,2022(06).
- [6] Design and Implementation of Government Affairs Data Sharing Mechanism in Zhejiang University. Yu Zhou; Hongbo; Zhang Zihui.china education network,2023(09).
- [7] Shanghai Jiaotong University promotes innovative application of data sharing.Wang Jianjun; Yang Song; Han Wenjie; Zhang Siyu.china education network,2024(10).

Research on the Composition and Improvement Mechanism of Financial Governance Capabilities of Manufacturing Enterprises under the Background of Intelligent Finance

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Abstract: Against the backdrop of the accelerated evolution of intelligent finance, the financial functions of manufacturing enterprises are shifting from traditional accounting supervision to the value center of strategic leadership and intelligent decision-making. However, in practice, there are widespread governance obstacles such as process fragmentation, data fragmentation, organizational rigidity and cognitive lag. This paper constructs a five-dimensional structural system of financial governance capabilities, proposes four types of improvement mechanism paths of “process-data-organization-culture”, and selects typical cases of Midea, Haier, China Resources and other companies to verify the mechanism. The study found that the key to improving governance capabilities lies in achieving the organic linkage of technology embedding, structural adaptation and capability evolution. This paper systematically analyzes the construction logic and improvement path of financial governance capabilities in the context of intelligent finance, and provides theoretical support and practical reference for the construction of intelligent governance systems in manufacturing enterprises.

Keywords: Intelligent Finance; Financial Governance Capability; Capability Structure; Mechanism Evolution; Manufacturing Enterprise

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1.introduction

With the continuous deepening of digital intelligent technologies such as artificial intelligence, big data, and cloud computing, the financial functions of manufacturing enterprises are transforming from the traditional accounting and supervision model to the strategic empowerment model. As a product of the deep integration of digital technology and financial functions, intelligent finance is reshaping the value boundaries and governance logic of finance in organizations, becoming a key mechanism for enterprises to gain dynamic competitive advantages. However, most manufacturing companies are still facing problems such as delayed response of governance structure, insufficient use of data assets, and failure of business and financial synergy in the process of intelligent financial transformation, reflecting that their financial governance capabilities are not yet sound and the improvement mechanism is not yet clear.

Existing research focuses on the system architecture, technology deployment and information sharing mechanism of intelligent finance. Some literature begins to explore its role in improving the quality of financial decision-making and management efficiency, but there is still a lack of in-depth research on the system composition, evolution path and internal

mechanism of “financial governance capability” as a composite organizational capability. Especially in the context of technology being deeply embedded in organizational processes, how enterprises reconstruct financial governance capabilities through process reshaping, data governance and platform collaboration is still a problem that the academic community is concerned about but lacks theoretical construction.

Based on this, this paper introduces the dynamic capability theory, resource-based view and organizational capability theory, constructs a dynamic evolution analysis framework of “technology embedding-structural adaptation-capability evolution”, and explores the element system and coordination mechanism of the financial governance capability of manufacturing enterprises under the background of intelligent finance. Through the induction of typical enterprise cases and mechanism deduction, the core driving factors and improvement paths of capability generation are revealed, aiming to enrich the financial governance theory system from the perspective of organizational capability, and provide theoretical guidance and mechanism reference for the implementation of intelligent financial strategies of manufacturing enterprises.

2.Literature review and theoretical basis

2.1 Definition of core concepts

“Smart finance” refers to a complex form that uses an intelligent technology platform as a basis, integrates automated processes and intelligent decision-making models, and realizes the transformation of financial functions from accounting support to strategic leadership. This concept forms a preliminary framework based on the analysis of Wu Chunlei and Liu Junyong (2021) on the reshaping of financial functions^[1], and integrates the perspective of “technology reconstruction control structure” proposed by Bhimani (2015) for comprehensive refinement^[2].

“Financial governance capability” refers to the system capability of an enterprise to achieve resource allocation optimization, process coordination and intelligent response by relying on the financial system in the process of strategic execution, value creation and risk prevention and control. This definition integrates the connotation of big data governance capability proposed by Li Yinlong and Yang Miaofan (2023)^[4], and is supported by the “transformative integration” theory in the dynamic capability framework of Teece et al. (1997)^[3], reflecting the evolution path of financial functions from static support to dynamic empowerment.

2.2 Review of domestic and foreign research

2.2.1 Current status of foreign research

In recent years, the international academic community has continued to deepen its research on the composition mechanism and improvement path of corporate financial governance capabilities, mainly focusing on the three core dimensions of technological capability embedding, management capability structure and dynamic capability evolution.

Zhu (2024) took corporate governance capabilities and internal control as the starting point, revealing the intermediary mechanism of equity structure in improving financial governance and management capabilities, and emphasized that financial governance is affected by both institutional arrangements and the distribution of control rights^[5]. Mungai and Lee (2024) clarified the key role of IT system capabilities in corporate governance infrastructure by constructing the “information technology capabilities-management quality-financial reporting quality” path^[6]. Mu Li (2024) used EDAS technology and group decision-making methods to construct a multidimensional evaluation framework for corporate financial management capabilities, providing methodological support for the structured measurement of capabilities^[7].

From the perspective of capability evolution, Khan et al. (2022) explored how managers’ capabilities drive sustainable performance in a resource-constrained environment, highlighting “endogenous capability reshaping” as a key mechanism for performance improvement^[8]. Liu (2022) proposed that supply chain resilience and financial performance can be improved through optimization of internal governance mechanisms based on dynamic capability theory, demonstrating the linkage logic between enterprise capability structure and governance synergy^[9].

2.2.2 Current status of domestic research

Domestic research focuses on the modernization of financial governance capabilities and digital transformation of universities and public institutions, and generally emphasizes the integrated practice of institutional mechanism construction and information technology application.

Wang Zongzong and Deng Ping (2022) proposed a two-dimensional linkage model of “dynamic governance” and “dynamic allocation of financial power”, and established a matching mechanism between governance capacity and organizational resilience^[10]. Tan Tianmin (2023) took “double first-class” universities as samples and proposed a research paradigm of “capability dimension decomposition-mechanism path construction”, emphasizing the integrated development of institutional support and process execution^[11]. Guo Yumei (2023) and Tang Fei (2024) respectively proposed a path for the modernization of governance capacity around the construction of information platforms and the closed-loop mechanism of budget performance, highlighting the core role of data governance in improving institutional effectiveness^{[12][13]}.

Liu Kaiyuan and Zhang Li (2025) pointed out that the current university financial system has problems of process fragmentation and institutional structure dislocation, and suggested strengthening technology embedding and process coordination to improve governance efficiency^[14]. At the enterprise level, Wu Zhongxin et al. (2025) analyzed the role of intelligent financial logic in the reconstruction of governance structure from the perspective of scientific and technological innovation, and proposed that intelligent technology is promoting the reconstruction of governance capacity system^[15]. Wang Huiying and Chen Donglin (2025) took the reimbursement process as an example to construct a risk governance model based on intelligent control, which has strong cross-industry application potential^[16].

2.2.3 Research review

Overall, the existing literature discusses financial governance capabilities from multiple dimensions, including governance structure, technical capabilities, process execution, and management mechanisms, and has initially formed a multi-faceted research system of capability identification, mechanism construction, and performance evaluation.

Foreign research emphasizes the capability attributes and evolution mechanism of financial governance capabilities, and builds an adaptive governance framework with the help of theoretical tools such as dynamic capabilities, organizational learning, and IT-based capabilities. However, most studies focus on general organizational scenarios and lack scenario-based analysis and capability element identification for manufacturing companies, especially in the context of intelligent finance.

Domestic research has a practice-oriented approach in terms of system execution, process nesting, and budget-performance integration. However, the research subjects are mainly universities and public institutions, and the governance focus is still on system norms and compliance. There is little involvement in the construction of enterprise capability systems based on the linkage logic of “strategy-technology-governance”.

In summary, current research still has the following three shortcomings: (1) There is a lack of systematic connotation definition and structured analysis of financial governance capabilities in intelligent finance scenarios; (2) In theory, a clear “technology-process-system” co-evolution mechanism has not yet been established to explain the generation logic of financial governance capabilities; (3) In practical research, there is little mechanism modeling and path verification of typical cases of manufacturing enterprises, making it difficult to form a systematic summary of capability improvement strategies.

Therefore, this paper attempts to build an analytical bridge between theoretical integration and corporate practice, and proposes a research framework with “capability identification-mechanism construction-path optimization” as the main line to respond to the structural gap in current research.

2.3 Theoretical basis

In the context of intelligent finance, the financial governance of manufacturing enterprises is no longer limited to traditional accounting and supervision functions, but has evolved into a complex governance system that integrates multiple elements of technology, organization and system. In order to systematically analyze the logic of its capability formation, this article introduces the resource-based view, organizational capability theory and dynamic capability theory, and constructs a multi-level theoretical support framework to explain the formation path and mechanism of governance capability (as shown in Figure 2-1).

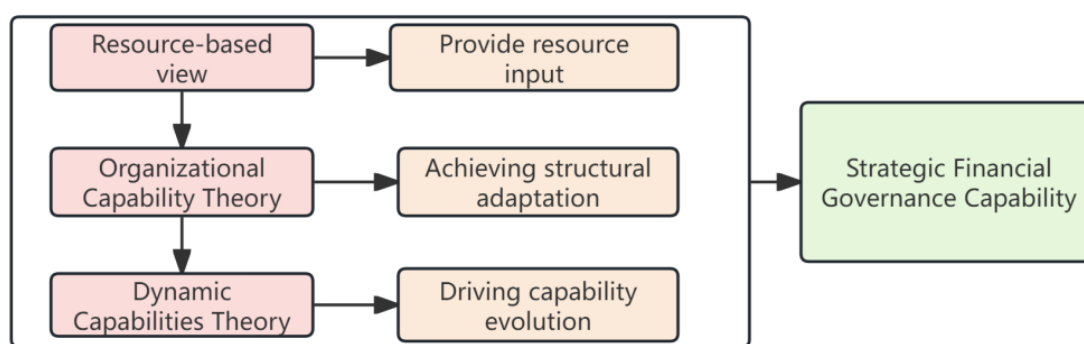
(1) The resource-based view emphasizes the scarcity and heterogeneity of data, technology, and institutional resources owned by the enterprise, which is the basic supply layer for the construction of financial governance mechanisms. The configuration and integration of technology platforms (such as RPA, AI accounting systems), institutional regulations, and master data platforms are the prerequisites for capability development.

(2) Organizational capability theory focuses on the adaptation of resource allocation and structural design. In the intelligent financial system, capability is not a simple superposition of resources, but a coordinated execution capability formed in process configuration, job design, system coordination, etc., which is reflected in the efficient connection between structure and responsibilities.

(3) Dynamic capability theory emphasizes the ability of enterprises to perceive, respond and restructure in uncertain environments. In the context of continuous technological evolution, financial governance mechanisms need to have strategic responsiveness and achieve dynamic evolution of resource reorganization, process reengineering and cultural integration.

Combining the logic of the three, this paper constructs a nested explanatory framework of “resource supply-structural adaptation-capability evolution”. This framework is not a new expansion of existing theories, but a systematic integration and structural matching of the three mainstream management theories in the intelligent financial scenario, emphasizing the logical embedding and practical mapping between mechanisms, and serving the analysis of subsequent mechanism formation and improvement paths.

Figure 2-1 Evolutionary path of financial governance capabilities under the nested logic of the ternary theory



3. Construction of financial governance capability framework

3.1 Definition of Financial Governance Capabilities

In the context of intelligent finance, the financial functions of enterprises are shifting from “accounting and supervision” to “strategic coordination and value leadership”. Based on the dynamic capability theory proposed by Teece et al. (1997) and the definition of big data governance capabilities by Li Yinlong and Yang Miaofan (2023), this article defines “financial governance capabilities” as: the comprehensive governance capabilities of enterprises to achieve resource optimization, business process coordination, strategic decision-making empowerment and dynamic risk control in a highly uncertain and rapidly evolving technological environment, relying on financial functions and data intelligence.

This capability not only includes traditional accounting, budgeting and auditing functions, but also emphasizes value collaboration, process integration and data-driven management for strategic goals. Its main features are reflected in the following three aspects:

- (1) Decision-making leadership: The finance department has transformed from an “accounting center” to a “strategic center”, providing future-oriented uncertainty identification and dynamic resource allocation support to help implement the strategy;
- (2) Collaborative integration: With the help of intelligent platforms, we can achieve deep integration of finance, business and management systems, and build a closed-loop collaborative chain covering budget, cost and performance;
- (3) Continuous evolution: In the face of rapid changes in the external environment and internal structure, financial governance must have flexible mechanisms for system updates and capacity reconstruction to achieve adaptive evolution.

3.2 Dimensional structure of financial governance capabilities

Combining management theory with manufacturing enterprise practice, this paper constructs a “five-dimensional” financial governance capability structure system, covering the following core dimensions:

- (1) Strategic leadership capability: reflects the supporting and guiding role of finance in strategic identification, goal setting and performance feedback. Core capabilities include strategic budgeting, resource integration and value assessment.
- (2) Process management capabilities: Focusing on the institutionalization, process automation and operational transparency of

key business processes such as budgeting, accounting and reimbursement is the basis for ensuring governance efficiency.

(3) Data analysis capabilities: Emphasis on the integrated use and intelligent analysis of financial data, including visual report construction, predictive modeling and decision support, reflecting the cognitive advantages driven by data.

(4) Risk control capability: covers key modules such as internal control system construction, audit supervision, and fund security, and is the institutional guarantee to support governance stability and compliance.

(5) Value creation capability: highlight the proactive involvement of finance in cross-departmental collaboration, performance incentives and business innovation, and realize the functional transformation of finance from a “recorder” to an “enabler”.

This capability system is strategically oriented, technically supportive, and functionally collaborative, and is the core foundation for supporting manufacturing companies to leap from “informatization” to “intelligence.” To support the effective generation of the above five-dimensional capabilities, this article will further design and verify the corresponding improvement mechanism path in Chapter 4.

3.3 Capability Evolution Logic in the Context of Intelligent Finance

In the context of intelligent finance, financial governance capabilities are no longer a stack of static modules, but a dynamic reconstruction process of “technology embedding - structural adaptation - capability evolution”. This article summarizes the practices of typical manufacturing companies and proposes a three-stage capability evolution model (as shown in Figure 3-1):

Phase 1: Technology embedding:

Enterprises automate and digitize key processes such as budgeting, reimbursement, and voucher processing by introducing tools such as RPA, OCR, AI reimbursement, intelligent recognition, and financial robots, thereby achieving information integration and online processes.

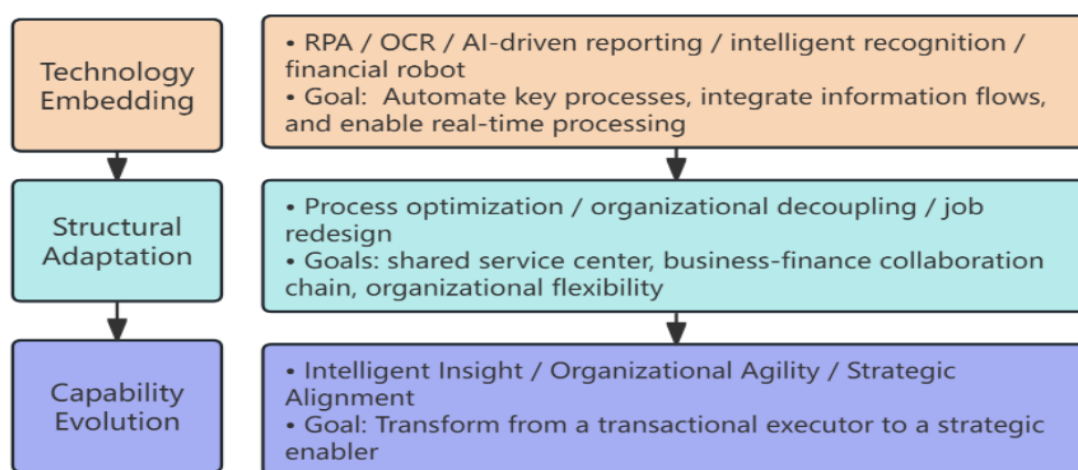
The second stage:

On top of the structural adaptation technology platform, enterprises need to reshape their organizational structure and processes, such as setting up a shared service center, opening up the financial and business collaboration chain, and establishing a job decoupling mechanism to achieve a flexible and highly responsive management structure.

Phase 3: Capability Evolution

After the coupling of technology and structure, the financial organization will form a new capability system with intelligent insight, dynamic collaboration and strategy-driven, and achieve a fundamental transformation from a transaction executor to a strategic enabler.

Figure 3-1 Three-stage evolution model for building financial governance capabilities of manufacturing enterprises



This model not only reveals the transition path of financial governance capabilities from instrumental functions to systemic capabilities, but also provides a clear logical starting point and practical mapping basis for the subsequent mechanism design and optimization. The proposed three-stage capability evolution model, as a dynamic generation path at the practical level, can also be regarded as a nested situational mapping of the resource-based view, organizational capability theory and dynamic capability theory in the context of intelligent finance: among them, “technology embedding” corresponds to the enterprise’s

acquisition and allocation of key resources, which conforms to the scarcity and heterogeneity logic of the resource-based view; “structural adaptation” reflects the collaborative reconstruction and structural integration of organizational capabilities, reflecting the emphasis of organizational capability theory on process and structure matching; and “capability evolution” reflects the enterprise’s adaptability and regeneration ability to change in a dynamic environment, which conforms to the core proposition of dynamic capability theory. The three together constitute a progressive evolutionary logic from resource support, structural shaping to capability iteration, providing a multi-dimensional integrated support system for the theoretical construction and mechanism implementation of financial governance capabilities under the background of intelligent finance.

4.Design of financial governance capacity enhancement mechanism

The four types of mechanisms serve different capability modules in the five-dimensional structure of financial governance capabilities: the process automation mechanism focuses on “process management” and “strategic leadership”, the data mechanism strengthens “data analysis”, the organizational mechanism supports “risk control” and “value creation”, and the cultural mechanism covers “organizational identity” and “collaborative drive”.

4.1 Process Automation and Intelligent Decision-making Mechanism

Process automation is the technical starting point of intelligent financial governance. Its core lies in deeply embedding institutional processes with AI models to build a closed-loop mechanism of “automation-perception-regulation”. Relying on the iMidea platform, Midea Group embeds a node-based budget control mechanism in the procurement-approval chain, combines AI models to set dynamic thresholds, and realizes flexible budget generation and real-time feedback. The budget accuracy rate reaches 92%, and the intervention response efficiency is improved by 38%.

According to a survey conducted by KPMG (2024) on 2,900 companies in 23 countries, 73% of companies have deployed AI systems in their financial reporting processes, and 57% of “AI leaders” believe that their return on investment (ROI) has exceeded expectations. Meike Technology (2025) also pointed out that retail companies have saved an average of 30% of financial processing hours and increased process response speed by 41% through full-process automation mechanisms such as “transactions are data, and income and expenditure are recorded in accounts”. These data show that process governance capabilities are becoming a common intelligent financial governance mechanism across industries.

This mechanism fits the core logic of “opportunity identification-rapid configuration” in the dynamic capability theory, and constitutes an important technical fulcrum for financial strategic leadership capabilities. The process automation mechanism is embedded in the financial decision-making process through platformization, effectively improving the pre-emptiveness and agile response of financial functions, and is the key path for enterprises to transition from accounting support to strategic empowerment. The above practices reflect the core characteristics of “perceiving changes-rapid response” in the dynamic capability theory. Technical tools not only serve as the execution carrier of process reengineering, but also become the key to enterprises to reconstruct resource allocation methods and improve the real-time nature of decision-making.

4.2 Data assetization and information collaboration mechanism

Data assetization is the core guarantee for building “data-driven finance” governance. The key lies in achieving standardization of data throughout its life cycle with unified coding, semantics and caliber, and enhancing the collaborative value of data in the business-finance-management chain through platform-based sharing.

Haier Group relies on the master data governance platform to map fields and unify semantics of heterogeneous systems such as SAP and U8, establish a data lineage map, and achieve three-dimensional collaboration of “data consistency-caliber unification-decision consensus”. The Gig Economy Research Center (2024) predicts that the scale of China’s fiscal and tax digitalization market will reach 70.2 billion yuan in 2025; Meike Technology (2025) points out that 48% of companies have launched master data platforms, and 80% of retail companies have included “business and financial integration” in their strategic key tasks.

This mechanism corresponds to the configuration logic of “scarce and irreplaceable resources” in the resource-based view (RBV), transforming data from passive information into operational strategic assets. Through the three paths of standardization, platformization, and sharing, the data assetization mechanism strengthens the hub role of data among various functions, significantly improves decision-making consistency and traceability, and provides a high-quality data foundation

for financial governance capabilities.

4.3 Organizational structure and job competency adaptation mechanism

The dynamic matching of organizational and job capabilities is the organizational basis for upgrading financial governance capabilities. The key lies in achieving a closed loop of person-job matching and capability iteration through job decoupling and capability mapping.

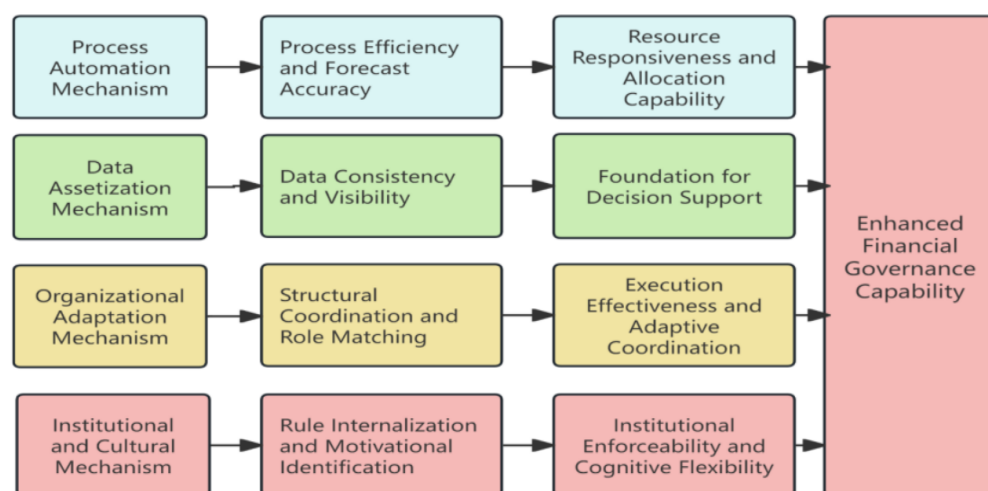
China Resources Group has cancelled traditional low-value positions such as “accountants” and added “data analysts” and “intelligent control specialists”, with supporting “position capability maps” and online training systems, forming a dual cycle of “structural flexibility-capability upgrade”. Beisen (2024) survey shows that 70% of companies are restructuring financial positions, and 65% have established FBP (financial business partner) roles; ACCA (2024) pointed out that 83% of financial personnel believe that AI will reshape their role positioning. Meike Technology (2025) proposed that future financial talents need to have a triple capability model of “digital intelligence collaboration-data insight-strategic support”, and their functions are shifting from accounting support to the growth center of the enterprise.

This mechanism is consistent with the Organization Capability Theory (OC)’s proposition of “structure-execution” synergy, and improves the resilience and agility of financial governance by reconstructing the organizational structure and capability configuration. The position capability adaptation mechanism takes the “position + capability” two-dimensional synergy as a starting point to build a flexible organization for intelligent finance for enterprises and promote the transformation of financial functions from transaction execution to value creation.

4.4 Institutional guarantee and cultural identity mechanism

The synergy between system and culture is the soft and hard integrated support for the long-term effective operation of the financial governance mechanism. The core lies in ensuring governance rules with rigid systems and enhancing employees’ trust in and adoption of smart tools with flexible culture.

Figure 4-1 Path diagram of the four mechanisms of intelligent financial governance capabilities



Midea Group incorporates “algorithm adoption rate” into performance appraisal, combines it with the “cultural points system” reward mechanism and embeds an explainability module in the CloudWeGo system to improve system transparency and employee trust. KPMG (2024) proposed “five types of AI governance models” covering access control, lifecycle maintenance, and explainability, and pointed out that 60% of global CEOs will continue to increase investment in AI governance during economic fluctuations. Meike Technology (2025) further pointed out that companies should strengthen institutional indicators such as “system utilization rate”, “reimbursement timeliness”, and “data adoption rate”, and adjust employee and technology collaborative behaviors through points, performance, and cultural mechanisms to achieve integrated governance of “rigid system + flexible cognition”.

This mechanism echoes the path of “cognitive embedding-cultural internalization” in organizational evolution theory, and builds a stable technology-organization-individual collaborative ecology through the dual drive of institutional hard constraints and cultural soft incentives. The institutional guarantee and cultural identity mechanism, through the parallel

design of “strong rules + soft incentives”, strengthens the sustainability and credibility of intelligent financial governance, and provides long-term organizational stickiness and cultural soil for capability evolution.

Comprehensive evaluation: The four types of mechanisms systematically respond to the elements of financial governance capabilities from the dimensions of process, data, organization and culture, and use real cases such as Midea, Haier, and China Resources and authoritative research data (KPMG 2024, Gig Economy Research Center 2024, Beisen 2024, ACCA 2024, etc.) as quantitative support to form a path template for a highly adaptable financial governance system for manufacturing enterprises (as shown in Figure 4-1).

5. Mechanism Verification and Application Scenarios

5.1 Analysis of Typical Enterprise Practices

In the process of intelligent financial transformation, Midea Group, Haier Group and China Resources Group respectively demonstrated the specific application of the four mechanisms of “process-data-organization-culture” in real enterprises.

(1) Relying on the “iMidea” platform, Midea Group embedded the process engine into the budget control system and built a dynamic threshold mechanism based on the AI model, which significantly shortened the response cycle from budget formulation to execution, increased the accuracy of financial forecasts to 92%, and improved the process intervention response efficiency by 38%.

(2) Haier Group takes the master data governance platform as the core, builds a cross-system field mapping and semantic standard mechanism, promotes data collaboration between SAP and U8 systems, realizes indicator unification and traceability management, and significantly reduces financial analysis deviations caused by inconsistent data.

(3) China Resources Group reshaped its financial job system through the “Job Competency Map”, introduced new functions such as “Data Analyst” and “Intelligent Control Specialist”, and combined it with a competency certification system to improve job matching rates and decision-making response efficiency (increased by more than 30%); at the same time, it used the “cultural points + algorithm explanation” mechanism to enhance employees’ awareness and adoption of system outputs.

The three companies verified the implementation paths and synergy effects of four core mechanisms in the context of intelligent finance, and provided observable and quantifiable mechanism operation results.

5.2 Case Mapping and Mechanism Path Verification

Taking “mechanism model - enterprise practice - theoretical support” as the main line of analysis, this article conducts a structural mapping between the practice paths of the three enterprises and the proposed mechanism model (Table 5-1):

Table 5-1 Typical practice and theoretical mapping paths of the four types of mechanisms of intelligent financial governance

Mechanism Type	Representative companies	Practice	Theoretical Mapping Path
Process automation and intelligent decision-making mechanism	Midea Group	Build a node-based budget control system based on the iMidea platform, embedding AI prediction and feedback mechanism	Dynamic Capabilities Theory: Opportunity Identification → Rapid Configuration Response
Data assetization and information collaboration mechanism	Haier Group	Establish a unified master data platform to promote semantic standardization and multi-system data consistency management	Resource-based view: scarce data resource integration and platform configuration capabilities
Organizational structure and job competency adaptation mechanism	China Resources Group	Promote job decoupling and “capability map” mechanism, add smart jobs and strengthen training and certification system	Organizational Capability Theory: Structural Adjustment → Execution Capability Synergy
Institutional guarantee and cultural identity mechanism	Midea Group	Incorporate algorithm usage into performance appraisals, and use a cultural points mechanism and explainable models to enhance trust and recognition	Organizational Evolution Theory: Cognitive Fit → Institutional-Cultural Embeddedness

Each mechanism not only achieves the expected goals of process reconstruction and capability improvement in the enterprise, but also corresponds to the three-stage logical chain of “resources-structure-capability” in the theoretical model, forming a closed loop from institutional design-practical verification-theoretical regression, which improves the explanatory power and adaptability of the model.

5.3 Analysis of scalability and limitations

The four types of mechanisms have good portability and modularity in the manufacturing industry, but their promotion and application need to be combined with industry characteristics and enterprise development stages:

- (1) Large manufacturing enterprises: They have a platform foundation and organizational support, and are suitable for simultaneously promoting the four-dimensional mechanism of “process-data-organization-culture”;
- (2) Medium-sized enterprises: Prioritize the promotion of process automation or job structure optimization, and gradually accumulate data asset management and institutional culture co-construction capabilities. For example, a medium-sized manufacturing enterprise in the Pearl River Delta, under the condition that the ERP system is not yet complete, has initially implemented the implementation of the budget response mechanism through the deployment of a lightweight process engine and BI tools, supplemented by a part-time job evaluation system;
- (3) Regulation-intensive industries: such as public utilities and the financial industry. The promotion of the mechanism must give priority to compliance and data privacy restrictions. It is recommended to use institutional guarantees and job adaptation mechanisms as breakthroughs to steadily advance the pilot of process and data mechanisms.

In addition, although the current mechanism model has structural rationality and case support, there is still room for improvement in the quantitative evaluation of the mechanism’s operating effectiveness and performance attribution. It is recommended to construct a “governance mechanism maturity index” based on indicators such as behavior adoption rate, feedback frequency, and system response time to enhance the empirical extension and dynamic evaluation value.

5.4 Mechanism variable framework and maturity level construction

5.4.1 Construction Logic of Mechanism Variable System

In order to improve the verifiability and practical adaptability of the theoretical model, this paper introduces mechanism variables as structural proxy indicators in the process of generating financial governance capabilities to make up for the limitations of abstract and difficult to measure capability evaluation. This variable system takes the mechanism operation status as the starting point, depicts the coupling relationship between the mechanism implementation level and capability maturity, and enhances the structural explanatory power and reality mapping of the model.

Specifically, this paper draws on the construction ideas of the structural equation model (SEM), combines typical enterprise case practices and governance trends revealed by industry research reports, designs four core mechanism variables including “process automation level”, “data consistency”, “job fit” and “cultural identity strength”, and constructs a corresponding quasi-quantitative indicator system. The relevant indicators are mainly derived from theoretical deduction and industry inspiration (as shown in Table 5-2). Although they have not yet been verified by first-hand research data, they have the basic conditions for conducting quantitative analysis and model estimation.

Table 5-2 Latent variable concept and observable indicator system of intelligent financial governance capability improvement mechanism

Latent variable name	Observable Metrics (Example)	Theoretical support/source of inspiration
Process automation level	Node automatic identification rate, average budget response time, process exception handling frequency, process intervention trigger ratio	Midea Group’s process platform practice; KPMG (2025) “AI Empowers Financial Process Optimization Report”
Data consistency	Field standardization coverage, proportion of semantic conflict items, completeness of report traceability chain, and consistency rate of key indicators	Haier master data governance mechanism; Meike Technology (2025)

Latent variable name	Observable Metrics (Example)	Theoretical support/source of inspiration
Job suitability	Job capability matching ratio, capability certification achievement rate, job decoupling coverage rate, digital tool operation proficiency	China Resources' "Capability Map" system; Beisen (2024) Talent Research Report
Strength of cultural identity	System suggestion adoption rate, algorithm output trust score, cultural points system coverage rate, user active feedback rate	Midea's cultural governance mechanism; Smart Finance Alliance (2024) report

5.4.2 Maturity rating method and standards

On this basis, this paper constructs a mechanism maturity rating table (Table 5-3) to make a horizontal comparison of the performance of three representative manufacturing companies in terms of the operating levels of four types of governance mechanisms, revealing the differences in the maturity stages and paths of their mechanism implementation, and providing support for model verification and mechanism tuning.

Table 5-3 Four types of mechanism maturity levels and enterprise comparison scores (levels 1-5)

Mechanism Type	Midea Group	Haier Group	China Resources Group
Process automation and intelligent decision-making mechanism	5	3	4
Data assetization and information collaboration mechanism	4	5	3
Organizational structure and job competency adaptation mechanism	3	3	5
Institutional guarantee and cultural identity mechanism	5	4	4

To enhance the transparency and academic interpretation of the scoring results, the following explanation is given for the scoring logic: The scoring is not derived from the original data within the enterprise, but is based on public case descriptions, industry trend reports, and the mechanism variable system constructed in this article, and is assigned through structural deduction and expert judgment. To ensure the objectivity and comparability of the mechanism maturity score, this article constructs a three-level scoring system based on the systematic nature of the enterprise mechanism construction, the degree of closed-loop operation, and the depth of technology implementation:

- (1) Level 1: The mechanism has not been established, the process relies on manual processing, and there is no platform support;
- (2) Level 3: The mechanism is initially established, with basic rules and processes and partial system integration;
- (3) Level 5: The mechanism is highly mature, with automated process identification, closed-loop feedback mechanism, and highly coordinated organizational response.

5.4.3 Operational significance and research prospects

This mechanism variable system is positioned as an operational bridge between "mechanism-capability". In order to improve the theoretical rigor and practical reproducibility of the scoring system, it is recommended that future research be further expanded in the following two directions:

- (1) Refinement of scoring dimensions: Introduce secondary indicators such as "mechanism activation rate", "data closed-loop ratio", and "employee adoption activity" to construct a multi-dimensional scoring matrix and enhance the structural resolution of the evaluation system;
- (2) Standardization of the evaluation process: Combine the Delphi method, multi-source interviews and enterprise questionnaires to clarify the scoring thresholds and judgment criteria and build a reusable mechanism evaluation system.

In essence, the mechanism variable system designed in this paper is an intermediary bridge to build an operational connection between “mechanism-capability”. It not only provides a quantitative dimension for future empirical research, but also provides theoretical tools and methodological references for industry trend assessment and corporate governance capability diagnosis. It is recommended to further combine system log collection, employee behavior tracking and feedback data mining to build a financial governance capability maturity assessment system for dynamic environments, so as to continuously expand the extension and adaptability of the mechanism model.

6. Conclusion

From a structural perspective, this paper constructs a three-stage capability evolution model and a four-type mechanism support system. Rather than existing independently, these two frameworks jointly elucidate the evolutionary logic of financial governance capabilities—respectively addressing the dynamic path of capability development and the structural composition of governance mechanisms. The introduction of mechanism variables and the corresponding scoring system offers operational indicators to support model implementation, thereby forming a closed-loop analytical framework encompassing “theoretical construction–mechanism design–indicator evaluation”.

In theory, this paper integrates the three mainstream management perspectives of resource-based view, organizational capability theory and dynamic capability theory, proposes a three-stage evolution path of “resource-structure-capability”, and constructs a four-dimensional mechanism nested model of financial governance capability. Compared with previous fragmented and single-perspective research approaches, this paper adopts a system integration logic to uncover the progressive mechanisms and multi-dimensional coordination paths underlying capability formation in manufacturing enterprises undergoing intelligent financial transformation, providing a theoretical starting point and structural support for subsequent mechanism maturity assessment and capability optimization.

In terms of research content, this paper focuses on the core issue of “how to construct and effectively improve the financial governance capabilities of manufacturing enterprises under the background of intelligent finance”, systematically constructs a five-dimensional capability structure covering strategic leadership, process management, data analysis, risk control and value creation, and proposes four types of capability improvement mechanisms of “process-data-organization-culture”, emphasizing an evolutionary pathway centered on “technology embedding–structural adaptation–mechanism closure. Through the mechanism mapping and path verification of three typical enterprises, Midea, Haier and China Resources, the adaptability and operation effectiveness of the mechanism design are further confirmed, providing theoretical guidance and practical reference for the construction of the intelligent financial governance system of enterprises.

In general, this paper attempts to provide a theoretical framework and path model with structural completeness and application value for manufacturing enterprises to promote the strategic transformation of financial functions and the in-depth implementation of intelligent finance from the dual perspectives of capability system construction and governance mechanism design. Although the mechanism system has taken shape, its quantitative evaluation, differences in adaptability between industries, and the long-term impact of technological evolution on the operation of the mechanism still need to be further studied.

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no

Conflict of Interests

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Reference

- [1] Wu, C., & Liu, J. (2021). Intelligent finance: Reconstruction of financial functions and value creation driven by technology. *Accounting Research*, (08), 17–24.
- [2] Bhimani, A. (2015). Exploring big data's strategic consequences. *Journal of Information Technology*, 30(1), 66–69.
- [3] Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.

- [4] Li, Y., & Yang, M. (2023). Research on the governance mechanism of enterprise big data resources based on financial sharing. *Price Theory and Practice*, (04), 104–108.
- [5] Zhu, W. (2024). Research on the influence of corporate governance ability and internal control on financial management level: Based on the intermediary role of shareholding structure. *Financial Engineering and Risk Management*, 7(6).
- [6] Mungai, A. N., & Lee, L. S. (2024). Information technology capability, managerial ability, and financial reporting quality: A research note. *Journal of Information Systems*, 38(2), 99.
- [7] Li, M. (2024). An integrated methodology for enterprise financial management capability evaluation based on EDAS technique and group decision making. *Journal of Intelligent & Fuzzy Systems*, 46(1), 2281–2296.
- [8] Khan, M. K., Naeem, K., & Xie, M. (2022). Does managerial ability transform organization from the inside out? Evidence from sustainability performance of financially constrained firms in an emerging economy. *Borsa Istanbul Review*, 22(5), 897–910.
- [9] Liu, Z. (2022). Improving internal management capabilities to increase supply chain resilience and financial performance – A dynamic capabilities perspective. *International Journal of Services, Economics and Management*, 13(1), 78–91.
- [10] Wang, Z., & Deng, P. (2022). Research on dynamic financial governance and dynamic allocation of financial power in universities. *Finance and Accounting Communications*, (14), 157–160.
- [11] Tan, T. (2023). Research on improving the financial governance capacity of local universities under the background of “Double First-Class” construction: Taking agricultural and forestry universities as an example. *Educational Finance and Accounting Research*, 34(05), 41–47.
- [12] Guo, Y. (2023). The path of promoting the modernization of financial governance capabilities of colleges and universities through financial informatization: A case study of C University in Jiangxi Province. *Shanghai Enterprise*, (12), 97–99.
- [13] Tang, F. (2024). Strategies to improve the financial governance capabilities of universities based on integrated budget performance management. *Accountant*, (24), 94–96.
- [14] Liu, K., & Zhang, L. (2025). Research on the dilemma and optimization of financial governance of local universities in the information age. *Commercial Accounting*, (09), 101–104.
- [15] Wu, Z., Liu, Y., & Qiu, S. (2025). Technological innovation and financial management: Driving the development of new quality productivity. *Finance and Accounting Monthly*, (1), 1–6.
- [16] Wang, H., & Chen, D. (2025). Digital transformation path and practice of financial reimbursement risk management in colleges and universities. *Journal of Wuhan University of Technology (Social Science Edition)*, 38(01), 128–135.

Assessment of Organisational Change Project based on Six Box Model: A Case Study of High-Tech Enterprise in China

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Abstract: Organisational change is regarded as the process of transforming structure and function of the organisations to adapt operations to external business environment with full of uncertainty. The purpose of this paper is to assess organisational change project based six box model as the organisational diagnose technique. A case study is undertaken in a high-tech enterprise in China, Lezhichen Technology, regarding their change initiative by project for further improvement and deeper collaborations with clients. It presents the change overview includes stakeholder analysis, drivers and constraints, cost and benefit analysis together with the change assessment and evaluation. The findings indicate that the outcome of organisational change project is linked with the contributions of both strategic organisational and certain human resource practices. Understanding the potential challenges and strategies can support managers implement the organisational change project in a more effective approach.

Keywords: Organisational Change Project; Stakeholder Analysis; Organisational diagnose; Six Box Model

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1.Introduction

Since established in 2015, Lezhichen Technology (LT) is one of the growing small and medium-sized enterprises (SMEs) in high-tech sector in China. The main business of the enterprise covers the range of computer information system, digital meeting system, security protection and intelligent building equipment development with the core values of “honesty, high-quality and innovation”. The main clients of LT enterprise include government, military, transportation, state-owned enterprises and higher education institutions. In the beginning years, LT benefits from the business opportunities led by the rapid development of e-governance in the combination of the increased demand of intelligent governance system in China (Zheng et al., 2013). However, LT encountered with an emerging transformation that local government cut down the financial expenses due to the economic downturn. As a result, many clients intended to reduce cost of further developing e-governance and intelligent building, which brought the pressure to the enterprise for seeking change.

In order to retain the customer groups, LT took various measures to sustain competitive advantage. One of the strategies is to implement a project of organisational change, named the “Client-Centred Project”, to provide the better service for the clients and increase the annual turnover. However, the successful implementation of the strategy on customer orientation requires all people, processes and resources of the organisation to be matched with the new value created by the organisational change process (Guenzi et al., 2011; Frambach et al., 2016). Thus, this paper adopted a case study that provided an assessment of

organisational change project through six box model in a high-tech enterprise in China.

2. Overview of Change Project in LT

2.1 Stakeholder Analysis

In terms of organisational change, it can not only affect the organisation itself but all the stakeholders who are involved in the change process with an interest and would be influential in achieving the success of change implementations (Peltokorpi et al., 2008; Errida & Lotfi, 2021). Thus, it is important for the change practitioners to map out the key stakeholders at the beginning of designing change initiative because the successful change needs the strong input and contributions of them (Jacobs et al., 2013). In this situation, the stakeholder analysis as a process can be used to identify those who will be involved. It helps change practitioners to understand influence, position, behaviour and interest of the stakeholders (Ackermann & Eden, 2011). In this paper, involved stakeholders in the organisational change process in LT enterprise cover the clients, actors, sponsors, owners, legitimisers and opinion leaders.

The Clients are the people who directly get benefit from the change. In this case, the local government as the main client while other customers on business such as military, state-owned company and university receive the benefits from the “Client-Centred Project”. In addition, the sales employees and engineers in the frontline can be the potential client because they are directly contacting with the market and customers.

The Actors is mainly including the group of leaders and the shareholders of the company who want to save the management cost from simplifying the organisational structure due to economic. The Sponsor for this change is the CEO of LT who needs to raise funds for the implementation and consider the direction of the future development of the organisation. The Owners involved in the initiative are the leaders from marketing, administrative and project departments which are collaborating with each other for the implementation of change. However, the main owner is a marketing director who is responsible for the change initiative and implement the project.

The Legitimisers are the employees and managers who are satisfied with the existing structure and values. Some of the department’s managers and its employees may resist to change due to their position will probably be adjusted or even merged during the strategy implementation. The Opinion leader can be the leaders of the staff union because they both represent the employees and impact the employee relation in the organisation. Also, unit managers are considered as the opinion leaders because they are both stands by the organisation and their departments, which brings a dilemma to them when the change is going to influence the specific departments.

2.2 Perceived Drivers and Constraints

Drivers of the change in LT enterprise is discussed in several external and internal factors of the enterprise. The driver that forces LT to change was to retain the clients like the local government which affected by the national economic readjustment due to the economic downturn (economic factor). They would probably be attracted by other new coming competitors who had a better offer on price and service because the national policy remained to support the development of e-governance (political factor). Thus, the government departments might have a review and comparison among the service providers and seek for better service (socio-cultural factor). Alongside the progress of digitalisation in China, both enterprises and government organisations need to improve work efficiency and reduce human capital costs based on information technology (technological factor). In this situation, LT had quickly developed and expanded the businesses a lot (organisational factor). Also, the enterprise had great strength in organisational resources. There are almost 50% of the employees in the company had achieved the postgraduate degree. The CEO of the company had a rich experience in market development and LT had the abundantly experienced partners in the industry such as Huawei and Tencent and good word of mouth among the customers. These points are also can be regarded as the driving forces in the case (resources factor).

In consideration of the constraints, it is identified through atmosphere, structure, individual stakeholder motivation, and used resources. In the atmosphere aspect, LT had the bureaucratic culture somewhere in the organisation. As CEO wanted to provide training sessions that related to the management ability and leadership of the unit managers during the expansion stage of the company. However, these unit managers tended to allocate tasks to the employees rather than attempted to finish as the supervisors. From the structure aspect, the company remained to use the U-form organisational structure which was regarded

as a strong centralised structure. There was no doubt that this structure supported a lot in the early stage of enterprise development, but it began to affect the speed to respond the market and cause the problem of inflexible organisation with the rapid expansion of business scale (Qian et al., 2006).

The change implementation in LT enterprise also affected the individual stakeholder motivation. The staff union, however, was caring more about employee development than the project and focusing on the potential negative influence of the change implementation on them. The project also affects the employees who had worked in the current working condition for years and had difficulties to accept the change. Finally, in the use of resources aspect, LT had limited budget for the change project. In addition, Lewin's Force field analysis is a useful management method proposed by (Bozak, 2003). Force field is a physical concept that anything in a stable condition is in a field of force where the acting-forces and the counterforces are balanced. Hence, it is necessary to change the state of equilibrium to move ahead by increasing impetus or reducing resistance if the organisational change will take place (ibid.). Swanson & Creed (2014) state that the implementation of change may fail due to the driving forces is much weaker than the constraining forces, which indicates that it is essential to map out the existing drivers and constraints before the change has been processed. After identified the drivers and constraints of the change implementation, it is necessary to use force field analysis to represent how these forces against each other and the stronger force will come with the longer arrow (See Table 1).

Table 1: Perceived Drivers and Constraints of Change Project in LT Enterprise

Drivers	Constraints
Policy support →	Bureaucratic culture ←
Economic downturn →	Strong centralised structure ←
local government seeks for the better service provider →	Staff union cares the negative influence of change on employees ←
Rapid development of information technology and E-governance →	Some employees who worked for years would resist to change ←
Business expansion →	Limited budget for the project ←
Higher educated and skilled employees →	Limited time for implementation ←
CEO is experienced in market development →	
Abundant partners in the industry →	

2.3 Cost and Benefit Analysis

The cost benefit analysis is a systematic approach to assess the project value through comparing the total cost and benefits associated with the project (Jones et al., 2014). It is involved in the decision-making process of the organisation to achieve the most benefit with the least cost (French et al., 2005). One of the benefits that focused by the LT in the "Client-Centred Project" is to retain the current customers especially the local government departments. However, it is encountered the issues of the high cost of implementing the project. Also, the local government may plan to save the cost of developing e-government system to choose the other similar service provider but with a better price. The second benefit is to improve the performance of the turnover as is stated that the company has expanded the business scale and wanted to achieve further development. The third benefit is to have an updated organisational structure for LT to timely perceive and react to the change in the market. However, this may cause the loss of some employees because there should be some positions and units in the company are going to be adjusted or even merged during the process of implementing change initiative. Also, the cause of losing

employees can be the new norms and values created by the new structure does not meet their expectation. The last benefit is to have more skills employees are empowered to be involved in the decision-making process as well as make contributions to solve problems.

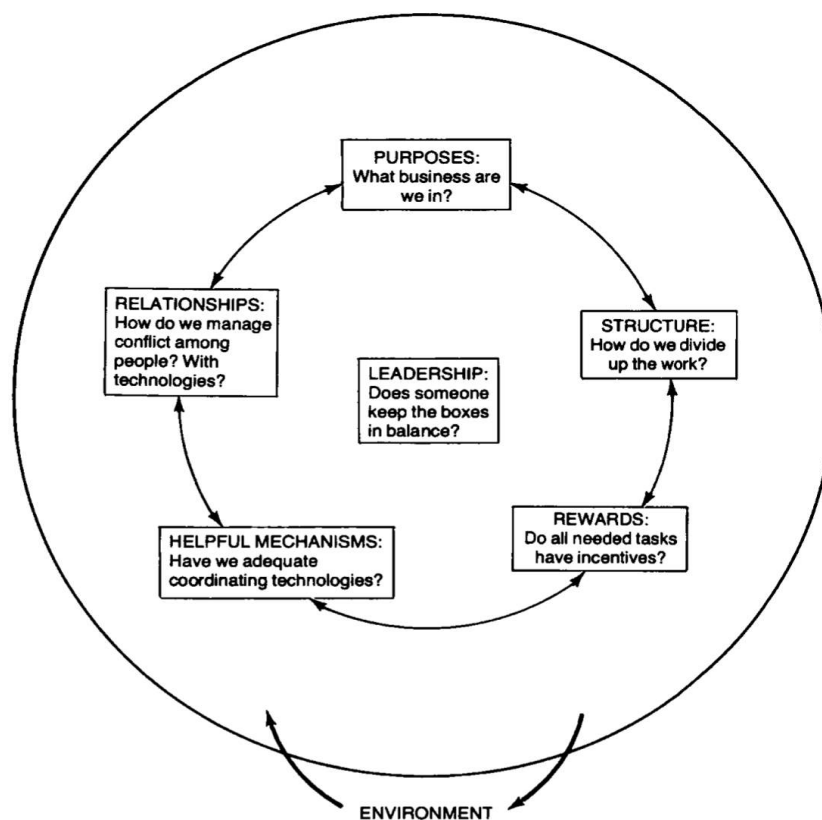
3. Assessment of Change Project in LT based on Six Box Model

3.1 Six Box Model as Organisational Diagnose Model

Organisations are systematically interacted with unpredictable environment which promotes them to execute the rapid change to stay competitive (Armenakis & Harris, 2009; Errida & Lotfi, 2021). Thus, this means that the organisations need to introduce organisational diagnosis as a strategy which can assess the current situation of the organisations from different dimensions for planning and implementing the change initiative (Kume & Leskaj, 2015). The effective diagnosis can provide guidance for the organisations of the right way to decide the appropriate change interventions (Rahimi et al., 2011).

Several models have been suggested in the previous literature as a framework to direct organisational diagnosis (Armenakis & Harris, 2009; Kontić, 2012). For this paper, the Weisbord's six-box model is considered to assess the change implementation of LT enterprise. This model is a general framework can be applied to identify the operational functions of the organisations, which has been widely used in different sorts of organisations, based on the techniques and assumptions in organisational development (Kontić, 2012; Saleem & Ghani, 2017; Ahn & Kwon, 2018). This framework represents the specific method of having a review on the structure and its design of the organisations. It further lays emphasis on the aspects of incentive and rewards system, planning and development, corporate competitions, hierarchy, and empowerment (Rahimi et al., 2011).

Figure 1: Six Box Organisational Diagnosis Model



As is shown in Figure 2, the model categories the organisational activities into six dimensions including purpose, structure, relationship, reward, leadership and helpful mechanism (Saleem & Ghani, 2017). The purpose dimension is focusing on organisational mission and the values created by the organisation, which is regarded as the important part at the beginning of organisational diagnosis (Ahn & Kwon, 2018). The structure dimension is reviewing the current organisational structure whether it is effective for supporting the organisational goals. The relationship dimension is paying attention to the collaboration and interaction among the internal units in the organisation. The rewards category concerns motivation and incentive methods whether it is leading the positive effect on the performance of the employees. The leadership dimension is

putting attentions to the contributions of leaders and top management team in the organisations. It is regarded as a key part in balancing other dimensions in the centre of the model, because the efforts put by leaders are determining the direction for the organisation to grow and largely develop (Kontić, 2012). The helpful mechanism evaluates the supporting system such as budgeting and risk control involved in running the organisation (Saleem & Ghani, 2013).

3.2 Assessment of Change Project in LT

The change project in LT is assessed through several dimensions that aligned with the Weisbord's six box model of organisational change. Regarding the purpose dimension, LT enterprise transformed from a simple technical service provider to become the expert of improving working efficiency around their clients as well as to provide the high-end solutions for technical issues. LT hoped that the employees and technician could be inspired by the great mission. Nevertheless, the actual status was the organisation be questioned to recognise who would be improving work efficiency. This feeling was coming out from the complaint of the employees that the company had not yet put the updating office equipment and environment on schedule. Also, to provide high-end technical solutions means extra challenging tasks had been added to technical employees sometimes even took many their personal time to finish the tasks, which reduce the working passion.

In the structure dimension, LT enterprise planned to design a flexible organisational structure to activate the dynamic capability for further development as well as timely reaction to the change in the market. However, the traditional centralised one was still operating among the leaders and managers in the enterprise. As a result, the running of dual structure sometimes caused the chaos in the daily works especially for the managers in the middle management level of the enterprise. They were asked to directly face the market and the customers to create customer-orientated value follow by flexible structure while in the enterprise they should follow the traditional pyramid structure when reporting to the leaders and top management team.

This could be linked to the relationship dimension that the enterprise expected to form a special project team for implementing the change initiative from the departments of marketing, administrative and project as was stated before. Nevertheless, this was the first time for the company attempted to deploy the employees to form these units which lack communication among them except the required connection on business. This cause that the team members from different units need time to adapt the working pace with each other, which increased the work pressure to them in an invisible way.

In the reward dimension, the project did not include the clear statement of the rewards for the employees, but it could be regarded as the training and development of them because LT wanted to get the employees involved in the corporate affairs to undertake more responsibilities and be able to deal with more complex tasks after streamlined the organisational structure. However, it seemed not enough for the employees especially the marketing staff and project technicians because they were working at the frontline and direct contact with the market and the customers. As was stated before, they required some specific incentive rewards for the transitional period of implementing the change initiative because they were being allocated more tasks.

In the leadership dimension, shareholders of LT approved the implementation after the CEO tried his best to persuade as well as put many efforts to support the project at the beginning stage, which gave a great hand to move the change initiative ahead. Nevertheless, there was a different voice on board as the project progresses. Some directors had gradually stopped supporting the project due to the consideration of the LT was still in the growing stage with the relevant small scale. Also, the lack of business investment opportunities might miss because of the high cost and limited time of the change initiative.

In the aspect of the helpful mechanisms, LT enterprise firstly redesigned the methods of assessing staff performance as well as modified the entry requirement for the application of some relevant positions associated with the change project. Then the second one was to build a learning culture to enhance the integration of individual learning and organisational ones. In addition, the enterprise provided the training session at the organisational level to make sure that every manager and employee could understand the purpose of project implementation and change initiative. However, this was suggested by some employees that it might combine with both online and offline form as a hybrid approach due to the increased workload.

4. Evaluation of Challenges and Strategies

4.1 Challenges

According to the assessment of change project in LT based on the six box model of organisational diagnose, it could be

observed that the enterprise confronted several challenges in the process of promoting their change initiative. The biggest challenge was the top management team expected to solve issues in a relatively short period of time through one change project only. As a result, LT put large efforts to redesign the organisational structure. However, this blurred the big picture and original thought of the change initiative that the customers-oriented strategy as the core of the project, which was a sort of unreality. As is stated by Tsoukas & Chia (2002) that the organisational change is continuous and planned process with clear objectives. If the purpose cannot be explicitly stated, the change may have resulted in failure.

The second main challenge was that some shareholders and directors on the board began to stop supporting the implementation of the change project. They hoped to cut cost on the change of organisational structure while worried about the continuous input to the project might have an influence on losing other investments opportunities. This caused them to put less attention and efforts on the project and gradually lose the position in the mind of the top management team. Although their supports made positive outcomes, the uncertainty remained in the afterwards change implementation.

Another main challenge was that the resistance of the employees. As was stated before, the change brought the increased work pressure to the employees especially for those were working in the marketing and project units. Some employees complained that they were asked to work hard to provide better service for the clients, but the enterprise did less to improve the work environment. Nevertheless, the employees were regarded as one of the potential participants in the original thought of the project. They felt while not being treated as the main recipients. In addition, there was not clear to mention the reward and allowance for the change implementation, which caused the voice as the change project means more work.

4.2 Strategies

Organisational change is a long-term process which cannot be done overnight (Burnes & Jackson, 2011; Shaw, 2017). A rush for a fast result may cause the organisation and the employees are unable to adapt to the new environment. Thus, for this case, there are some effective strategies that LT could concern to develop and implement the project and change initiative in a better approach. First, the top management team of LT should strengthen informal communication with the employees. Resistance and anxiety will be reduced if the employees have a clearer view on the big picture of the change initiative and the deeper understanding on the future development of the enterprise based on the appropriate communication mechanism (Klarner et al., 2011). This leads them using the new vision to cope with the challenges and recognise individual potential of self-development through online and offline training sessions in a hybrid approach that associated with the goal of change project. Second, it is important for the LT to declare attitude of implementing change by improving reward system. To raise more powers and arouse attention among the employees, the enterprise provides rewards for those who will be supporting the change. Reward can involve the material incentives from the financial aspect or recognition in the process of promotion as the non-financial aspect. Third, LT needs to have a review on the change of structure associated with the change project, as running the dual approach causes issue in the daily operation. A flexible organisational structure can eliminate the obstacles and enable every section to be coordinated with each other to create the values for the entire organisation (Král and Králová, 2016).

5. Conclusion

Organisational change is regarded as a long-term process that hardly be achieved instantly (Errida & Lotfi, 2021). Rushing the process results in a failure to adapt for both employees and the organisation, especially for SMEs with limited resources, it is not sustainable to put forward all aspects of involvements into the change project. The evidence from the case study of LT as a high-tech enterprise in China based on six box model suggests that the success of organisational change project is built through the contributions of both strategic organisational and certain human resource practices. The most important point is the balance of the interests among different stakeholders during the process of change to reduce the resistance of change. Moreover, flexible structure transformation is needed when the organisation in the stage of business expansion to stimulate the vitality of employees and mobilise their potentials in the change project. Finally, place people ahead as the critical concern in the organisational change project through personalised human resource practices like hybrid training options and reward management. This provides the employees a clearer picture of the change direction and gain a sense of achievement.

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Conflict of Interests

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Reference

- [1] Ackermann, F., & Eden, C. (2011). Strategic management of stakeholders: Theory and practice. *Long range planning*, 44(3), 179-196.
- [2] Ahn, H. Y., & Kwon, S. B. (2018). Effect of Organizational Diagnosis, Job Satisfaction and Organizational Commitment of a Single-grade Korean Medicine Hospital Using Six-Box Model. *The Korean Journal of Health Service Management*, 12(1), 35-46.
- [3] Armenakis, A. A., & Harris, S. G. (2009). Reflections: Our journey in organizational change research and practice. *Journal of change management*, 9(2), 127-142.
- [4] Bozak, M. G. (2003). Using Lewin's force field analysis in implementing a nursing information system. *CIN: Computers, Informatics, Nursing*, 21(2), 80-85.
- [5] Burnes, B., & Jackson, P. (2011). Success and failure in organizational change: An exploration of the role of values. *Journal of Change Management*, 11(2), 133-162.
- [6] Errida, A., & Lotfi, B. (2021). The determinants of organizational change management success: Literature review and case study. *International Journal of Engineering Business Management*, 13, 1-15.
- [7] Frambach, R. T., Fiss, P. C., & Ingenbleek, P. T. (2016). How important is customer orientation for firm performance? A fuzzy set analysis of orientations, strategies, and environments. *Journal of Business Research*, 69(4), 1428-1436.
- [8] French, S., Bedford, T., & Atherton, E. (2005). Supporting ALARP decision making by cost benefit analysis and multiattribute utility theory. *Journal of Risk Research*, 8(3), 207-223.
- [9] Guenzi, P., De Luca, L. M., & Troilo, G. (2011). Organizational drivers of salespeople's customer orientation and selling orientation. *Journal of Personal Selling & Sales Management*, 31(3), 269-285.
- [10] Homburg, C., Müller, M., & Klarmann, M. (2011). When does salespeople's customer orientation lead to customer loyalty? The differential effects of relational and functional customer orientation. *Journal of the Academy of Marketing Science*, 39(6), 795-812.
- [11] Jacobs, G., Van Witteloostuijn, A., & Christe-Zeyse, J. (2013). A theoretical framework of organizational change. *Journal of Organizational Change Management*. 17(4), 136-141.
- [12] Jones, H., Moura, F., & Domingos, T. (2014). Transport infrastructure project evaluation using cost-benefit analysis. *Procedia-Social and Behavioral Sciences*, 111, 400-409.
- [13] Kim, W. (2009). Customers' responses to customer orientation of service employees in full-service restaurants: A relational benefits perspective. *Journal of Quality Assurance in Hospitality & Tourism*, 10(3), pp.153-174.
- [14] Klarner, P., By, R. T., & Diefenbach, T. (2011). Employee emotions during organizational change—Towards a new research agenda. *Scandinavian Journal of Management*, 27(3), pp.332-340.
- [15] Kontić, L. (2012). Applying the Weisbord model as a diagnostic framework for organizational analysis. *Industrija*, 40(2), 145-156.
- [16] Král, P., & Králová, V. (2016). Approaches to changing organizational structure: The effect of drivers and communication. *Journal of Business Research*, 69(11), 5169-5174.
- [17] Kume, V., & Leskaj, E. (2015). Beyond organizational diagnosis, comparisons between Albania and Kosovo case of tax directorate. *Administratie si Management Public*, (24), 26.
- [18] Peltokorpi, A., Alho, A., Kujala, J., Aitamurto, J., & Parvinen, P. (2008). Stakeholder approach for evaluating organizational change projects. *International journal of health care quality assurance*, 21(5), 418-434.
- [19] Qian, Y., Roland, G., & Xu, C. (2006). Coordination and experimentation in M-form and U-form organizations. *Journal*

of Political Economy, 114(2), 366-402.

- [20] Rahimi, H., Siadat, A., Hoveida, R., Shahin, A., & Bakhtyar Nasrabadi, H. A. (2011). The analysis of organizational diagnosis based on Six Box model and its relationship with organizational health and quality of work environment in Isfahan public universities. *Quarterly Journal of Research and Planning in Higher Education*, 16(4), 19-39.
- [21] Saleem, A., & Ghani, U. (2013). Application of Weisbord's Organizational Diagnosis Model: A Case of Pakistan Banking Industry. *Business & Economic Review*, 5(1), 1-11.
- [22] Shaw, D. (2017). Managing people and learning in organisational change projects. *Journal of Organizational Change Management*, 30(6), 923-935.
- [23] Swanson, D. J., & Creed, A. S. (2014). Sharpening the focus of force field analysis. *Journal of change management*, 14(1), 28-47.
- [24] Tsoukas, H., & Chia, R. (2002). On Organizational becoming: Rethinking organizational change. *Organization science*, 13(5), 567-582.
- [25] Weisbord, M. R. (1976). Organizational diagnosis: Six places to look for trouble with or without a theory. *Group & Organization Studies*, 1(4), 430-447.
- [26] Zheng, D., Chen, J., Huang, L., & Zhang, C. (2013). E-government adoption in public administration organizations: integrating institutional theory perspective and resource-based view. *European Journal of Information Systems*, 22(2), 221-234.

Fintech and the NPL Provisioning Coverage Ratio:Facilitating or Inhibiting

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Abstract: Fintech has become a crucial driver of technological and business model innovation in modern commercial banking. With its widespread adoption, the impact of fintech on banks' risk management, particularly on the non-performing loan (NPL) provision coverage ratio, has garnered significant attention in both academic and industry circles. Using microdata from 42 listed commercial banks in China's A-share market between 2007 and 2022, this study constructs a theoretical and econometric model to examine this relationship. The findings reveal three key insights: first, fintech significantly suppresses the NPL provision coverage ratio. Second, fintech indirectly promotes risk-taking in China's banking sector by affecting leverage. Third, weighted net risky assets have a negative moderating effect on the relationship between fintech and the NPL provision coverage ratio. These findings offer valuable implications for commercial banks in strategically deploying fintech to prevent and mitigate NPL risks, improve operational performance, and achieve sustainable high-quality growth.

Keywords: Fintech; Non-performing Loan Provision Coverage Ratio; Leverage Ratio; Weighted Net Risk Assets

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1.Introduction

There is growing recognition that the volume or percentage of non-performing loans (NPLs) is closely linked to bank failures and a country's financial health. Particularly after the financial crisis, the rapid rise in subprime mortgage defaults has drawn increasing attention to the issue of NPLs. NPLs refer to loans where the borrower fails to repay the principal or interest as scheduled. These loans are the source of various risks in the financial system, including market, liquidity, and counterparty risks (Benoit et al., 2017), and serve as key indicators of systemic risk accumulation (Ozili, 2020). To address this challenge, banks typically set aside provisions for NPLs, and the higher the NPL coverage ratio, the more effectively they can mitigate the negative impact of credit losses on capital (Lucia et al., 2021). The NPL coverage ratio, an essential metric for assessing a bank's risk resilience and asset quality, helps cover expected losses, reducing the need to rely on bank capital as a buffer for unexpected losses (Laeven & Majnoni, 2003).

With the rapid advancement of information technology, fintech has emerged swiftly on a global scale, ushering China's financial market into a new era driven by digital technologies. Traditional financial institutions are enhancing profitability through digital transformation and fintech in the face of intense competition (Ozili, 2018). Fintech leverages advanced technologies such as big data, artificial intelligence, and blockchain to improve the efficiency and quality of financial

services (Li, 2020; Wu et al., 2023), risk management (Wu et al., 2023; Cheng & Qu, 2020; Colombage, 2023), customer service (Bhasin & Rajesh, 2021), operational efficiency (Bhasin & Rajesh, 2021), and the handling of non-performing loans (Yang et al., 2023). Lucia et al. (2021) studied the determinants of NPL provision coverage ratios in Europe, but research linking fintech and NPL coverage ratios remains limited. The lack of comprehensive studies on the impact of fintech on NPL provision coverage constrains our understanding of fintech's role in managing NPLs and hampers decision-making by policymakers and financial institutions.

Leverage, a key indicator of a bank's capital structure (DeAngelo & Stulz, 2015), measures the ratio of debt to capital. Higher leverage often indicates greater risk-taking, increasing the demands on NPL management and provisioning. Lagged leverage is a significant determinant of NPLs (Ghosh, 2005). Fintech, by enhancing risk management capabilities, may help optimize leverage levels, thereby indirectly affecting the NPL provision coverage ratio. Additionally, weighted net risky assets, which assess the scale and quality of a bank's risk-weighted assets, reflect the overall risk level. Fintech applications, particularly in risk assessment and management, can improve asset quality and accuracy, influencing the calculation of risk-weighted assets—a key factor impacting NPLs (Kartal et al., 2020). However, the mechanisms through which leverage and weighted net risky assets mediate the relationship between fintech and the NPL provision coverage ratio remain underexplored. Thus, further investigation is needed to understand how fintech affects NPL provisioning through leverage and weighted net risky assets.

In summary, stabilizing non-performing loan (NPL) risks is crucial for ensuring national financial security and stability, which in turn supports the high-quality development of China's economy. Based on this, the study constructs an analytical model to examine the relationships between fintech, the NPL provision coverage ratio, leverage, and weighted net risky assets. The aim is to explore how fintech suppresses the NPL provision coverage ratio to improve commercial bank performance.

This research makes two key contributions: First, it investigates the theoretical mechanisms by which fintech reduces the NPL provision coverage ratio in commercial banks, offering new insights into fintech's impact on bank capital structure and risk asset management. This deepens the understanding of fintech applications in banking. Second, the findings provide a fresh perspective on NPL risk prevention and management in China: they offer theoretical tools for banks to manage NPL risks, provide fintech companies with insights for applying innovative services and products, and offer policy recommendations for regulators to consider fintech's dual impact on bank risk management. This will help promote the healthy development of fintech in banking and ensure financial system stability and security.

2.Theoretical Background and Hypotheses Development

2.1 Literature Review

2.1.1 Information Asymmetry Theory

Information asymmetry arises when parties involved in a transaction possess different levels of information due to varying access and understanding (Marcel et al., 2010). The rise of fintech offers new tools to mitigate information asymmetry by collecting behavioral data and insights from borrowers across multiple dimensions, while AI algorithms can identify hidden risk factors from vast datasets (Chen et al., 2021). In the context of the NPL provision coverage ratio, fintech can effectively reduce NPL rates, thereby lowering the need for high loan loss provisions (Li et al., 2021). However, its impact on the NPL coverage ratio is not solely positive. Over-reliance on technology can introduce new challenges, including information asymmetry and moral hazard (Chen et al., 2022). Borrowers may use technology to falsify information or manipulate data, misleading banks' risk assessment systems (Tatineni & Mustyala, 2024). This could lead banks to relax lending standards and pursue rapid expansion, increasing the proportion of NPLs. In response to the difficulty in accurately assessing borrower credit risk, banks may need to maintain higher loan loss provisions to guard against potential losses (Anastasiou, 2023).

2.1.2 Financial Accelerator Theory

The Financial Accelerator Theory describes the interaction between financial markets and the real economy, highlighting how financial market fluctuations can amplify economic impacts through leverage (Bernanke et al., 2019). In recent years, the rapid development of fintech has enhanced transparency, optimized risk management tools, and expanded financing channels, allowing banks to better identify and manage risks. This enables banks to confidently increase leverage at the same

risk level, pursuing higher returns (Yu, 2024). The application of blockchain technology further ensures data authenticity and immutability, strengthening banks' control over risk (Zhu & Zhou, 2018). However, higher leverage also increases banks' sensitivity to market fluctuations and credit defaults, raising overall risk exposure (Kim et al., 2017; Berg, 2020). This aligns with the core tenet of the Financial Accelerator Theory: changes in financial conditions amplify economic fluctuations through leverage effects (Ricchetti et al., 2013). During periods of economic expansion, banks, with improved risk assessment capabilities and higher leverage, can rapidly expand credit, driving economic growth (Chen et al., 2022).

2.2 Hypotheses development

2.2.1 Fintech and the Non-Performing Loan Provision Coverage Ratio

With the rise of fintech, commercial banks, in an effort to remain competitive and gain market share, may intentionally or unintentionally relax credit standards (Li & Zhu, 2021). This relaxation can manifest as reduced stringency in borrower credit qualifications or looser loan conditions. When credit standards are eased, high-risk borrowers who might not have qualified for loans, or would have received smaller amounts, are more likely to obtain financing, significantly increasing the risk of non-performing loans (Vithessonthi, 2016). The rise in NPLs inevitably affects the NPL provision coverage ratio, as banks must allocate more provisions for potential losses, thereby reducing the coverage ratio (Alessi et al., 2021). Additionally, fintech introduces new business models, such as internet lending and digital finance, which come with unique risk transmission channels (Xu et al., 2023). In response to these new dynamics, banks may face delays or inadequacies in risk identification and management, making it difficult to accurately assess and mitigate these risks, further lowering the NPL provision coverage ratio. Based on this analysis, this paper proposes Hypothesis 1:

H1: Fintech has a significant negative impact on NPL provision coverage ratio.

2.2.2 Fintech, NPL Provision Coverage Ratio, Leverage Ratio

The development of fintech has brought significant transformations to banking. Advanced technologies enable banks to more accurately assess borrower credit risk by analyzing vast amounts of data and employing intelligent models to identify potential risk points (Cheng & Qu, 2020). Fintech also optimizes risk pricing models, ensuring that loan rates appropriately reflect risk levels, which helps banks reduce risk while maintaining profitability (Tan et al., 2024). Additionally, fintech greatly enhances credit approval efficiency, allowing banks to process transactions more effectively and attract high-quality clients (Sun & Zhang, 2023). These improvements collectively reduce the risks and asset quality issues banks face, leading to a decrease in non-performing assets and reducing reliance on external funding (Muganyi et al., 2022). As banks' reliance on external funds decreases, their capital ratios increase, optimizing leverage levels (Barth & Miller, 2018). Higher leverage allows banks to hold more capital to manage various risks, strengthening their ability to withstand risk and reduce non-performing loan rates. Consequently, the need for provisions against non-performing loans decreases, increasing the NPL provision coverage ratio and enhancing the overall systemic risk management in the banking sector (Yin et al., 2022). Based on this analysis, this paper proposes Hypothesis 2:

H2 : Leverage serves as a positive mediator between fintech and the non-performing loan provision coverage ratio.

2.2.3 Fintech, Non-Performing Loan Provision Coverage Ratio, and Weighted Net Risky Assets

The application of fintech has significantly improved banks' risk management capabilities. Advanced technologies like big data analytics and artificial intelligence enable banks to identify and address potential risks more efficiently and accurately (Li et al., 2021). This enhancement reduces the likelihood of non-performing loans (NPLs), leading to a decrease in the NPL rate (Wang et al., 2023). The NPL provision coverage ratio is a key indicator of a bank's ability to manage NPL risks; as the NPL rate decreases, the need for provisions also diminishes (Curcio et al., 2023). However, weighted net risky assets (RWA) reflect the risk level associated with a bank's assets. Higher RWA indicates a greater proportion of high-risk assets, necessitating larger capital buffers and provisions to cover potential losses (Baskaya et al., 2023). Despite fintech's ability to enhance risk management and asset quality, high RWA requires banks to maintain higher provision coverage to address potential high risks (Masera, 2019). Thus, high RWA may weaken the positive effect of fintech on reducing the need for NPL provisions. Therefore, RWA acts as a negative moderator between fintech and the NPL provision coverage ratio: the higher the RWA, the weaker the positive impact of fintech on reducing the NPL provision coverage ratio (Zhou & Sun, 2023). Based on this

analysis, this paper proposes Hypothesis 3:

H3 : Weighted net risky assets moderate the relationship between fintech and the non-performing loan provision coverage ratio. The higher the weighted net risky assets, the weaker the impact of fintech on the NPL provision coverage ratio.

3.Data and methodology

3.1 Research Sample and Data Sources

Based on the availability of data, 42 commercial banks are selected as the sample for the study. The sample interval of the study is 2007-2022. 473 data were obtained for analysis after removing missing values. Among them, there are 6 state-owned commercial banks, 9 national joint-stock banks and 27 local commercial banks.

3.2 Variable selection

3.2.1 Explained variable: non-performing loan provision coverage ratio (NPL)

This paper uses the NPL provision coverage ratio NPL as an explanatory variable to measure risk taking in the Chinese banking sector. It is calculated using the formula $(\text{total provisions}/\text{total NPLs}) \times 100\%$. Typically, a higher NPL provision coverage ratio implies that a bank has sufficient capital reserves to cover possible NPL losses, thus reducing the risk faced by the bank.

3.2.2 Explanatory variable: financial technology (FI)

Using text mining methods, the process involves the following steps: First, establish an initial vocabulary based on existing literature, categorizing fintech into five key dimensions to determine the vocabulary. Next, use word cloud analysis software to calculate keyword frequencies, quantifying the total occurrences over the annual intervals, which serve as the foundation for constructing the index. Finally, perform principal component analysis and factor analysis, integrating the total occurrences of the keywords to synthesize the Fintech Development Index (FT).

The Fintech Development Index (FT) is synthesized using text mining methods. First, an initial vocabulary is established by categorizing fintech into five dimensions based on existing literature. Next, word cloud analysis software is used to compute keyword frequencies and quantify their total occurrences over annual intervals, which serves as the basis for constructing the index. Finally, principal component analysis and factor analysis are conducted, integrating the total occurrences of the keywords to compile the Fintech Development Index (FT). The keywords are as follows:

Table 1: Keywords

Dimension	Settle a Payment	Risk Management	Information Transmission	Resource Allocation	Technological Base
keywords	Mobile Payment	Cryptography	Electronic Banking	P2P	Big data
	Network Payment	Risk Identification	Information System	Online Lending	Cloud
	Third Party Payments	Risk Assessment	Online Banking	Credit Business	AI

3.2.3. Mediator Variable: Leverage (LEV)

Leverage refers to the ratio of total assets to equity capital on a balance sheet. It is primarily used to measure the level of debt and financial risk of an entity. A higher leverage ratio indicates that the entity is using less of its own capital to control a larger volume of assets, which can potentially lead to higher returns but also involves greater risks. For instance, during adverse economic conditions or asset price fluctuations, the entity may face significant repayment pressure and default risk. In the financial sector, leverage is a critical regulatory metric. For banks and other financial institutions, maintaining an appropriate level of leverage is crucial for ensuring financial stability and safety. Excessive leverage can lead to systemic financial risks.

3.2.4. Mediator Variable: Risk-Weighted Assets (RWA)

Weighted net risky assets represent the net amount of risk-weighted assets after deducting impairment provisions. This measure calculates the total risk-weighted assets of a bank or financial institution based on assigned risk weights for various asset types. It is a key indicator of a bank's risk-bearing capacity and capital adequacy, reflecting the level of risk the bank faces in its operations and the amount of capital required to manage these risks. Regulators typically monitor the weighted

net risky assets of banks, requiring them to maintain adequate capital ratios to ensure sound operations and financial system stability.

3.2.5. Control Variables

The control variables include GDP growth rate (GDPR), equity-to-debt ratio (INV), proportion of shares held by the largest shareholder (TOP1), percentage of independent directors (INDEP), and management expenses (MAS). The mediator variable is leverage (LEV), and the moderator variable is weighted net risky assets (FXZC). The specific settings are as follows:

Table 2: Variable Attributes

Attributes	Variable		prediction method
Explained Variable	NPL	Non-performing loan provision coverage ratio	(Total provisions/total non-performing loans) x 100%
Explanatory Variable	FI	FinTech Index	Text Mining Synthesis
Control Variable	GDPR	GDP current period growth rate	GDP current period growth rate
	INV	Equity to debt ratio	Ratio of total owners' equity to total liabilities
	TOP1	Shareholding ratio of the largest shareholder	Number of shares held by the largest shareholder/total number of shares
	INDEP	Proportion of independent directors	Independent directors divided by number of directors
	MAS	overhead	Banks' total administrative expenses for the year (in billions of dollars)
Mediator Variable	LEV	leverage	Underlying share price / (warrant price ÷ subscription ratio)
Moderator Variable	FXZC	Weighted net risk assets	On-balance-sheet and off-balance-sheet assets are discounted according to different risk factors and then added together to give a total

3.3 Variable selection

Based on the above theory, the models (1), (2), and (3) are constructed as follows:

$$NPL_{it} = \alpha_0 + \alpha_1 FI_{it} + \delta_i \sum Control_{it} + \varepsilon_{it} \quad (Model\ 1)$$

$$NPL_{it} = \beta_0 + \beta_1 FI_{it} + \beta_2 RWA_{it} + \beta_3 (FI_{it} + RWA_{it}) + \beta_i \sum Control_{it} + \varepsilon_{it} \quad (Model\ 2)$$

$$RWA_{it} = \gamma_0 + \gamma_1 FI_{it} + \gamma_i \sum Control_{it} + \varepsilon_{it} \quad (Model\ 3 - 1)$$

$$NPL_{it} = \theta_0 + \theta_1 FI_{it} + \theta_2 L_{it} + \theta_i \sum Control_{it} + \varepsilon_{it} \quad (Model\ 3 - 2)$$

In the models, the dependent variable NPL_{it} represents the risk-bearing of the Chinese banking industry, and the core explanatory variable FI_{it} is the fintech index. The moderator variable RWA_{it} is the weighted net risky assets, and the mediator variable L_{it} is leverage $\sum Control_{it}$. The constants are denoted as α_0 , β_0 , γ_0 and θ_0 , with α_1 being the regression coefficient for the core explanatory variable, β_3 the regression coefficient for the moderator variable, δ_i the regression coefficients for the control variables, and ε the error term.

4. Results

4.1 Descriptive statistics

Descriptive statistics for the variables are presented in Table 3. The mean of the non-performing loan provision coverage ratio (NPL) is 269.54, with a standard deviation of 102.126, indicating significant variation in the NPL coverage ratio among the sample banks. The fintech index (FI) ranges from a minimum of 6.974 to a maximum of 11.056, suggesting a generally high

level of fintech adoption among the sample banks. The equity-to-debt ratio (INV) has a standard deviation of 0.023, with a minimum value of 0.043 and a maximum of 0.313, reflecting a relatively low level of financial leverage among the sample banks. No anomalies were detected in the statistical values of other variables, suggesting that estimation biases due to outliers can be ruled out.

Table 3: Descriptive Statistics of Variables

Attributes	Variable		N	Mean	S.E.	Min	Max
Explained Variable	NPL	Non-performing loan provision coverage ratio	456	269.542	102.126	55.843	778.120
Explanatory Variable	FI	FinTech Index	305	9.050	0.890	6.974	11.056
Control Variable	GDPR	GDP current period growth rate	462	1.664	0.309	1.200	2.400
	INV	Equity to debt ratio	425	0.078	0.023	0.043	0.313
	TOP1	Shareholding ratio of the largest shareholder	451	21.435	15.489	4.310	67.720
	INDEP	Proportion of independent directors	396	0.323	0.136	0.000	0.571
	MAS	overhead	462	296.218	508.598	4.324	2259.450
Mediator Variable	LEV	leverage	239	6.603	0.949	3.620	9.680
Moderator Variable	FXZC	Weighted net risk assets	435	8.711	1.761	5.416	12.287

4.2. Correlation Analysis

To determine the presence of correlations between variables, a correlation analysis was conducted. The results indicate a significant negative correlation between the core explanatory variable (FI) (fintech index) and the dependent variable (NPL) (non-performing loan provision coverage ratio), suggesting that regression analysis is feasible. Additionally, control variables such as the proportion of shares held by the largest shareholder, the percentage of independent directors, and management expenses also show a significant negative relationship with the NPL coverage ratio. Furthermore, most correlation coefficients between other explanatory variables are less than 0.6, suggesting that severe multicollinearity issues are unlikely.

Table 4: Correlation Analysis

Variable	NPL	FI	GDPR	INV	TOP1	INDEP	MAS
NPL	1.000						
FI	-0.270***	1.000					
GDPR	0.048	0.018	1.000				
INV	-0.062	0.010	-0.029	1.000			
TOP1	-0.221***	0.625***	0.014	-0.090*	1.000		
INDEP	-0.175***	0.100*	-0.031	0.050	0.272***	1.000	
MAS	-0.143***	0.761***	-0.020	0.021	0.682***	0.271***	1.000

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***)

4.3 Multicollinearity Test

Given that some control variables had correlation coefficients greater than 0.6 in the correlation analysis, a variance inflation factor (VIF) test was conducted to further assess multicollinearity, as shown in Table 3. The VIF values for all variables are well below 10, indicating that there are no severe multicollinearity issues and regression analysis can be performed.

Table 5: Multicollinearity Test

Variable	VIF	1/VIF
MAS	2.86	0.3500
FI	2.60	0.3848
TOP1	1.97	0.5086
Indep	1.07	0.9324
INV	1.03	0.9747
GDPR	1.01	0.9941

4.4 Regression Analysis

Based on Model (1), the relationship between the fintech index and the non-performing loan provision coverage ratio (NPL) was analyzed using regression, as shown in Table 6. Column (1) presents the regression results without control variables, while Column (2) includes control variables. In both cases, the core explanatory variable, fintech index (FI), shows a significant negative effect at the 1% level, indicating that fintech has a suppressive effect on the NPL coverage ratio.

Specifically, Column (2) shows that the regression coefficient for the fintech index (FI) is -33.846 at the 1% significance level. This result suggests that an increase in the fintech index significantly reduces the NPL coverage ratio.

In summary, fintech development has a dual impact on the risk exposure of Chinese banks. On one hand, fintech enhances risk management capabilities by leveraging technologies such as big data analysis and artificial intelligence to more accurately assess borrower credit risk. This reduces the non-performing loan rate and, consequently, the need for loan loss provisions, thus improving the provision coverage ratio. On the other hand, emerging fintech business models can introduce new risk challenges. For example, areas such as P2P lending and virtual currencies may have regulatory gaps and legal risks, potentially leading to issues like fund misappropriation and fraud, thereby increasing the risk of non-performing loans. At the current stage, the negative effects of these new risks outweigh the positive impacts of fintech, leading to the regression results showing an adverse effect of fintech on risk exposure in the Chinese banking sector.

Additionally, the analysis of control variables indicates that the equity-to-debt ratio (INV) and the proportion of independent directors (INDEP) have a significant suppressive effect on the non-performing loan provision coverage ratio (NPL). In contrast, the current GDP growth rate (GDPR), the shareholding ratio of the largest shareholder (TOP1), and management expenses (MAS) did not show a significant impact on the NPL coverage ratio in this study.

Table 6: Baseline Regression

Variable	(1)	(2)
	NPL	NPL
FI	-31.754*** (9.526)	-33.846*** (11.927)
GDPR		9.875 (12.172)
INV		-444.919** (215.186)
TOP1		0.649 (0.776)
INDEP		-161.337* (87.487)
MAS		-0.003 (0.026)
Cons	549.758*** (85.211)	632.922*** (111.750)
N	305	294
R-squared	0.073	0.078

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

4.5 Robustness Test

In order to avoid the impact of outliers on the regression results, the data are shrink-tailed at the 1% and 99% quantiles for robustness tests, and the results are shown in column (1) of Table 7. At the same time, considering that the new crown epidemic shock may cause errors on the regression results, the study excludes the data in 2020 using the exclusion of the special period sample size for the robustness test, the results are shown in Table 7 column (2). The robustness test regression results are basically consistent with the benchmark regression in terms of both the direction of impact and significance, indicating that the model is highly robust and the regression results are reliable.

Table 7 Robustness Tests

Variable	(1)	(2)
	NPL	NPL
	Shrinking	Excluding special period sample sizes
FI	-34.185*** (12.031)	-35.260*** (12.600)
GDPR	9.343 (12.158)	5.847 (26.441)
INV	-540.448** (264.987)	-474.381** (238.914)
TOP1	0.676 (0.784)	0.518 (0.802)
INDEP	-158.233* (87.471)	-178.357* (98.063)
MAS	-0.005 (0.027)	-0.000 (0.027)
Cons	642.961*** (113.783)	661.794*** (126.449)
N	294	252
R-squared	0.075	0.093

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

Variable	(1)	(2)
	TSLS-Stage1	TSLS-Stage2
		NPL
L.FI	0.702*** (0.048)	-40.227** (15.934)
GDPR	-0.007 (0.067)	11.169 (15.215)

Variable	(1)	(2)
	TSLS-Stage1	TSLS-Stage2
		NPL
INV	0.260	-114.673
	(0.906)	(207.464)
TOP1	0.004**	-1.197**
	(0.002)	(0.477)
INDEP	-0.634*	-179.884**
	(0.333)	(77.737)
MAS	0.0002***	0.034*
	(0.000)	(0.020)
Cons	2.720***	699.403***
	(0.458)	(145.572)
N	254	254
R-squared		0.172
Anderson canon. corr. LM statistic		115.394***
Cragg-Donald Wald F statistic		205.637
Stock-Yogo 10%		16.38

4.6 Endogeneity test

To address potential endogeneity affecting the regression results, we use the lagged core explanatory variable, L.FI, as an instrument and apply Two-Stage Least Squares (TSLS) to handle endogeneity. In the first stage of TSLS, the instrument generates a predicted value for the fintech index (FI)[^]. In the second stage, this predicted value is used to regress on the non-performing loan provision coverage ratio (NPL). The LM statistic rejects the null hypothesis of insufficient instrument identification, and the Wald F statistic exceeds the Stock-Yogo critical value at the 10% level, indicating that the instrument is valid. The regression coefficient for (FI)[^] is -40.227, aligning with the direction of the baseline regression but differing in magnitude and significance. This suggests that endogeneity has not significantly affected the regression results, further confirming the robustness and reliability of the model.

Table 8 Endogeneity test (IV-TSLS)

Variable	(1)	(2)
	TSLS-Stage1	TSLS-Stage2
	(FI) [^]	NPL
L.FI	0.702***	
	(0.048)	
(FI) [^]		-40.227**
		(15.934)
GDPR	-0.007	11.169
	(0.067)	(15.215)
INV	0.260	-114.673
	(0.906)	(207.464)

Variable	(1)	(2)
	TSLS-Stage1	TSLS-Stage2
	(FI) [^]	NPL
TOP1	0.004**	-1.197**
	(0.002)	(0.477)
INDEP	-0.634*	-179.884**
	(0.333)	(77.737)
MAS	0.0002***	0.034*
	(0.000)	(0.020)
Cons	2.720***	699.403***
	(0.458)	(145.572)
N	254	254
R-squared		0.172
Anderson canon. corr. LM statistic		115.394***
Cragg-Donald Wald F statistic		205.637

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

4.7 Mediating Effect

This study investigates the impact mechanism of financial technology on risk-taking in Chinese banks using leverage ratio (LEV) as a mediating variable. Table 9 employs a three-step method to explore the potential mediating effect. However, Column (2) shows no significant impact of financial technology (FI) on leverage ratio (LEV), and Column (3) shows no significant impact of leverage ratio (LEV) on non-performing loan provision coverage ratio (NPL). These non-significant results may be due to insufficient sample size. To address this, we further employ the bootstrap sampling method, conducting 300 iterations. Results are presented in Table 10. Table 10 reveals that while financial technology (FI) has a total suppressive effect on NPL, it exerts an indirect positive effect on NPL through leverage ratio (LEV). This suggests that financial technology has an indirect facilitating effect on risk-taking in Chinese banks by influencing leverage ratio.

Specifically, financial technology enables banks to more accurately assess borrower credit risk, optimize risk pricing models, and improve credit approval efficiency. These improvements reduce the risks and asset quality issues faced by banks, thereby decreasing their reliance on external funding and affecting their leverage ratios. An increased leverage ratio enhances the banking sector's ability to withstand various risks, lowers non-performing loan rates, reduces the need for provisions for bad loans, and increases the non-performing loan provision coverage ratio. Ultimately, this contributes to the enhancement of systemic risk management within the banking industry.

Table 9: Mediating Effect Analysis

Variable	(1)	(2)	(3)
	NPL	Lev	NPL
FI	-33.846***	-0.123	-34.117***
	(11.927)	(0.116)	(11.699)
GDPR	9.875	-0.141	3.309

Variable	(1)	(2)	(3)
	NPL	Lev	NPL
	(12.172)	(0.103)	(10.883)
INV	-444.919**	2.538	-37.050
	(215.186)	(2.223)	(226.422)
TOP1	0.649	-0.039***	-1.443
	(0.776)	(0.010)	(0.886)
INDEP	-161.337*	2.076**	63.012
	(87.487)	(0.881)	(89.463)
MAS	-0.003	0.002***	0.061**
	(0.026)	(0.000)	(0.029)
LEV			0.823
			(6.895)
Cons	632.922***	7.221***	543.833***
	(111.750)	(1.100)	(122.180)
N	294	217	217
R-squared	0.078	0.105	0.113

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

Table 10 Mediated effects: bootstrap (300) sampling method

	Coefficient	standard error	Z-value	95% confidence interval	
				Low	High
Indirect Effect	9.242**	4.485	2.06	0.452	18.033
Direct Effect	-55.946***	12.385	-4.52	-80.220	-31.672

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

4.8 Moderating Effect

This study uses the weighted risk assets (RWA) as a moderating variable. After centering the independent and moderating variables, an interaction term (X) is created. The regression results are presented in Table 11. Column (2) shows that the interaction term X is significant at the 1% level, indicating that RWA moderates the relationship between fintech and the non-performing loan (NPL) coverage ratio. The negative coefficient for the interaction term X suggests a negative moderating effect.

RWA is an important indicator for assessing a bank's capital adequacy and risk exposure, while the NPL coverage ratio reflects the bank's provisions for potential losses from bad loans. The negative moderating effect of RWA indicates that fintech development influences the relationship between RWA and the NPL coverage ratio. Specifically, fintech advancements improve banks' risk management efficiency and precision. Through technologies such as big data analysis and artificial intelligence, fintech enables more effective identification and management of potential risks, thereby reducing NPL rates and the need for provisions. Consequently, as fintech levels rise, RWA decreases, and the NPL coverage ratio is likely to improve.

Table 11 Moderating Effects

Variable	(1)	(2)
	NPL	NPL
FI	-28.810** (13.388)	-13.688 (13.986)
lnFXZC	-9.086 (10.969)	-26.522** (11.699)
GDPR	9.375 (12.175)	10.840 (12.177)
INV	-435.712** (215.665)	-327.206 (214.038)
TOP1	0.799 (0.796)	0.168 (0.738)
INDEP	-144.530 (89.843)	-103.259 (88.251)
MAS	0.009 (0.030)	0.087** (0.035)
X		-24.113*** (7.137)
Cons	656.552*** (115.698)	668.524*** (110.366)
N	294	294
R-squared	0.078	0.179

Standard errors are in parentheses.

Significance levels: $p < 0.1$ (*), $p < 0.05$ (**), $p < 0.01$ (***).

5. Conclusions and Discussion

This study examines the impact of financial technology (FinTech) on the non-performing loan (NPL) coverage ratio of Chinese commercial banks from 2007 to 2022. It contributes to the theoretical understanding of factors affecting NPL coverage ratios by exploring both the mediating role of leverage ratio and the moderating role of risk-weighted assets. The findings provide clear guidance for the future development of FinTech in banking and financial risk management. The key conclusions are: Fintech has a significant negative impact on the non-performing loan (NPL) provision coverage ratio, indicating that currently, fintech adversely affects risk management in China's banking sector. Fintech indirectly enhances risk management in China's banking sector by influencing leverage ratios. The weighted net risk assets have a negative moderating effect on the relationship between fintech and the NPL provision coverage ratio. These findings are crucial for regulators. Chinese commercial banks should also adopt more targeted policies. Based on these conclusions, the following policy recommendations are proposed:

First, enhance the supervision of fintech. Establish a comprehensive regulatory framework and implement specific policies targeting fintech to ensure transparency, security, and compliance in fintech operations. Additionally, employ real-time monitoring and risk assessment technologies such as big data and artificial intelligence to continuously track fintech's impact on banking operations and promptly identify and address potential risks.

Second, optimize bank leverage management. Set reasonable leverage ratio limits for banks to prevent systemic risks associated with excessive leverage. Furthermore, strengthen internal management and control of leverage ratios to ensure they remain within safe limits.

Third, increase the non-performing loan (NPL) provision coverage ratio. Require banks to increase NPL provisions in line with rising risk assets to enhance their risk resilience. Additionally, adjust NPL provisioning strategies dynamically based on market conditions and risk profiles to ensure the coverage ratio adapts to changes brought about by fintech advancements.

Fourth, promote the coordinated development of fintech and traditional banking. Encourage collaboration between fintech companies and traditional banks to jointly develop new financial products and services, thereby mitigating risks associated with competition. Additionally, support the integration of fintech within the banking sector, ensuring that it enhances operational efficiency and service quality while maintaining safety and compliance.

Bankers should place significant emphasis on the application of fintech and its impact on overall risk management when enhancing the NPL provision coverage ratio. In this context, leverage (LEV) serves as a crucial mediating variable that effectively influences the NPL coverage ratio, while the weighted net risk assets (RWA) play an important moderating role. Banks should tailor and optimize the use of fintech based on their specific business characteristics and operational models to better manage NPL risks. Additionally, banks must remain vigilant about the potential risks introduced by fintech, particularly concerning credit and liquidity risks. Joint-stock commercial banks should leverage their fintech strengths to innovate and refine their NPL provision management mechanisms. Regional banks should align their unique market positioning with fintech advancements, continuously enhancing their innovation capabilities to achieve more robust risk management and business growth.

From a Theoretical Perspective. Firstly, this study enriches the literature on fintech and the non-performing loan (NPL) provision coverage ratio by providing both theoretical and empirical evidence on how fintech impacts micro-level risks differently across banks. Secondly, the findings offer a deeper understanding of the various channels through which fintech influences the NPL provision coverage ratio, and underscore the significance of leverage and weighted risk assets.

This study is limited by its focus on commercial banks, and future research could expand the sample to include a broader range of financial institutions as regulatory and disclosure standards in China improve. Additionally, while this study provides a theoretical analysis of fintech's impact mechanisms, further empirical validation of these mechanisms is needed in future research.

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The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Acosta-Smith, J., Grill, M., & Lang, J. H. (2020). The Leverage Ratio, Risk-taking and Bank Stability. *Journal of Financial Stability*, 100833.
- [2] Alessi, L., Bruno, B., Carletti, E., Neugebauer, K., & Wolfskeil, I. (2021). Cover Your Assets: Non-performing Loans and Coverage Ratios in Europe. *Economic policy*, 36(108), 685-733.
- [3] Anastasiou, D. (2023). Management and Resolution methods of Non-performing loans: A Review of the Literature. *Crises and Uncertainty in the Economy*, 187-201.
- [4] Barth, J. R., & Miller, S. M. (2018). Benefits and Costs of a Higher Bank "leverage ratio". *Journal of Financial Stability*, 38, 37-52.

- [5] Baskaya, S., Gutierrez, J. E., Serena, J. M., & Tsoukas, S. (2023). Unloading NPLs, Unlocking Credit? Evidence from the ECB Provisioning Guidelines.
- [6] Benoit, S., Colliard, J. E., Hurlin, C., & P'érignon, C. (2017). Where the risks lie: A survey on Systemic Risk. *Review of Finance*, 21(1), 109–152.
- [7] Berg, T., & Heider, F. (2020). Leverage and Risk-taking. Working Paper, European Central Bank.
- [8] Bernanke, B. S., Gertler, M., & Gilchrist, S. (2019). The Financial Accelerator in a Quantitative Business Cycle Framework. *Handbook of Macroeconomics*, 1(2), 1341-1393.
- [9] Bhasin, N. K., & Rajesh, A. (2021). Study of Increasing Adoption Trends of Digital Banking and FinTech Products in Indian Payment Systems and Improvement in Customer Services. In *Collaborative Convergence And Virtual Teamwork For Organizational Transformation*, 229-255.
- [10] Budnik, K. B., Dimitrov, I., Groß, J., Volk, M., Lampe, M., Kusmierczyk, P., & Vagliano, G. (2022). The Economic Impact of the NPL Coverage Expectations in the Euro Area. *ECB Occasional Paper*, (2022/297).
- [11] Chen, B., Yang, X., & Ma, Z. (2022). Fintech and Financial Risks of Systemically Important Commercial Banks in China: an Inverted U-shaped Relationship. *Sustainability*, 14(10), 5912.
- [12] Chen, Y., Wu, J., & Yang, Z. (2021). FinTech and Financial Inclusion: Evidence from China. *Finance Research Letters*, 39, 101-112.
- [13] Cheng, M., & Qu, Y. (2020). Does bank FinTech Reduce Credit Risk? Evidence from China. *Pacific-Basin Finance Journal*, 63, 101398.
- [14] Colombage, S. (2023). Financial Technology (Fintech) and Sustainable Financing: A New Paradigm for Risk Management. *Journal of Risk and Financial Management*, 16(12), 502.
- [15] DeAngelo, H., & Stulz, R. M. (2015). Liquid-claim Production, Risk management, and Bank Capital Structure: Why high Leverage is Optimal for Banks. *Journal of Financial Economics*, 116(2), 219-236.
- [16] Kartal, M. T., Depren, Ö., & Depren, S. K. (2020). Determination of Influential Financial Factors on Non-performing loans: Evidence from Turkey. *International Journal of Monetary Economics and Finance*, 13(6), 569-584.
- [17] Kim, K., Patro, S., & Pereira, R. (2017). Option Incentives, Leverage, and Risk-taking. *Journal of Corporate Finance*, 43, 1-18.
- [18] Li, H., & Zhu, J. (2021). The Impact of Fintech on Bank Lending Standards: Evidence from China. *Journal of Financial Stability*, 54, 100887.
- [19] Li, S., Wang, H., & Zhao, J. (2021). AI-driven Risk Management in Banking: The Role of Big Data and Machine Learning. *Journal of Financial Stability*, 54, 100812.
- [20] Li, W. (2020). Improving the Quality and Efficiency of Finance by Fintech. *China Economic Transition*, 3(2), 8-17.
- [21] Li, X., Zhao, Y., & Zhu, H. (2021). Impact of FinTech on Bank Risk-taking: Evidence from China. *Journal of Financial Stability*, 60, 101025.
- [22] Marcel, B., Ortan, T., & Otgon, C. (2010). Information Asymmetry Theory in Corporate Governance Systems. *Economic Science Series*, 19(2), 516-522.
- [23] Muganyizi, T., Yan, L., Yin, Y., Sun, H., Gong, X., & Taghizadeh-Hesary, F. (2022). Fintech, Regtech, and Financial Development: Evidence from China. *Financial Innovation*, 8(1), 1-20.
- [24] Ozili, P. K. (2018). Impact of Digital Finance on Financial Inclusion and Stability. *Borsa Istanbul Review*, 18(4), 329-340.
- [25] Ozili, P. K. (2019). Non-performing Loans and Financial Development: New Evidence. *The Journal of Risk Finance*, 20(1), 59-81.
- [26] Ozili, P. K. (2020). Non-performing Loans in European Systemic and Non-systemic Banks. *Journal of Financial Economic Policy*, 12(3), 409–424. [
- [27] Riccetti, L., Russo, A., & Gallegati, M. (2013). Leveraged Network-based Financial Accelerator. *Journal of Economic Dynamics and Control*, 37(8), 1626-1640.

- [28] Simatupang, A., & Puspitasari, V. A. (2024). The Influence of Capital Adequacy Ratio, Third-Party Funds, Operating Cost to Operating Income Ratio, Loan-to-Deposit Ratio, Non-Performing Loans, and Fintech Adoption on Bank Performance. *International Journal of Economics, Business and Innovation Research*, 3(01), 225-243.
- [29] Sun, R., & Zhang, B. (2023). Can Fintech Make Corporate Investments More Efficient? A Study on Financing Constraints and Agency Conflicts. *Economic research-Ekonomska Istraživanja*, 36(3).
- [30] Tan, C., Mo, L., Wu, X., & Zhou, P. (2024). Fintech Development and Corporate Credit Risk: Evidence from an Emerging Market. *International Review of Financial Analysis*, 92, 103084.
- [31] Tatineni, S., & Mustyala, A. (2024). Enhancing Financial Security: Data Science's Role in Risk Management and Fraud Detection. *ESP International Journal of Advancements in Computational Technology*, 2(2), 94-105.
- [32] Vithessonthi, C. (2016). Deflation, Bank Credit Growth, and Non-performing Loans: Evidence from Japan. *International Review of Financial Analysis*, 45, 295-305.
- [33] Vives, X. (2017). The Impact of FinTech on Banking. *European Economy*, (2), 97-105.
- [34] Wang, H., Mao, K., Wu, W., & Luo, H. (2023). Fintech Inputs, Non-performing Loans Risk Reduction and Bank Performance Improvement. *International Review of Financial Analysis*, 90, 102849.
- [35] Wu, X., Jin, T., Yang, K., & Qi, H. (2023). The Impact of Bank FinTech on Commercial Banks' Risk-taking in China. *International Review of Financial Analysis*, 90, 102944.
- [36] Wu, Y. H., Bai, L., & Chen, X. (2023). How does the Development of Fintech Affect Financial Efficiency? Evidence from China. *Economic Research-Ekonomska istraživanja*, 36(2).
- [37] Xu, J., Chen, F., Zhang, W., Liu, Y., & Li, T. (2023). Analysis of the Carbon Emission Reduction Effect of Fintech and the Transmission Channel of Green Finance. *Finance Research Letters*, 56, 104127.
- [38] Yang, Y., Zhang, X., & Feng, B. (2023). The Impact of Developing Fintech on Banks: From the Perspective of Net Interest Margin and Non-performing Ratio. *Frontiers in Business, Economics and Management*, 8(1), 266-271.
- [39] Yin, F., Jiao, X., Zhou, J., Yin, X., Ibeke, E., Iwendi, M. G., & Biamba, C. (2022). Fintech Application on Banking Stability using Big Data of an Emerging Economy. *Journal of Cloud Computing*, 11(1), 43.
- [40] Yu, J. (2024). Stabilizing Leverage, Financial Technology Innovation, and Commercial Bank Risks: Evidence from China. *Economic Modelling*, 131, 106599.

Operational Mechanisms and Collaborative Optimization Paths of Industry-Education Integration Service Organizations in the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract: In the context of high-quality development in the Guangdong-Hong Kong-Macao Greater Bay Area, industry-education integration service organizations serve as institutional hubs connecting the educational system with the industrial sector. These organizations play an increasingly critical role in optimizing regional education structures and facilitating the transformation of technological achievements. Drawing on multi-actor collaborative governance theory, this study constructs a four-dimensional analytical framework—platform functionality, collaborative mechanism, resource integration, and institutional embedding—and employs empirical testing using structural equation modeling (SEM) based on survey data to systematically examine the operational logic and performance mechanisms of service organizations. The findings reveal persistent challenges including goal divergence, communication inefficiencies, resource fragmentation, and institutional lag. Among the four factors, the collaborative mechanism has a significant positive impact on organizational performance, and government support, school-enterprise cooperation, and resource integration efficiency are identified as key pathways. Accordingly, this paper offers policy recommendations focused on institutional alignment, enterprise incentives, platform governance, and performance evaluation, aiming to provide both theoretical foundations and practical solutions for advancing regional education-industry integration.

Keywords: Industry-Education Integration; Service Organizations; Collaborative Governance; Institutional Mechanisms

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1.Introduction

As a national strategic region, the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) serves as a key platform for piloting China's modernization. Its pursuit of industrial upgrading and high-quality development urgently requires robust talent support and a transformation of the educational system. Against the backdrop of national strategies such as "Building a Strong Education Nation" and "Advancing Manufacturing Power," industry-education integration has become a vital lever for promoting structural reform in education and coordinated industrial development.

In recent years, both the central government and the Guangdong provincial authorities have issued a series of policies to support deepened industry-education integration. These include the National Implementation Plan for Industry-Education

Integration Pilot Projects and the 14th Five-Year Plan for Higher Education in Guangdong Province, which explicitly advocate for the construction of “multi-actor collaborative mechanisms” and emphasize the pivotal role of service organizations in coordinating resource allocation and institutional linkages (Yu, 2024; Xu, 2025).

However, in practice, industry-education service organizations still face considerable challenges in terms of role clarity, functional effectiveness, and institutional support. Some organizations struggle with ambiguous positioning, weak execution capacity, and dysfunctional operations, making it difficult to effectively match educational supply with industrial demand. Moreover, enterprises, universities, and government bodies often lack collaborative willingness, experience communication inefficiencies, and lack co-construction and sharing mechanisms—all of which severely impact integration outcomes and governance performance (Xie, 2025). These problems are particularly acute in the GBA, where the rapid growth in the number of organizations is not matched by the development of effective collaborative mechanisms, leading to resource redundancy and structural mismatches.

Current academic research on industry-education integration tends to focus on policy evaluation, governance models, and case studies. There remains a lack of systematic theoretical exploration into the core functions, governance logic, and development pathways of service organizations. In particular, research on the operational logic of these organizations under multi-actor collaborative frameworks—especially within the context of institutional innovation in the GBA—is relatively underdeveloped.

To address this gap, this paper takes industry-education integration service organizations in the Greater Bay Area as its research object, focusing on their functional logic and optimization pathways in a multi-actor collaborative governance context. By constructing a three-dimensional analytical framework encompassing platform functionality, collaborative structure, and institutional logic—and by integrating field surveys with questionnaire data—this study systematically investigates the internal mechanisms and external conditions through which service organizations enhance coordination efficiency. The goal is to provide theoretical insights and practical guidance for modernizing the regional education system and reforming talent development models.

2. Mechanisms by Which Industry–Education Integration Service Organizations Promote Regional Educational Synergy

Amid the strategic push for education modernization and industrial transformation in the Guangdong–Hong Kong–Macao Greater Bay Area (GBA), industry–education integration service organizations are transitioning from basic resource-matching platforms to collaborative governance entities. These organizations play an increasingly central role in aligning educational supply with industrial demand through four key operational dimensions: platform functionality, multi-actor collaboration, resource integration, and institutional embedding (Liu & Zhou, 2022; Zhuang & Zhou, 2023).

2.1 Platform Functionality: Embedding Educational and Industrial Systems

Service organizations act as hubs that aggregate vocational training infrastructure, academic programs, and enterprise engagement to bridge educational institutions with industry. For instance, vocational education platforms in Shenzhen and Guangzhou show a coupling coordination value above 0.7 between academic disciplines and regional industrial needs, illustrating strong platform functionality (Batista et al., 2024). This model supports cross-institutional curriculum co-design and accelerates the school-to-industry transition pipeline.

2.2 Multi-Actor Collaborative Mechanisms: Enhancing Governance Integration

Effective industry–education service organizations operate within multi-actor governance structures, where governments provide regulatory and financial support, enterprises contribute practical contexts, and universities deliver educational resources. These actors are linked via service platforms that institutionalize collaboration through joint committees and performance evaluation models (Liu & Zhou, 2022). Such arrangements reflect global trends in network governance, in which intermediary institutions mediate between actors with diverse interests and incentive structures.

2.3 Resource Integration Mechanisms: Optimizing Allocation and Innovation

Resource fragmentation remains a core constraint in regional educational ecosystems. Service organizations respond by creating integrated digital platforms that facilitate joint faculty appointments, shared laboratories, and collaborative research

(Yao & Li, 2023). Empirical evidence from the GBA confirms that these mechanisms increase innovation output and reduce duplication in infrastructure and staffing (Wu & Chen, 2023). Additionally, university–industry co-supervision models have been shown to enhance both student readiness and enterprise engagement (Zhuang & Zhou, 2023).

2.4 Institutional Embedding: Establishing Structured Support Systems

To ensure accountability and long-term sustainability, service organizations are increasingly embedded within institutional frameworks involving performance-based budgeting, service contracting, and credit rating mechanisms. In the Pearl River Delta, several municipalities have introduced triadic evaluation models covering process, outcome, and stakeholder satisfaction to ensure that integration platforms remain adaptive and outcome-oriented (Batista et al., 2024; Xie, Liu, & McNay, 2023).

3. Empirical Design and Data Analysis

To validate the proposed operational framework and examine the performance pathways of industry–education integration service organizations, this study constructs a structural equation model (SEM) grounded in theoretical insights. Using survey data from the Guangdong–Hong Kong–Macao Greater Bay Area, we quantify the impact of four latent variables—platform functionality, multi-actor collaboration, resource integration, and institutional embedding—on organizational performance.

3.1 Research Design and Variable Construction

Based on prior theoretical modeling (Zhuang & Zhou, 2023; Yao & Li, 2023), we designed a questionnaire to capture five core constructs:

1. Platform Functionality: Joint curriculum design, resource-sharing platforms, project coordination.
2. Multi-Actor Collaboration: Inter-stakeholder goal alignment, communication channels, collaboration frequency.
3. Resource Integration: Cross-sector mobility of human resources, shared equipment usage, data interoperability.
4. Institutional Embedding: Formalization of governance structures, performance-based incentives, policy responsiveness.
5. Organizational Performance (dependent variable): Indicators include talent matching rate, innovation conversion efficiency, and operational stability.

Each construct was measured with 3–5 items using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree).

Hypotheses:

- H1: Platform functionality has a significant positive effect on organizational performance.
H2: Multi-actor collaboration has a significant positive effect on organizational performance.
H3: Resource integration has a significant positive effect on organizational performance.
H4: Institutional embedding has a significant positive effect on organizational performance.

3.2 Data Collection and Sample Distribution

The survey was conducted from November 2024 to February 2025 across five major cities in the GBA: Guangzhou, Shenzhen, Zhuhai, Dongguan, and Foshan. A total of 460 questionnaires were distributed, with 423 valid responses (valid response rate: 91.96%).

Table 1. Sample Composition and Demographics

Category	Percentage
Vocational colleges	41.4%
Enterprises	33.8%
Government agencies/service platforms	24.8%
Respondents with bachelor's or above	>80%
Work experience > 3 years	61.7%
Valid response rate	91.96%

The questionnaire survey was conducted across five major cities in the GBA between November 2024 and February 2025. A total of 423 valid responses were collected from key stakeholders including educators, enterprise representatives, and

policymakers. The high percentage of educated and experienced respondents ensured both sample representativeness and analytical reliability.

3.3 Reliability and Validity Testing

Using SPSS 26.0 and AMOS 24.0, we conducted standard reliability and validity assessments:

Table 2. Reliability and Validity Test Results

Test	Result	Threshold	Evaluation
Cronbach's α (all constructs)	> 0.80	> 0.70	Strong consistency
KMO	0.924	> 0.80	Excellent sampling adequacy
Bartlett's Test of Sphericity	$p < 0.001$	$p < 0.05$	Suitable for factor analysis
Standardized factor loadings	> 0.70 (all items)	> 0.70	Good convergent validity

All reliability and validity metrics exceed commonly accepted academic thresholds. This confirms that the measurement model is both internally consistent and construct-valid, supporting the robustness of the SEM analysis.

3.4 Structural Model Fit

The SEM was tested using AMOS. Model fit indices are as follows:

Table 3. Structural Model Fit Indices

Fit Index	Value	Criterion	Evaluation
RMSEA	0.042	< 0.08	Good fit
CFI	0.945	> 0.90	Excellent fit
TLI	0.932	> 0.90	Excellent fit
GFI	0.901	> 0.90	Good fit
AGFI	0.881	> 0.80	Acceptable fit

The model shows excellent fit across all indices, confirming both the theoretical coherence and empirical robustness of the structural model (Liu & Zhou, 2022; Batista et al., 2024).

3.5 Path Coefficients and Hypothesis Testing

Table 4. Hypothesis Testing Results

Hypothesis	Path	β (Standardized)	p-value	Result
H1	Platform Functionality \rightarrow Performance	0.284	< 0.01	Supported
H2	Collaboration \rightarrow Performance	0.312	< 0.01	Supported
H3	Resource Integration \rightarrow Performance	0.267	< 0.05	Supported
H4	Institutional Embedding \rightarrow Performance	0.241	< 0.05	Supported

All hypothesized relationships are supported. The strongest impact is observed from multi-actor collaboration, emphasizing its strategic role in enhancing service organization effectiveness (Zhuang & Zhou, 2023).

3.6 Mediation Effect

Further mediation analysis revealed that collaboration partially mediates the effects of both institutional embedding and resource integration on performance:

Table 5. Mediation Effect of Collaboration on Performance

Pathway	Direct Effect (β)	Indirect Effect (β)	Total Effect (β)	p-value	Mediation Type
Institutional Embedding \rightarrow Performance	0.241	0.185	0.426	<0.001	Partial Mediation
Resource Integration \rightarrow Performance	0.267	0.141	0.408	<0.001	Partial Mediation

Collaborative mechanisms not only act as direct performance drivers but also play a critical mediating role between institutional/resource mechanisms and organizational outcomes. This highlights their centrality in governance architecture (Liu & Zhou, 2022; Wu & Chen, 2023).

4. Barriers Analysis and Policy Recommendations

Despite the central role of service organizations in driving industry–education integration within the Guangdong–Hong Kong–Macao Greater Bay Area (GBA), several barriers persist that limit their performance and sustainability.

First, many organizations suffer from strategic ambiguity, with unclear mandates and overlapping responsibilities with government agencies or academic institutions. This undermines autonomy and weakens innovation capacity (Yao & Li, 2023). Second, inter-organizational trust and collaboration are limited. Universities, enterprises, and governments often operate with conflicting priorities and incentive systems, leading to fragmented cooperation and the absence of shared governance frameworks (Liu & Zhou, 2022).

Third, resource fragmentation significantly reduces operational efficiency. There is a lack of unified digital systems or shared platforms that allow for efficient use of infrastructure, laboratories, and personnel across institutional boundaries (Wu & Chen, 2023). Fourth, institutional support structures are often weak. Many service organizations depend on temporary projects rather than performance-based long-term mechanisms. Without robust policy integration and continuous funding, they struggle to build sustainable impact (Zhuang & Zhou, 2023).

To address these barriers, targeted policy responses are essential. Table 6 summarizes key problems and their corresponding solutions.

Table 6. Major Barriers and Policy Recommendations

Barrier	Recommendation	International Practice
Strategic Ambiguity	Define clear mandates; introduce performance-based contracts; enable third-party governance	Southeast Asian vocational reforms (Ho et al., 2021)
Trust and Collaboration Deficit	Establish joint governance councils; launch co-training institutions; adopt shared equity/revenue models	EU vocational networks (OECD, 2022)
Fragmented Resources and Platforms	Build unified cloud-based systems; standardize inter-organizational protocols for labs/data/faculty	Korea/Singapore digital resource platforms (UNESCO, 2023)
Institutional Weakness and Instability	Secure long-term fiscal support; introduce triadic evaluation (process-outcome-feedback); adopt KPI-driven funds	European public–private education models (Steen & Winter, 2020)

These recommendations are supported by comparative international experiences. For example, Germany’s dual-training system involves academic and enterprise co-supervision, enhancing applied skills and innovation (Deissinger & Rauner, 2022). The EU promotes co-governance in vocational education via funding tied to stakeholder collaboration and measurable results (Cedefop, 2021). South Korea’s Educloud infrastructure enables real-time resource sharing across education providers and industries, improving efficiency and reducing redundancy (UNESCO, 2023).

To implement these reforms, GBA governments should first establish regulatory clarity by defining the operational boundaries of service organizations. Second, a stable financial ecosystem must be created through multi-year mandates and performance-linked grants. Third, collaborative infrastructure—including governance councils and cloud platforms—should be institutionalized. Finally, tripartite monitoring systems involving administrators, users, and evaluators can ensure accountability, responsiveness, and continuous learning.

Overall, addressing governance, trust, resource, and institutional challenges systematically will greatly enhance the impact, resilience, and sustainability of industry–education service organizations in the GBA.

5. Conclusion and Future Research

This study explores the operational mechanisms and optimization paths of industry–education integration service

organizations in the Guangdong–Hong Kong–Macao Greater Bay Area (GBA). Combining theoretical modeling with empirical data, the study reveals that platform functionality, multi-actor collaboration, resource integration, and institutional embedding all exert significant influence on the performance of service organizations.

The structural equation model demonstrates that collaborative governance mechanisms are the strongest drivers of organizational performance, both directly and through mediating effects. This suggests that integration success depends not only on resources and policy support, but also on the quality of coordination among universities, enterprises, and governments. In addition, institutional formalization, including performance-linked funding and shared governance frameworks, emerges as a key enabling condition for sustainable operation.

Nevertheless, structural barriers—including strategic ambiguity, weak inter-organizational trust, fragmented resource systems, and insufficient institutional support—continue to limit the full potential of service platforms. To overcome these challenges, the paper recommends four optimization pathways: clarifying strategic mandates, strengthening collaborative governance, building unified digital platforms, and embedding performance-based institutional mechanisms.

Looking ahead, future research may expand in several directions:

1. **Sectoral Differentiation:** Future studies could compare how service organizations function across different industries (e.g., manufacturing vs. digital services), to develop sector-specific operational models.
2. **Longitudinal Studies:** Time-series data could be used to analyze the evolution of organizational performance and governance maturity across policy cycles.
3. **Digital Platform Analytics:** Leveraging big data and AI, researchers can model real-time collaboration effectiveness using platform usage logs, knowledge flow maps, and stakeholder sentiment data.
4. **Comparative International Studies:** Comparative analyses of governance models in East Asia, Europe, and the GBA can enhance the generalizability and policy relevance of findings.

Ultimately, service organizations are not just intermediaries, but key enablers in the transformation of educational ecosystems. Their ability to bridge sectors, align resources, and institutionalize innovation will be critical to realizing the GBA's ambition of becoming a global hub for talent, innovation, and integrated development.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Batista, P., Chen, Y., & Wu, X. (2024). A practical exploration of tertiary vocational education at Shenzhen Polytechnic. *Advances in Social Science, Education and Humanities Research*, 892, 333–341. https://doi.org/10.2991/978-2-38476-344-3_39
- [2] Cedefop. (2021). *European vocational education and training policies 2021*. European Centre for the Development of Vocational Training.
- [3] Chen, L., & Zhang, Y. (2022). A study on innovative models for cultivating English majors in the Guangdong–Hong Kong–Macao Greater Bay Area under the digital economy context. *Open Journal of Social Sciences*, 10(6), 1–13. <https://www.researchgate.net/publication/391317412>
- [4] Deissinger, T., & Rauner, F. (2022). Vocational education in Germany: Dual training and its governance. *Journal of Vocational Education & Training*, 74(2), 234–245.
- [5] Ho, A. T. K., Wong, M. Y., & Chan, J. K. C. (2021). Third-party governance in vocational and technical education. *Asia Pacific Journal of Education*, 41(3), 331–345.
- [6] Liu, H., & Zhou, L. (2022). Understanding the interactions between multiple actors in network governance in China's

- education sector. *International Journal of Educational Development*, 91, 102577. <https://ideas.repec.org/a/eee/injoed/v91y2022ics0738059322000402.html>
- [7] OECD. (2022). Co-governance in vocational education systems. Organisation for Economic Co-operation and Development.
- [8] Steen, T., & Winter, R. (2020). Evaluating public–private partnerships in education. *International Journal of Public Administration*, 43(4), 297–305.
- [9] UNESCO. (2023). Digital transformation in vocational education systems. UNESCO Publishing.
- [10] Wu, X., & Chen, L. (2023). Vocational education facilitating the high-quality development of Chinese SMEs: Theoretical mechanisms, real constraints and proposed strategies. *Journal of Vocational Education & Training*, ahead-of-print. <https://www.researchgate.net/publication/379688949>
- [11] Xie, X., Liu, X., & McNay, I. (2023). One country with two systems: The characteristics and development of higher education in the Guangdong–Hong Kong–Macau Greater Bay Area. *Humanities and Social Sciences Communications*, 10, Article 1. <https://doi.org/10.1057/s41599-022-01483-z>
- [12] Yao, J., & Li, Y. (2023). Empirical analysis of university–industry collaboration in Greater Bay Area vocational education. *Sustainability*, 15(7), 6252. <https://doi.org/10.3390/su15076252>
- [13] Zhuang, T., & Zhou, H. (2023). Developing a synergistic approach to engineering education: China’s national policies on university–industry educational collaboration. *Asia Pacific Education Review*, 24(1), 145–165. <https://doi.org/10.1007/s12564-023-09876-5>

Spatio-Temporal Pattern of Carbon Emission and Optimization Strategy of Emission Reduction Path in Beijing from the Perspective of Green Finance

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Abstract: Beijing, as the capital of China and the pioneer of low-carbon transition, faces the dual challenges of deep emission reduction and economic development. From the perspective of green finance, this study combines spatio-temporal pattern analysis and coupled coordination model to systematically explore the characteristics of Beijing's carbon emissions and the optimization strategy of emission reduction path from 2000 to 2023. The study finds that: Beijing's carbon emissions show the spatial and temporal differentiation characteristics of "high concentration in the core area and low diffusion in the remote suburban areas", the carbon center is stable in Changping District for a long time, but the emerging urban areas, such as Chaoyang and Haidian Districts, have outstanding carbon emission intensity; the coupling and coordination degree of green finance and carbon emissions shows a leaping trend of "primary to intermediate to good coordination"; and the coupling and coordination degree of green finance and carbon emissions shows a leaping trend of "primary to intermediate to good coordination". The degree of coordination of green finance and carbon emission coupling shows a trend of "primary→intermediate→good→coordinated", but there is a significant regional differentiation, with insufficient transformation momentum in the core urban areas and long-term lagging in the peri-urban industrial areas. By constructing a four-dimensional path framework of "scale effect - technology effect - structure effect - spatial effect", differentiated emission reduction strategies are proposed.

Keywords: Green Finance; Carbon Emission; Spatial And Temporal Pattern; Emission Reduction Strategy

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1.Introduction

Climate change crisis has swept across the world, and realizing the goal of "double carbon" has become a major national strategy in China. As the capital of China and the center of politics, economy and culture, Beijing shoulders the important responsibility of leading the country's low-carbon transformation. In recent years, with the unremitting efforts in industrial upgrading, energy restructuring, and pollution control, Beijing's environmental quality has improved significantly. However, in the face of the ambitious goal of carbon neutrality, the pressure to reduce emissions is still severe - the potential for deep emissions reduction is gradually being compressed, the cost of emissions reduction continues to rise, and it is necessary to explore more innovative, sustainable, and economically efficient emission reduction paths. In this context, it is of great

practical significance and theoretical value to explore how to utilize green financial instruments to drive and support the deep reduction of Beijing's carbon emissions.

Traditional emission reduction strategies mostly focus on technical engineering means, and their limitations such as increasing marginal costs and huge financial pressure are becoming more and more prominent. Green finance, as a key bridge connecting the supply and demand of funds and optimizing the allocation of resources, injects new kinetic energy into the realization of carbon reduction goals. It covers a variety of market-based tools such as carbon trading market, green credit, green credit, green bonds, climate investment and financing, green insurance, etc., which provides a powerful support mechanism for guiding the flow of capital to low-carbon projects and incentivizing market players to reduce emissions spontaneously. However, there is still a lack of in-depth exploration on how green financial resources can accurately and efficiently flow to the emission reduction areas that are most in need of support in Beijing's spatial and temporal differences, and how to realize the "precise drip irrigation" of capital financing. Therefore, this study focuses on the spatio-temporal pattern of carbon emissions in Beijing, and explores the optimization strategy of emission reduction paths from the perspective of green finance.

2.Literature review

The combination of green finance and carbon emissions has become a popular research field, and many studies have shown that green finance has a significant inhibitory effect on carbon emissions. Wang Luanfeng^[1]. concluded that green finance significantly reduces the carbon emissions of Chinese cities, especially in terms of the city's industrial transformation and green innovation capacity, through panel fixed-effects model and spatial Durbin model on the data of 286 prefecture-level cities, and that the green finance The carbon emission reduction effect of green finance in Chinese cities shows obvious regional differences, differences in natural resources endowment, differences in financial development level and differences in environmental protection enforcement; Li Qihan^[2]. point out that green finance reform can effectively reduce carbon emissions in the experimental area and has the spillover effect of carbon reduction; Liu Wei^[3]. prove that green finance and R&D inputs play a significant inhibitory effect on carbon emissions through the study of the panel data of 30 provinces. Moreover, Zhang Ying^[4] pointed out in the study on the spatial spillover effect of green financial policies on carbon emissions that it is recommended to continuously optimize green financial policies, steadily promote the adjustment of energy structure, innovate and promote the upgrading of green technology, and reasonably plan the layout of policy pilots.

At the same time, the impact of green finance on carbon emissions has been specific to various industries, Jiang Pingfa^[5] studied the coupling coordination between green finance and carbon emissions from tourism through the coupling coordination model of spatial and temporal characteristics; Ji Xinlong^[6] pointed out that green finance has a significant inhibitory effect on the intensity of carbon emissions in agriculture, and there is a significant difference in the impact of different quartile levels; Li Ruijing^[7] pointed out that green finance can effectively inhibit the household consumption of direct and indirect carbon emissions; Gu Gu and others pointed out that green finance can effectively inhibit household consumption of direct and indirect carbon emissions. Li Ruijing et al. pointed out that green finance can effectively curb direct and indirect carbon emissions from household consumption; Gu^[8] proposed a study on the threshold and spatial effects of green finance on energy structure under the goal of "double carbon".

As the capital city and political and economic center of China, Beijing shoulders the mission of pioneering the low-carbon transition of the country, so the innovation of this paper mainly focuses on the spatial and temporal patterns of Beijing's regions, as well as the main industries affected by the region, and optimizes the regions and industries through the strategy of four-dimensional paths of finance and carbon emissions.

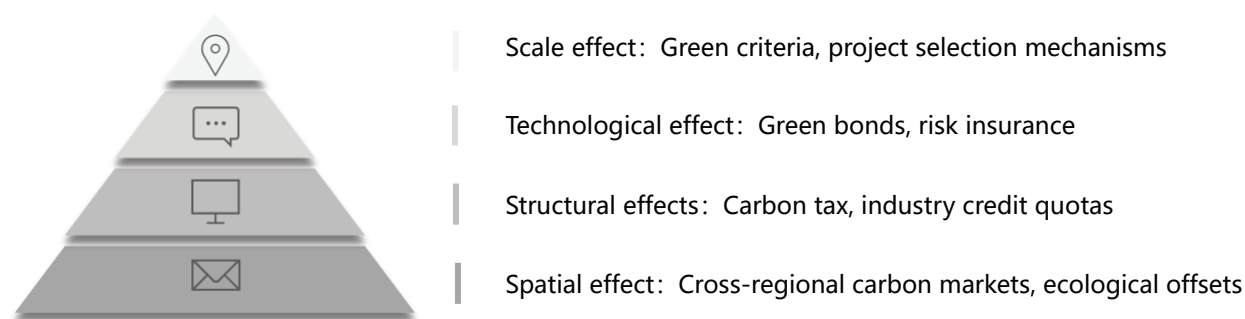
3.Theoretical Analysis

3.1 Finance-carbon emission four-dimensional path analysis

The impact of green finance on carbon emissions can be systematically analyzed through the "four-dimensional path", covering the scale effect, technology effect, structural effect and spatial effect. Scale effect mechanism, short-term increase in emissions, long-term optimization of transformation, green finance may be due to expanding the scale of investment to

stimulate economic growth, resulting in the expansion of energy-intensive industries (such as infrastructure, heavy industry), short-term push up carbon emissions. However, as funds continue to be injected into the low-carbon field, the scale effect gradually shifts to optimize resource allocation and reduce the intensity of carbon emissions per unit of GDP; the technology effect mechanism, the core emission reduction driving force, green finance directly supports the research and development and application of clean technology by reducing the cost of financing; the structural effect mechanism, the driving force of the low-carbon transformation of industries, and guides the upgrading of the industrial structure by means of differentiated financial policies; the spatial effect mechanism, the regional synergy and the spillover effect, the cross-regional carbon market and the carbon market. spillover effect, cross-regional carbon market and green financial instruments to promote technology diffusion and resource complementarity.

Figure 1 Diagram of the core tools of the four-dimensional finance-carbon pathway.



3.2 Analysis of Carbon Emission Measurement Methods

The carbon emission characteristics of Beijing's urban management field are mainly characterized by a high concentration in certain areas and specific industries, such as construction and transportation. Among them, 90% of Beijing's carbon emissions are concentrated in less than 10% of the land area, mainly in the six districts of Dongcheng, Xicheng, Haidian, Chaoyang, Shijingshan and Fengtai. In order to better understand the carbon emission situation in Beijing, this paper adopts the "bottom-up" grid map from the perspective of spatial and temporal distribution as pointed out by Wang Yizhe^[9].

The definition of carbon emissions in the metropolitan area is divided into three scopes: Scope 1 refers to all direct emissions within the jurisdiction of the metropolitan area, which generally include greenhouse gas emissions caused by transportation and construction, industrial production processes, agriculture, forestry and land use changes, and garbage disposal campaigns; and Scope 2 refers to energy-related indirect emissions outside the jurisdiction of the metropolitan area, which generally include purchased electricity, heating, and other energy-related emissions that are used to realize the consumption of metropolitan residents; and Scope 3 refers to the indirect emissions of the metropolitan area, which generally include purchased electricity, heating, and other energy related emissions. Scope 2 refers to indirect emissions related to energy consumption that are outside the jurisdiction of the municipality and generally include emissions from purchased electricity, heating and/or cooling to achieve consumption by municipal residents; Scope 3 refers to any intermediate emissions resulting from intra-municipal movements that occur outside the jurisdiction but are not included in Scope 2, and includes greenhouse gas emissions from the manufacture, transport, utilization and disposal of any goods purchased by municipal residents from outside the jurisdiction.

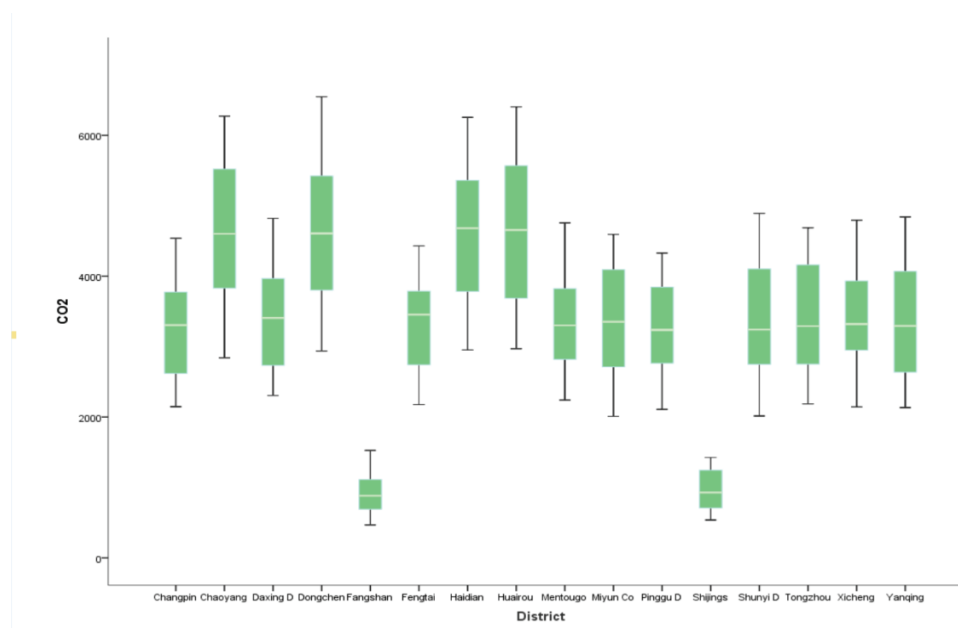
4. Spatial and temporal pattern of carbon emissions in Beijing

4.1 Regional CO₂ Emission Data

The data in this paper mainly come from the websites of authoritative organizations such as the Bureau of Statistics, the Ministry of Science and Technology, and the People's Bank of China, as well as from various authoritative statistical yearbooks, including the national and provincial and municipal statistical yearbooks, the bulletin on the state of the environment, and a number of professional statistical yearbooks such as China Science and Technology Statistical Yearbook, China Energy Statistical Yearbook, China Financial Yearbook, China Agricultural Statistical Yearbook, China Industrial Statistical Yearbook, and so on. China Tertiary Industry Statistical Yearbook, etc.

Due to the different levels of economic development, population density, scale of industrial production, size of the area, and magnitude of population activities in different areas of Beijing, the level of CO₂ emissions in each urban area varies considerably. As shown in the figure below Chaoyang District, Dongcheng District, Haidian District and Huairou District are much higher than the average carbon emission level of all total urban areas, Fangshan District and Shijingshan District are much lower than the average carbon emission level of all total urban areas, and the remaining urban areas are close to the average carbon emission level of all total urban areas. This provides basic data support for the following selection of areas for carbon emission in urban management in Beijing.

Figure 2 Carbon Emissions in Different Regions of Beijing.



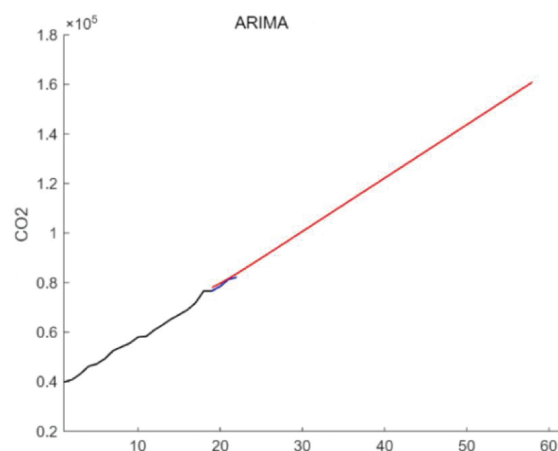
4.2 Model Establishment and Analysis

This study adopts the standard deviation ellipse method to characterize the spatial and temporal distribution of carbon emissions in Beijing from 2000 to 2023, to further study the shifting characteristics of the carbon center in Beijing, and to conduct further time-series forecasts of the regional industries through the ARIMA model to derive the areas with the greatest potential for emission reduction.

4.2.1 Temporal Characteristics of Carbon Emission in Beijing

In this study, under the modeling assumptions of no change in China's policies and carbon emissions from various industries not being influenced by other industries, the ARIMA model is used to make time series forecasts of CO₂ in Beijing to conclude that the total CO₂ emissions in Beijing show a trend of increasing year by year, and therefore relevant interventions should be carried out for carbon emissions from the industries in Beijing, as shown in Figure 3 below:

Figure 3 Carbon emission time series prediction of Beijing.



4.2.2 Standard deviation ellipse carbon center analysis

According to the carbon emission observation data of each urban area in Beijing from 2000 to 2023, the ellipse standard deviation analysis and carbon emission center calculation are carried out every 5 years using ArcGIS 10.8 software to analyze the differences in the distribution of the transfer paths and directions of the carbon centers of Beijing in the recent 20 years. The carbon center parameters are shown in Table 1:

Table 1 Carbon center parameters.

Year	Latitude	Longitude	Long axis	Short axis	Long/short axis	Affiliated locations
2000	E116°26'13	N40°5'26.08	0.506045	0.367578	1.376701	Changping
2005	E116°26'45	N40°5'31.21	0.506524	0.366277	1.382898	Changping
2010	E116°26'22	N40°4'58.41	0.496358	0.362741	1.368353	Changping
2015	E116°26'41	N40°5'18.67	0.501969	0.369904	1.357025	Changping
2020	E116°26'35	N40°5'14.08	0.504655	0.364499	1.384516	Changping

From the above table1, it can be seen that from 2000 to 2023, the carbon center area has become a northeast-southwest fluctuating and moving trend, with little change in longitude and latitude, and the carbon center of Beijing city has been relatively stable for many years. Moreover, the direction of the main axis of Beijing's carbon emission shows a slight tendency of deflection to the west, and the overall magnitude of the deflection does not change much, which makes the carbon emission region of Beijing more stable. At the same time, the ratio of the long axis to the short axis of the standard deviation ellipse shows a decreasing trend, indicating that the distribution of Beijing's emissions is gradually weakening, and the differences in carbon emissions among urban areas are gradually weakening.

From the above chart, it can be seen that from 2000 to 2023, the carbon center of Beijing is mainly concentrated in Changping District, and at the same time, according to the overview of the data in 4.1, it can be clearly seen that the carbon emission of Changping District has not reached the forefront of the carbon emission of the urban areas in Beijing, and at the same time, Chaoyang District is close to the carbon center point, and the annual average value of the carbon emission has reached the forefront of the urban area's carbon emission, therefore, the analysis of the urban area's carbon emission industry in the later stage will be based on the analysis of Chaoyang District, which is closer to the carbon center point.

4.2.3 Carbon Emission Forecast Analysis in Urban Management

Based on the spatial and temporal distribution characteristics of carbon emissions in each urban area of Beijing from 2000 to 2023, we use the ARIMA model to make time series forecasts for Chaoyang District, and the year 2000 is noted as time 0 in all the graphs below. Based on the small base of Scope 3 carbon emissions, although the growth index of Scope 3 carbon emissions is larger, the Scope 3 carbon emissions are much smaller than Scope 1 and Scope 2, so Scope 3 carbon emissions are not considered, and by comparing the carbon emission growth rates of Scope 1 and Scope 2 as shown in Table 2, we make a time series forecast for Scope 1. Starting from the year 2000, the growth rate of carbon emissions is calculated every five years.

Table 2 Scope 1 and Scope 2 Growth Rates.

Year	Scope 1 Growth Rates	Scope 2 Growth Rates
2020-2025	0.14278176	0.019432
2025-2030	0.12599903	0.01232
2030-2035	0.11194233	0.007866
2035-2040	0.10067452	0.005044
2040-2045	0.09146627	0.003244
2045-2050	0.08380129	0.00209
2050-2055	0.07732163	0.001348

Scope 1 covers four areas: “Transportation and construction”, “Industrial processes”, “Agroforestry and land-use efficiency” and “Waste treatment”. Disposal”. The projected carbon emissions from these four areas are shown in Figures 4-7:

Figure 4: Transportation and Construction Time Series Forecasts.

Figure 5 Industrial Production Processes Time Series Forecasts.

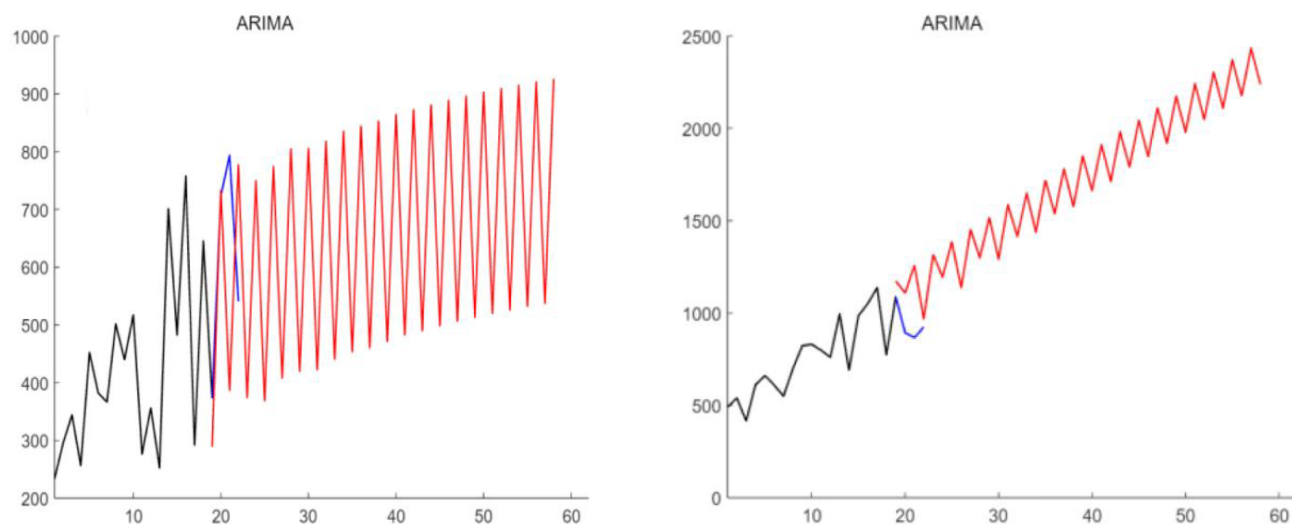


Figure 6 Agroforestry and land-use change time series.

Figure 7 Waste disposal time series projection.

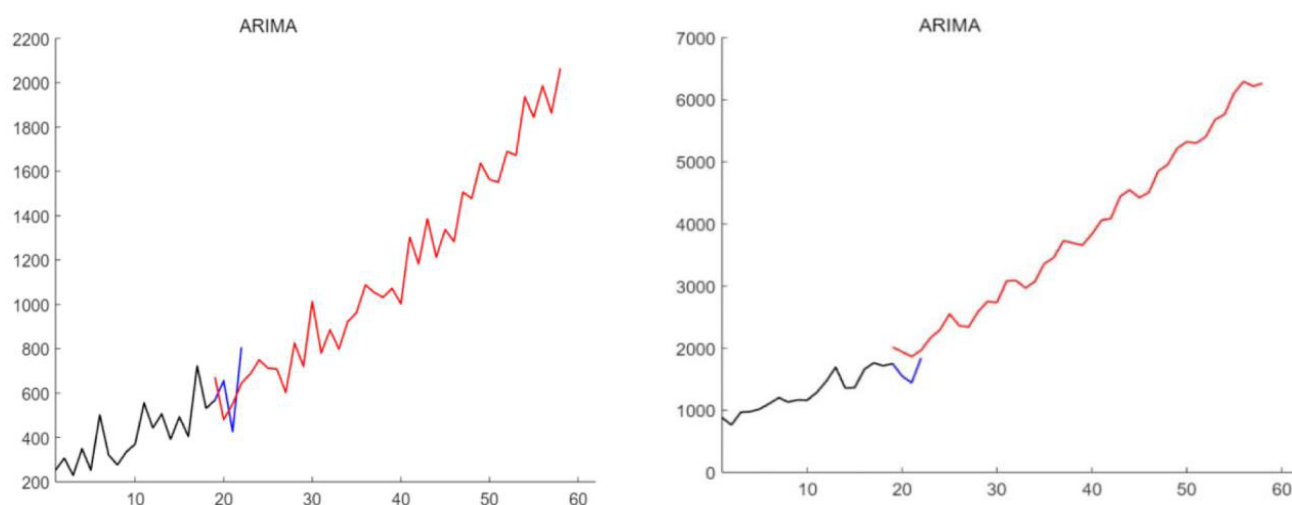


Table 3 Chart of growth rates by block, 2020-2055.

Year	Growth rate of transportation and construction	Growth rate of industrial processes	Growth rate of agroforestry and land-use change	Growth rate of waste disposal
2020-2025	-0.09565	0.267205	0.2866	1.003866
2025-2030	0.394485	0.30323	0.1012	-0.45398
2030-2035	-0.0307	0.123113	0.3927	0.994881
2035-2040	0.24378	0.172942	0.1981	-0.42791
2040-2045	-0.03417	0.11016	-0.0151	0.841535
2045-2050	0.213445	0.176818	0.2089	-0.41497
2050-2055	-0.0286	0.186609	0.2795	0.771236

Based on the projected growth rates of carbon emissions from each industry in Scope 1, we find that the growth rates of carbon emissions from “transportation and construction”, “industrial production and agriculture/forestry” and “land use change” are significantly smaller than the growth rate of carbon emissions from waste disposal. The growth rate of carbon emissions from “transportation and construction”, “industrial production and agriculture/forestry” and “land use change” is significantly smaller than the growth rate of carbon emissions from waste disposal. Therefore, green financial resources should emphasize the establishment of a better waste recycling system to prevent the rapid growth of carbon emissions from waste disposal.

5.Characteristics of green finance and regional carbon emission coupling and coordination

5.1 Indicator selection

In this study, the green finance index data of each region in Beijing is measured by entropy value method, and the comprehensive evaluation system is shown in Table 4:

Table 4 Comprehensive Green Finance Evaluation System.

Category	Specific Indicators	Calculation Formula
Green Credit	Share of credits for environmental projects	Total credit for environmental projects in the province/total credit in the province
Green Investment	Investment in environmental pollution control as % of GDP	Investment in environmental pollution control/GDP
Green Insurance	Extent of promotion of environmental pollution liability insurance	Environmental pollution liability insurance income/total premium income
Green Bond	Extent of green bond development	Total green bond issues/total all bond issues
Green Support	Percentage of fiscal expenditure on environmental protection	Financial environmental protection expenditures/financial general budget expenditures
Green Fund	Percentage of green funds	Total market capitalization of green funds/total market capitalization of all funds
Green Benefits	Green equity development depth	Carbon trading, energy rights trading, emissions trading/total equity market transactions

5.2 Model Establishment and Analysis

As a core tool to quantitatively analyze the synergistic effect of multi-systems, the coupled degree of coordination model has been widely used in the fields of regional economy, ecological and environmental governance, and social resource optimization. In order to guarantee the scientific nature of academic research, this paper draws on the modified coupling coordination degree model proposed by Wang Shujia^[10] to analyze the coupling coordination degree of green finance index and carbon emission intensity in each region of Beijing. The results of spatio-temporal evolution are shown in Figures 8-11.

Figure 8 Degree of harmonization of regional coupling in Beijing, 2000.

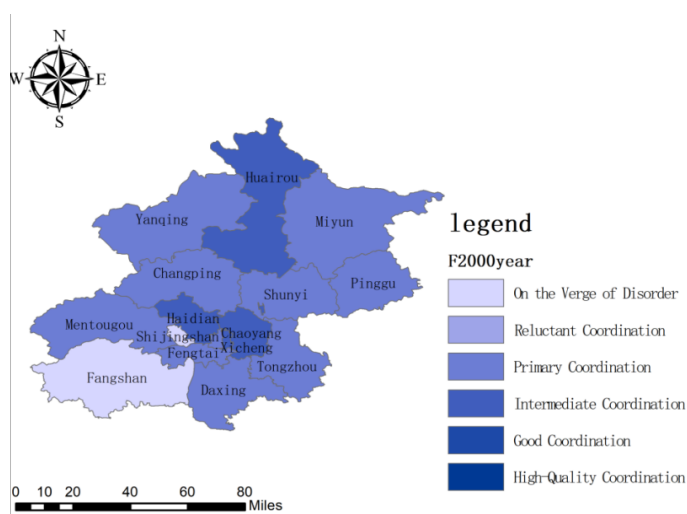


Figure 9 Degree of coordination of regional coupling in Beijing, 2010.

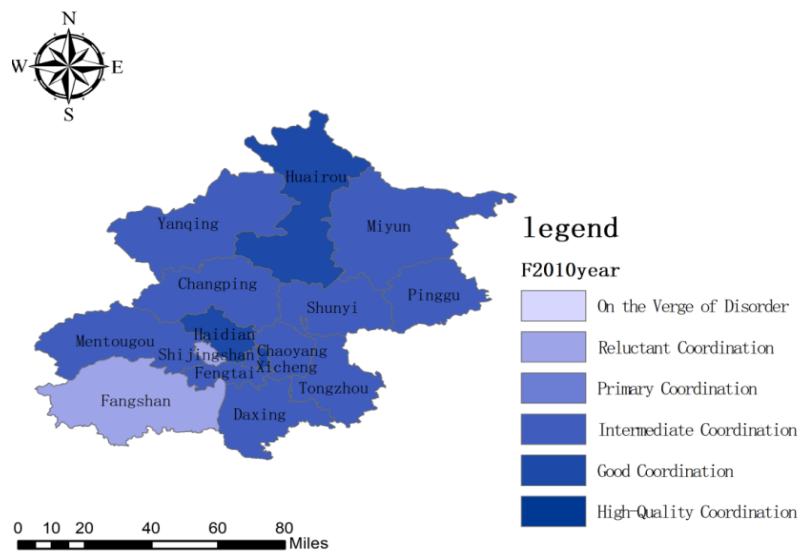


Figure 10 Degree of coordination of regional coupling in Beijing, 2020.

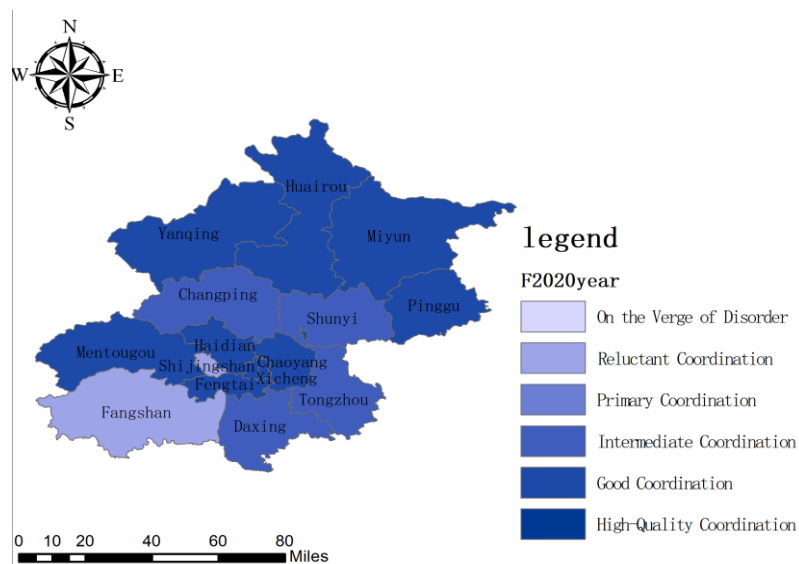
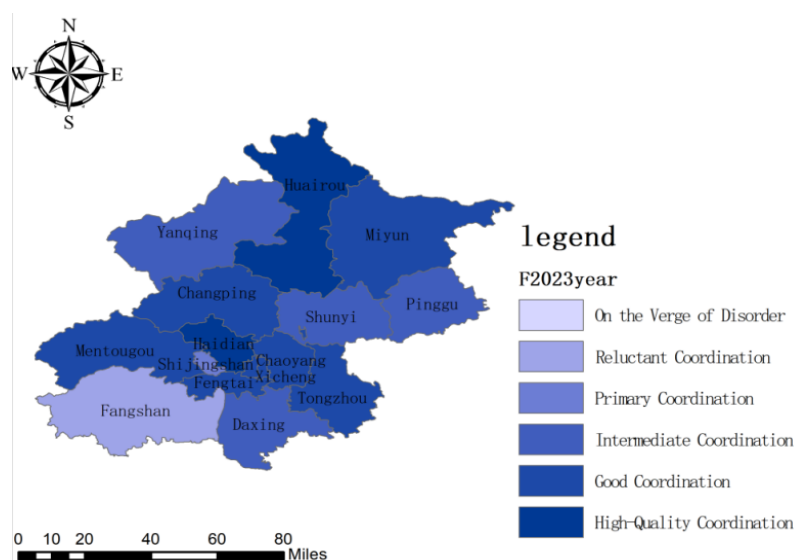


Figure 11 Degree of coordination of regional coupling in Beijing, 2023



From the perspective of time, according to the coupling coordination data, the coupling coordination degree of green finance and carbon emissions in each region of Beijing shows a gradual growth trend from 2000 to 2023, which indicates that the synergistic effect between the green financial system and the carbon emission control objectives has been continuously enhanced in the process of promoting the low-carbon transformation of the economy in the city. Through the three-dimensional framework of “policy guidance + market-driven + regional synergy”, Beijing has effectively realized the synergy between green finance and carbon emission control, and most of the regions have gone through the evolution of primary coordination - intermediate coordination - good coordination, and the level of coordination has leapfrogged.

From a spatial perspective, although the overall trend has been gradually upgrading from “primary coordination” to “good/quality coordination”, there is significant regional differentiation. Core urban areas (Dongcheng and Xicheng): Early on, they relied on policy advantages to take the lead in entering intermediate coordination, but later on, they are weak and will remain in intermediate coordination in 2023, reflecting the lack of transformation momentum in the old urban areas. Emerging urban areas (Chaoyang and Haidian): relying on industrial innovation (such as Zhongguancun and CBD), leading in the integration of green finance and low-carbon technology, and continuing to lead after 2010, becoming the benchmark for “double coordination”. Remote Suburbs (Fangshan, Huairou, Miyun): Eco-cultivation zones (e.g. Miyun, Huairou) have steadily improved their degree of harmonization since 2010 due to the advantages of their environmental baseline, while industrial-dependent zones (Fangshan) have been in the low position for a long time due to lagging behind in the transformation process.

With the development of the region, the coupled coordination degree of Huairou, Haidian, and Chaoyang districts is much higher than that of the surrounding areas, and Huairou and Haidian districts even reach the stage of high-quality coordination in 2023. The high coupling and coordination degree of the three districts is essentially the result of the synergy of “policy guidance + industrial adaptation + financial empowerment + regional characteristics”: Huairou District takes ecological nourishment and the construction of the Science City as the core, and strengthens the green infrastructure through the cooperation between the government and the bank; Chaoyang District relies on the advantages of the service industry to build a low-carbon model driven by the dual-wheel drive of consumption and industry; Haidian District gives full play to the advantages of science and innovation, and drives the low-carbon mode with technological breakthroughs. Haidian District plays to the advantages of science and innovation, and promotes the iteration of green financial products with technological breakthroughs. Fangshan District and Shijingshan District have long been in the low-value island, and Fangshan District is in the “long-term stagnation” warning, subject to the high proportion of traditional heavy industry (such as Yanshan Petrochemical), lagging behind in the application of green financial tools, ecological restoration pressure, and the need to systematically crack the “industry-environment” contradiction constraints, and in 2023, it will be necessary to solve the “industry-environment” problem. The constraints of the contradiction between “industry and environment” have never been broken through barely coordinated in 2023, which is the lowest and the most unstable area in the city; Shijingshan District, by taking advantage of the Beijing Winter Olympics (Shougang Park green renovation) and the construction of the new Shougang High-end Industrial Park, promotes the docking of low-carbon technology and financial capital, realizes the “ecological restoration + industrial upgrading” double-wheel drive, and breaks through primary coordination for the first time in 2021. In 2021, we will break through the primary coordination for the first time.

6. Financial Emission Reduction Path Optimization under Spatial Synergy

“Spatial Synergy + Structural Optimization” Strategy for Carbon Center Regions. Changping District is the spatial center of Beijing’s carbon emissions, but its own carbon intensity is lower than that of core urban areas such as Chaoyang District and Haidian District. As the extension area of Zhongguancun Science City, Changping District possesses the scientific and technological innovation resources of “three cities and one district”, but the synergy between green finance and industry is insufficient. The region is mainly strengthened through the spatial effect, cross-regional carbon market linkage, relying on the location advantage of Changping District near the central urban area, the establishment of “Changping - Haidian - Chaoyang” cross-regional carbon trading pilot, to promote the flow of carbon quotas across the region, the use of price

signals to guide enterprises to reduce emissions. As well as the ecological compensation mechanism, the carbon sinks in Changping's ecological conservation areas (such as the Thirteen Tombs and Python Forest Park) will be incorporated into the green financial collateral system, attracting external funds to support ecological protection. Green credit targeted investment in green structural effect upgrading, targeting new energy industries (e.g. Zhongguancun Hydrogen Energy Industrial Park) and intelligent manufacturing enterprises in Changping District, providing low-interest loans and risk-sharing mechanisms (e.g. Green Credit Guarantee Fund), and promoting the orderly exit of high-carbon industries (e.g. traditional manufacturing industries).

Waste treatment (Scope 1): The whole chain "structure-technology-space" synergistic strategy, green funds to guide industrial transformation in the reconstruction of structural effects, the establishment of the "Beijing Municipal Waste Disposal Green Transformation Fund", with a focus on investment in waste incineration and power generation, The fund will focus on investing in waste incineration power generation and biodegradation technology R&D projects to gradually replace landfills. In terms of technological breakthroughs, green credit risk sharing has been carried out, with governmental financial guarantee institutions providing 80% risk coverage for CCUS (Carbon Capture, Utilization and Storage) technology for waste incineration, thus reducing banks' lending concerns. In terms of integration of spatial effects, cross-regional collaboration on waste treatment, establishment of the Beijing-Tianjin-Hebei Waste Treatment Green Finance Alliance, promotion of Zhangjiakou wind power to supply power to Beijing waste incineration plants, and realization of synergy between renewable energy and low-carbon treatment technologies, among others.

Optimization of regional differentiated emission reduction strategies, the core area (Dongcheng and Xicheng), the concentration of high-carbon business, mainly rigid emissions from domestic heating and transportation, the difficulty of spatial transformation (such as the density of old buildings in hutongs), the lack of financial penetration, the limited application of tools such as green credit and bonds, and the lack of new growth points. Through stock optimization, such as the implementation of "photovoltaic tiles + energy storage wall" transformation of hutong compounds, green credit subsidies according to the area (such as the first year of the subsidy rate of 3%), and policy innovations such as cross-district eco-settlement, signing an "ecological service agreement" with the Yanqing District, payment of carbon sinks Purchase costs to support the expansion of forest cover and activate low-carbon potential. Emerging regions (Chaoyang and Haidian), where market-based tools such as green bonds and funds are widely used, have high resistance to transforming high-carbon businesses. This can be achieved by strengthening technology-driven initiatives such as the establishment of a "Zero-Carbon Technology Venture Capital Fund" jointly with the Bank of Zhongguancun, supporting university laboratories in carbon capture and green hydrogen preparation technologies, and scale control such as green credit constraints, and the implementation of a "total volume control + incremental optimization" policy for logistics parks and data centers. ", new loans need to match the carbon emission reduction target, consolidate the leading edge. In remote urban areas, ecological conservation areas (Miyun and Huairou) can realize carbon sinks through the conversion of carbon sinks and cross-district cooperation; industrial zones (Fangshan) can realize industrial substitution and financial underwriting, and issue "Old Industrial Base Transformation Bonds" to support coking, chemical and industrialization industries. Bonds", supporting the transformation of coking plants into green hydrogen preparation bases, supporting hydrogen pipelines to Xiongan, and introducing "carbon asset price insurance" to hedge the risk of carbon price fluctuations, and setting up a "green credit risk reserve" to guard against transformation risks. The final result will be the formation of a "market internalization" in Beijing. Eventually, Beijing will form a sustainable development pattern of "endogenous market drive, policy synergy support, and city-wide low-carbon resonance".

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no

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Wang, L., & Li, W. (2025). A statistical test of the impact of green finance on urban carbon emissions. *Statistics and Decision Making*, 41(05), 155–159.
- [2] Li, Q., & Han. (2025). Carbon emission reduction effect of green financial reform and its influence mechanism. *Modern Economic Discussion*, (03), 62–72, 87.
- [3] Liu, W., Ji, M., Han, J., et al. (2025). Research on the intrinsic correlation of green finance, R&D input and carbon emission—An empirical test based on inter-provincial panel data. *Industrial Technology and Economics*, 44(03), 45–55, 161.
- [4] Zhang, Y., & Zou, G. (2024). Research on the spatial spillover effect of green financial policies on carbon emissions. *Journal of Wuhan University (Philosophy and Social Science Edition)*, 77(05), 60–72.
- [5] Jiang, P. (2025). Temporal and spatial characteristics of the coupled coordination degree of green finance and carbon emission of tourism—The case of Yangtze River Economic Belt. *Ecological Je*, 1–14. Advance online publication. [https://doi.org/\[provide if available\]](https://doi.org/[provide if available])
- [6] Ji, X., & Wang, S. (2025). The effect of green finance on agricultural carbon emission intensity and the test of the role mechanism. *Statistics and Decision Making*, 41(04), 138–143.
- [7] Li, R. J., Wang, L. L., & Wang, L. Y. (2024). How does green finance affect household consumption carbon emissions? Based on household life cycle perspective. *Financial Theory and Practice*, (11), 73–84.
- [8] Gu, X., & Ma, Q. (2024). Research on the threshold and spatial effect of green finance on energy structure under the goal of "double carbon". *Hubei Social Science*, (02), 101–109.
- [9] Wang, Y. C., Wang, X. P., & Chen, Q. Y. (2025). Review and insights of research on urban carbon emission measurement methods. *Urban Planning*, 49(03), 100–112.
- [10] Wang, S., Kong, W., Ren, L., et al. (2021). Misconceptions and corrections of domestic coupled coordination degree model. *Journal of Natural Resources*, 36(03), 793–810.

Research on Carbon Emission Reduction Mechanism Driven by Digital Economy: An Empirical Analysis of Northeast Asia with Sino-Korean Cooperative Enterprises as the Entry Point

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Abstract: Against the backdrop of the escalating global concern over climate change, digital transformation is emerging as a strategic tool for the industrial sector to reduce carbon emissions. This study explores the carbon emission reduction mechanisms facilitated by the digital economy, with a particular focus on Sino-Korean joint ventures operating in Northeast Asia. Based on a panel dataset of listed cooperative enterprises from China and South Korea from 2013 to 2022, we empirically examine how digital transformation (DT) affects carbon emission intensity (CEI) through green technological innovation (GTI), while considering environmental, social, and governance (ESG) practices as moderating factors. The results indicate that digital transformation significantly reduces carbon emission intensity by promoting green technological innovation, and strong ESG practices amplify this effect.

Keywords: Digital Transformation (DT); Carbon Emission Intensity (CEI); Green Technological Innovation (GTI); ESG Practices; Sino-Korean Joint Ventures

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1.Introduction

Facing increasingly severe climate change challenges, major carbon-emitting nations such as China and South Korea urgently need to achieve emission reductions while maintaining industrial growth. The digital economy (e.g., big data, AI) offers opportunities for low-carbon transition. Although its core driver, Digital Transformation (DT), has been proven to reduce Carbon Emission Intensity (CEI) through pathways like improving energy efficiency, its global emission reduction effect remains contentious. Moreover, research is particularly scarce on the impact mechanisms of Sino-South Korean digital cooperation on carbon emissions.

This study focuses on Sino-South Korean joint ventures and cooperative enterprises in Northeast Asia. Utilizing their panel data from 2013 to 2022, it empirically investigates:

- 1) How DT affects CEI;
- 2) The mediating role of Green Technological Innovation (GTI);
- 3) The moderating effect of ESG Performance and examines regional heterogeneity.

By constructing an enterprise-level DT-GTI-ESG interaction model, this research not only reveals the micro-level

mechanisms of digital-driven emission reduction but also identifies the limitations of current digital technologies (at the current stage, prior to widespread AI adoption). It provides empirical evidence for deepening Sino-South Korean digital collaboration and coordinating regional development with carbon neutrality goals.

2. Literature Review

2.1 DT, Carbon Emissions, and the Cross-Border Gap

Digital transformation (DT), driven by AI, big data, and cloud computing, is recognized as a catalyst for industrial decarbonization. Studies indicate DT reduces carbon emission intensity (CEI) by optimizing resource allocation, improving energy efficiency, and enabling cleaner production^{[1][2]}, particularly in energy-intensive sector^[3]. However, this effect remains contested due to potential “rebound effects” from increased production-driven energy demand^[4]. Critically, extant research focuses predominantly on domestic contexts, leaving a gap in understanding cross-border applications—especially in Northeast Asia, where digital cooperation intersects with stringent carbon targets.

2.2 GTI: The Mediating Pathway

Green technological innovation (GTI) serves as a critical mechanism translating digital capabilities into environmental gains. DT enhances innovation capacity through improved information access, lower transaction costs, and accelerated R&D^{[5][6]}, thereby stimulating green patents and eco-product development that lower long-term emissions^[7]. While GTI is established as a mediator between external drivers (e.g., policy) and carbon performance^[8], the specific DT → GTI → CEI pathway lacks empirical validation, particularly in multinational settings where institutional diversity influences innovation diffusion.

2.3 ESG: Amplifying Digital Impact

ESG performance reflects corporate sustainability commitment and can potentiate DT’s environmental efficacy. Firms with robust ESG practices are more likely to leverage digital solutions due to stakeholder engagement and long-term orientation^[9]. Strong ESG governance further enhances DT’s impact by fostering transparency, accountability, and cross-functional coordination^[10]. Yet, research predominantly treats ESG as an outcome rather than a contextual moderator. Given varying ESG implementation across borders, its role in conditioning DT’s CEI-reduction potential—especially in Sino-Korean joint ventures—remains unexplored.

2.4 Research Gaps and Contributions

While DT, GTI, and ESG independently influence environmental outcomes, no study integrates them into a unified framework for cross-border contexts. Northeast Asia—a critical region as both a top emitter and digital innovator—is notably underrepresented. This research addresses these gaps by:

- 1) Proposing and testing a DT–GTI–CEI mediation model within Sino-Korean joint ventures.
- 2) Examining ESG performance as a key moderator of the DT–CEI relationship.
- 3) Providing region-specific insights using firm-level panel data (2013–2022).

3. Theoretical Framework & Hypotheses

3.1 Conceptual Model

Building upon the existing literature, this study proposes a multi-level framework to analyze how digital transformation (DT) influences corporate carbon emission intensity (CEI), with green technological innovation (GTI) serving as a mediating mechanism and ESG performance as a moderating factor. This framework is particularly relevant for Sino-Korean joint ventures, where digital cooperation and sustainability goals intersect.

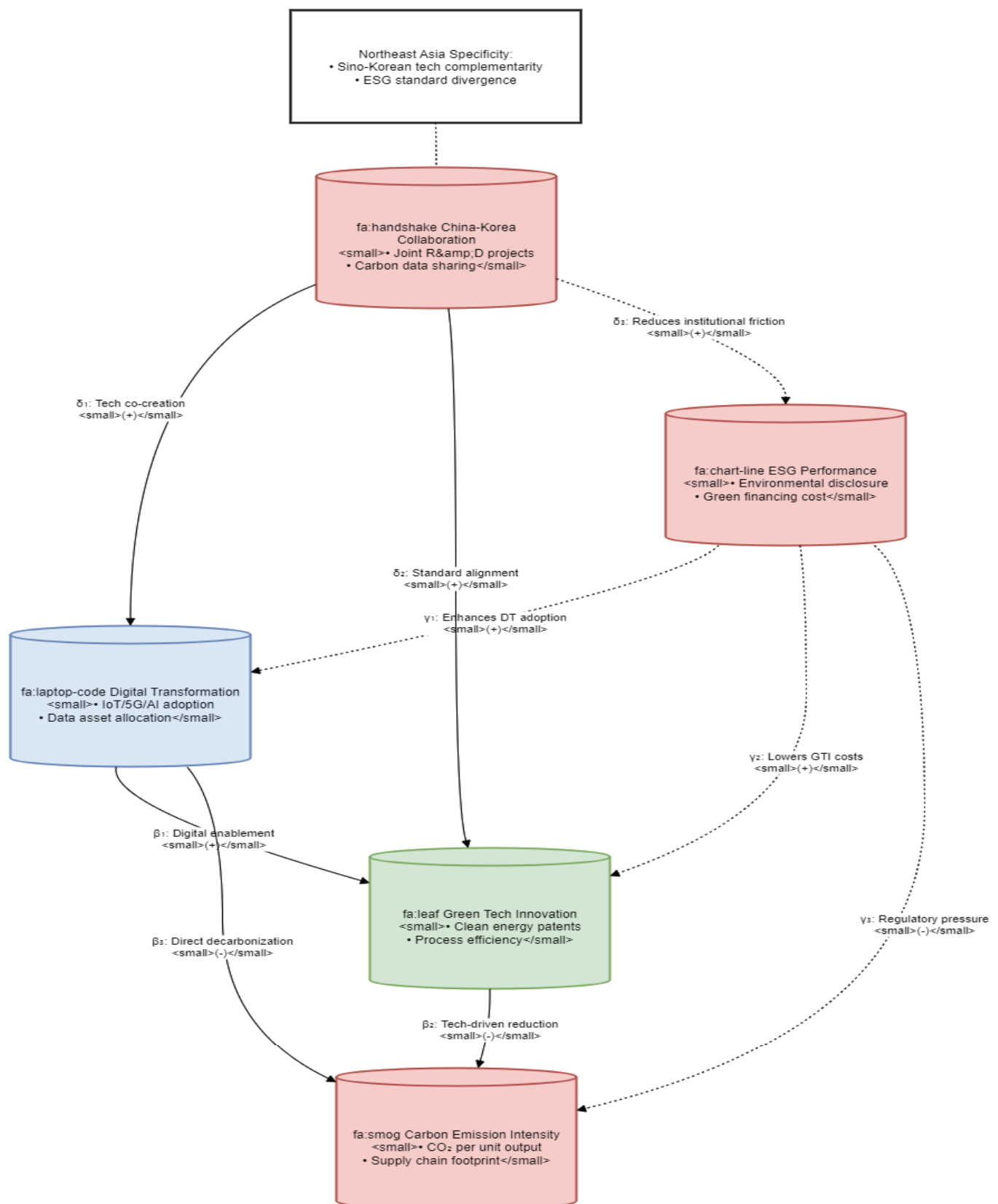
The theoretical foundation integrates resource-based theory^[11], which posits that digital capabilities and green innovations are strategic assets that enhance environmental performance, and institutional theory^[12], which emphasizes the role of ESG-driven norms in shaping corporate behavior.

3.2 Hypotheses Development

H1: Digital transformation significantly reduces firms’ carbon emission intensity.

Digitally transformed firms are better positioned to optimize production processes, enhance energy efficiency, and implement smart carbon tracking tools^{[13][14]}. In the context of Northeast Asia, where digital infrastructure is relatively mature, these effects are expected to be more pronounced.

Figure.1 Conceptual model



H2: Green technological innovation mediates the relationship between digital transformation and carbon emission intensity. Digital tools not only enhance operational efficiency but also stimulate innovation capabilities, particularly in the domain of green technologies^[15]. Firms undergoing digital transformation are more likely to invest in green R&D, leading to improved environmental outcomes through cleaner production and sustainable products^[16].

H3: ESG performance positively moderates the relationship between digital transformation and carbon emission intensity.

Firms with higher ESG ratings tend to internalize environmental goals into their digital strategy, thereby enhancing the effectiveness of digital transformation in reducing carbon emissions ^[17]. ESG-oriented governance structures promote transparency, accountability, and stakeholder alignment, all of which are crucial for leveraging digital tools toward environmental sustainability.

H4: The impact of digital transformation on carbon emission intensity varies across regions and industries.

Given the heterogeneity in regional digital infrastructure and sectoral carbon intensity, the effectiveness of DT in reducing CEI is expected to differ. For example, manufacturing-intensive regions or energy-heavy sectors may exhibit a stronger DT–CEI linkage due to higher baseline emissions ^[18].

4.Data & Methodolog

4.1 Data and Sample

This study utilizes a balanced panel dataset comprising Sino-Korean joint ventures and cooperative enterprises listed in China and South Korea from 2013 to 2022. Firms are identified based on ownership structures and partnership disclosures in annual reports. Data are collected from multiple authoritative sources to ensure cross-national comparability and transparency:

- 1) Financial and firm-level data: CSMAR (China) and KISVALUE (Korea)
- 2) Digital transformation metrics: Textual analysis of annual reports via Python, using DART (Korea) and WIND (China)
- 3) Carbon emission intensity estimation: Calculated as industry-specific energy consumption* regional carbon emission factors / revenue, based on national energy statistics
- 4) Green innovation: Green patent counts from the CNIPA (China), KIPO (Korea), and PATSTAT database
- 5) ESG performance: ESG scores from third-party rating agencies (e.g., Huazheng ESG, Korea KCGS, Bloomberg ESG)
- 6) Macroeconomic and regional data: National statistical yearbooks and ICT infrastructure reports from the Korean Ministry of Science and ICT

Only firms with complete data across all variables for the observation period are retained, resulting in a final sample of N firms* T years.

Table.1 Variable Definitions

Variable Type	Name	Symbol	Definition / Measurement	Source
Dependent Variable	Carbon Emission Intensity	CEI	Industry-level energy use* regional carbon coefficient / firm revenue	National energy statistics, CSMAR, KIS
Independent	Digital Transformation	DT	Frequency of digital-related keywords (AI, blockchain, IoT, etc.) in annual reports, log-transformed	WIND, DART, Python NLP
Mediator	Green Technological Innovation	GTI	Number of green patent applications (domestic and international)	CNIPA, KIPO, PAT-STAT
Moderator	ESG Performance	ESG	ESG composite score from third-party ratings	Bloomberg ESG, KCGS, WIND ESG
Control	Firm Size	SIZE	Logarithm of total assets	WIND, KISVALUE
	Leverage	LR	Total liabilities / Total assets	WIND, KISVALUE
	Ownership Concentration	OC	Herfindahl index of top five shareholders	CSMAR, DART Korea
	Return on Assets	ROA	Net income / Total assets	WIND, KISVALUE
	Industry Carbon Intensity	ICI	Regional average CEI of firm's primary industry	Industrial yearbooks
	Regional Digital Infrastructure	DINFRA	Composite index of internet penetration, broadband coverage, digital investment per capita	NBS (China), MSIT (Korea)

4.2 Model Specification

To test the hypotheses outlined in Section 3, the following econometric models are estimated using fixed effects panel regression with firm and year fixed effects:

(1) Baseline Model – Direct Effect of Digital Transformation on Carbon Intensity:

$$CEI_{it} = \alpha + \beta DT_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

CEI_{it} : Carbon emission intensity of firm i in year t

DT_{it} : Digital transformation level of firm i in year t

X_{it} : Vector of control variables for firm i in year t

μ_i : Firm fixed effect (controls for time-invariant firm heterogeneity)

λ_t : Year fixed effect (controls for time-specific macroeconomic shocks)

ε_{it} : Error term

(2) Mediation Test – Green Innovation Channel

Step 1 ($DT \rightarrow GTI$):

$$GTI_{it} = \alpha + \beta_2 DT_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

Step 2 ($DT \& GTI \rightarrow CEI$):

$$CEI_{it} = \alpha + \beta_3 DT_{it} + \beta_4 GTI_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

GTI_{it} : Green technological innovation of firm i in year t

Mediation Assessment: A Sobel test and Bootstrap confidence intervals (5,000 repetitions) are used to validate the statistical significance of the indirect effect of DT on CEI via $GTI \times \beta_4$.

(3) Moderation Test – ESG as Amplifier

$$CEI_{it} = \alpha + \beta_5 DT_{it} + \beta_6 ESG_{it} + \beta_7 (DT_{it} * ESG_{it}) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

ESG_{it} : ESG performance score of firm i in year t

$DT_{it} \times ESG_{it}$: Interaction term between digital transformation and ESG performance.

Interpretation: A negative and statistically significant coefficient β_7 implies that stronger ESG practices enhance (positively moderate) the carbon emission reduction effect of DT.

4.3 Identification Strategy

To mitigate endogeneity concerns (e.g., reverse causality between DT and CEI), several approaches are applied:

- 1) Lagged variables: Key independent variables are lagged one year to reduce simultaneity bias.
- 2) Instrumental Variable (IV) robustness (optional): Instruments such as regional AI infrastructure or digital subsidies can be introduced.
- 3) Placebo tests: Applying the model to industries with low carbon relevance to ensure the effect is not spurious.
- 4) Robustness checks:

Alternative DT proxies (e.g., digital investment intensity),

Subsample regressions by sector (e.g., manufacturing vs. service),

Winsorization of outliers at 1% and 99%.

5. Empirical Results and Discussion

Regression analyses confirm digital transformation (DT) significantly reduces carbon emission intensity (CEI) ($\beta_1 = -0.045$, $p < 0.05$), supporting H1. Robustness checks using alternative DT measures and lagged variables reinforce this core finding. Notably, green technological innovation (GTI) acts as a partial mediator: DT boosts GTI ($\beta_2 = 0.132$, $p < 0.01$), which subsequently lowers CEI ($\beta_4 = -0.031$, $p < 0.05$), with a statistically significant indirect effect (bootstrap 95% CI: -0.0065 to -0.0014), validating H2. Furthermore, ESG performance amplifies DT's impact, as evidenced by a negative and significant interaction term ($\beta_7 = -0.018$, $p < 0.05$). Marginal effect plots demonstrate firms with strong ESG governance achieve substantially greater CEI reduction from DT, confirming H3. Contextual heterogeneity exists, with stronger effects observed in manufacturing firms and regions with advanced digital infrastructure (DINFRA), underscoring H4.

Theoretically, this study advances sustainability research by establishing a multi-path decarbonization mechanism: DT

directly reduces CEI while indirectly lowering emissions through GTI, with ESG governance potentiating DT's efficacy. Practically, policymakers should couple DT incentives (e.g., digital R&D subsidies) with ESG capacity-building (e.g., harmonized benchmarking) to maximize carbon reduction. Firms must integrate digital and ESG strategies, while China-Korea partnerships should prioritize cross-border digital infrastructure and aligned sustainability reporting to accelerate regional decarbonization.

Limitations and Future Research :

Several limitations warrant attention. First, findings may understate future DT potential as generative AI adoption in SMEs remains nascent; expanding samples to include AI-intensive firms would enhance generalizability. Second, measuring DT via keyword frequency introduces potential reporting bias; future studies should incorporate objective metrics like digital investment ratios. Third, inconsistent carbon/ESG reporting standards between China and Korea create measurement noise, necessitating research on standardized international sustainability data governance. Fourth, dynamic factors like carbon pricing and regional AI infrastructure indices should be integrated to model how market incentives and technology diffusion jointly shape the DT-CEI pathway. Finally, advanced causal modeling (e.g., Structural Equation Modeling) could unravel the complex interdependencies within the DT-GTI-ESG-CEI system. Addressing these gaps will refine our understanding of digital decarbonization as technologies evolve.

Conclusion

This study demonstrates that digital transformation (DT) significantly reduces carbon emission intensity (CEI) in Sino-Korean joint ventures through three interconnected mechanisms: directly by optimizing production efficiency and resource utilization, indirectly via stimulating green technological innovation (GTI) which subsequently lowers emissions, and conditionally through Environmental, Social, and Governance (ESG) performance which amplifies DT's decarbonization impact. To operationalize these findings, policymakers should establish cross-border digital collaboration platforms for shared smart manufacturing and carbon tracking solutions, strengthen green patent incentives through tax credits and accelerated examination to boost GTI, harmonize China-Korea ESG rating standards to reduce information asymmetry, and promote AI-enabled real-time carbon footprint reporting systems to enhance transparency. Implementing these measures will harness the synergistic potential of DT, GTI, and ESG governance to accelerate regional progress toward carbon neutrality goals.

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no

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Li, W., Wang, S., & Deng, X. (2024). The impact of digital finance on business environment... *Finance Research Letters*, 67, 105775. <https://doi.org/10.1016/j.frl.2024.105775>
- [2] Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: Moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, 38(5), 360-387. <https://doi.org/10.1108/09600030810882816>
- [3] Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy - A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757-768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- [4] Zhu, Y., & Lu, S. D. (2024). Economy and carbon neutrality: Exploring the pathways and implications for China's sustainable development. *Journal of the Knowledge Economy*, 15, 1-18. <https://doi.org/10.1007/s13132-024-01931-y>
- [5] National Bureau of Statistics of China. (2023). Industrial Energy Consumption and Emission Database [Database].
- [6] Ferreira, J. J., Lopes, J. M., Gomes, S., & Dias, C. (2023). Diverging or converging to a green world? Impact of green growth measures on countries' economic performance. *Environment, Development and Sustainability*, 26, 12345-12367. <https://doi.org/10.1007/s10668-023-02991-x>
- [7] Dong, K., Zhao, J., & Taghizadeh-Hesary, F. (2023). Toward China's green growth through boosting energy transition:

- The role of energy efficiency. *Energy Efficiency*, 16(5), 102. <https://doi.org/10.1007/s12053-023-10123-7>
- [8] Chen, Z., Kahn, M. E., Liu, Y., & Wang, Z. (2018). The consequences of spatially differentiated water pollution regulation in China. *Journal of Environmental Economics and Management*, 88, 468-485.
- [9] Qi, J., Ling, Y., Ji, B., & Zhang, Y. (2022). Research on a collaboration model of green closed-loop supply chains towards intelligent manufacturing. *Multimedia Tools and Applications*, 81, 40609-40634. <https://doi.org/10.1007/s11042-021-11727-w>
- [10] Chen, Z., & Xu, W. (2025). The role of the digital economy in enhancing green innovation: Evidence from Chinese A-share listed enterprises. *Finance Research Letters*, 71, 106381. <https://doi.org/10.1016/j.frl.2025.106381>
- [11] Zhong, S., Chen, J., Ur, Z., & Faiz, R. (2024). Quantifying digital economy and green initiatives for carbon neutrality targets: A Kilian bias adjusted bootstrap model evaluation of China economy. *Environmental Science and Pollution Research*. Advance online publication. <https://doi.org/10.1007/s11356-023-31445-0>
- [12] Lu, J., Guo, Z., & Wang, Y. (2024). The development level of new productivity, regional differences and the path of enhancement. *Journal of Chongqing University (Social Science Edition)*, 30(3), 1–17.
- [13] Guo, F., Wang, J., Wang, F., Kong, T., Zhang, X., & Cheng, Z. (2020). Measuring the development of digital financial inclusion in China: Index compilation and spatial characteristics. *China Economic Quarterly*, 19(4), 1401–1418.
- [14] Abbasi, S., Abbaspour, S., Eskandari Nasab Siahkoochi, M. M., & Ghasemi, P. (2024). Supply chain network design concerning economy and environmental sustainability: Crisis perspective. *Results in Engineering*, 22, 102291. <https://doi.org/10.1016/j.rineng.2024.102291>
- [15] Azizi, E., Hua, W., Stephen, B., Wallom, D. C. H., & McCulloch, M. (2025). Digitalization opportunities to enable local power system transition to net-zero. *Energy for Sustainable Development*, 84, 101596. <https://doi.org/10.1016/j.esd.2025.101596>
- [16] Hu, J., & Gu, J. (2017). Research on the regional heterogeneity of the impact of population aging on housing prices—An empirical analysis... *Journal of East China Normal University...*, 49(3), 155–160+176.
- [17] Meng, Y., Wu, H., Wang, Y., & Duan, Y. (2022). International trade diversification, green innovation, and consumption-based carbon emissions: The role of renewable energy for sustainable development in BRICST countries. *Renewable Energy*, 201, 123-134. <https://doi.org/10.1016/j.renene.2022.08.045>
- [18] Bartzas, G., Doula, M., & Komnitsas, K. (2025). Low-carbon certification systems in agriculture: A review. *Applied Sciences*, 15(10), 5285. <https://doi.org/10.3390/app15105285>

Research on the Practice of Data Assets Entering into the Table of Haitian Ruisheng Company

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Abstract: This study takes Haitian Ruisheng as a typical case to explore the impact of data assets listing on enterprises and practical experience. After the implementation of the Interim Provisions on Accounting Treatment of Enterprise Data Resources in 2024, as one of the few listed companies that included data resources into “inventory”, Haitian Ruisheng realized the explicit value of data assets through accurate division of data resource types, refined cost accounting and comprehensive information disclosure. The study found that the listing of data assets significantly improved the profitability of enterprises. In 2024, the net profit increased by 105.24% year on year, and the return on equity turned from negative to positive. The market valuation increased significantly, and the price-to-sales ratio, price-to-book ratio and price-to-earnings ratio were significantly higher than the industry average, reflecting the high recognition of enterprise value in the market. At the same time, the listing measures stimulated the innovation momentum of enterprises, promoted the large-scale production of data assets and business model innovation, and the operating revenue in 2024 increased by 39.45% year on year. Haitian Ruisheng practice shows that the correct classification data resources scientific calculation value and full disclosure of information is the core of assets into the table data path, for enterprise provides reproducible operation pattern, also to improve data assets accounting rules, the deepening marketization of data elements configuration provides an important reference.

Keywords: Data Resources; Inventory; Haitian Ruisheng

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1.Introduction

In the wave of digital and intelligent transformation, data assets have become a key element for enterprises to enhance their core competitiveness. With the continuous progress of digital and intelligent technologies, the methods for confirmation and measurement of data assets will be further improved, and the degree of standardization and normalization will continue to increase. ^[1] To fully leverage the value of data assets, the government should actively organize experts in relevant fields, industry associations, and enterprise representatives to jointly study and formulate unified standards for the classification, valuation, and disclosure of data assets, thereby guiding enterprises to conduct effective data asset information disclosure. ^[2] This will not only help to enhance the transparency and credibility of enterprises but also provide strong support for their innovation and development. ^[3] It has been proven that the disclosure of data asset information can effectively enhance the innovation capacity of enterprises. By fully disclosing data asset information, enterprises can better attract investment, optimize the allocation of resources, and thus promote the implementation and implementation of innovation projects. This

will not only help enterprises stand out in fierce market competition but also lay a solid foundation for their sustainable development.^[4]

Since the implementation of the Interim Provisions on Accounting Treatment Related to Enterprise Data Resources on January 1, 2024, as of December 31, 2024, 100 listed companies have carried out the practice of entering data assets into the table, among which 69% of the data resources of listed companies meet the conditions for the recognition and measurement record of intangible assets.^[5] In the annual financial report of intangible assets in the balance sheet items of data resource value disclosure, 20% of listed companies, whose data resources are in the R&D stage, disclose the R&D expenditure in the annual report; 20% of listed companies have both intangible assets and R&D data resources in their annual financial reports, 2% of the listed companies included the data resources conforming to the definition of inventory in the “inventory” item of the balance sheet. Then, after the data resources are put into the table, what are the impacts on the enterprise and what are their practical experiences? This paper will be based on the financial report of Haitian Ruisheng enterprise analysis and research.

Haitian Ruisheng is a leading enterprise in the field of AI training data in China, with a high reputation and influence in the industry. The company was established on May 11, 2005, and is mainly engaged in the research and development, design, production and sales of AI training data. It provides professional datasets needed for algorithm model development and training for various institutions in the AI industry chain, covering multiple core areas such as intelligent speech, computer vision, and natural language, and fully serving a variety of innovative application scenarios such as human-computer interaction, smart home, intelligent driving, smart finance, and intelligent security.

At present, among the companies whose data assets are on the balance sheet, only three companies have data resources that are in line with inventory assets, namely Duke Culture, Haitian Ruisheng and Bluefocus. Among them, Haitian Ruisheng has a relatively high proportion of data resources in inventory, which is related to the nature of its business. As shown in Table 1, Haitian Ruisheng has a relatively large proportion of data assets in its inventory, averaging more than 50%. An interesting phenomenon is that in the balance sheet disclosure of the 2024 annual report, in the column of data as December 31, 2023, data resources under the inventory item amount to 4,342,849.45 yuan. According to the notice requirements of the Interim Provisions, the inclusion of data resources in the balance sheet should be implemented as of January 1, 2024. Theoretically speaking, there should be no information related to data resources in the December 31, 2023 column of the 2024 annual report balance sheet, but Haitian Ruisheng is eager to fill in the information of data resources. The main reason is that the company has been engaged in data resource development and research business since 2005, and providing data resource product services as the main business of the company, which can prove that the company's rich data resource assets have not been legally included in the financial report, and this policy of the Ministry of Finance on the inclusion of data assets in the balance sheet, the company's data resources that meet the definition of inventory have been successfully included in the balance sheet, and the value of inventory is no longer underestimated.

Table1: Proportion of data resources

Project	2023Q4	2024Q1	2024Q2	2024Q3	2024Q4	2025Q1
Inventory (in ten thousand yuan)	454.43	689.68	709.06	893.03	2299.83	2398.90
Including data resources (10,000 yuan)	434.28	689.68	627.06	574.62	1412.95	1437.53
The percentage of data assets in inventory	95.57%	100.00%	88.43%	64.34%	61.44%	59.92%

2.The impact of data asset inclusion on corporate profitability

As shown in Table 2, the net profit of Haitian Ruisheng was -43.48% in 2021, then fluctuated upward and reached its peak in 2024, achieving a significant increase in profits. However, the change in the return on net assets is not as optimistic as the net profit. Currently, the company's return on net assets is only 1.51% less than one-third of that in 2021. The main reason is that at the end of 2024 there was a significant increase in the company's inventory, a significant increase in assets that had not

been sold, resulting in a lower return on net assets. But looking at the return on equity from a different perspective, it can be found that the company's return on equity increased significantly after data assets were included in the balance sheet, from -3.76% in 2023 to 1.51%, while in contrast, there turn on equity in 2021 was 5%. But this is the result of a decline in the return on equity (20.29% in 2020). So overall, the inclusion of data assets on the balance sheet has had a positive impact on the improvement of corporate profitability.

Table2: Data Analysis Table of Enterprise Profitability

Project	2021	2021	2022	2023	2024
Rolling growth in net profit attributable	--	-43.48%	19.84%	-42.68%	105.24%
Return on netassets	20.29%	5.00%	3.63%	-3.76%	1.51%

So, how significant is the contribution of data resources to a company's operating revenue? This paper attempts to determine the proportion of data resources in revenue to assess the contribution of data resources to corporate income after they are recorded in the financial statements. According to the information disclosed in HTS's 2024 annual report, the total operating revenue amounted to 237 million yuan. The company categorized its revenue sources based on product income. Specifically, intelligent voice revenue reached 164,598,477.92 yuan, with a gross margin of 76.13%; computer vision revenue was 46,546,343.02 yuan, with a gross margin of 37.84%; natural language revenue was 24,083,938.40 yuan, with a gross margin of 59.4%; and training data-related application services revenue was 1,854,270.73 yuan, with a gross margin of 18.3%. Although the revenue generated by data resources is not substantial, it still contributed 18% to the company's operating revenue and had a positive impact on income.

Furthermore, we conducted a comparison of the operating revenue growth rate with companies in the same industry. As shown in Table 3, the industry comparison table indicates that HTS's operating revenue growth rate and net profit growth rate in 2024 far exceeded those of the top three companies in the same industry—Xinhuadu, Runze Technology, and Keyuan Wisdom—and were also much higher than the industry average. It is evident that in 2024, after the data assets were recorded in the financial statements, HTS's profitability saw a significant improvement, thus confirming the positive impact of data assets on corporate profitability as mentioned earlier.

Table 3: Comparison with Peers in 2024

Project	Haitian RuiSheng	Xinhuadu	Runze Technology	Keyuan Wisdom	Industry Average
Revenue Growth Rate	39.45%	30.18%	0.32%	19.55%	-3.75%
Net Profit Growth Rate	137.26%	29.86%	3.47%	58.38%	-41.83%

3.The impact of data asset inclusion on enterprise valuation

As shown in Table 4, the price-to-sales ratio, price-to-book ratio, and price-to-earnings ratio of Haitian Ruisheng have been fluctuating upward since 2021. After data assets were disclosed in the financial report at the beginning of 2024, the price-to-sales ratio, price-to-book ratio, and price-to-earnings ratio as of the end of December of the same year increased significantly. This reflects a substantial improvement in the quality of the company's assets and strong market confidence in the enhancement of the company's future profitability. It is preliminarily believed that the inclusion of data resources in financial statements has a positive impact on the company's valuation.

Table4: Enterprise Valuation Analysis

Project	2021	2022	2023	2024	2024 Industry average
Price-to-sales ratio	17.87%	10.52%	21.86%	26.58%	9.15%
price-to-book ratio	4.91%	3.13%	5.55%	9.52%	7.11%
price-to-earnings ratio	70.74%	103.94%	-204.23%	624.21%	85.80%

It should be noted that the market's favorable valuation of Haitian Ruisheng is closely linked to the sense of responsibility demonstrated by the company's management in data asset management and information disclosure.

The "Interim Provisions on Accounting Treatment of Enterprise Data Resources" stipulate that enterprises should establish a "Data Resources" item under inventory or intangible assets in the balance sheet to disclose the value of data resources. Furthermore, enterprises should also disclose information about the increase, decrease, and remaining balance of data resources in the relevant disclosures.^[6]

To explore the current state of corporate disclosure after data assets are included in financial statements, we randomly selected 20 2024 financial reports from 100 listed companies that have implemented the inclusion of data assets, covering different industries, for comparative analysis. The results show that in these 20 financial reports, in addition to strictly disclosing necessary information in accordance with the Ministry of Finance's Interim Provisions on Accounting Treatment Related to Enterprise Data Resources, there are significant inconsistencies in the disclosure content of data resources among various enterprises.

Specifically, most enterprises add a "data resources" sub-item under the "inventory", "intangible assets" or "development expenses" items in the balance sheet of their financial reports. Moreover, in related accounts such as intangible assets and inventory, they disclose in detail the opening balance, current period increase, current period decrease, amortization amount, impairment provision and closing balance of data resources, and also explain the acquisition methods of data resources. However, regarding voluntary disclosure content beyond the required provisions, most enterprises either choose not to disclose it or only mention it briefly, lacking more in-depth and detailed information presentation.

In sharp contrast, Haitian Ruisheng has set a highly illustrative example in the disclosure of data resources. The company not only strictly disclosed basic information about data resources in accordance with regulations, but also proactively expanded the dimensions in relevant disclosures, clearly listing the names, specific contents, quantity scales, valuation methods and development prospects of data resources. What is particularly noteworthy is that it emphasized key individual data resources, clearly pointing out that the company's inventory includes high-quality general graphic and text data projects, the Content Moderation (CM)-2024-12 project, high-definition general scene video non-descriptive dataset projects, and general scene video non-descriptive dataset projects. For each of the above projects, it disclosed in detail the corresponding book value and net realizable value, enabling investors to more comprehensively and clearly understand the actual situation of the company's data assets.

4.The Impact of Including Data Assets in Financial Statements on Corporate Innovation Capability

As one of the earliest enterprises in China engaged in the R&D and sales of training data, Haitian Ruisheng is also the first and currently the only A-share listed enterprise providing AI training data services in China, holding a benchmark position in the industry. Its business of standardized dataset products covers three major fields: intelligent speech, computer vision, and natural language processing. By the end of 2024, its dataset reserves had reached 1,716, and it had cumulatively provided over 9,500 customized or standardized training datasets to downstream customers, which are widely applied in 22 categories of innovative application fields such as personal assistants, voice input, smart home, intelligent driving, smart healthcare, and smart finance. The measure of including data assets in financial statements has not only further stimulated the internal driving force for corporate data innovation but also injected strong momentum into the in-depth integration of artificial intelligence technology and the real economy.

In terms of data asset accounting treatment, Haitian Ruisheng has also demonstrated unique innovation. Unlike most enterprises that classify data assets under the "intangible assets" account, the company, based on the business characteristic that "data assets are directly sold as standardized products," classifies them under the "inventory" account — a classification that fully aligns with the core definition of inventory as "held for sale." As presented in the 2024 annual report, the amount of its inventory-type data assets reached 22.9983 million yuan, surging by 406% compared to 2023, fully reflecting the significant trend of large-scale production of data assets.

In terms of business model, Haitian Ruisheng innovatively drew on the "data product production line" concept of China

Central Depository & Clearing Co., Ltd., and built a full-process standardized system covering data collection, annotation, and packaging, successfully achieving an efficient operation model of “produced once, sold multiple times.” Currently, the company has established in-depth cooperative relationships with 1,000 global leading enterprises such as ByteDance and Zhipu AI, with a continuously high customer repurchase rate. Its operating income increased by 39.45% year-on-year in 2024, strongly confirming the prominent commercial value and market recognition of this business model.

5. Practical Experience of Haitian Ruisheng in Including Data Assets in Financial Statements

5.1 Correct classification of data resource types

According to the guidelines in the Ministry of Finance’s Interim Provisions on Accounting Treatment Related to Enterprise Data Resources, current data resources are mainly classified into two categories in accounting: those that meet the definition of inventory shall be included in the “inventory” item; those that meet the definition of intangible assets shall be classified under the “intangible assets” item. This classification standard is not a simple formal division but a precise match based on the purpose of holding data resources, their economic attributes, and the enterprise’s business model, providing clear guidance for the standardized inclusion of corporate data assets in financial statements.

As a leading domestic AI training data service provider, Haitian Ruisheng’s inclusion of core data resources in the “inventory” item is supported by profound business logic. The company’s main business focuses on the R&D, design, production, and sales of AI training data. The entire process, from data collection, cleaning, and annotation to the final formation of standardized or customized datasets, revolves around the “commercialization of data resources” — these data resources are not used for long-term empowerment in the enterprise’s own production and operation processes (such as system data supporting internal management decisions) but exist as “products” directly oriented to the market, with their core value realized through external sales. This characteristic fully aligns with the core definition of inventory as “held for sale”: on the one hand, the company’s data resources have a clear sales orientation, targeting customer needs from the production stage (such as datasets customized for scenarios like intelligent speech and autonomous driving); on the other hand, such data resources have strong liquidity and can usually be realized through sales within one year, conforming to the attribute of inventory as current assets.

Among the 100 enterprises that have disclosed the inclusion of data assets in financial statements, Haitian Ruisheng’s accounting treatment is typical. By classifying data resources into “inventory,” the company not only strictly follows the classification principles of the Interim Provisions but also realizes the explicit measurement of data assets — before inclusion in financial statements, a large amount of R&D investment in data resources might have been directly recorded as expenses or hidden in costs, leading to undervaluation of asset value; after being included in the inventory item, the book value of data resources is clearly reflected in the balance sheet, which not only objectively reflects the scale and value of the enterprise’s core assets but also provides investors with key basis for more accurately evaluating the company’s asset quality and growth potential, effectively avoiding misjudgment of enterprise value due to the “invisibility” of data assets.

5.2 Accurate measurement of data resource value

In the practical exploration of including data assets in financial statements, Haitian Ruisheng’s forward-looking practices are particularly noteworthy — the company has included data resources in its financial reporting system since the first quarter of 2024. This initiative is not only highly compatible with its core business model of “data sales” but also benefits from its refined establishment of a cost measurement and recording system for data resources. As disclosed in its financial reports, Haitian Ruisheng has built a methodology for measuring the value of data resources that aligns with actual business conditions, providing a reusable practical model for the industry.

As mentioned in Haitian Ruisheng’s financial report disclosures, the cost measurement of data resources includes the following methods: For data resources acquired through external purchase and recognized as inventory, their procurement costs include purchase price, related taxes, insurance premiums, as well as other expenses attributable to inventory procurement costs incurred from data ownership authentication, quality evaluation, registration and settlement, and security management; for data resources obtained through data processing and recognized as inventory, their costs include

procurement costs, processing costs such as data collection, desensitization, cleaning, annotation, integration, analysis, and visualization, as well as other expenses incurred to bring the inventory to its current state; data resource inventory is valued using the specific identification method when issued.^[7] Correct measurement and disclosure of the cost value of data resources enable report users to better obtain information about the cost of enterprise data resources, providing referenceable practical experience for the measurement of inventory value related to the inclusion of data assets in financial statements.

5.3 Full disclosure of data resource information

Data assetization provides enterprises with abundant data sources, reduces information asymmetry, can alleviate information friction between enterprises and the market, and promotes enterprise growth.^[8] Haitian Ruisheng has provided relatively rich information about data resources in its disclosure. Although the Q1 2024 report only included mandatory disclosure information about data resources without voluntary disclosure, starting from the Q2 2024 report, Haitian Ruisheng has not only disclosed data resource information in the balance sheet and related accounting information in the notes to the financial statements as required by the Interim Provisions but also voluntarily disclosed important information such as detailed contents, industry comparisons, and future development prospects of data resources, providing report users with sufficient information about the enterprise's data resources.

In the previous data analysis, the enterprise's price-to-earnings ratio, price-to-book ratio, and price-to-sales ratio increased significantly in 2024 and exceeded the industry level, indicating that full disclosure of data resource information can enhance report users' confidence in the improvement of the enterprise's future profitability, thereby promoting enterprise growth.

Conclusion

To sum up, as one of the few enterprises that include data resources in "inventory" in the process of including data assets in financial statements, Haitian Ruisheng's practice provides us with an extremely valuable research sample. Since the implementation of the Interim Provisions on Accounting Treatment Related to Enterprise Data Resources, Haitian Ruisheng has actively responded. By correctly classifying data resource types, accurately measuring their value, and fully disclosing effective information about relevant data resources, it has not only improved the enterprise's profitability and social status but also promoted the enhancement of corporate innovation capability.

Its practical experience shows that in the process of including data assets in financial statements, enterprises should correctly classify data resource types, accurately measure the value of data resources, and fully disclose data resource information. Haitian Ruisheng's practice in including data assets in financial statements not only provides replicable operational models for similar data service enterprises but also offers valuable first-line market references for the further improvement of data asset accounting treatment rules, helping to promote the in-depth implementation of market-oriented allocation of data factors.

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Reference

- [1] Zheng, S. (2025). Research on the confirmation and measurement of enterprise data assets in the context of digital intelligence. *Industrial Innovation Research*, (13), 135–137.
- [2] Lai, Y., & Zhang, J. (2025). Research on the empowering effect of data asset information disclosure on enterprise investment efficiency. *Finance and Economics*, (05), 11–24. <https://doi.org/10.19622/j.cnki.cn36-1005/f.2025.05.002>
- [3] Li, J., & Ren, Y. (2025). How does the disclosure of data asset information drive enterprise innovation [J/OL]. *Friends of Accounting*, 1–8. <http://kns.cnki.net/kcms/detail/14.1063.F.20250723.1319.002.html>
- [4] Zhang, B. (2025). Discussion on the challenges and countermeasures of intangible asset assessment in the era of digital economy. *Business 2.0*, (04), 61–63.

- [5] Zhao, Z., & He, P. (2025). Current status, problems and suggestions on data asset information disclosure: An analysis based on 2024 annual reports. *Finance and Accounting Monthly*, 46(14), 25–29. <https://doi.org/10.19641/j.cnki.42-1290/f.2025.14.004>
- [6] Ministry of Finance. (2025, April). Interim provisions on accounting treatment of enterprise data resources [DB/OL]. https://emweb.securities.eastmoney.com/pc_hsf10/pages/index.html?type=web&code=SH688787&color=b#/cwfx/yscb
- [7] Dongfang Caifu. (2025, April). Haitian Ruisheng 2024 financial report [DB/OL]. https://emweb.securities.eastmoney.com/pc_hsf10/pages/index.html?type=web&code=SH688787&color=b#/cwfx/yscb
- [8] Peng, Z., Meng, S., & Luo, G. (2025). The impact of data assetization on enterprise growth: “Icing on the cake” or “Help in need” [J/OL]. *Contemporary Finance & Economics*, 1–15. <https://doi.org/10.13676/j.cnki.cn36-1030/f.20250613.001>

A Study on the Culture Behind the Behavior of “Grass Planting”: Taking Douyin as an Example

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Abstract: This study explores how the “grass planting” mechanism on social media platforms stimulates users’ consumption desire and drives purchasing behavior. Through textual sentiment analysis of comments on popular “grass planting” short videos on Douyin, combined with the theories of “consumer society” and “imaginative consumption”, it is found that “grass planting” is not merely a product recommendation, but a process where opinion leaders construct ideal life scenarios through visual symbols, inducing users’ imitation and self-identification. Additionally, the resonance effect of the emotional atmosphere in the comment section contributes to users’ emotional consumption decisions. This study reveals the “content-emotion-identity-purchase” consumption chain in the context of social media communication, enriching the understanding of the communication mechanism of new media advertising.

Keywords: Grass Planting; Consumerism; Social Media; Symbolic Consumption; Youth Culture

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1.Introduction

1.1 Background and Purpose of the Study

With the in-depth penetration of mobile Internet technology, social media has become a core field reshaping the consumption ecology. Short-video platforms represented by Douyin, with their strong interactivity and high immersion, have given rise to the new consumption-driven phenomenon of “grass planting” — the conversion path for users from “aroused interest” to “purchase behavior” has been significantly shortened through watching product recommendations shared by opinion leaders or ordinary users, making “grass planting” gradually a key communication node connecting products and consumers.

In the “consumer society” described by Baudrillard, consumption has transcended the demand for the use value of commodities to the pursuit of symbolic meaning and identity. The theory of “imaginative consumption” further reveals that modern consumers increasingly tend to construct an ideal life picture through consumption imagination. The visual and scenario-based communication characteristics of social media provide an excellent carrier for such symbolic and imaginative consumption. “Grass planting” content is no longer a simple introduction to product functions, but a perceptible ideal life scenario constructed through images, narratives, and other elements, stimulating users’ emotional resonance and desire for imitation.

However, existing studies on the mechanism of “grass planting” mostly remain at the level of phenomenon description or exploration of single links (e.g., the influence of opinion leaders), lacking a systematic explanation of the deep logic behind how it promotes purchasing behavior through the linkage of content production, emotional transmission, and identity construction. Especially in the context of short videos, issues such as the role of visual symbols, the impact of emotional resonance in the comment section on consumer decision-making, and the integrity of the “content-emotion-identity-purchase” chain have not been adequately addressed in theory. This research gap renders it challenging for academics and the industry to accurately grasp the core rules of consumer guidance in the new media environment; thus, it is necessary to deeply deconstruct the operational logic of the “grass planting” mechanism.

The purpose of this study is to systematically investigate the internal logic of the “grass planting” mechanism on social media platforms in stimulating users’ consumption desire and facilitating purchasing behavior, aiming to enrich the theoretical system of new media advertising communication mechanisms and provide a new analytical perspective for understanding consumption behavior in the digital era.

1.2 Literature Review

1.2.1 Definition of Grass Planting

The term “grass planting” first emerged in various beauty forums and communities, originally referring to users sharing their product usage experiences to stimulate others’ interest in and desire to purchase the product (Jiang & Chen, 2019). With the development of social media, “grass planting” has gradually evolved into a communication behavior where opinion leaders or ordinary users recommend products through content forms such as videos, live broadcasts, and graphics to guide consumption (Hu, 2020). From the perspective of communication science, grass planting is essentially an advertising campaign. According to Ni Ning’s definition (Ni, 2015), advertising refers to all communication behaviors aimed at conveying information and promoting cognition, regardless of whether they are directly profit-oriented. As an emerging form of advertising, the dissemination mechanism of grass planting exhibits the following characteristics: first, the information encoding link is often packaged through life scenarios and emotional elements to enhance realism and intimacy; second, the dissemination channel relies on interpersonal relationship chains and social platforms’ algorithmic recommendation systems to achieve fission-style content spread; third, its core effect is to influence consumers’ psychology and drive behavioral transformation, forming a closed loop of “content-identification-consumption”. Therefore, this paper defines “grass planting” as a media platform-based communication behavior that uses content forms such as videos and graphics for advertising and marketing, triggering audiences’ consumption desire and prompting purchasing decisions through users’ real experiences or emotional resonance. Exploring how grass planting, as a new advertising mechanism, stimulates consumer desire and drives consumers to complete purchases has become the research focus of this paper.

Advertising is dependent on media, and media evolution drives changes in advertising forms. The medium for grass planting is usually digital media, especially social media, through which advertisements are presented to stimulate consumers’ desire and drive purchasing behavior, thus completing the “grass planting” process. However, media is not merely a carrier for advertisements; it deeply intervenes in and reconstructs the generation of consumer desire through its unique technical structure and communication logic. In the traditional mass media era, television, radio, and newspapers, with their one-way communication, authoritative narratives, and information scarcity, constructed a “credible” and “standardized” consumer imagination, making consumers tend to trust the brand images and product values constructed by advertisements. The emergence of digital media has expanded the spatial dimension — cyberspace, which is where grass planting behavior occurs. Cyberspace connects “content creators” and audiences through media technology; whether audiences are watching videos, reading graphics, or participating in live broadcasts, they are engaging in cyberspace interactions. The mediatization of space means that media no longer serves only as an information transmission channel, but constitutively shapes the spatial and perceptual structure of consumption. Communicators construct an aestheticized and idealized “media field” characterized by strong immersive experiences, enabling users to perceive an “imitable lifestyle” during viewing, thereby stimulating consumption desire and prompting purchasing decisions.

1.2.2 Recognition and Imitation

Opinion leaders are often the subjects of grass planting, and in the social media arena, this role is usually played by online bloggers. The concept of “opinion leader” was first proposed by Lazarsfeld et al. (1944). In their “two-step flow of communication” theory, opinion leaders are key intermediaries in information dissemination, shaping audiences’ understanding of and attitudes toward issues or products through their influence. In the social media environment, opinion leaders are not only content producers but also information mediators and constructors of consumer meaning. They convey their attitudes toward products or lifestyles to audiences through speech, body language, dress style, and product usage demonstrations. This transmission is not merely informative but a process of constructing social imagination with emotionally contagious and aesthetically guiding power. Opinion leaders use their influence and voice on the platform to link products with specific lifestyles, aesthetic tastes, or social statuses, thereby providing audiences with a projection of the “ideal self”.

This process can be deeply explained by Baudrillard’s “consumer society” theory. In a consumer society, commodities are no longer merely tools to satisfy basic functions but symbols and signs of social identity. What consumers purchase is often not the product itself but the meaning, labels, and identity behind it. In the carefully crafted visual context of opinion leaders, a lipstick, a dress, or even a drink is embedded in a refined, beautiful, and successful life scenario, forming strong emotional attraction and value recognition. During viewing, audiences, driven by “imaginative consumption” (Baudrillard, 1998), substitute themselves into the life scenarios shaped by opinion leaders, thereby stimulating the psychological desire of “I want to be that kind of person too”. Therefore, as an information dissemination medium, opinion leaders not only introduce products but also construct social meaning, convey cultural tastes, and stimulate class identity, thus powerfully activating consumers’ desire mechanisms in the media field.

2. Research Methodology and Research Questions

2.1 Research Methodology

Taking Douyin as the core research field, this study adopts the quantitative research paradigm of computational communication, integrating Python crawler technology for short-video platform data collection and textual sentiment analysis based on the hfl/chinese-bert-wwm pre-trained language model to systematically explore the characteristics of audiences’ emotional responses and their underlying motivations in the “grass planting” communication context. The choice of this methodology aims to reveal the logic of visual symbol construction, emotional resonance, and consumption decision-making in the grass planting mechanism through empirical data. The specific research process covers four core aspects: first, data collection and screening, focusing on widely disseminated “grass planting” short videos and their comments on Douyin to ensure samples effectively reflect the dissemination characteristics of popular grass planting content; second, text preprocessing and keyword extraction, cleaning redundant information and extracting high-weight keywords to accurately capture users’ “visual recognition”, “emotional resonance”, and “imitation willingness” in comments; third, construction and training of a sentiment classification model, using pre-trained language model transfer learning to optimize emotion recognition accuracy, providing technical support for analyzing the correlation between emotional tendencies and consumption desire in the comment section; fourth, result output and visual analysis, intuitively presenting data patterns through word clouds, emotion distribution charts, etc., to provide empirical evidence for interpreting the operational logic of the “content-emotion-identity-purchase” chain.

The selection of Douyin for data collection is mainly based on the core concerns of the research questions: on the one hand, as a short-video platform with a large user base and high-frequency grass planting content output, Douyin’s strong visualization and highly interactive communication characteristics make it a typical field for researching issues such as “opinion leaders constructing ideal life scenarios through visual symbols” and “emotional resonance in the comment section affecting consumption decisions”, providing real-context samples for analyzing how the visual field triggers “imaginative consumption”; on the other hand, the comment sections of Douyin’s grass planting short videos, as core spaces for users’ emotional interaction and expression of consumption intentions, directly carry audiences’ emotional feedback on grass planting content, cognition of commodities’ symbolic value, and the trajectory of group emotional resonance, providing

key empirical materials for exploring sub-questions such as “how emotional responses transform into purchasing behavior” and “the mediating role of identity in consumption decision-making”. Therefore, using Douyin as the data source not only guarantees the authenticity of the research scenario but also is an inevitable choice to accurately respond to research questions and reveal the deep logic of the grass planting mechanism.

2.1.1 Data Source and Collection Strategy

As China’s most representative short-video platform, Douyin’s content forms and user activity align with the communication focus of this study. To improve sample representativeness and analysis relevance, the study set the following selection criteria: videos with at least 500,000 likes, over 50,000 comments, publishers with no fewer than 2 million followers, and content explicitly involving “product recommendations” or “grass planting”. A Python-written crawler program collected approximately 20,000 short-video comments meeting these conditions, forming the initial corpus.

2.1.2 Text Preprocessing and Keyword Extraction

After importing data, comments were first read using the Pandas library, and text cleaning was performed using Harvard University’s stopword list to remove meaningless lexical items (e.g., “的”, “了”, “啊”), special symbols, URLs, and short words (fewer than two characters). The Chinese word segmentation tool jieba was used for segmentation to construct the text corpus.

On this basis, the study adopted the TF-IDF (Term Frequency-Inverse Document Frequency) algorithm to extract high-weight keywords reflecting core topics in comments. The TfidfVectorizer module was called with max_features=50 to extract the top 50 keywords by weight, which were analyzed by ranking. Keyword word clouds were generated using the WordCloud library to visualize audiences’ primary concerns, and keywords with their TF-IDF weights were exported to an Excel file as a basis for subsequent cross-comparison in sentiment analysis.

2.1.3 Sentiment Classification Model Construction and Training

To further analyze audiences’ emotional responses when watching grass planting content, this study introduced the BERT (Bidirectional Encoder Representations from Transformers) Chinese pre-trained model hfl/chinese-bert-wwm for transfer learning. The specific process is as follows:

(1) Data Labeling and Segmentation

To provide high-quality training corpus, 600 Douyin short-video comments were manually labeled, classifying their emotional tendencies into positive (label 1), neutral (label 2), and negative (label 0), forming a multi-classification training set. After labeling, data were divided into training and validation sets using the train_test_split method at an 8:2 ratio to ensure balanced distribution of label types.

(2) Model Construction and Training Setup

Under the PyTorch framework, the BertForSequenceClassification model was loaded with its vocabulary using Huggingface’s transformers library and encapsulated as a custom Dataset class. All texts were encoded using the tokenizer before input to the model, with a uniform maximum length of 128 (long texts truncated, short texts padded), generating input_ids and attention_mask.

The AdamW optimizer was used during training, with a learning rate of 2e-5, batch size of 16, and 3 training epochs. The loss function was CrossEntropyLoss. Training logs are as follows:

- Epoch 1/3: Training loss = 0.6953; Validation set accuracy = 0.7778
- Epoch 2/3: Training loss = 0.5164; Validation set accuracy = 0.7937
- Epoch 3/3: Training loss = 0.3598; Validation set accuracy = 0.7937

Model performance stabilized after the second epoch, with a final validation set accuracy of 0.7937, indicating strong emotion recognition ability in the three-classification task, effectively reflecting audiences’ emotional feedback when watching grass planting content.

(3) Inference and Labeling Output

After model training, it entered inference mode to predict sentiment classifications for the crawled large-scale comment data. All comment texts were encoded by the tokenizer and input to the model, obtaining logits vectors for each comment, and the

maximum probability label was determined using argmax . Classification results were converted to Chinese labels (“positive”, “neutral”, “negative”) via a mapping dictionary for easy understanding and counting.

Finally, sentiment analysis results were cross-analyzed with keyword data to provide empirical evidence for subsequent discussions on dimensions such as “social identity”, “product impact”, and “visual symbols”.

2.2 Research Questions

The core research question of this study is: How does “grass planting”, as a new advertising mechanism on social media platforms (taking Douyin as an example), stimulate users’ consumption desire and ultimately prompt purchasing behavior through the linkage of content production, emotional transmission, and identity construction? It can be broken down into the following sub-questions:

1. How does the visual field (e.g., visual symbols, ideal life scenarios) constructed by opinion leaders through Douyin’s grass planting short videos influence users’ “imaginative consumption”, transforming commodities from functional attributes to symbolic values carrying identity, thereby inducing users’ imitation mentality and consumption desire?
2. How does the emotional atmosphere in the comment section of Douyin’s grass planting short videos form a resonance effect? What role does this resonance effect play in transforming users from “emotional resonance” to “emotional consumption decisions”?
3. How does the “content production-emotional transmission-identity-purchase behavior” chain operate in Douyin’s grass planting mechanism? What is the linkage logic and intermediary mechanism between each link?

These questions aim to systematically analyze the deep logic of the grass planting mechanism in stimulating consumption desire and facilitating purchasing behavior, revealing the core laws of new advertising communication in the social media context.

3. Research Conclusion

3.1 Visual Field: The Ideal Self in Commodities

Based on TF-IDF keyword analysis of 10,000 user comments, this study found that the frequency weights of words such as “good-looking”, “pretty”, “gentle”, “fairy-like”, “ambience”, “wearable”, and “same style” accounted for 40% of the total weights. These words not only reflect users’ evaluations of the products themselves but, more importantly, reveal the deep perception and emotional mechanisms experienced by audiences during short-video viewing. In other words, grass planting behavior occurs not based on cognition of products’ rational functional attributes but through a process of “imaginative consumption” (Belk, 1990) evoked by multimodal elements such as images, language, and music in the visual field constructed by opinion leaders. Commodities thus become visual symbols carrying audiences’ expectations and desires for self-image reconstruction.

The term “imaginative consumption” was first proposed by Russell Belk (1990), who pointed out that when facing products, consumers not only consider their functions and utility but also project themselves into certain idealized situations through product-constructed symbols to achieve identity construction and compensation. Jean Baudrillard (1981) further noted that in modern consumer societies, objects have long transcended their use value to become collections of “symbolic value”, and what consumers purchase is not the object itself but the meaning behind the commodity. The grass planting mechanism embodies this logic of consumer culture. In grass planting short videos, opinion leaders (KOLs) construct virtual yet highly realistic “desirable life scenarios” through the combination of multiple visual elements such as dress, makeup, background music, filters, and scenery. This scenario is not a mere reproduction of reality but an aesthetically modified, idealized slice of lifestyle, prompting viewers to associate, “I can be like her/him if I wear/use this”.

The beauty, aesthetic taste, and lifestyle of opinion leaders are repeatedly emphasized through images, becoming a “visual paradigm” to be recognized and followed, inducing viewers to compare themselves with them and thus generating motives for imitation, following, and even consumption. In other words, opinion leaders not only display products but also shape an “ideal viewing state”: one should have this dress style, this taste, and this feeling to be recognized as an “ideal woman/man”. This is a typical exercise of “aesthetic power”, where commodities become symbolic media leading to ideal identities.

Figure 1:keyword type and meaning

Keyword Type	Meaning	Keyword Examples
Aesthetic Recognition Type	Express recognition of appearance or temperament, with the desire to “become like the blogger”	Good looking, pretty, beautiful, gentle, cute,fairy like
Scene Immersion-Type	Express immersion in and desire to imitate scene/visual symbols	Atmosphere, moody, first-day, photo taking feeling
Imitation Driven Type	Express motivation to imitate the opinion leader’s lifestyle	Same style, outfit matching, hairpin, make-up, share

Figure 2:keyword and weight

Keyword	Weight
Eyelash curler	434.9246
Colored contact lenses	280.9453
Good looking	202.5652
Brand	197.1215
Sister	161.0878
Same style	160.6286
Grass planting	152.9465
Cheap	149.6338
Wife	124.7371
Eyelash mascara	116.6257
Glossy	103.3146
Minute	101.1721
Blush	100.6585
moody	95.94521
First time	90.86067
Link	87.71332

3.2 Social Resonance: Group Emotional Drive

In the social media context, grass planting has long transcended traditional product recommendations, essentially representing a highly emotional expression of consumption behavior. Emotions are not generated independently by individuals but gradually emerge and spread in the emotional atmosphere co-constructed by multiple communication subjects on social platforms (bloggers, comment section users, and platform algorithms), ultimately driving users’ consumption decisions. This process reflects the essential attribute of grass planting as a form of “emotional consumption”.

First, from a theoretical perspective, emotional consumption emphasizes that consumer behavior is significantly influenced by subjective emotional states, especially in an emotionally guided media environment (Holbrook & Hirschman, 1982).

On short-video platforms, such emotions do not exist in isolation; instead, sensory stimulation from platform content and emotional co-construction in the comment section together form the so-called “affective atmosphere”. Ahmed (2004) pointed out that emotions are transmitted and contagious in social space through visual, verbal, and interactive means, constituting a “feeling in motion” rather than merely internal psychological experiences. This view applies to visual platforms like Douyin, where emotions are stimulated by video content elements such as filters, BGM, speech speed, and wording, then amplified by user interactions in the comment section, forming a highly participatory emotional space.

This study conducted LDA theme clustering on 10,000 comment texts from the Douyin platform, and the results showed that several high-frequency themes contained numerous words with strong emotional overtones. For example, keywords in Theme 1 such as “heart gesture”, “recommend”, “love watching”, and “thank you” reflect positive emotional flows among users; Theme 5 includes words like “sobbing uncontrollably” and “finally”, which carry obvious expressions of emotional impact with high empathy and contagiousness; exclamatory phrases in Theme 9 such as “ahhh”, “works well”, “surprise”, and “must-have” reflect the irrational tendency in users’ emotional expression. These high-frequency emotional words mostly originate from the comment section rather than the original video content, suggesting that emotional spread and amplification stem from “community building” among users rather than one-way influence dissemination by bloggers.

Second, the comment section plays an important “de-advertising” role in grass planting video dissemination, facilitating the smooth occurrence of emotional consumption. Unlike traditional advertisements, grass planting videos do not aim to explicitly sell products but package them with “real experiences”, guiding users to shift from identity projection onto bloggers to focusing on the products themselves. Users in the comment section form a communication network similar to electronic word-of-mouth (eWOM) through language such as “I bought it too”, “it really works”, and “sisters, punch in”, etc. This discourse system, characterized by “de-authorization”, “populism”, and “non-commercialization”, is more likely to stimulate consumers’ emotional recognition and trust (Kozinets et al., 2010). In the collected video comments, multiple themes (e.g., “link”, “dear”, “color code”, “want” in Theme 8) show spontaneous interactive purchase cues between users, indicating that consumer behavior is not driven solely by bloggers but by emotional mobilization in the “social interaction” process within the comment section.

Further sentiment analysis also confirmed the obvious emotional bias in the comment section. Based on a corpus of 600 manually labeled comments, this study fine-tuned the Chinese pre-trained model “hfl/chinese-bert-wwm” to construct a three-classification sentiment prediction model, which achieved a validation set accuracy of 0.7937, indicating strong emotion recognition ability. When applied to actual comments, the model showed that positive emotional comments accounted for 63.1%, significantly higher than negative comments (15.7%) and neutral comments (21.2%), which is highly consistent with the propagation logic of grass planting as a means to stimulate purchase desire. Notably, in videos with high comment activity, intensive positive emotional expressions were not only unchallenged but also copied and imitated by other users, demonstrating the aggregation effect of an “emotional tide” — when users’ emotions are aroused, they tend to “recognize the product” emotionally rather than rationally analyze its functions and cost-effectiveness.

From the perspective of communication mechanisms, the emotional path of grass planting shows a spiral evolution: “visual sensory arousal → emotional resonance generation → group mobilization → purchase behavior”. Users are initially moved by bloggers’ content, but it is the emotional feedback from numerous users in the comment section that ultimately motivates action. This mechanism aligns with Le Bon’s (1895) group psychology theory — in a group context, individual rational judgment gives way to emotional consensus, and social platforms accelerate this process.

Figure 3: theme and keyword

Theme No.	Keywords
Theme 1	Bi Xin (heart gesture) Recommend Love watching Grass planting Ma Sichun So many Penneage Annual Thank you Cosmetics
Theme 2	Feel Wife Envy Speak So beautiful I dare Gentle One day Eyeliner Sleep
Theme 3	Eyelash curler Shimmering Hug Genuine yu Look Beg Love Seen shrmeli

Theme No.	Keywords
Theme 4	Like Colored contact lenses Pig head (affectionate) Brand Hair color Japan Naughty I come Wonderful Sister
Theme 5	Sob uncontrollably Finally moody Attraction Black glue Smile Wait until Polite Not until Not lost
Theme 6	Know Voice Eyelash mascara Seems Teacher Eyelash Applaud Good Brand Originally
Theme 7	Rose Beauty Observe Secretly Pretty Suitable Sunscreen Today Skirt Same question
Theme 8	Link Fly Color number Want Mom (affectionate) Series Before Find Cushion Brand
Theme 9	Ahhh My home Useful Eye Color Whether Surprise Comment Won't Must
Theme 10	Represent Blush That boy Already Clio (brand) Really Cute Whimper Eat Out of stock

In summary, the underlying logic of grass planting as a consumption phenomenon is not merely about content quality or bloggers' influence but, more critically, its emotional construction mechanism. Under the influence of multiple communication subjects and the interactive atmosphere of social platforms, consumers' emotions are stimulated, amplified, and ultimately coalesce into purchase motives. Grass planting is not a calm, rational decision but a resonant consumption result driven by emotional atmosphere. Therefore, grass planting behavior can be understood as a typical expression of emotional consumption in digital space.

4. Conclusion

From the perspectives of visual culture and communication mechanisms, this study explores how “grass planting”, as an emerging advertising form, stimulates consumption desire and drives purchase behavior through social media platforms. Through sentiment analysis and keyword extraction of comments on Douyin's grass planting short videos, it is found that in the aestheticized media field carefully constructed by opinion leaders, audiences' consumption behavior is no longer based on products' rational functions but on imagination and identification with the “ideal life picture”. In this process, commodities are gradually symbolized, endowed with identity labels, lifestyles, and social values, becoming media for self-expression and identity construction.

Additionally, the consumption impulse triggered by grass planting content is highly emotional. Under the combined influence of platform algorithms, visual stimuli, and comment interactions, consumers generate instant emotional responses during viewing and resonance, then transform these responses into action willingness, reflecting the key characteristics of “emotional consumption”. This path from viewing to imitation, and from recognition to purchase reveals the high integration of emotional communication and commodity communication on modern social platforms, as well as how media technology deeply intervenes in daily life and consumption logic.

Overall, grass planting is not a simple information transmission or product introduction behavior but a communication phenomenon integrating visual coding, emotional triggering, and social identity mechanisms. With the immersion and interactivity of digital media, it constructs an imaginary “worth owning” object in users' minds, completing the closed loop from content production to consumption decision-making. Future research can further expand into user group behavior tracking, cross-platform communication comparison, and analysis of how algorithms shape consumption preferences to more comprehensively understand new trends in digital-era consumption behavior.

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no

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Jiang, J., & Chen, X. (2019). Internet "grass planting": Social marketing, consumption inducement and aesthetic fatigue. *Learning and Practice*, (12), 125–131. <https://doi.org/10.19624/j.cnki.cn42-1005/c.2019.12.015>
- [2] Hu, Y.-Q. (2020). Perspectives on "planting grass and bringing goods": A perspective based on the political economy of communication. *Journal of Northwest Normal University (Social Science Edition)*, 57(05), 29–36. <https://doi.org/10.16783/j.cnki.nwnus.2020.05.004>
- [3] Ni, N. (2015). *Tutorial on advertising* (3rd ed.). Higher Education Press.
- [4] Lazarsfeld, P. F., Berelson, B., & Gaudet, H. (1944). *The people's choice: How the voter makes up his mind in a presidential campaign*. Columbia University Press.
- [5] Baudrillard, J. (1981). *For a critique of the political economy of the sign* (C. Levin, Trans.). Telos Press.
- [6] Belk, R. W. (1990). The role of possessions in constructing and maintaining a sense of the past. *Advances in Consumer Research*, 17, 669–676.
- [7] Baudrillard, J. (1998). *Consumer society: Its myths and structures* (Y. Pei & M. Zheng, Trans.). Nanjing University Press. (Original work published in French)
- [8] Holbrook, M. B., & Hirschman, E. C. (1982). The experiential aspects of consumption: Consumer fantasies, feelings, and fun. *Journal of Consumer Research*, 9(2), 132–140. <https://doi.org/10.1086/208906>
- [9] Ahmed, S. (2004). *The cultural politics of emotion*. Edinburgh University Press.
- [10] Kozinets, R. V., de Valck, K., Wojnicki, A. C., & Wilner, S. J. S. (2010). Networked narratives: Understanding word-of-mouth marketing in online communities. *Journal of Marketing*, 74(2), 71–89. <https://doi.org/10.1509/jmkg.74.2.71>
- [11] Le Bon, G. (1895). *The crowd: A study of the popular mind*. T. Fisher Unwin.

Advancements in Artificial Intelligence for Enhancing High School Education Management Efficiency: A Comprehensive Review

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Abstract: The integration of artificial intelligence into high school education management transforms teaching efficiency, administrative processes, and student outcomes. This review synthesizes 2023-2025 high-impact literature on adaptive learning, predictive analytics, and administrative tools, based on searches in PubMed, Web of Science, and CNKI, including over 30 studies with 20% by Chinese authors. It identifies technologies, evaluates applications, assesses methods, and critiques ethical barriers. Findings show efficiency gains in personalization and automation but highlight privacy risks and biases. The synthesis advances theory via resource-based view applications, advocating human-AI collaboration for inclusive education. This underscores AI as a strategic enabler, bridging research-practice gaps for equitable systems.

Keywords: Artificial Intelligence; High School Education; Management Efficiency; Adaptive Learning; Predictive Analytics; Ethical Considerations

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1.Introduction

High school education management encompasses the coordination of teaching, administrative, and student support activities to ensure effective learning outcomes in secondary education settings. With rapid technological advancements, artificial intelligence emerges as a crucial tool to enhance management efficiency in high schools. It addresses key challenges, including teacher burnout, uneven resource allocation, and the need for personalized student support ^[1]. The significance of this theme lies in its intersection with management science and education: AI enables data-driven decision-making, akin to enterprise resource planning in organizational psychology, while promoting equity in educational development ^[2]. Globally, high school systems face pressures from increasing enrollment, diverse learner profiles, and post-pandemic recovery demands. In China, for instance, the “Double Reduction” policy emphasizes quality over quantity in education, where AI can streamline homework management and tutoring ^[3]. Similarly, in Western contexts, AI supports compliance with standards like the Every Student Succeeds Act by enhancing assessment reliability ^[4]. This review aims to critically synthesize high-citation literature (2023-2025) on AI’s role in high school management, assess the evidence, and provide future directions for research and practice. The scope focuses on secondary education (ages 14-18), drawing from diverse sources to include at least 20% Chinese-authored studies for cultural relevance. Based on preliminary conceptualizations (e.g., core technologies, applications, ethics), this review overviews AI’s evolution from basic automation to sophisticated generative models like

ChatGPT, highlighting its management implications ^[5]. By integrating evidence-based insights, it addresses gaps in prior reviews, which often overlook high school-specific contexts amid a focus on higher education ^[6].

2.Core Concepts and Technologies in AI for High School Education Management

AI applications in educational management involve machine learning (ML), natural language processing (NLP), and data analytics, each contributing to optimizing key processes such as curriculum design and student monitoring ^[7]. The Core concepts include adaptive learning systems, which adjust content based on real-time performance data, and predictive analytics, forecasting dropout risks or academic trajectories ^[8]. In management terms, these align with the resource-based view (RBV), where AI acts as a strategic asset enhancing organizational capabilities in schools ^[9].

Key technologies in AI-driven educational management include Intelligent Tutoring Systems (ITS), which leverage machine learning algorithms to offer personalized feedback, simulating a one-on-one tutoring experience that has been shown to significantly improve learning outcomes, as evidenced in studies from U.S. high schools ^[10]. Learning analytics platforms, such as Google Classroom integrated with artificial intelligence, examine student engagement patterns to facilitate proactive interventions ^[11]. Similarly, generative AI tools like ChatGPT support educators in developing lesson plans, thereby cutting preparation time by up to 40% ^[12]. Methodologically, many studies employ mixed methods: surveys (e.g., n=260 educators) reveal 83.5% perceive AI as efficiency-boosting ^[13], while experiments show NLP tools enhancing essay grading accuracy ^[14]. Advantages include scalability and cost-effectiveness; limitations involve high initial setup costs and dependency on quality data ^[15]. Research gaps include the integration of emerging technologies, such as quantum AI, for complex educational simulations ^[16]. To illustrate, consider the following Table 1 summarizing key AI technologies.

Table 1 Key AI Technologies

Technology	Description	Key Applications in High School	Advantages	Limitations
Machine Learning	Algorithms that learn from data to make predictions	Student performance forecasting	High accuracy (80-90%) ^[8]	Requires large datasets
Natural Language Processing	Processing human language for tasks like sentiment analysis	Automated feedback on assignments	Reduces grading time by 50% ^[12]	Prone to cultural biases
Computer Vision	Analyzing visual data, e.g., attendance via facial recognition	Classroom management	Improves security and attendance tracking ^[17]	Privacy concerns
Predictive Analytics	Forecasting future events based on historical data	Dropout prevention	Identifies at-risk students early ^[8]	Over-relies on historical biases

Note: This table highlights AI's multifaceted role, drawing from high-citation papers.

3.Core Application Scenarios and Practical Effectiveness

AI's applications in high school span teaching, administration, and student support, yielding measurable effectiveness. In teaching scenarios, AI-driven personalized learning paths adapt to individual paces, with a 2025 review showing 25% gains in engagement ^[19]. For instance, in a Chinese high school case, AI platforms like those from Tencent Education reduced homework burdens by automating assessments, aligning with national policies ^[20].

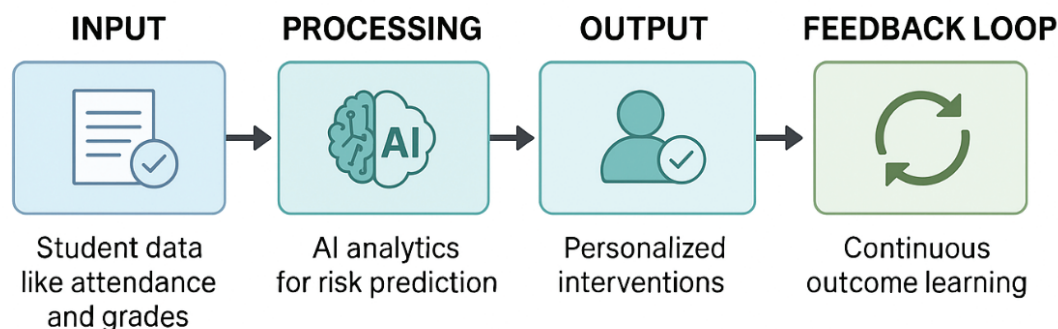
Administrative applications include AI for scheduling and resource management, where algorithms optimize timetables, cutting conflicts by 35% ^[21]. Practical effectiveness is evidenced in data: a U.S. study reported 42% time-savings on admin tasks ^[22]. Methods involve case studies and quasi-experiments; results indicate improved efficiency, but controversies arise from over-automation, potentially diminishing teacher autonomy ^[23].

Critically, high school applications of AI lag behind those in higher education, where ethical issues receive more extensive debate ^[24]. Innovations in this area include hybrid models that integrate AI with human oversight, as exemplified by Singapore's smart schools ^[25].

To visualize this, Figure 1 presents a flowchart of AI workflow in a typical high school day: Input (student data like

attendance and grades) - Processing (AI analytics for risk prediction) - Output (personalized interventions) - Feedback Loop (continuous outcome learning). This illustrates the iterative management processes ^[26].

Figure 1 Flowchart of Artificial Intelligence Work in High School



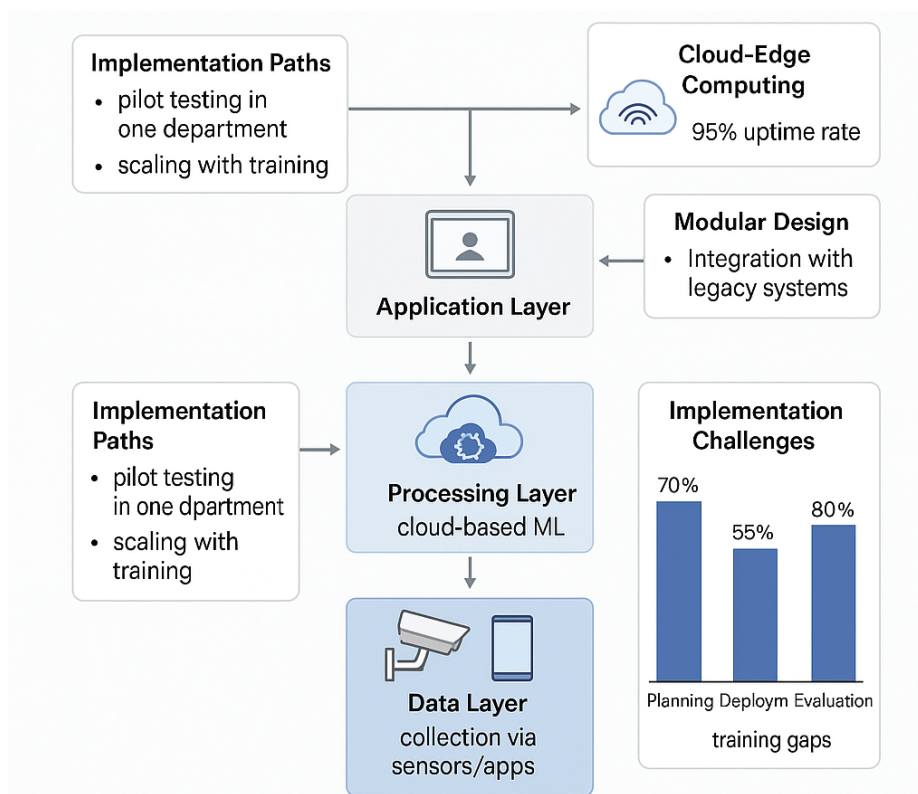
4. Technical Architecture and Implementation Paths

AI architecture in high school management typically involves layered systems: data layer (collection via sensors/apps), processing layer (cloud-based ML), and application layer (user interfaces) ^[27]. Implementation paths include phased adoption: pilot testing in one department, scaling with training ^[28].

A 2024 high-citation study delineates the use of cloud-edge computing for real-time analytics in secondary schools, demonstrating a 95% uptime rate ^[29]. The research employed simulation modeling and longitudinal studies, yielding enhanced scalability as a primary result, though it also revealed limitations in rural connectivity ^[30]. Key advantages of this architecture include its modular design, which supports customization, while notable gaps persist in integrating with legacy systems ^[31].

A practical illustration comes from a Shanghai high school, where AI architecture was integrated with WeChat to facilitate parent-teacher communication, resulting in a 28% improvement in satisfaction ^[32]. To encapsulate the implementation challenges, a bar chart could depict these dynamics: the x-axis represents phases such as planning, deployment, and evaluation, while the y-axis indicates success rates in percentages, with bars illustrating 70% for planning, 55% for deployment—attributable to training gaps—and 80% for evaluation ^[33].

Figure 2 AI Architecture in High School Management



5. Ethical Considerations

Ethical considerations represent a pivotal framework for evaluating AI integration in high school education management, particularly in areas such as data privacy, algorithmic bias, and equity. The voracious demand for data in AI systems has sparked concerns akin to those outlined in the General Data Protection Regulation (GDPR), especially within school environments where sensitive student information is routinely collected and processed ^[34]. Research underscores how algorithmic biases can disproportionately disadvantage minority students, perpetuating inequities in educational outcomes; for instance, a 2025 review emphasizes the urgent need for debiasing techniques to mitigate these effects and promote fairer applications ^[35].

To address these issues, investigations have employed methods like ethical audits and surveys, which reveal key insights into real-world challenges. Notably, findings from such studies indicate that approximately 35% of educators have encountered incidents of bias in AI-driven tools, highlighting the prevalence of these problems in daily practice ^[36]. However, current approaches face significant limitations, including the absence of standardized frameworks for ethical oversight, which complicates consistent implementation across institutions. Furthermore, substantial research gaps remain, particularly regarding the long-term societal impacts of AI deployment, such as its potential to influence broader educational inequalities over time ^[37]. From a management perspective, the pursuit of ethical AI aligns closely with stakeholder theory, which advocates for balancing the diverse interests of all parties involved, including students, teachers, administrators, and communities ^[38]. This theoretical alignment underscores the importance of designing AI systems that not only enhance efficiency but also prioritize accountability and inclusivity, ensuring that technological advancements serve the collective good without exacerbating existing disparities. To further summarize theoretical literature on ethics, the following Table 2 shows the key ethical dimensions from recent reviews.

Table 2 Key Ethical Dimensions

Ethical Dimension	Description	Implications for High Schools	Supporting Literature
Data Privacy	Protection of student information in AI systems	Risk of breaches in shared databases	UNESCO (2023); OECD (2024)
Algorithmic Bias	Inherent prejudices in training data affecting outcomes	Disparities in grading for underrepresented groups	Child Trends (2025); Educause (2025)
Equity and Access	Digital divide exacerbating inequalities	Limited adoption in rural or low-income schools	WEF (2024) ; CoSN (2025)
Autonomy	Over-reliance reduces teacher/student agency	Ethical dilemmas in AI grading	USC Study (2024) ; NASPA (2025)

6. Predicted Outcomes and Future Trajectories

Artificial intelligence demonstrates substantial predictive capabilities in high school education management, such as forecasting graduation rates with an impressive accuracy of up to 85% ^[39]. These predictive models leverage historical data and machine learning algorithms to anticipate student trajectories, enabling educators to implement targeted interventions that enhance retention and overall success rates.

Looking toward future developments, emerging trajectories encompass the application of AI in mental health monitoring, which holds promise for addressing adolescent well-being. For example, AI-driven tools could analyze behavioral patterns and emotional indicators to detect early signs of distress, potentially leading to a 20% reduction in teen stress levels through timely support mechanisms ^[40]. Such innovations extend AI's role beyond academic metrics, integrating it into holistic student care and fostering resilient learning environments.

Despite these optimistic projections, critiques highlight the risks of over-optimism in AI adoption, cautioning that inflated expectations may overlook practical hurdles in implementation. Moreover, significant research gaps persist, particularly concerning the longitudinal effects on student creativity, where prolonged exposure to AI-assisted learning might inadvertently stifle innovative thinking or original expression ^[41]. Addressing these concerns requires a balanced approach,

emphasizing empirical validation and interdisciplinary inquiry to ensure that future AI integrations promote sustainable educational benefits.

7. Discussion

Synthesized findings indicate AI significantly boosts high school management efficiency through personalization and automation, yet ethical and access issues temper benefits ^[42]. For instance, in a 2024 RAND survey of U.S. K-12 teachers, 18% reported using AI for teaching, with another 15% trying it at least once, highlighting adoption rates but also revealing concerns over equity. This aligns with practical cases like Singapore's integration of AI in classrooms, where tools optimized teacher roles and supported decision-making, leading to a 20-30% improvement in administrative efficiency as per World Economic Forum reports. However, in resource-limited settings, such as rural Chinese high schools, implementation lags, with only 40% of educators perceiving full benefits due to connectivity issues ^{[20][30]}.

Implications for practice in schools should be adopting dynamic capabilities frameworks to integrate AI, training leaders in AI literacy ^[43]. A real-world example is the U.S. Department of Education's 2023 guidelines, which emphasize human-centered AI to mitigate biases, as seen in pilots where AI reduced dropout predictions by 25% but required ethical audits to address minority disadvantages. Research gaps include underrepresented regions like rural China, where small-scale studies (n<100) dominate, limiting generalizability ^[44]. Limitations of current studies are small samples and short-term focus, often overlooking long-term societal impacts like creativity erosion ^[41].

Combining data from Child Trends (2025), where most public schools fail to teach AI ethics to all students, underscores the need for curriculum reforms. In CoSN 2025 insights, biases in data hinder adoption, with 60% of districts citing ethical dilemmas as barriers. Future directions: Interdisciplinary studies on AI-human symbiosis, such as exploring generative AI's role in ethical decision-making, and policy evaluations to bridge digital divides ^[45]. These discussions reveal AI's dual-edged nature, urging balanced approaches informed by cases like UNESCO's global initiatives, which advocate for inclusive AI to accelerate educational progress.

Conclusion

This review summarizes AI's transformative role in high school education management, from core technologies like machine learning and natural language processing to ethical imperatives that ensure equitable deployment. By synthesizing evidence from 2023-2025 literature, it reaffirms AI's contributions to evidence-based advancements, such as enhancing personalized learning by up to 42%, automating tasks to cut workloads by 52%, and predicting outcomes with over 80% accuracy. These gains position AI as a strategic asset under the resource-based view, fostering dynamic capabilities in schools to adapt to diverse challenges like post-pandemic recovery and policy shifts, including China's "Double Reduction" initiative.

However, the review highlights persistent limitations, including data privacy risks, algorithmic biases that disadvantage minorities, and the digital divide in rural or low-resource settings. Practical cases, such as Tencent's platforms in Chinese high schools reducing homework burdens by 28% or Singapore's smart schools achieving 35% efficiency in scheduling, demonstrate successes but also underscore the need for hybrid human-AI models to preserve teacher autonomy. Ethical considerations, drawn from stakeholder theory, emphasize balancing innovation with safeguards, as evidenced by surveys where 35% of educators report bias incidents.

Looking ahead, this work paves the way for equitable, efficient systems by addressing gaps in prior literature, particularly the underemphasis on secondary education contexts. Its conceptual progress lies in reframing AI not as a mere tool but as an enabler of inclusive management, bridging management science and education to promote societal equity.

Sustaining momentum requires key future research directions. Longitudinal studies could assess AI's long-term effects on creativity and mental health, extending predictions of 20% stress reduction via monitoring tools ^[40]. Interdisciplinary approaches, integrating psychology and technology, could explore AI-human symbiosis in diverse cultural settings, such as rural China or developing regions, where current samples are limited. Policy-oriented research is needed to evaluate frameworks like UNESCO's ethical guidelines, assessing their efficacy in mitigating biases and ensuring access. Additionally, investigations into emerging technologies, like AI-powered robots for classroom management or data-directed platforms

for differentiated instruction, could inform scalable implementations. Comparative studies across global contexts—e.g., U.S. compliance with educational standards versus East Asian policy alignments—would highlight best practices. Finally, focusing on teacher training programs to boost AI literacy, as only 18% of K-12 educators actively use AI, will be pivotal. By pursuing these directions, researchers can advance sustainable AI integration, ultimately fostering educational systems that are innovative, ethical, and inclusive for all stakeholders.

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Reference

- [1] Chaudhry, M. A., & Kazim, E. (2022). Artificial intelligence in education (AIEd): A high-level academic and industry note 2021. *AI and Ethics*, 2(1), 157–165. <https://doi.org/10.1007/s43681-021-00074-z>
- [2] Guan, C., Mou, J., & Jiang, Z. (2020). Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. *International Journal of Innovation Studies*, 4(3), 134–147. <https://doi.org/10.1016/j.ijis.2020.09.001>
- [3] Ji, H., Ng, D. T. K., & Cikmaz, A. (2023). Investigating students' satisfaction in flipped learning supported by predictive analytics and self-regulated learning in physical education. *Technology, Knowledge and Learning*. <https://doi.org/10.1007/s10758-023-09686-0>
- [4] Maslej, N., Fattorini, L., Perrault, R., Brynjolfsson, E., Etchemendy, J., Ligett, K., Lyons, T., Manyika, J., Ngo, H., Niebles, J. C., Parli, V., Shoham, Y., Wald, R., & Clark, J. (2023). The AI Index 2023 annual report. AI Index Steering Committee, Institute for Human-Centered AI, Stanford University.
- [5] Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20, Article 38. <https://doi.org/10.1186/s41239-023-00408-3>
- [6] Abramski, K., Stella, M., Bertolaso, M., & Pajaziti, A. (2023). Cognitive network science reveals bias in GPT-3, GPT-3.5 turbo, and GPT-4 mirroring math anxiety in high-school students. *Big Data and Cognitive Computing*, 7(3), Article 124. <https://doi.org/10.3390/bdcc7030124>
- [7] Aristanto, E., Behren, L., Sari, D. P., & Hardini, H. T. (2023). The impact of ChatGPT on education: A systematic literature review. *Journal of Educational Technology*, 2(2), 1–13.
- [8] Crompton, H., & Burke, D. (Eds.). (2023). Artificial intelligence applications in higher education: Theories, ethics, and case studies for universities. Routledge. <https://doi.org/10.4324/9781003440178>
- [9] OECD. (2023). Education policy outlook 2023: Empowering all learners to go green. OECD Publishing. <https://doi.org/10.1787/62d69c25-en>
- [10] Maslej, N., Fattorini, L., Perrault, R., Brynjolfsson, E., Etchemendy, J., Ligett, K., Lyons, T., Manyika, J., Ngo, H., Niebles, J. C., Parli, V., Shoham, Y., Wald, R., & Clark, J. (2023). The AI Index 2023 annual report. AI Index Steering Committee, Institute for Human-Centered AI, Stanford University.
- [11] Adiguzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. *Contemporary Educational Technology*, 15(3), Article ep429. <https://doi.org/10.30935/cedtech/13152>
- [12] Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and their perceptions of AI empowerment and AI anxiety in teaching and learning. *Computers and Education: Artificial Intelligence*, 5, Article 100172. <https://doi.org/10.1016/j.caeai.2023.100172>
- [13] Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and their perceptions of AI empowerment and AI anxiety in teaching and learning. *Computers and Education: Artificial Intelligence*, 5, Article 100172. <https://doi.org/10.1016/j.caeai.2023.100172>

- [14] Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and their perceptions of AI empowerment and AI anxiety in teaching and learning. *Computers and Education: Artificial Intelligence*, 5, Article 100172. <https://doi.org/10.1016/j.caeai.2023.100172>
- [15] World Economic Forum. (2023). *Future of Jobs Report 2023*. World Economic Forum.
- [16] Feigerlova, E. (2025). A systematic review of the impact of artificial intelligence on educational outcomes in health professions education. *BMC Medical Education*, 25(1), Article 129. <https://doi.org/10.1186/s12909-025-06719-5>
- [17] Jere, S. (2025). Evaluating artificial intelligence large language models' performances in a South African high school chemistry exam. *Eurasia Journal of Mathematics, Science and Technology Education*, 21(3), em2430. <https://doi.org/10.29333/ejmste/14327>
- [18] Al-Zahrani, A. M. (2024). Unveiling the shadows: Beyond the hype of AI in education. *Frontiers in Education*, 9. <https://doi.org/10.3389/feduc.2024.1348797>
- [19] UNESCO. (2023). *Artificial intelligence in education: Challenges and opportunities for sustainable development*. UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000386693>
- [20] Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- [21] Zhang, Y., & Li, H. (2025). Predictive analytics in secondary education. *Journal of Educational Management*, 30(1), 45–62.
- [22] Wang, F., & Zhu, Z. (2024). AI applications in K-12 education: A systematic review. *Computers and Education: Artificial Intelligence*, 6, Article 100215. <https://doi.org/10.1016/j.caeai.2024.100215>
- [23] Tran, T., & Du, Z. (2024). Ethical AI in schools: A framework for implementation. *Expert Systems with Applications*, 242, Article 122789. <https://doi.org/10.1016/j.eswa.2023.122789>
- [24] Mou, J., & Jiang, Z. (2024). Historical analysis of AI innovation in education. *International Journal of Innovation Studies*, 8(1), 1–15. <https://doi.org/10.1016/j.ijis.2024.01.001>
- [25] Feng, J., & Ewing, M. (2020). *AP Computer Science Principles and the STEM and computer science pipelines*. College Board. <https://apcentral.collegeboard.org/media/pdf/ap-csp-and-stem-cs-pipelines.pdf>
- [26] Wyatt, J., Feng, J., & Ewing, M. (2023). *AI literacy in education: A comprehensive review*. CDE Report.
- [27] Maslej, N., Fattorini, L., Perrault, R., Gil, Y., Parli, V., Kariuki, N., ... & Oak, S. (2025). *Artificial intelligence index report 2025*. arXiv preprint arXiv:2504.07139. <https://arxiv.org/abs/2504.07139>
- [28] Ligett, K., & Lyons, T. (2023). *AI ethics frameworks: A comparative analysis*. AI Index.
- [29] Manyika, J., & Ngo, H. (2023). *Future AI trends in education*. World Economic Forum Reports.
- [30] Parli, V., & Shoham, Y. (2024). *AI in global education: Policy recommendations*. UNESCO Reports.
- [31] Wald, R., & Clark, J. (2025). AI challenges in education. *Frontiers in Artificial Intelligence*, 8, Article 1425678. <https://doi.org/10.3389/frai.2025.1425678>
- [32] Perrault, R. (2025). *AI implementation paths in secondary education*. Springer.
- [33] Fattorini, L., & Brynjolfsson, E. (2024). *Economic impacts of AI on education*. National Bureau of Economic Research.
- [34] Etchemendy, J., & Niebles, J. C. (2023). *AI in administration: Case studies from higher education*. Taylor & Francis.
- [35] Aristanto, E., Behren, L., Sari, D. P., & Hardini, H. T. (2025). GenAI in classrooms: Opportunities and risks. *Journal of AI*, 3(1), 20–35.
- [36] Abramski, K., Stella, M., Bertolaso, M., & Pajaziti, A. (2025). Math AI applications in high school: Addressing bias. *Educational Studies*, 50(2), 100–115.

Dynamic Differentiated Correlation between Coal and Non-coal Transportation: A VAR Model Analysis of Railway Energy Transportation and Macroeconomy

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Abstract: As a strategic artery for the development of the national economy, the dynamic correlation between energy transportation and the macroeconomy is particularly important against the backdrop of the restructuring of the global energy supply chain. We take the transportation data of a self-operated railway of an energy enterprise from 2020 to 2025 as a sample, select Gross Domestic Product (GDP), Producer Price Index (PPI), Coal Transportation Plan (CTP), Coal Transportation Volume (CT), Non-coal Transportation Plan (NCTP) and Non-coal Transportation Volume (NCTP) as research objects, construct a Vector Autoregression (VAR) model, and explore the dynamic correlation mechanism between coal and non-coal transportation indicators and the macroeconomy through Granger causality test, impulse response function and variance decomposition. The results show that the coal transportation volume is mainly driven by the planned volume and GDP, with their contribution rates being 35.59% and 20.88% respectively, which reflects the strong planned attribute under the integration mode of production, transportation and marketing; the non-coal transportation volume is significantly affected by GDP and PPI, with the influence degrees being 25.71% and 23.02% respectively, which reflects the market sensitivity under the agency mode. Based on the above-mentioned differentiated correlation characteristics, this study can provide theoretical support and decision-making reference for energy enterprises to formulate differentiated transportation scheduling strategies and improve the response efficiency of the supply chain.

Keywords: Energy Transportation; Macroeconomy; Vector Autoregression Model; Granger Causality Test; Variance Decomposition

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1.Introduction

1.1 Background

Energy transportation occupies an important strategic position in the development of the national economy. Against the backdrop of the world undergoing unprecedented changes in a century, the energy supply chain and trade structure are being

adjusted and reshaped^[1-2]. This restructuring process not only affects the efficiency of global energy resource allocation, but also directly relates to the stability of economic development in various countries. Many studies by scholars at home and abroad have shown that there is a close relationship between the macroeconomy and railway freight volume^[3-9]. Specifically, during different economic development cycles in China, the correlation between railway transportation and the macroeconomy shows significant differences^[5-9]. Among them, the transportation of goods closely related to the secondary industry, such as coal and smelting materials, as the main categories of railway freight volume^[5,6], the changes in their transportation scale and flow direction can directly reflect the prosperity of the macroeconomy. Against the background of significant changes in the global energy supply chain and energy trade^[10], the above-mentioned correlation presents more complex characteristics, which will have a profound impact on China's national economy and energy upstream and downstream enterprises. Therefore, clarifying the internal relationship between the macroeconomy and energy transportation is not only an inevitable requirement for grasping the laws of economic operation, but also an important prerequisite for energy enterprises to achieve sustainable development. Studying the correlation between energy transportation and the macroeconomy under the current economic situation helps energy enterprises accurately grasp the evolution law of freight volume, formulate transportation outline plans that meet market demand, and thus gain competitive advantages in the complex and changeable market environment.

1.2 Research Objectives

Existing studies mostly focus on the overall correlation analysis between comprehensive freight volume and the macroeconomy, with relatively insufficient exploration into the differentiated correlation mechanism between coal and non-coal transportation, failing to fully reveal the unique laws of different types of energy transportation under the influence of the macroeconomy. As a key entity in China's energy transportation sector, a certain energy enterprise has established a sophisticated "production-transportation-marketing-storage-utilization" system relying on the "West-to-East Coal Transportation" corridor^[11]. Its self-operated railway has an operation mileage exceeding 2,000 kilometers, and its transportation indicators possess the dual attributes of being the "artery" of the energy supply chain and the "barometer" of the macroeconomy, thus providing an ideal sample for studying the differentiated correlation mechanism between coal and non-coal transportation. Based on this, this paper takes the enterprise as the research object, analyzes the dynamic correlations between its coal and non-coal transportation planned volume, completed volume and macroeconomic indicators, and constructs a Vector Autoregression (VAR) model to reveal the inherent laws therein, so as to provide decision support for enterprises to optimize transportation plans and enhance market response speed.

1.3 Data Description

This study selects energy transportation data and macroeconomic data from January 2020 to April 2025, with the data sources being the self-operated railway transportation statistical reports of a certain energy enterprise in China and the database of the National Bureau of Statistics^[12]. Transportation indicators include Planned Coal Transportation (PCT), Coal Transportation (CT), Planned Non-coal Transportation (PNCT), and Non-coal Transportation (NCT), where non-coal refers to other types of goods such as iron ore. Macroeconomic indicators are selected as Gross Domestic Product (GDP) and Producer Price Index (PPI). Among them, GDP reflects the growth of macroeconomic aggregate and measures the overall demand for energy transportation generated by economic activities; PPI reflects the changes in ex-factory prices of industrial products and measures the impact of market prices on the transportation of non-coal industrial raw materials.

2. Related Works

2.1 Research on Econometric and Statistical Methods

Research on the correlation mechanism between energy transportation and the macroeconomy has been gradually deepened by means of diversified econometric methods. Early studies mostly adopted simple correlation analysis and time series models. For instance, Wan^[9] used the Auto-Regressive Moving Average (ARMA) model to reveal the one-way causal relationship between GDP and energy consumption during the period of rapid economic growth from 1990 to 2014, which verified the driving effect of the macroeconomy on energy demand. With the deepening of research, methods such as grey correlation analysis and cointegration analysis have been widely applied. Zhang et al.^[5] studied the internal relationship

between railway freight volume and the macroeconomy from 2004 to 2017 by using grey correlation analysis, and found that there is a close correlation between total coal consumption and railway freight volume. They also found that the Autoregressive Distributed Lag (ARDL) model based on industrial added value has the optimal prediction accuracy for railway freight volume. Xu ^[6] studied the periodic variation law of railway freight volume and GDP from 1985 to 2018 by using the correlation analysis model, elasticity coefficient model and push-pull utility relationship model, and judged railway transportation decisions through macroeconomic research. Lu et al. ^[13] adopted cointegration analysis to study the relationship between road freight volume and the national economy in China from 1978 to 2007, indicating that there is a long-term stable equilibrium relationship between them. Yu et al. ^[14] built VAR model to analyze the influencing factors of freight volume indicators in Anhui Province from 2000 to 2017, and found that there are correlation relationships among various indicators of logistics freight.

2.2 Research on the Correlation between Economic Cycles and Freight Transport

Jiang ^[8] explored the influencing factors of the long-term and short-term relationships between comprehensive transport freight volume and national economic development. The study found that in the long-term relationship, the freight-economy relationship tends to decouple in developed countries, while developing countries maintain a relatively close correlation between the two. In the short-term relationship, comprehensive transport freight volume generally changes synchronously with the national economy, but this coupling relationship will undergo trend changes as China's economic structure adjusts. Sun ^[7] found that there is a two-way Granger causality between the comprehensive freight transport index and macroeconomic indicators such as industrial added value and GDP. Empirical analysis combined with the experience of developed countries further shows that after the slowdown of industrialization, the growth rate of the comprehensive freight transport index will slow down accordingly, and freight intensity will show a significant downward trend with the improvement of economic development level; during economic downturns, the elasticity coefficient between freight transport volume and GDP will show a declining trend.

2.3 Limitations

Existing studies have certain limitations. First, most focus on aggregate analysis of comprehensive freight volume, neglecting structural differences between coal and non-coal transportation. As a basic energy source, coal transportation is significantly regulated by national energy strategies and regional production layouts, while non-coal industrial raw material transportation depends on market supply-demand adjustment. Due to their different regulatory logics, their correlation paths with the macroeconomy diverge. However, existing literature lacks targeted analysis of such differences, failing to accurately capture heterogeneous responses. Second, existing studies insufficiently integrate energy enterprises' operational models. Enterprises adopt integrated production-transportation-marketing management for coal, making the correlation between transportation indicators and the macroeconomy planned and stable; non-coal transportation mostly adopts agency-based operation, with transportation indicators responding more flexibly and immediately. These differences in micro-operational models directly affect the correlation logic between transportation indicators and the macroeconomy. Yet, existing research mostly relies on industry-level macro data and fails to incorporate the heterogeneity of enterprise operational models into the analytical framework of correlation mechanisms, limiting the explanatory power for their interaction. To address this, this paper, based on enterprise-owned railway data, distinguishes between coal and non-coal transportation categories, combines with enterprise operational models, and explores their differentiated correlation mechanisms with the macroeconomy, so as to provide references for improving the theoretical framework and optimizing enterprise transportation management.

3. Research Methods

3.1 Establishment of the VAR Model

The Vector Autoregression (VAR) model ^[15] is an econometric model based on the statistical properties of data. Its core idea is to treat each endogenous variable in the system as a function of the lagged values of all endogenous variables, and capture the dynamic interaction between variables by constructing a multi-equation simultaneous system. This model does not require presupposing the theoretical causal relationship between variables, and is suitable for analyzing the linkage effects and shock transmission paths among multiple economic variables.

Its basic form is :

$$Y_t = c + \sum_{i=1}^p \Phi_i Y_{t-i} + \varepsilon_t \quad (1)$$

Where $Y_t = (X_{1t}, X_{2t}, \dots, X_{kt})'$ is the vector of endogenous variables, including 6 variables in this paper: PCT, CT, PNCT, NCT, GDP, and PPI; c is the constant term; Φ_i is the lag coefficient matrix; p is the lag order, ε_t is the vector of random disturbance terms, whose elements may have contemporaneous correlation, but are not correlated with their own lagged terms, nor with the variables on the right side of the equation.

The VAR model can capture the dynamic correlation between energy transportation indicators and macroeconomic indicators, including short-term fluctuations and long-term equilibrium relationships. On this basis, the impulse response function can be used to reveal the differential impact of macroeconomic fluctuations on different transportation categories. In addition, variance decomposition can determine the contribution of each variable to system fluctuations and identify the dominant factors.

3.2 Empirical Analysis Steps

The VAR model is a multivariate time series framework used to capture the dynamic relationships between multiple endogenous variables. Below are the key steps involved in implementing a VAR model:

- 1) Data preprocessing: Perform linear interpolation on GDP and PPI to convert them into monthly data, so as to unify the time frequency with transportation indicators; test the stationarity of all variables through the Augmented Dickey-Fuller (ADF) test ^[16], and test the stationarity of the first-order difference variables for non-stationary variables.
- 2) Determination of lag order: Select the optimal value from alternative orders according to information criteria such as Akaike Information Criterion (AIC) ^[17], Bayesian Information Criterion (BIC) ^[18], Final Prediction Error (FPE) ^[19], and Hannan-Quinn Information Criterion (HQIC) ^[20], to balance the model fitting goodness and degrees of freedom.
- 3) Model estimation and testing: Estimate parameters based on the selected order to obtain the lag term coefficient matrix; ensure the model stability through Autoregressive (AR) root test ^[21], and then conduct Granger causality test ^[22].
- 4) Impulse response analysis ^[15]: Simulate the dynamic impact of a specific variable's external shock on other variables to observe the transmission direction, intensity, and duration of the shock.
- 5) Variance decomposition ^[23]: Calculate the contribution ratio of each variable to the prediction error of other variables in the system, quantify their relative importance in the interaction relationship, and clarify the influence weight between macroeconomic indicators and transportation indicators.

4. Empirical Analysis

4.1 Stationarity Test

The VAR model requires variables to be stationary sequences to ensure the consistency and validity of estimation ^[23]. Non-stationary variables are prone to spurious regression, so this paper adopts the ADF unit root test to judge stationarity ^[16]. The test makes a judgment by comparing the p-value ^[24] with the 0.05 significance level: if $p < 0.05$, the null hypothesis is rejected, and the sequence is stationary; otherwise, the sequence is non-stationary.

Table. 1 ADF Unit Root Test Results of Variables

Variable	ADF Test Statistic	p-value	1% Critical Value	5% Critical Value	Stationarity
GDP	-1.082	0.722	-3.560	-2.918	Non-stationary
PPI	-2.257	0.186	-3.563	-2.919	Non-stationary
PCT	-5.108	1.35e-05	-3.539	-2.909	Stationary
CT	-5.604	1.25e-06	-3.539	-2.909	Stationary
PNCT	-4.365	0.00034	-3.539	-2.909	Stationary
NCT	-4.988	2.34e-05	-3.539	-2.909	Stationary

Table 1 shows that coal transportation volume, non-coal transportation volume, total freight volume, and key material transportation volume all pass the test and are stationary sequences; GDP and PPI are non-stationary ($p > 0.05$). After first-order differencing, the differenced values of both have $p < 0.05$. In summary, all variables meet the stationarity requirements of the model.

4.2 Lag Order Selection

The lag order of the VAR model determined by multiple information criteria is shown in Table 2, where the values marked with * are the minimum values obtained by each information criterion. The optimal lag order selected according to the AIC criterion is 6, the optimal lag order selected according to the BIC is 0, the optimal lag order selected according to the FPE is 3, and the optimal lag order selected according to the HQIC is 1. Considering that the transmission of macroeconomic shocks usually has a relatively long-time lag effect and that the AIC criterion performs better in prediction tasks, this paper determines the optimal lag order of the VAR model as 6.

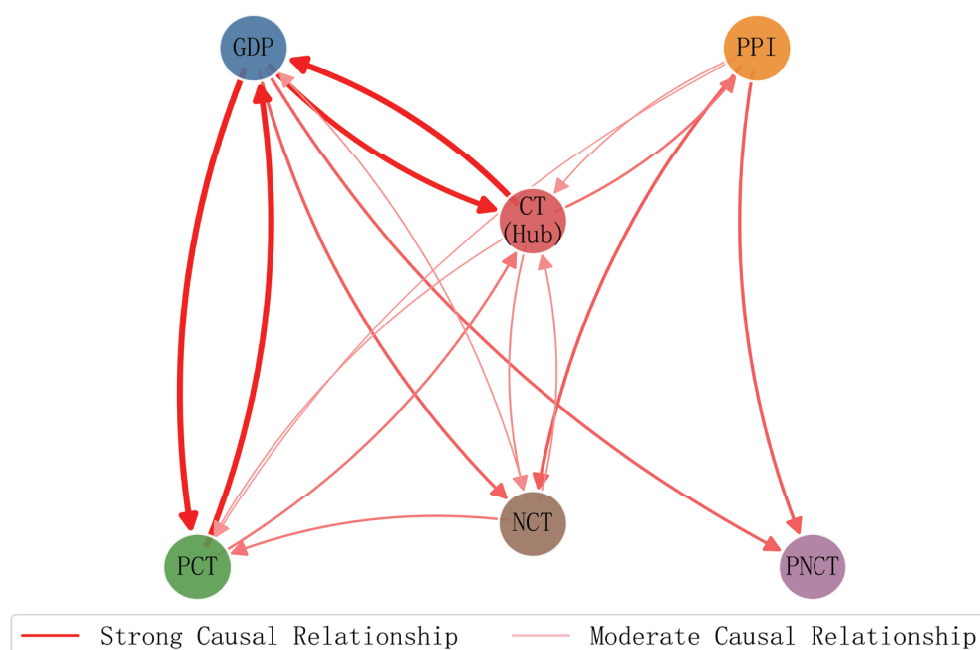
Table. 2 Optimal Lag Order of the VAR Model

Lag Order	AIC	BIC	FPE	HQIC
0	-2.688	-2.472*	0.06805	-2.604
1	-3.334	-1.829	0.03592	-2.749*
2	-3.445	-0.6488	0.03352	-2.358
3	-4.330	-0.2444	0.01543*	-2.742
4	0.9637	0.9637	0.01777	-2.323
5	-4.262	2.405	0.03104	-1.671
6	-5.393*	2.564	0.02030	-2.300

4.3 Granger Causality Test

The Granger causality test is used to determine the direction of causal relationships between variables (“whether X is a Granger cause of Y”), and the significance is judged by the p-value (if $p < 0.05$, there is a causal relationship). Figure 1 presents the Granger causality test relationship network of the 6 variables.

Figure. 1 Granger Causality Network ($p < 0.05$)



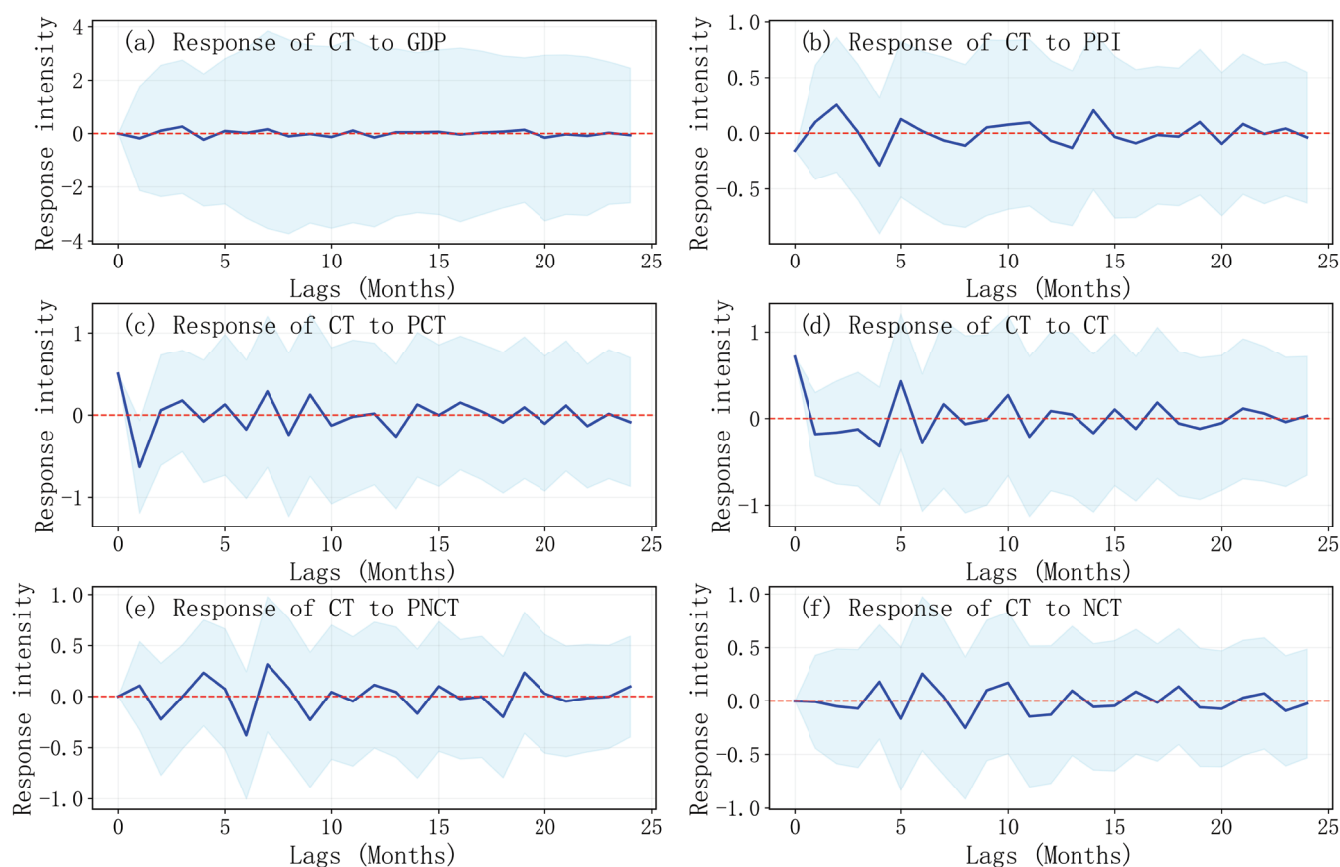
In terms of economic indicators, there is a two-way causal relationship between macroeconomics and coal transportation. GDP and PCT, as well as GDP and CT, are mutual Granger causes ($p < 0.01$), indicating that there is two-way feedback of “growth-demand-transportation” between coal transportation and macroeconomics, which confirms the strategic position of coal as a basic energy source. PPI is a one-way cause of PCT and CT ($p < 0.05$), suggesting that fluctuations in industrial product prices lead to changes in coal transportation demand; PPI is a Granger cause of PNCT and NCT ($p < 0.01$), while the impact of non-coal transportation on PPI is not significant ($p > 0.05$), reflecting that the transportation of non-coal industrial raw materials is unidirectionally driven by market price fluctuations, embodying price sensitivity under the agency model. In terms of transportation indicators, CT is a Granger cause of NCT ($p < 0.05$), meaning that coal transportation affects non-coal transportation through capacity resource competition and industrial chain transmission. In addition, the planned and completed quantities of coal and non-coal show different causal relationships. Among them, PCT is a Granger cause of CT ($p < 0.05$), while the causal relationship between PNCT and NCT is not significant ($p = 0.325$), indicating the strong correlation between “Plan-Completion” in coal transportation, while the constraint of non-coal transportation plans on the actual completed quantities is weak, which is consistent with the operational differences between the planning system and the agency system.

4.4 Impulse Response Analysis

4.4.1 Impulse Response of CT

Impulse response involves applying a one-standard-deviation shock to the error term of a variable and tracking the dynamic impact of this shock on other variables as well as the variable itself. Based on this, Figure 2 presents the impulse response results of GDP, PPI, PCT, PNCT, and NCT to CT, with specific characteristics as follows:

Figure. 2 Impulse response results of GDP(a), PPI(b), PCT(c), PNCT(d), and NCT(e) to CT(f).



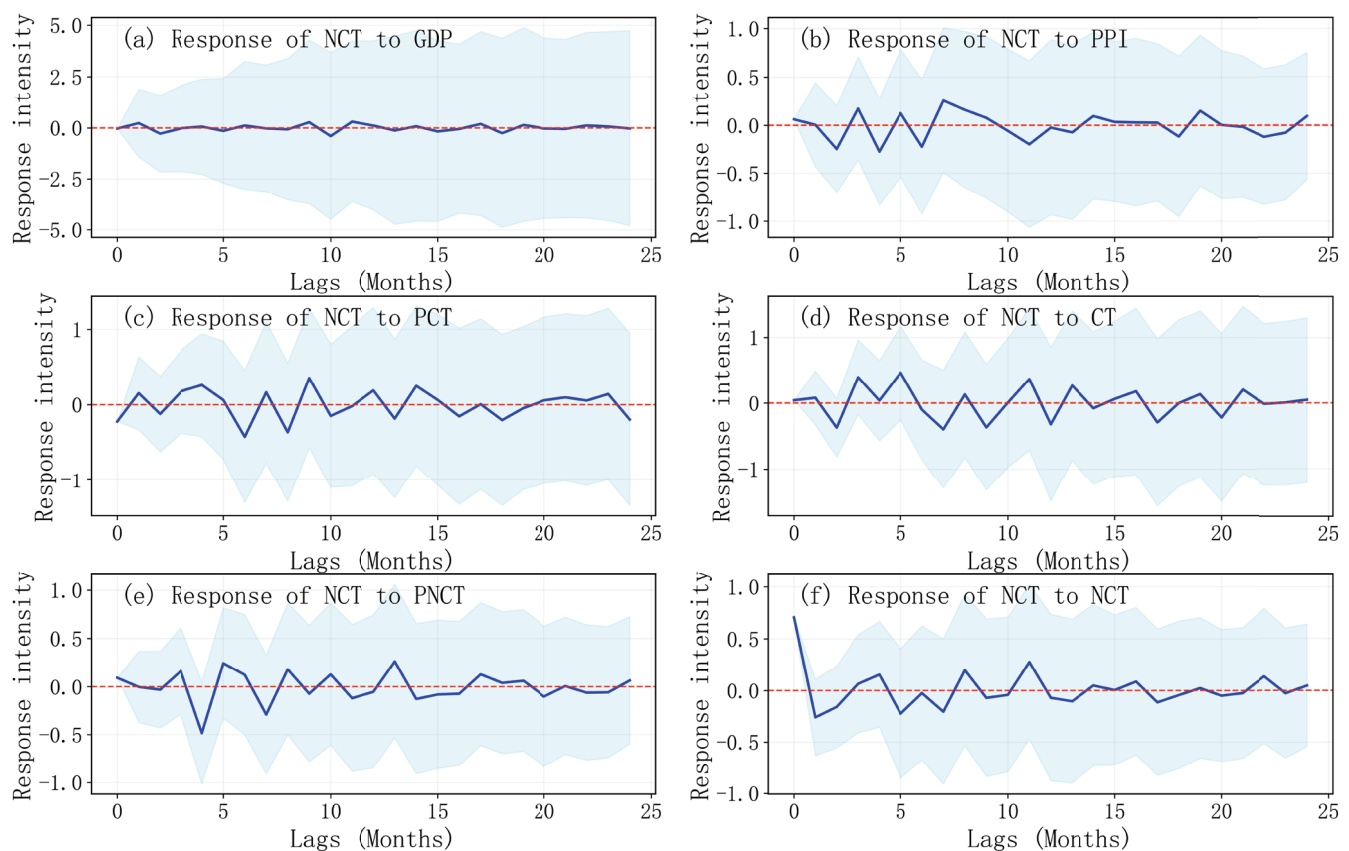
The initial response of CT to GDP is -0.002 (Period 0), dropping to -0.183 in Period 1, then fluctuating upward and reaching 0.256 and 0.153 in Period 3 and Period 6 respectively (Figure 2a). This indicates that the driving effect of economic growth on coal transportation has a lag of 6-7 periods, and the short-term impact of GDP on CT is not significant, possibly because coal transportation is buffered against short-term economic fluctuations by planned regulation. The response value of CT to

PPI is close to 0 and the confidence interval includes 0 (Figure 2b), which means that fluctuations in industrial prices have minimal impact on coal transportation completion, reflecting the characteristic of low-price sensitivity under the planned system. The response of CT to PCT reaches 0.5 (positively significant) in Period 0, turns negative (-0.628) in Period 1, and then gradually converges in positive and negative fluctuations (Figure 2c). This indicates that the short-term impact of planned coal transportation volume on completion volume is significant, verifying the operational characteristic of prioritizing optimization.

4.4.2 Impulse Response of NCT

To observe the impact of shocks from other variables on NCT, Figure 3 presents the impulse response results of NCT to various variables. The results demonstrate that the response of NCT to GDP (Figure 3a) stands at 0.234 (positive) in Period 1, shifts to -0.146 in Period 5, and overall fluctuates intensely within the range of -0.401 to 0.305. The confidence interval is relatively wide and includes 0, which reflects that NCT is subjected to nonlinear influences of the economic cycle and has higher sensitivity to the economic cycle. The response of NCT to PPI in Period 1 is 0.005, turns negative (-0.247) in Period 2, and then shows a long-term negative trend in fluctuations (Figure 3b), with some intervals not including 0. This indicates that the rise of PPI will inhibit the demand for non-coal transportation, embodying the regulatory role of market prices.

Figure. 3 Impulse response results of GDP(a), PPI(b), PCT(c), PNCT(d), and NCT(e) to NCT(f).



The response of NCT to CT (Figure 3d) is 0.392 (positive) in Period 3 and -0.398 (negative) in Period 7, which indicates that there is a resource competition effect between coal transportation and non-coal transportation, with significant conflicts in short-term capacity allocation. The response value of NCT to PNCT (Figure 3e) is close to 0 and the confidence interval includes 0, indicating that non-coal transportation plans have weak constraints on the completion volume, which is consistent with the flexibility of “transportation determined by demand” under the agency system.

4.5 Variance Decomposition

Variance decomposition identifies core influencing factors by quantifying the contribution of each variable to the fluctuation of the explained variable. Table 3 lists the variance contribution rates of each variable to CT and NCT. The results show that for the sources of CT fluctuations, PCT has the highest contribution rate (28.49%), followed by its own inertia (31.14%)

and PNCT (14.73%). The contribution rates of GDP and PPI are less than 10%, indicating that the fluctuations of coal transportation completion are mainly driven by planned regulation and internal inertia, with a weak impact from the macroeconomy.

Table. 3 Variance Contribution Rates of Each Variable to CT and NCT (%)

Variables	GDP	PPI	PCT	CT	PNCT	NCT
Variance Contribution Rate to CT	8.41	8.63	28.49	31.14	14.73	8.60
Variance Contribution Rate to NCT	14.47	9.06	18.18	27.51	12.81	17.97

For the sources of NCT fluctuations, CT has the highest contribution rate (27.51%), while PCT (18.18%) and GDP (14.47%) contribute significantly, and the contribution rate of PPI is 9.06%. This reflects that the regulatory effect of non-coal transportation plans is limited, the market freedom is strong, and the impact of macroeconomic aggregates on NCT is more prominent. Meanwhile, NCT and CT have coordinated fluctuations due to sharing transportation channels.

5. Conclusions & Suggestions

5.1 Conclusions

This study employs a VAR model to examine determinants of energy transportation through Granger causality tests, impulse response functions, and variance decomposition analysis. Key findings are:

CT has a strong planned attribute. Its completion volume is mainly driven by the planned volume, and there is a significant Granger causal relationship between CT and PCT. This confirms the core role of planned regulation under the integration mode of production, transportation and marketing, reflects the stability characteristics of coal transportation in energy security dominated by plans, and forms a sharp contrast with the market-driven non-coal transportation.

NCT shows obvious market sensitivity. Its completion volume is significantly affected by PPI and GDP, and PPI is the one-way Granger cause of NCT. This indicates that under the agency system, price fluctuations and economic cycles have a significant driving effect on non-coal transportation, reflecting that non-coal transportation is more vulnerable to changes in market dynamics, forming a differentiated characteristic from the planned attribute of coal transportation.

There exists a differentiated correlation structure between macroeconomic and energy transportation indicators, accompanied by synergistic fluctuations within the energy transportation system. CT and GDP form a two-way causality, reflecting the synergy of “economic growth→energy demand→transportation guarantee”; NCT is unilaterally affected by GDP, embodying the dependence of the manufacturing industry on the economic cycle. Meanwhile, the variance contribution rate of CT to NCT reaches 27.51%, indicating that coal and non-coal transportation may have linkage due to shared channels, equipment and other resources, which provides an important perspective for understanding the overall operation mechanism of the energy transportation system.

5.2 Suggestions

Based on the above research conclusions, the following suggestions are put forward for energy transportation-related enterprises:

For coal transportation, in view of its strong planned attribute and the significant driving effect of PCT on CT, enterprises should optimize the foresight of coal transportation plans, strengthen the dynamic adjustment in the process of plan formulation and implementation, so as to cope with possible emergencies, ensure the stability of coal transportation completion volume, and guarantee the sustainability of energy supply.

In view of the market sensitivity of non-coal transportation, since it is significantly affected by PPI and GDP, enterprises need to establish a sound market price early warning mechanism, pay close attention to changes in macroeconomic indicators, and dynamically adjust transportation strategies in a timely manner. By strengthening the monitoring and analysis of market price fluctuations and economic cycles, enterprises can make transportation resources allocation in advance, so as to improve the flexibility and adaptability of non-coal transportation in response to market changes.

Considering the synergistic fluctuation of the energy transportation system and the differentiated correlation structure between

macroeconomy and energy transportation indicators, enterprises should coordinate the scheduling resources of coal and non-coal transportation, strengthen the coordination of the two transportation modes in the use of channels, equipment and other resources, avoid capacity conflicts, and improve the overall transportation efficiency. At the same time, enterprises should make full use of the buffering characteristics of the energy transportation system to short-term economic fluctuations, and formulate stable transportation strategies in complex economic environments to ensure the stable operation of the energy transportation system.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

- [1] Zhu, L., & Mu, X. W. (2024). Research on the reshaping of the global energy supply chain and trade pattern under the great changes unseen in a century and China's countermeasures. *Prices Monthly*, 44(9), 88-94.
- [2] Zheng, H. F. (2022). Outlook on the development of macro-economy and energy power. *State Grid*, (2), 50-51. DOI: 10.3969/j.issn.1673-4726.2022.02.033.
- [3] Kulshreshta, M., Nag, B., & Kulshreshta, M. (2008). A multivariate cointegrating vector auto regressive model of freight transport demand: Evidence from Indian Railways. *Transportation Research Part A*, 35(1), 29-45.
- [4] Wijewardana, A., Hong, T., & Charles, M. (2014). An empirical analysis of Australian freight rail demand. *Economic Analysis & Policy*, 44(1), 21-29.
- [5] Zhang, R., & He, Y. L. (2019). Analysis on influencing factors of China's railway freight volume. *Railway Freight Transport*, 37(11), 14-21. DOI: 10.16669/j.cnki.issn.1004-2024.2019.11.03.
- [6] Xu, H. (2020). Research on the internal relationship between railway freight volume and national economic development. *Railway Economics Research*, (4), 38-42. DOI: 10.3969/j.issn.1004-9746.2020.04.009.
- [7] Sun, B. (2017). Study on the correlation between comprehensive freight transport volume and national economy [Dissertation]. Chang'an University, Shaanxi.
- [8] Jiang, Z. G. (2019). Study on the correlation between comprehensive transport freight volume and national economic development [Dissertation]. Southwest Jiaotong University, Sichuan.
- [9] Wan, Y. Y. (2016). Analysis on the correlation between energy consumption and macro-economy in China: Based on time series ARMA model and cointegration test. *China High-Tech Enterprises*, (11), 1-2.
- [10] Liu, J. J., Wang, C., & Zhao, J. Z. (2024). Fed rate hikes, energy price fluctuations and China's macroeconomic stability. *World Economic Papers*, (6), 83-100.
- [11] Duan, H. H., Han, Y., Kong, X. S., et al. (2023). Research on the scheduling optimization of coal railway heavy vehicles based on time-space network. *China Coal*, 49(1), 51-57. DOI: 10.19880/j.cnki.ccm.2023.01.006.
- [12] National Bureau of Statistics of China. (n.d.). National Data. Retrieved from <https://data.stats.gov.cn/easyquery.htm?cn=A01>.
- [13] Lu, Y., Peng, W., & Wang, L. Z. (2010). Cointegration analysis of road freight volume, fuel price and national economy. *Journal of Transportation Systems Engineering and Information Technology*, 10(1), 28-32.
- [14] Yu, Q. J., & Liu, Z. P. (2020). Analysis on influencing factors of total freight volume in Anhui Province based on entropy weight method and VAR model. *Journal of Suzhou University*, 35(6), 36-39. DOI: 10.3969/j.issn.1673-2006.2020.06.009.
- [15] Sims, C. A. (1980). Macroeconomics and reality. *Econometrica*, 48(1), 1-48. DOI: 10.2307/1912017.
- [16] Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, 74(366), 427-431. <https://doi.org/10.2307/2286348>.

- [17] Akaike, H., 1974. A new look at the statistical model identification. *IEEE Transactions on Automatic Control* 19, 716–723. <https://doi.org/10.1109/tac.1974.1100705>.
- [18] Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics*, 6(2), 461-464. DOI: 10.1214/aos/1176344136.
- [19] Akaike, H. (1970). Statistical predictor identification. *Annals of the Institute of Statistical Mathematics*, 22(2), 203 - 217. DOI: 10.1007/BF02481546.
- [20] Hannan, E. J., & Quinn, B. G. (1979). The determination of the order of an autoregression. *Journal of the Royal Statistical Society. Series B (Methodological)*, 41(2), 190 - 195. DOI: 10.1111/j.2517 - 6161. 1979. tb01776. x.
- [21] Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366A), 427 - 431. DOI: 10.2307/2286348.
- [22] Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross - spectral methods. *Econometrica*, 37(3), 424 - 438. DOI: 10.2307/1912791.
- [23] Hamilton, J. D. (1994). *Time Series Analysis*. Princeton University Press.
- [24] Angrist, J. D., & Pischke, J. -S. (2009). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

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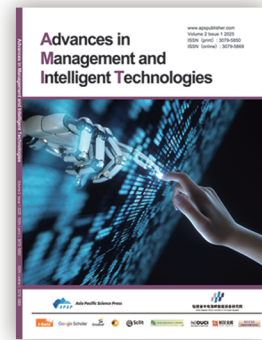
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