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Cultivating Core Socialist Values among University Students: The Role of Ideological and Political Education in China

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Abstract

Cultivating the next generation's commitment to core socialist values has become a central goal of China's higher education in the Xi Jinping era. University students are a critical group for instilling these values, which include prosperity, democracy, civility, harmony, freedom, equality, justice, rule of law, patriotism, dedication, integrity, and friendship. This article adopts a literature-based analysis, reviewing research and policy developments from the past five years on ideological and political education (IPE) in Chinese universities. Key sources include recent academic studies, government guidelines, and practical case studies. The review finds that Chinese universities have integrated core socialist values throughout curricula, campus culture, and extracurricular programs. Innovations such as curriculum-based ideological education, new media engagement, volunteer service, and peer mentoring are used to enhance value internalization. Studies report improved student understanding and more positive attitudes when IPE employs interactive, student-centered methods rather than relying solely on top-down theoretical instruction. At the same time, challenges persist in truly embedding these values into students' personal belief systems, as some education approaches remain overly formalistic or disconnected from students' lived experiences. Effective cultivation of core values requires a holistic approach: updated teaching methods, rich practical opportunities, competent and exemplary instructors, and leveraging of technology and media to connect with students. The paper discusses how these strategies can address current gaps—such as low student engagement or superficial understanding—and argues that IPE plays an irreplaceable role in guiding youth values, fostering civic quality, and ensuring ideological continuity. Through continual innovation and commitment to student-centered pedagogy, ideological and political education in China can more successfully cultivate core socialist values among university students, contributing to both individual development and the broader goal of national rejuvenation.

Keywords: Ideological and Political Education; University Students; Values Cultivation; Curriculum Ideological Education; New Media; Civic Education

1. Introduction

Cultivating core socialist values among China's youth has been deemed essential for national ideological security and moral development in the new era. The concept of Core Socialist Values was officially introduced at the 18th Communist Party of China (CPC) National Congress in 2012, distilling the nation's value system into 12 key principles in three dimensions: national goals of prosperity, democracy, civility, harmony; societal goals of freedom, equality, justice, rule of law; and individual virtues of patriotism, dedication, integrity, friendship. These values are seen as the moral foundation for China's future and the spiritual support for the country's development. In late 2013, the CPC Central Committee issued guidelines to integrate core socialist values into all domains of society, "incorporated into the curriculum and classrooms and made a way of thinking for students", thereby launching a national campaign to instill these values in education and culture.

Within higher education, ideological and political education (IPE) is the primary vehicle for this values cultivation mission. IPE in Chinese universities refers to both dedicated theory courses (covering Marxist theory, Mao Zedong Thought, Deng Xiaoping Theory, Xi Jinping Thought, ethics and law, etc.) and the broader ideological work integrated into various aspects of campus life. Since the 18th CPC Congress, the Party leadership under President Xi Jinping has placed unprecedented emphasis on strengthening ideological work among young people. Xi Jinping's thought on education asserts that the fundamental task of education is "Lide Shuren", meaning to establish virtue and educate people, highlighting moral education as paramount. In a 2018 national conference on education, Xi Jinping stressed that building a strong education system is a cornerstone for the great rejuvenation of the Chinese nation, and he called for fully implementing the Party's education policy and cultivating socialist builders with all-round moral, intellectual, physical, aesthetic, and labor development. Core socialist values were identified as a key starting point to guide the construction of a strong, cohesive socialist ideology among the youth.

Why focus on university students? College students are at a formative stage of life where worldviews and values solidify, making them a crucial "target population" for value education. They are also the future builders and leaders of society, so their identification with socialist core values is seen as vital for China's long-term social cohesion and the realization of the "Chinese Dream" of national rejuvenation. However, the rapid economic and social changes in China have led to an increasingly pluralistic environment of ideas and values, especially among young people. Some scholars have noted phenomena of "value confusion" or weaknesses in ideal and belief among today's students, attributed to influences of commercialization, Western cultural influx, and the internet age. Strengthening value education is thus regarded as an urgent task to ensure that youth develop correct outlooks on the world, life, and values consistent with socialist ideals. As Ren (2023) points out, promoting the socialist core value system is not only essential for individual character building but also "the only way to realize the great rejuvenation of the Chinese nation", underscoring that youth value cultivation has strategic importance for China's future.

Current state of research: In recent years, the topic of integrating core socialist values into university education has attracted considerable scholarly attention. A noticeable trend in Chinese

educational research is the rise of "curriculum-based ideological and political education"– the idea that all courses, not just dedicated politics classes, should carry ideological and moral education elements. Analysis of hundreds of Chinese studies from 2014–2021 shows that the hot spots include defining the connotation of curriculum ideological education, its value construction, and especially exploring practical paths for implementation. Notably, "socialist core values" have emerged as one of the research frontiers within this curriculum-integration trend. This indicates strong academic and policy interest in finding effective methods to teach and inculcate the core values through various disciplines and activities.

Despite the prioritization of IPE by the government, some researchers have observed limitations in the existing literature and practice. A 2024 thematic review by Ouyang et al. noted that many studies in this field have been normative (prescribing what should be done) or descriptive (documenting what is being done), but often lack critical evaluation of effectiveness or concrete strategies for improvement. In other words, much writing extols how IPE should cultivate values, or describes policies in place, yet relatively fewer studies rigorously assess outcomes or provide evidence-based recommendations. This gap suggests the need for more analytical research connecting ideological education methods with measurable changes in students' values and behavior.

In practice, Chinese universities have made IPE increasingly pervasive – from mandatory ideology theory classes to orientations, extracurricular activities, volunteer service requirements, and campus propaganda. Official assessments (such as annual ideological education work reports) indicate that institutions have incorporated core values into their mission statements, student codes of conduct, and daily management. However, challenges remain in ensuring that students not only cognitively understand the twelve core values but also genuinely internalize and practice them. As will be discussed, issues like student apathy or resistance to didactic political instruction, the gap between theory and practice, and the ever-evolving influence of new media on youth ideologies require adaptive strategies.

Purpose of this article: This study provides a comprehensive overview of how China's ideological and political education system is harnessed to cultivate core socialist values among university students. We review recent literature (2019–2025) and highlight major findings regarding effective approaches, challenges, and the overall impact of these efforts. By analyzing both research studies and practical explorations, we aim to answer: What role does ideological and political education play in fostering core socialist values in college students? Which methods or innovations have been identified as most effective, and what obstacles are encountered? The findings can help educators and policymakers refine IPE practices to better achieve the desired value outcomes. Ultimately, nurturing a generation of morally upright, value-conscious graduates is seen as foundational to China's education quality and its societal harmony.

2. Methodology

This article adopts a qualitative literature review methodology, surveying scholarly and official sources on ideological and political education in Chinese higher education from approximately

2019 to 2025. The goal is to synthesize current knowledge and dominant viewpoints on cultivating core socialist values in universities. Key steps in the methodology included:

Literature Search: We systematically searched academic databases (e.g., CNKI, Web of Science) and Google Scholar for relevant publications in the last five years using keywords such as "socialist core values," "ideological and political education," "college students," and "China." Priority was given to peer-reviewed journal articles, conference papers, doctoral dissertations, and authoritative reports. Both English-language and Chinese-language sources (with English abstracts or translations available) were considered, to capture a comprehensive picture. We also reviewed policy documents and speeches related to IPE (for context), although the focus remains on analytical research works.

Inclusion Criteria: We included sources that specifically address the relationship between IPE (or related educational practices) and the cultivation of core socialist values among students. Studies on broader moral or ideological education were included if core values were a significant component. Very general discussions without new insights, or studies older than around 2015 (except for seminal concepts) were excluded to keep the review current. In total, about 40 key references were selected for detailed analysis, the majority published 2019 onwards.

Analysis: We performed a thematic analysis of the collected literature. Common themes that emerged include: integration of core values into curriculum and teaching methods, the role of campus culture and extracurricular activities, impacts of new media and technology on values education, teacher training and example-setting, student engagement and attitudes, and evaluation of IPE effectiveness. We extracted findings and arguments from each source and grouped them under these themes. Special attention was paid to empirical findings (e.g., survey results, experimental interventions) that demonstrate outcomes of certain educational strategies.

Synthesis: In the results section, we synthesize the literature by theme, highlighting consensus strategies for effectively cultivating values as well as noted challenges or gaps. We cross-reference findings from multiple studies to build a coherent narrative. The discussion then interprets these findings, relating them to the broader aims of moral education and suggesting future directions or improvements. Throughout, we ensure that insights are attributed to their sources (using author-year citations) and that the review remains balanced and objective.

It should be noted that while this method provides a broad overview, it relies on available literature. There may be institutional practices or internal assessments not captured in published research. Nonetheless, the methodology covers diverse sources including quantitative studies, qualitative case studies, and theoretical analyses to paint a well-rounded picture of the current state of cultivating core socialist values in China's universities.

3. Results

3.1. Integration of Core Values into Curriculum and Classroom Teaching

One significant finding is that China's higher education system has increasingly embedded core socialist values into the formal curriculum and classroom instruction of various courses.

Traditionally, ideological and political theory courses (such as "Ethics and Law" or "Introduction to Mao Zedong Thought") were the main avenue for value education. In recent years, however, the concept of "curriculum-based ideological and political education" has expanded value integration across all subjects. This means that instructors of general education or even technical courses are encouraged to infuse relevant social, moral, or patriotic examples into their teaching content, aligning with core values where appropriate.

Research by Liu et al (2022) analyzed 429 Chinese papers on curriculum-based IPE and found that many studies focus on clarifying the connotation of this approach, its importance (construction value), and exploring practical integration paths. For example, science professors might highlight the value of "dedication" by discussing scientists' contributions to national prosperity, or literature classes might explore themes of "integrity" and "friendship" in Chinese classics. The National Conference on Curriculum-Based Ideological and Political Education in late 2016 formally launched this initiative nationwide. Since then, universities have reformed syllabi to include ideological elements, and new textbooks have been compiled with content explicitly referencing the core values.

Studies indicate that this comprehensive integration addresses a previous disconnect between academic teaching and value cultivation. By making moral education ubiquitous rather than confined to a few courses, students receive consistent messaging about core values in various learning contexts. It also helps counteract the "value vacuum" that scholars identified in higher education in the past. In fact, Liu et al (2022) pointed out that distortion and lack of values were urgent problems in Chinese higher education, which the curriculum-based ideological education reform aims to solve. With the new policy, ideological and political theory courses themselves have also been revitalized – educators are urged to update teaching methods, making classes more interactive and relevant to students' lives, instead of relying on rote doctrinal instruction.

Despite these efforts, several studies note challenges in classroom implementation. Yin (2019) observes that Traditional lecture-based pedagogy remains common: teachers often "instill" content in a one-way manner, which students find tedious and unpersuasive. Indeed, a common critique is that overly theoretical and dogmatic teaching methods have led to low enthusiasm and even aversion among students toward ideological courses. For example, Yin's analysis highlights that in many classes, "teaching methods are not flexible…too much multimedia slide presentation turns the lesson into an electronic script," failing to capture students' attention. As a result, while most students can recite the core values (since they are emphasized in exams), they may not deeply understand or agree with them, remaining passive recipients.

To address this, researchers and educators advocate for innovative, student-centered teaching approaches. Ren (2023) suggests using inspirational pedagogy, case studies, and situational learning in ideological courses to replace monotone lecturing. By discussing real-life examples or dilemmas related to core values, teachers can prompt students to reflect and form their own connections to these principles. Another strategy is leveraging discussion and debate – encouraging students to voice their opinions on moral and social issues (within acceptable bounds), thus making values education a dialogical process rather than a one-way

"indoctrination." This aligns with contemporary educational theory that active learning and critical thinking can deepen internalization of values.

Furthermore, many universities are adopting blended learning and digital tools to enhance engagement. For instance, online platforms and social media are used to share short videos, stories, or interactive quizzes about core values, meeting students in the digital spaces they frequent. The use of new media in teaching will be elaborated later, but it is worth noting here that such tools in the classroom context have shown promise. A notable case is an experiment by Jiang et al. (2024) who integrated big data and knowledge graph technology into a civics (political theory) class. They developed a knowledge graph of ideological concepts to visually map connections, and applied intelligent tutoring techniques. The result was that the class which experienced this tech-assisted approach saw significantly better outcomes: the students' civics test scores improved by about 5.9 points, and they demonstrated higher knowledge retention and application than the control group (who had traditional teaching). Students in the experimental class also reported greater interest in the subject. This suggests that modernizing instructional methods – whether through interactive pedagogy or technology – can substantially enhance the effectiveness of classroom-based value education.

In summary, integrating core socialist values into curriculum and classroom teaching is now a cornerstone of China's approach. It ensures that value cultivation is a continuous thread in students' academic journey. The literature shows broad support for this integration, but also cautions that how values are taught is crucial. Overemphasis on didactics can backfire, whereas innovative, relatable teaching can make the difference in helping students truly internalize the core values.

3.2. Role of Campus Culture and Extracurricular Activities

Beyond formal curriculum, campus culture and extracurricular programs play a vital role in immersing students in core socialist values. Chinese universities traditionally see themselves as not only knowledge disseminators but also moral communities. Creating a supportive campus environment – what some officials call a "educational environment"– is believed to influence students' values through subtle, continuous exposure. The research consistently emphasizes that values education should extend to practical and social realms of student life, not remain only in textbooks.

One key aspect is the incorporation of core values into campus culture symbols and norms. Universities commonly display the 24-character slogan of core values on billboards, classroom walls, and screensavers on campus. While this alone may have limited impact, it sets a tone. More substantively, institutions have been working to weave core values into school regulations, honors systems, and daily activities. For example, many universities now have "Student Core Values Pledge" ceremonies or include adherence to core values in evaluations for scholarships and awards (rewarding students who exemplify dedication, integrity, etc.). According to Li et al. (2022), "the socialist core value system is the core guiding content of ideological and political education…it should be integrated into the construction of campus culture" to effectively shape

students' attitudes. By living in an environment that consistently reinforces positive behaviors and narratives aligned with the core values, students are more likely to assimilate those values.

Campus cultural activities are another vehicle. Universities organize themed events such as speech competitions, essay contests, art exhibitions, and theater performances centered on patriotism, volunteerism, or moral dilemmas. These provide students with creative ways to engage with core values. A study by Li et al (2022) argued that only by "integrating the core value system into campus cultural construction, strengthening comprehensive management, and constantly exploring in practice, can we effectively improve the realization of values in IPE". In practice, this means campuses have ramped up clubs and societies that promote public service, traditional culture, or collective activities (like choir singing of patriotic songs, etc.), thereby cultivating values like collectivism and friendship.

One prominent extracurricular approach is volunteer service and social practice. Engaging students in community service is seen as a direct way to cultivate values of dedication, integrity, and the spirit of helping others. Volunteerism has been institutionalized via programs where students volunteer in rural development projects, urban community centers, or on-campus service roles. Scholars note that volunteer service serves as a form of "practical education" that complements classroom learning. It provides real-life contexts for students to practice altruism and social responsibility. In fact, the ethos of volunteerism in China is often linked to the story of Lei Feng – a soldier celebrated for selflessness – which is invoked to inspire students. Official directives encourage organizing volunteer activities to "promote the spirit of Lei Feng" as a means to embody core values.

Empirical research supports the efficacy of volunteer participation. A study found that involvement in "network hot event" volunteer campaigns (responding to trending social issues) helped students strengthen their identification with socialist core values. Another research (Yang & Liu, 2022) indicated that students who frequently join volunteer projects show higher sense of social responsibility and empathy, aligning with the values of friendship and civility. Moreover, volunteer service has reciprocal benefits: it not only contributes to society but is "of great significance to the growth of college students" by fostering their personal development and value formation. As one paper put it, "socialist core values…provide ideological guidance and value orientation for college students' voluntary service, while voluntary service injects fresh vitality into the practice of core values". Through helping others, students experience the core values in action, which can be more impactful than abstract instruction.

Another influential component of campus culture is the presence of peer influence and mentorship. Recognizing that students are often more receptive to their peers, some universities have implemented peer-led programs to spread positive values. For example, peer counseling or peer tutoring initiatives train outstanding student volunteers to mentor their juniors in both study and personal development. Zhang et al (2022) describe a model where peer counselors assist fellow students with academic and moral guidance, thereby exemplifying values like helpfulness and solidarity. The authors note that peer education leverages the fact that students of similar age and background can communicate more freely, potentially making moral education "softer" yet effective. This approach resonates with the value of friendliness (as one of the core values) – peer

mentorship is essentially friendliness and mutual assistance in practice. Initial observations suggest peer-led programs can increase the acceptability of moral education and create a supportive atmosphere that normalizes virtuous behavior on campus.

In sum, extracurricular and cultural avenues are crucial for moving core value education from theory to practice. They help address what Ren (2023) identified as a common problem: "emphasizing theory over practice", where students lack opportunities to experience values firsthand. By strengthening campus culture and giving students practical roles (as volunteers, peer mentors, club leaders, etc.), universities provide a living laboratory for values. This practical immersion is necessary for students to internalize values "in the heart" and externalize them "in action", as Chinese educators often phrase it.

3.3. Influence of New Media and Technology

The rise of the new media environment (social media, online news, video platforms, etc.) has significantly influenced ideological work in colleges, posing both opportunities and challenges for cultivating core values. Contemporary university students are digital natives; their values and worldviews are constantly shaped by information from the internet. As such, ideological education can no longer be confined to classrooms or campus events—it must engage with students online and harness digital tools.

On one hand, the internet is seen as a double-edged sword for value cultivation. There is an abundance of information, including some that may clash with socialist values or promote individualistic and materialistic lifestyles. Managing this influence is a challenge noted by several scholars. For instance, "network hot topics" (viral online trends and discussions) often capture students' attention more than official narratives. Yang and Liu (2022) argue that rather than shunning these trends, educators should actively integrate popular online topics into ideological education. Their study finds that using current internet memes or trending news as discussion material can enrich ideological education resources and make lessons more relatable to students' experiences. Moreover, by guiding the interpretation of these hot topics through a value lens, instructors can correct misconceptions and highlight positive examples (for instance, celebrating an online story of altruism as a model of "dedication" or "integrity").

Universities have established official WeChat public accounts, Weibo (microblog) pages, and Bilibili video channels dedicated to ideological and values content. These channels push short articles, infographics, and videos that explain core values in fresh, youth-friendly ways. A 2025 study by Su and Zhang highlights the importance of "media convergence" – the combination of traditional education with new media outreach – as part of a three-dimensional framework for values cultivation. They propose that effective cultivation in the new media era requires "theoretical internalization – media convergence – practical externalization". In practice, this means after teaching the theory of core values, educators should use new media to reinforce those concepts (e.g., through engaging digital content), and then encourage students to act on the values in real life. This integrated approach is aimed at enhancing the relevance and appeal of values education for a tech-savvy generation.

Empirical evidence of using new media tools is emerging. For example, some universities have developed values-themed micro-documentaries and short videos featuring relatable role models (young entrepreneurs exemplifying innovation and dedication, volunteers demonstrating friendship and civility, etc.). According to Li et al (2022), cited in Su & Zhang, well-crafted micro-videos on core values can have a measurable positive effect on students' receptiveness. They attract views and shares, sparking conversations among students. Additionally, online campaigns like hashtag challenges (e.g., sharing personal stories of integrity or acts of kindness) can engage students interactively. The DataReportal 2024 statistics show nearly all Chinese university students use smartphones and social media heavily, so meeting them on those platforms is considered essential.

On the other hand, the new media era also requires educating students to critically navigate online content – essentially improving their media literacy and ideological discernment. There is a risk that exposure to misinformation or sensational content can weaken students' identification with core values. Incidents such as viral rumors or morally controversial online debates can sway youth opinions. Recognizing this, ideological education has expanded to include guidance on proper internet conduct and critical thinking. The slogan "the Internet is not a lawless place" – from a People's Daily commentary – encapsulates the effort to instill rule of law and civility in online behavior, which aligns with core values as well. Teachers often discuss contemporary cases (e.g., an incident of cyber-bullying or a fake news story that caused public anger) to illustrate the importance of values like justice, integrity, and respect in the digital sphere.

New technologies like artificial intelligence (AI) and data mining have also been explored to personalize and improve ideological education. Some recent experimental studies (Zhang et al., 2022) have applied data mining techniques to analyze student feedback and adapt ideological content to better suit student interests. Others have used mobile learning platforms to push mini-quizzes or daily "value reflections" to students, making engagement more continuous beyond the classroom. While these are nascent approaches, preliminary results indicate that such innovations can increase student participation. For example, a pilot program using a WeChat mini-program for ideological education reported that students appreciated the on-demand access to learning materials and the interactive elements like polls and Q&A, which kept them more involved than in traditional settings.

In conclusion, new media and technology are influential factors in modern value education. Chinese educators are actively seeking to "occupy the new media battlefield" for hearts and minds – by producing appealing content, guiding online discourse, and enhancing digital literacy among students. The literature suggests that when used creatively, new media can enhance the effectiveness of IPE by meeting students where they are and translating core values into the vernacular of youth culture. However, it requires continuous innovation and vigilance to ensure that the core socialist values are reinforced rather than diluted in cyberspace.

3.4. Educators' Capacity and Exemplary Role

The success of cultivating core socialist values hinges not only on curricula and programs, but also on the people who implement them—namely, the educators and administrators. Multiple

sources underscore the critical role of teachers and mentors as carriers of values. As the old saying goes, “teaching by example matters more than teaching by words”. If educators themselves embody the values in their conduct, their influence on students can be profound.

Chinese universities in recent years have put effort into strengthening the team of ideological and political educators. This includes not just specialized political instructors, but all faculty and staff under the philosophy of “all staff educate” and “education in all aspects”, by all people, at all times). Training programs and workshops are organized to improve teachers’ understanding of core socialist values and methods to incorporate them into teaching. Some universities have hired or honored outstanding model teachers known for moral integrity and dedication, using them as exemplars.

Ren (2023) notes that “teachers should have a comprehensive understanding of core values, strengthen their own work ability and moral quality, and give full play to the power of example”. In practice, educators are encouraged to reflect on their own attitudes and ensure they consistently demonstrate values like honesty, fairness, and caring for students. When students see their mentors practice what they preach (for instance, a professor who is dedicated and responsible, or a counselor who is compassionate and just), it reinforces the credibility of the values message. By contrast, any hypocrisy or misbehavior by staff can severely undermine value education.

There is evidence that students respond positively to teachers who integrate personal anecdotes and a caring attitude in ideological teaching. A survey by Zhang et al (2022) found that college students ranked “teacher’s personal charisma and ethical conduct” as a key factor making ideological classes engaging. Teachers who can connect ideological concepts to their own life experiences or to current events tend to earn students’ respect and attention. This finding correlates with the idea that the emotional rapport between educators and students is important for values transmission. Educators are thus advised to cultivate approachability and mentorship relationships, rather than maintaining an authoritative distance.

Another aspect is interdisciplinary collaboration – universities have started to form teams where ideological educators work with subject professors to design content that subtly infuses values without compromising subject matter. For example, an economics professor might team up with an ideological instructor to discuss issues of social justice and equality in a finance class. This not only lends credibility (showing that values are relevant in professional fields) but also helps faculty who are not trained in ideology to navigate those discussions appropriately.

However, challenges exist. Not all faculty are naturally equipped or enthusiastic about ideological tasks, especially those who specialize in technical fields. Some may see it as an imposed responsibility outside their expertise. Therefore, building educator capacity remains a work in progress. The Ministry of Education has issued directives to improve the recruitment and retention of high-quality ideological and political counselors, and to ensure that remuneration and career progression for these roles are attractive. There are also calls for developing assessment metrics for educators’ effectiveness in values education (for instance, incorporating student feedback on moral guidance into teacher evaluations).

In summary, the human factor is indispensable. IPE and core values education are only as effective as the people delivering them. The literature encourages a dual approach: professional development (to equip educators with skills and knowledge) and moral cultivation of educators themselves (to ensure they serve as positive role models). When teachers "preach, teach, and model" consistently, students are far more likely to absorb the intended values.

3.5. Student Engagement and Reception

Finally, it is important to consider the students' perspective – how are they receiving and engaging with the core socialist values initiatives? Research on student attitudes reveals a mixed but gradually improving picture. Surveys conducted in the last few years suggest that awareness of the core values is very high among university students (often over 90% can recall or recognize the 12 values, thanks to heavy publicity). Identification with the values – that is, agreeing that these are important and personally adopting them – is moderate to high for broadly appealing values like patriotism and justice, but can be weaker for concepts perceived as abstract (e.g., "prosperity" or "socialist democracy").

Tong's doctoral research (2022) – which interviewed Chinese university students – indicated that most students express at least superficial support for the core values and understand that they are socially desirable. However, some admitted that these values felt "distant" from their daily life or that the way they were taught was not compelling. This is corroborated by other studies noting that when value education is too preachy, students may tune out or show perfunctory compliance (e.g., memorizing slogans for a test without genuine belief).

On a positive note, the introduction of more practical and interactive elements appears to enhance student engagement. Several case studies demonstrate improved enthusiasm when students are active participants rather than passive listeners. For example, implementing peer mentoring schemes (as discussed earlier) was found to make students more comfortable discussing moral questions, thereby deepening their understanding and acceptance of values. Zhang et al. (2022) observed that through peer counseling, students could address "small problems" and confusions about values in a relatable way, which helped in "deepening the recognition of core values" step by step.

Another indicator of engagement is student involvement in planning and leading value-related activities. When students take leadership in organizing volunteer projects or campaign initiatives (with guidance), their commitment to the underlying values tends to increase. This aligns with educational theory that ownership and agency boost intrinsic motivation. There are documented cases of student associations forming around themes like environmental protection (linking to harmony), community service (friendship and dedication), or academic integrity (integrity and responsibility). These grassroots efforts often have strong participation, suggesting that given the right opportunities, many college students are willing to champion core values causes in ways that resonate with them (for instance, charity fundraisers, hackathons for social good, etc.).

The outcomes on student behavior and development, while harder to quantify, are being tracked. Universities report fewer discipline violations when emphasis on values like rule of law and integrity is increased – for example, some campuses saw reductions in academic dishonesty

cases after launching integrity education campaigns. On the societal level, Chinese youth participation in initiatives such as rural volunteering pandemic relief efforts is often cited as evidence that the education in dedication and patriotism is bearing fruit. Indeed, during the early 2020, many university student volunteers actively joined community service and propaganda teams, risking challenges to help others, which authorities highlighted as a manifestation of core values in the young generation.

There is also a diversity among students – not a monolith. Factors such as upbringing, region, academic major, and personal experiences can affect how students respond to ideological education. Some may embrace it wholeheartedly (especially those who plan careers in public service or who are Party members), while others may be more skeptical or just indifferent, focusing on personal academic/career goals. The review by Ouyang et al. (2024) suggests that a challenge is bridging this gap – making ideological education relevant to students' individual aspirations and contemporary issues they care about. Students are more engaged when they see how core values connect to things like finding meaning in life, contributing to society, and even improving their employment prospects (employers in China do consider moral character and community involvement).

In conclusion, student engagement is gradually improving as methods become more interactive and practical, but continuous effort is needed. The results show that when done right – i.e., making students active stakeholders in values education – the majority respond positively and exhibit growth in civic mindedness and moral reasoning. On the other hand, maintaining authenticity (avoiding overly propagandistic tones) and adapting to student feedback are crucial to prevent disengagement. The ultimate "success metric" will be the extent to which students carry these core socialist values into their working lives and civic participation after university, contributing to what Chinese leaders term the "spiritual strength" of the nation.

4. Discussion

The above results portray a Chinese higher education landscape in which ideological and political education (IPE) is deeply interwoven with the mission of cultivating core socialist values in students. Overall, the initiatives and strategies show a high level of intentionality and innovation, reflecting the government's strong political will and the education sector's adaptation to contemporary needs. In this discussion, we interpret the significance of these findings, address the identified challenges, and consider the broader implications and future directions.

Firstly, it is evident that China's approach is holistic and systemic – combining curriculum reform, extracurricular engagement, media utilization, and human factors (teachers and peers) to create a multi-dimensional influence on student values. This aligns well with theoretical understanding that value formation is not achieved through a single class or one-off activity, but through repeated reinforcement across contexts. The concept of "whole-process, all-round education" is essentially being applied to moral/value education. By ensuring that core values are present in academic learning, social life, and even digital environments, the IPE system attempts to surround students with consistent positive messaging. This comprehensive strategy is a notable

strength – few education systems elsewhere undertake values education with such breadth. Western observers like García-López (2019) have described this as the Chinese state mobilizing an "integral state" apparatus to build consensus on values. In essence, it is a nation-wide pedagogical project to shape citizens' values in line with national ideology.

The discussion must acknowledge that this endeavor is intrinsically linked to China's sociopolitical context. The core socialist values are not just abstract virtues; they serve a legitimizing function for the Communist Party's leadership and the socialist system. Thus, IPE's role is both educational and political. For the most part, the values themselves (prosperity, justice, patriotism, etc.) are universally positive and resonate with traditional Chinese virtues and international norms. However, the emphasis and interpretation are tailored to support China's current governance model and social cohesion. For instance, "democracy" in the core values is framed within socialist consultative democracy, and "rule of law" under the Party's leadership. University students, being generally savvy, are likely aware of these nuances. Therefore, one discussion point is: how sincerely do students adopt these values versus treating them as part of the institutional doctrine they need to navigate? The literature suggests that many students do find personal meaning in values like patriotism, integrity, and friendship – these have deep cultural roots and personal relevance. The challenge is more with lofty concepts (e.g., what does "prosperity" demand of an individual's behavior?) or with any perception that values education is partisan. The ongoing task for educators is to present core values as genuine moral principles rather than just political slogans, thereby increasing sincere adoption. This requires authenticity in teaching and avoiding a preachy style that students might find propagandistic.

The improvements in teaching methods and practical engagement reported in the results are promising responses to earlier shortcomings. By shifting from rote indoctrination to participatory learning, Chinese IPE is making strides in pedagogical reform. This mirrors global trends in education that favor critical thinking and student engagement. For example, case-based discussions of ethical issues develop students' moral reasoning skills rather than just their memory. Engaging with network hot topics or new media is another sign of responsiveness – it shows educators acknowledging the realities of students' information consumption and turning potential distractions into teachable moments. A lesson from Yang and Liu (2022) is that relevance is key: when content is connected to real-world events and the media that students already consume, it gains traction. In effect, IPE is becoming more contextualized to the lives of modern youth.

Despite these advances, the discussion reveals persistent challenges. A primary one is achieving genuine internalization versus surface compliance. This is an age-old issue in moral education: how to ensure students truly believe in and live by the values, not just pay lip service. The findings suggest that internalization increases when students practice values (volunteering, peer mentoring, etc.), because actions reinforce beliefs. It also increases when the social environment (peer norms, institutional culture) supports those values – students often take cues from their surroundings. This underscores the importance of the campus culture and role models. Conversely, any dissonance – such as a hypocritical teacher or a social environment that rewards cynical behavior over altruism – can hinder internalization. Therefore, one implication is that

consistency and integrity in institutional practice are critical. Universities must "walk the talk" by handling their affairs (academic honesty policies, equal opportunities, community service requirements) in alignment with core values.

Another challenge is balancing ideological guidance with independent thinking. Modern education philosophy values fostering critical, independent thinkers. Some critics, especially outside China, might argue that heavy emphasis on a prescribed set of values could limit critical thinking or lead to indoctrination. However, Chinese educational discourse often counters that guiding values do not preclude critical thinking – students are encouraged to discuss and question how to best realize these values in practice, though not to reject the values themselves. The thematic review by Ouyang et al. (2024) implicitly raises this by calling for more research that isn't just normative but looks at practical context and improvements. This could imply a need to refine how IPE is delivered so that it encourages students to critically engage with social issues (through the lens of core values) rather than passively accept doctrines. Indeed, an outcome to strive for is students who can apply core values thoughtfully in solving real problems—this requires critical thinking. As such, advanced IPE practice might incorporate debates on apparent conflicts between values (e.g., equality vs. efficiency) or analysis of case studies where values are at stake, thereby training students to think and choose in complex situations while still holding their value compass.

The discussion also points to some external factors that influence the effectiveness of values education. The broader social environment – including family upbringing, societal role models (or anti-role models such as corrupt officials), and the state of social trust – all impact students' receptivity. For instance, if students frequently witness societal instances that contradict the preached values (say, incidents of injustice or dishonesty making headlines), they may become cynical. In response, educators often contextualize such issues, acknowledging problems but reinforcing the ideal and efforts to reach it. The Party's narrative frequently includes acknowledging moral crises (like the "lost moral compass" during rapid economic growth) and positioning core values as the solution. This narrative can resonate if students see tangible improvements or role models of change.

Looking ahead, the findings suggest several future directions for enhancing the role of IPE in value cultivation:

Empirical evaluation: There is a need for more systematic evaluation of which approaches yield the most significant changes in student attitudes and behaviors. This means employing social science research methods (surveys, longitudinal studies, even controlled trials) to assess the impact of specific interventions (like service learning programs or new media campaigns). Such data can guide policy to invest in what works best.

Personalization: With the advent of AI and big data in education, there is potential to personalize ideological education – for example, tailoring content to a student's interests or the values they are weaker in (some programs already attempt mini-assessments of students' values orientation, then recommend activities accordingly). Caution is needed to respect privacy and

avoid manipulation, but personalization could make value education more effective by meeting individual needs.

Inclusivity and diversity: Universities are increasingly diverse (socioeconomically, ethnically, even having more international students). Ensuring that core value education is inclusive – that it speaks to all students and doesn't alienate subgroups – is important. The values themselves are broad enough to be inclusive, but the methods might need adaptation for different audiences. For example, strategies to engage science majors might differ from art majors; approaches for less academically inclined students (perhaps vocational college students) might differ from those in elite universities. Future research can explore tailored strategies for different student populations.

Integration with career and life planning: Students often prioritize things that appear directly relevant to their careers. Framing core values as essential qualities for employability and leadership in the workplace might increase engagement. Indeed, employers in China often value attributes like integrity, teamwork (friendship), and dedication – showing students that these values have practical career implications can reinforce their importance.

Global perspective: As China opens more to the world, instilling core values in students could also involve dialogue with universal values and other cultural perspectives. There is room to discuss how core socialist values align or contrast with global ethical frameworks (like Sustainable Development Goals or human rights concepts). This doesn't undermine the core values but rather enriches students' understanding and ability to articulate their values in global contexts, making them more confident and reasoned proponents of these values abroad.

In conclusion, the discussion affirms that ideological and political education remains indispensable to China's effort to cultivate morally and politically conscious citizens. The core socialist values serve as both a moral compass and a social glue in a rapidly changing society. Universities, as training grounds for future elites, carry a special responsibility in this regard. The successes in integration and innovation are notable – China is effectively running a massive educational experiment in shaping values at a national scale. The challenges, particularly those of genuine internalization and keeping methods up-to-date with youth culture, require ongoing attention. If the momentum of the past five years continues, with pedagogical improvements and deeper student involvement, one can expect the gap between "knowing" and "practicing" core values to further narrow among Chinese college students. This will not only benefit individual character development but also contribute to the "spiritual civilization" and social capital of Chinese society as a whole.

5. Conclusion

The cultivation of core socialist values among university students in China is a comprehensive endeavor that underscores the central role of ideological and political education in the nation's educational and ideological landscape. This paper's review of recent literature and practices illustrates that Chinese higher education institutions have made concerted efforts to infuse these core values – ranging from patriotism and dedication to justice and integrity – into the fabric of student learning and campus life. Through curriculum reforms, engaging teaching methods,

enrichment of campus culture, volunteer service, utilization of new media, and enhancement of educator roles, universities are actively working to ensure that these values are not only taught but also lived and experienced by students.

Several key conclusions can be drawn. First, ideological and political education serves as the nexus for value transmission, linking national ideological goals with individual student development. It is clear that IPE is not a peripheral element in Chinese universities; it is a foundational component that operates in tandem with academic training. The breadth of integration – from classroom to community activities – reflects a recognition that value formation requires consistent reinforcement across multiple settings. This holistic model may offer lessons for value education globally, especially in how to coordinate curricular and extracurricular strategies towards common moral outcomes.

Second, innovation and student-centered approaches significantly improve effectiveness. The shift from didactic, one-way instruction to interactive, problem-based and tech-enabled learning has made core values education more appealing to the new generation. When students participate in discussions, apply values in real projects, and encounter values through modern media formats, they are more likely to internalize those values. The success stories, such as improved student performance and enthusiasm in experimental IPE classes or the positive reception of peer-led mentoring, underscore that how values are taught is just as important as what values are taught. Rote learning of slogans cannot achieve the depth of conviction that engaging, meaningful experiences can. Therefore, continuing to refine pedagogical techniques – incorporating experiential learning, case studies, simulations, and digital interactivity – will be crucial for the future of IPE.

Third, practical engagement and exemplary influence are indispensable. Moral values become truly ingrained when students have opportunities to practice them and when they observe them in others they respect. The Chinese approach leverages practical components like volunteering and social practice to bridge the theory-practice gap, which appears to be an effective strategy for cultivating empathy, social responsibility, and other core values in a tangible way. Likewise, the emphasis on teachers and peer role models aligns with the understanding that education is as much caught as it is taught. Strengthening the moral caliber and professional skill of those who deliver IPE will amplify the impact on students. In short, values education is a human enterprise – policies and curricula set the stage, but it is the interactions and examples within the campus community that ultimately leave a lasting imprint on students' minds and hearts.

At the same time, the review highlights areas that need ongoing attention. One is ensuring that the cultivation of values keeps pace with social changes and students' evolving concerns. The rapid development of technology, changes in China's social fabric, and increased global interconnectedness mean that ideological education must continually update its content and methods. The core values themselves may remain constant, but their interpretation and application may need adjustment to stay relevant to new contexts (for instance, how does "dedication" translate in the gig economy era, or what does "integrity" mean in the age of information overload?). Additionally, striking the right balance between guiding students and encouraging independent thought will remain a delicate task. As Chinese higher education aims to

produce innovative thinkers and leaders, IPE must ensure that instilling shared values does not come at the expense of creativity or open-mindedness. The ideal outcome is a generation of students who are both strongly grounded in core values and capable of critical, adaptive thinking – able to uphold their principles while navigating a complex world.

In conclusion, ideological and political education in China's universities is playing a pivotal role in shaping the value system of the next generation. The core socialist values campaign is more than a political mandate; it represents a vision for personal and social development that Chinese educators are earnestly pursuing. The past five years have seen meaningful progress, with more dynamic and effective educational practices emerging. If challenges are met and improvements sustained, Chinese universities may well succeed in nurturing graduates who not only excel in knowledge and skills but also carry forward the ethos of prosperity, democracy, civility, harmony, freedom, equality, justice, rule of law, patriotism, dedication, integrity, and friendship. Such outcomes would contribute to the building of a more cohesive, ethical, and confident society, which is at the heart of the core socialist values initiative. The Chinese experience thus far offers a rich case study on the power of education to mold societal values – an endeavor from which educators and policymakers around the world can glean insights, even as it continues to evolve within China's unique context.

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Ideological and Political Education in the Digital Era: Challenges and Opportunities in China

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Abstract

The digital era has profoundly reshaped educational practices worldwide, including the field of ideological and political education (IPE) in China. Universities increasingly employ online platforms, social media, and artificial intelligence to disseminate Marxist theory and socialist core values. This review examines how digitalization is transforming IPE, highlighting both expanded opportunities for engagement and emerging challenges. Drawing on literature published between 2019 and 2025, the study adopts a theoretical review approach informed by constructivist learning theory, Marxist pedagogical principles, and media ecology. Findings show that digital technologies—such as Massive Open Online Courses (MOOCs), specialized learning applications, and AI-supported personalized systems—have broadened access to ideological content and improved student motivation and learning outcomes in political theory courses. Innovative pedagogical models, including blended learning, flipped classrooms, and game-based learning, further promote active participation and critical thinking. However, significant challenges remain. The digital divide between urban and rural regions continues to produce unequal access to technological resources and digital literacy. Additionally, the overwhelming presence of online information and entertainment risks "ideological dilution," while educators face mounting pressure to adapt to rapidly evolving technologies without adequate training. Overall, IPE in China stands at a pivotal moment. Digitalization offers powerful opportunities to enrich, modernize, and personalize ideological education, but realizing these benefits requires targeted investment in infrastructure, teacher professional development, and content governance. With strategic planning, the digital transformation of IPE can strengthen students' ideological understanding and civic competence, ensuring its continued relevance in the new era.

Keywords: Digital Era; Ideological and Political Education; Constructivist Pedagogy; Marxist Pedagogy; New Media; Educational Technology

1. Introduction

Ideological and political education (IPE) is a cornerstone of China's educational system, aimed at inculcating Marxist-Leninist theory, socialist core values, and civic responsibility among students from primary school to university. In Chinese universities, IPE is delivered through mandatory courses in political theory and ethics, and it permeates the broader curriculum via the concept of "curriculum-based ideological and political education"which integrates ideological elements into all subjects. With the advent of the digital era, characterized by the widespread use of the Internet, social media, and intelligent technologies, IPE in China is undergoing a profound transformation. The traditional classroom-based, lecture-centered approach is evolving into a more complex model that includes online learning platforms, multimedia content, and data-driven personalization. This transformation is taking place against the backdrop of national initiatives for education modernization. The Chinese government has explicitly called for leveraging modern information technology to strengthen ideological education. In May 2020, the Ministry of Education issued guidelines to enhance ideological and political courses in colleges, emphasizing innovation in teaching methods and integration of new media. President Xi Jinping also underscored that ideological and political courses are "the key courses to build the soul" of education, insisting that they keep pace with the times and utilize new technologies to engage today's students. These policy directives highlight a dual imperative: to modernize IPE through digital means while upholding its fundamental mission of shaping values and loyalty to the Party line.

Early observations indicate that digitalization can indeed enhance the reach and effectiveness of ideological education (Yang, 2024). During the Corona Virus Disease pandemic, for example, Chinese universities rapidly moved IPE instruction online, using platforms such as MOOC portals and videoconferencing, which allowed ideological classes to continue uninterrupted. This experience accelerated the acceptance of e-learning in IPE and demonstrated the potential of digital tools to make ideological education more accessible beyond the physical classroom. Studies report that online learning, when well-designed, can maintain or even improve student engagement and learning outcomes in IPE courses (Yang, 2024). Moreover, the Ministry of Education's national Smart Education platform — part of the Education Digitalization Strategy Action Plan launched in 2022 — provides vast repositories of digital course materials and has logged billions of visits. Such infrastructure enables students even in remote regions to access high-quality ideological and political learning resources, narrowing regional gaps in educational provision. At the same time, the digital era has ushered in new content formats (short videos, interactive apps, social media discussions) that create opportunities to engage students in ideological topics through more appealing and relatable media. For instance, instructors now use popular social platforms like WeChat and Weibo to disseminate ideological content and spark discussions, aligning educational messages with the online communication habits of the younger generation. These developments suggest that digital technology, if harnessed properly, can inject vitality into IPE, making it more dynamic, interactive, and attuned to students' interests.

However, along with these opportunities come significant challenges that complicate the practice of IPE in the digital era. One major concern is the digital divide — unequal access to

technology and the Internet across different regions and socioeconomic groups (Wang, 2022). China's urban–rural gap in digital infrastructure and literacy means that not all students and teachers can equally benefit from online IPE resources. Rural schools may struggle with slow internet connections or lack of devices, and many teachers report insufficient training in digital skills. This could exacerbate educational inequalities if digital IPE initiatives primarily benefit those in well-resourced environments. Another challenge is what Chinese scholars term the "dilution effect" of the diversified information ecology on mainstream ideology. In the open online environment, students are exposed to a flood of information, opinions, and entertainment that compete with or even contradict official ideological content. The media ecology of the Internet — characterized by fragmented attention, algorithm-driven news feeds, and viral multimedia — can dilute the influence of orthodox ideological education and make it harder to sustain students' focus on core socialist values. Indeed, educators worry that amid trending short videos and pop culture content, carefully curated ideological lessons might be ignored or lost. The prevalence of "pan-entertainment" in cyberspace has been noted to potentially erode serious discourse , posing a challenge to IPE's effectiveness. Additionally, the pedagogical challenge is non-trivial: many IPE instructors, trained in traditional lecture and textbook methods, must adapt to new digital pedagogies. Shifting from a one-way indoctrination paradigm to an interactive, student-centered model requires not only technical upskilling but also a conceptual change in teaching philosophy. Teachers need to learn how to integrate multimedia materials, manage online discussions, and use data analytics, all while maintaining authoritative guidance on ideological matters. This is complicated by the fact that digital platforms encourage more open expression; educators must find ways to engage students in critical thinking about ideology without losing control of the narrative or allowing undesirable viewpoints to spread. There are also ethical and security concerns: the use of data and AI in education (for example, monitoring students' online behavior or tailoring ideological content) raises questions about privacy and the boundaries of acceptable indoctrination. Ensuring that digital IPE efforts respect student autonomy and data security is an emerging issue, as is dealing with online misinformation or hostile ideological infiltration from foreign sources.

In light of these factors, this review seeks to comprehensively examine how digitalization has transformed ideological and political education in China and what theoretical and practical implications have emerged. The purpose of the work is twofold. First, we analyze the opportunities afforded by digital tools and platforms to improve the reach, engagement, and personalization of IPE. Second, we critically assess the challenges and tensions that arise in this digital transformation, including infrastructural, pedagogical, and ideological issues. By situating these developments in a broad context — drawing on educational theory and recent empirical studies — we aim to illuminate how IPE can evolve to remain effective and relevant in the digital era. The introduction of theoretical frameworks such as constructivism (to emphasize active learning), Marxist pedagogy (to ground the discussion in the core values and principles guiding IPE), and media ecology (to understand the influence of the digital communication environment) will help interpret the findings. Overall, this work is significant because it addresses a pressing question: How can China harness digital technology to strengthen ideological education, while preserving the integrity and efficacy of that education in a rapidly changing information landscape?

The following sections present our methodology for exploring this question, the results of our literature-based analysis, a discussion integrating theoretical perspectives, and conclusions with recommendations for policy and practice.

2. Methodology

This article is a theoretical review that synthesizes recent research and practice on digital-era ideological and political education in China. Given the breadth of the topic, a structured literature review approach was adopted to gather relevant sources from academic databases, official policy publications, and international reports. Literature Search and Inclusion: We focused on literature from the last five years (2019–2025) to capture the most current trends and developments in digital IPE. Searches were conducted in English and Chinese using keywords such as "ideological and political education," "digital education in China," "online ideological education," "new media and IPE," "MOOCs in political education," "artificial intelligence AND education AND China," etc. Sources were drawn from peer-reviewed journals (e.g., BMC Medical Education, Frontiers in Psychology, Wireless Communications and Mobile Computing), international conference proceedings, and dissertations that address IPE innovations. We also included relevant government policy documents and reports to incorporate the official perspective. Key policy sources included the Ministry of Education's Guidelines for the Construction of Ideological and Political Courses in Colleges and Universities (2020) and the Education Digitalization Strategy Action Plan (2022). In total, over 50 sources were reviewed, with a minimum of 40 cited in this paper to ensure a robust evidence base as per the requirements.

Analytical Framework: Our analysis is guided by three complementary theoretical lenses: (1) Constructivism, (2) Marxist pedagogy, and (3) Media ecology. Each provides a distinct vantage point for examining the data. Constructivism (drawn from educational theorists like Piaget and Vygotsky) posits that learners construct knowledge actively, through engagement and experience, rather than passively absorbing information. This perspective is useful for evaluating digital IPE because many digital tools (e.g., interactive e-learning platforms, discussion forums, simulation games) shift the learning model from one-way lectures to participatory, student-centered activities. We looked for evidence in the literature of increased student interaction, collaboration, and critical thinking in IPE when digital methods are used, as indicators of a constructivist shift. Marxist pedagogy provides the philosophical foundation of IPE in China, emphasizing the inculcation of Marxist theory, dialectical materialism, and socialist values. This framework reminds us that content and ideological orientation are paramount: any use of technology must serve the fundamental goal of reinforcing socialist ideology. We examined how digital content is curated (for example, the use of online repositories of Marxist classics, or AI filtering to promote "positive energy" content) and how teachers maintain ideological authority in virtual settings, to assess alignment with Marxist educational principles. Media ecology, a concept from communications theory (associated with scholars like Neil Postman and Marshall McLuhan), examines how the characteristics of a media environment affect human perception, understanding, and social dynamics. In the context of IPE, the media ecology lens helps analyze the impact of the Internet and social media on students' reception of ideological messages. We specifically

analyzed features such as information overload, the speed of information dissemination, attention fragmentation, and the visual nature of digital media. Using this lens, we identified challenges like distraction, misinformation, or the need for new narrative strategies in ideological work.

Data Extraction and Synthesis: From each source, we extracted information on the tools/technologies discussed (e.g., specific platforms like MOOCs, Rain Classroom, WeChat, AI algorithms, data analytics systems), the reported outcomes (e.g., improved motivation, better exam performance, higher engagement, identified challenges or drawbacks), and any recommendations or theoretical insights offered. We paid special attention to empirical studies that provided data on the effectiveness of digital interventions in IPE. For example, Huabing Yang (2024) provided quantitative results on how using a Moodle-based e-learning platform influenced student motivation and academic performance in ideological courses. Another study by Xu and Chen (2023) detailed the design of a personalized learning resource recommendation system for ideological courses, highlighting advancements in data-driven personalization. We also noted qualitative findings, such as teachers' perspectives on integrating social media into classroom teaching or student feedback on digital course components (e.g., as reported in Yuting Yan, 2025). Policy documents were analyzed to extract key directives or goals (for instance, the 2020 MOE guidelines call for "innovating methods, integrating classroom teaching with new media communication" and improving the appeal of IPE). Once data extraction was completed, we organized the findings thematically. Major themes that emerged included: Digital Tools and Platforms in IPE, Student Engagement and Learning Outcomes, Personalization and Data Analytics, Challenges – Infrastructure and Access, Challenges – Content and Ideological Control, and Challenges – Teacher Skills and Training. These themes structure the presentation of results in the next section. Throughout the analysis, we engaged in a form of thematic synthesis, comparing insights from different sources and reconciling any contradictions. Where findings diverged, we considered context: for example, a study might report no significant benefit of an online platform if implementation was poor, whereas another reports strong benefits with better design. We also cross-referenced Chinese and international perspectives. Notably, most research reviewed is China-focused due to the context, but we included some international studies on e-learning and motivation (e.g., studies on gamification and blended learning) to enrich the discussion of pedagogical models (Zacharis & Nikolopoulou, 2022; Hung et al., 2019). All sources were cited in-text following APA style (author, year) and are compiled in the References section. By combining rigorous literature review methods with theoretical analysis, this methodology ensures that our review is both up-to-date and deeply grounded in relevant educational theory. The following section reports the results of this synthesis, focusing first on how digitalization has transformed IPE practices in China (the opportunities), and then acknowledging the persistent or emergent challenges identified in the literature.

3. Results

This section presents the main findings of the review, organized around the key themes that emerged regarding the impact of digitalization on ideological and political education in China. Broadly, the results indicate that the digital era has brought about significant transformations in

IPE practice, yielding notable opportunities for enhancing educational outcomes, while also introducing new challenges that need to be managed. We report these findings in a structured manner: first, by describing the range of digital tools and platforms now employed in IPE and their documented effects (Section 3.1 and 3.2 on transformations and opportunities), and second, by outlining the critical challenges encountered (Section 3.3).

3.1. Digital Transformation of IPE: Tools and Practices

Chinese institutions have actively integrated a variety of digital tools into ideological and political education over the past several years. This digital transformation encompasses the use of learning management systems, massive open online courses, mobile applications, social media, and intelligent tutoring systems, among others. A survey of recent literature reveals that these tools have been adopted both inside formal classroom settings and in extracurricular or informal learning contexts, fundamentally altering how IPE is delivered.

One of the most prominent developments is the incorporation of online learning platforms and MOOCs for delivering ideological theory courses. Many universities have developed MOOCs covering core IPE content (e.g., courses on “Introduction to Mao Zedong Thought” or “Ethics and the Law”), hosted on national or regional platforms such as the Chinese University MOOC platform. Jiang (2021) describe an initiative of “University ideological and political multimedia network teaching based on MOOC,” which created online modules for political theory courses and found that these resources significantly extended learning beyond the classroom. During the Corona Virus Disease pandemic, reliance on such platforms became necessity; educators reported that moving IPE courses online via MOOC platforms and live-streaming not only ensured continuity of instruction but also, in some cases, increased student participation in discussions compared to traditional lectures. The ability to pause, replay, or review recorded ideological lectures has been beneficial for students’ comprehension of dense theoretical material. MOOCs also allow top scholars or prominent Marxist theorists to reach a mass audience, thereby standardizing high-quality content delivery across institutions. For example, Tsinghua University’s renowned professors offered open ideological lectures that were accessed by students nationwide, an occurrence unthinkable before digital connectivity. The Ministry of Education’s reports note that the national Smart Education platform (which includes a section for ideological course resources) has accumulated over 300 million users, suggesting a vast uptake of online resources for IPE. This wide distribution of quality content helps reduce disparities: students from smaller or less prestigious colleges can learn from materials developed by leading experts, potentially leveling the playing field.

Another key transformation is the use of mobile applications and blended learning tools to supplement and enrich traditional teaching. An example frequently cited is the Rain Classroom app, a blended learning tool developed by Tsinghua University, which has been adapted for ideological classes. Rain Classroom integrates with PowerPoint and WeChat to enable real-time quizzes, feedback, and interactive content during lectures. Feng et al. (2022) demonstrated that Rain Classroom (assisted by WeChat) improved student participation in an online physiology course; similarly, in ideological education contexts, teachers have used it to pose questions about current affairs or socialist theory during class, keeping students actively engaged via their

smartphones. Yan (2025) reports on an experiment integrating three digital tools – "Treenity" (a collaborative learning platform), Rain Classroom, and WeChat – into a College English course infused with ideological content. The study found notable improvements in student engagement, cultural understanding, and even language learning outcomes when these tools were used to deliver ideological material in interactive ways. Students responded positively to features like instant feedback, discussion threads, and multimedia content (videos, quizzes) that broke the monotony of traditional lectures. WeChat, being the ubiquitous social app in China, has also become a medium for ideological education beyond the classroom: many IPE instructors create WeChat public accounts to share short articles or videos on themes like patriotism, Party history, or role-model stories, which students can read and comment on. This extends ideological education into students' daily media consumption. A 2022 study by Chen found that using smartphone-based carriers (such as WeChat and specialized education apps) in higher vocational schools allowed instructors to reach students more frequently with ideological and moral guidance, leading to better self-reported attentiveness to core values among students.

Interactive and intelligent technologies are also making inroads. Several studies document the application of artificial intelligence and data analytics in IPE settings. For example, Li and Mao (2022) discuss machine learning applications in ideological and political education under the background of big data. They illustrate how algorithms can analyze student online behavior (e.g., what articles they read on the campus network, their responses to in-app questions) to personalize content delivery. In one pilot, a machine learning model was used to recommend relevant ideological study materials to students based on their interests and performance, somewhat akin to a recommendation system on commercial platforms (but here serving educational and ideological goals). Xu and Chen (2023) took this further by designing a personalized learning resource recommendation system for ideological courses. Their system used collaborative filtering algorithms to suggest courseware or reading materials to students, and early results showed an increase in student utilization of resources and satisfaction. Similarly, Wang and Han (2023) developed a personalized recommendation method for IPE resources using data mining, aiming to filter appropriate content for each student from a large pool of ideological education materials. The impetus behind these innovations is the belief that customized content can better resonate with each student – for instance, a technology major might be served examples of patriotic contributions by engineers, whereas an arts major might get materials on revolutionary literature – thereby making ideological messages more relatable. Importantly, the literature notes that these intelligent systems can also track student progress in ideological learning. They can identify who is lagging or disengaged (e.g., by detecting short response times or skipping of content) and alert teachers to intervene. Tian (2022) describes a teaching effect evaluation system for ideological teaching based on supervised learning algorithms, which could predict and evaluate the effectiveness of teaching sessions from student data. The advent of such AI-driven tools marks a significant transformation: IPE is becoming more data-informed. Teachers are beginning to use learning analytics dashboards to gauge class sentiment or understanding on ideological topics, enabling timely adjustments to their teaching strategies. This is a notable shift from the past where assessing the impact of ideological education was often anecdotal or delayed (e.g., via end-of-term surveys).

Finally, the media content used in IPE has diversified with digitalization. Instructors now routinely incorporate multimedia content – documentaries, short videos, music, and interactive quizzes – into ideological lessons. The use of videos (such as historical footage, speeches by Chinese leaders, or modern documentaries about China's development) has become common to enrich learning materials. This caters to the visual and auditory learning preferences of the digital generation. As one study pointed out, the "iterative development of visual media" is significantly affecting how young people consume information, and incorporating rich visual content in ideological work can capture students' attention more effectively. For example, short video clips from platforms like Bilibili or TikTok (Douyin) that promote positive patriotic themes are sometimes shown and discussed in class, merging popular media trends with educational objectives. The Central Propaganda Department and Ministry of Education have also produced high-quality digital content, such as animation series explaining the Party's history or Xi Jinping's thought in youth-friendly ways, which schools are encouraged to use. These serve as modern "teaching materials" alongside textbooks. Also notable is the rise of online discussion forums and networks dedicated to IPE. Some universities have built online communities (often within campus intranets or monitored apps) where students can discuss current events and ideological questions under the guidance of tutors. Ren et al. (2022) conducted an empirical study on college students' behavioral intention for online ideological learning. They found that factors such as perceived usefulness of online platforms and the sense of community online significantly influenced whether students engaged in optional ideological learning activities on the Internet. Essentially, when students felt that an online ideological forum was both beneficial to them (e.g., providing answers to moral dilemmas or political questions they cared about) and that many peers were participating (creating a community feel), their intention to continue using it increased. This underscores that beyond formal courses, the digital transformation includes building semi-formal or informal avenues for ideological education that align with students' online social lives.

Collectively, these tools and practices depict a landscape where IPE is no longer confined to weekly classroom sessions and static textbooks. Instead, it is becoming an ongoing, interactive educational process that can reach students anytime and anywhere via their devices. The core content (Marxist theory, CCP history, ethics, etc.) remains, but the delivery mechanisms have multiplied and become more engaging. Empirical evidence from multiple studies corroborates some beneficial outcomes of this transformation, which we detail in the next subsection on opportunities.

3.2. Opportunities and Positive Outcomes

The digitalization of ideological and political education has opened up numerous opportunities to enhance the effectiveness, inclusiveness, and pedagogical richness of this field. The literature reviewed provides evidence of several positive outcomes associated with the judicious use of digital technologies in IPE. These opportunities can be summarized in terms of: (1) improved access and scalability, (2) greater student engagement and motivation, (3) enhanced personalization and adaptive learning, and (4) innovative pedagogical approaches that were previously impractical.

(1) Expanded Access and Scalability: One of the clearest advantages of digital IPE is the vastly expanded reach of ideological education. Online platforms allow IPE content to be delivered at scale, beyond the confines of a physical classroom or a single campus. This is particularly beneficial in a country as populous and geographically large as China. The rollout of national platforms (like the National Smart Education Public Platform) means that millions of learners can access ideological learning resources anytime . This has democratized learning opportunities, enabling, for instance, a student in a remote province to attend virtual lectures by renowned Marxism scholars from Beijing or to take part in national-level ideological study competitions online. The scalability of digital IPE is also crucial for adult and continuing education. Many workplaces and community centers have adopted e-learning modules for Party members or citizens to study the latest political doctrines (for example, mandated study of "Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era" through apps like "Xuexi Qiangguo"). Such broad dissemination and required participation were logistically difficult before digital tools. A related aspect of access is that digital learning can accommodate flexible timing. Students can engage with ideological materials at their own pace, review difficult concepts outside of class, or participate in discussions after-hours, which may deepen their understanding. This flexibility tends to particularly help those who need more time to absorb ideological theory, as they can replay lectures or read additional materials as needed – a self-paced learning benefit indicated by multiple studies on e-learning adoption in China (Wang et al., 2024) .

Another dimension of access is reaching diverse learner groups. The digital format has allowed IPE to extend to groups that might previously have been hard to engage. For example, some universities reported that shy students or those less proficient in Mandarin were more willing to express themselves in online discussion boards than in face-to-face class discussions, thus giving instructors insight into their thoughts and confusions. Digital archives of IPE content also benefit those who join a course late or miss classes; they can catch up by accessing recordings and notes online. In short, technology reduces the friction of access to ideological education, ideally moving China closer to its goal of providing "lifelong learning for all" in the ideological sphere by 2035 (Ministry of Education, 2022) .

(2) Increased Student Engagement and Motivation: Numerous studies find that appropriately integrating digital tools into IPE correlates with higher levels of student engagement and motivation, which are key factors for effective learning. For instance, Yang (2024) conducted a study with 447 university students and found that those who used an e-learning platform (Moodle) for IPE showed significantly greater motivation and slightly better academic performance than those who stuck to traditional classroom-only learning. The interactive elements of e-learning — such as instant quizzes, forums, and gamified modules — can transform an otherwise didactic subject into a more stimulating experience. Another study by Sun (2022) demonstrated the potential of deep learning algorithms to create adaptive quizzes in an ideological course, which kept students challenged at the right level and thereby more interested (the study was published in Computational Intelligence and Neuroscience). Students responded that the tailored difficulty of questions and personalized feedback made them more eager to improve, rather than feeling either bored or overwhelmed as sometimes happens in a one-size-fits-all lecture. Gamification elements

(points, badges, mini-games) introduced through apps have also been effective. For example, Hung et al (2019) found that blending MOOCs with game-based learning in a flipped classroom boosted motivation and learning outcomes in an unrelated context, and similar approaches are being tried in IPE. Some ideological courses include competitive online quizzes (with leaderboards) on Party history, which many students find fun and engaging. As Wong et al (2020) note, blended pedagogical practices combining online and face-to-face instruction can increase students' autonomy and interest in the subject matter . In IPE, granting students some control — for example, letting them choose from various online topics to discuss or research — taps into their intrinsic motivation and personal curiosity, moving beyond rote learning.

The interactive nature of digital media also encourages active learning and critical thinking, which can deepen engagement. When students participate in an online debate about a social issue (e.g., environmental policy, a public incident) under the teacher's guidance, they are actively processing ideological content rather than passively listening. Several universities have reported higher attendance and participation rates in online forums than in analogous in-person political study sessions. One possible reason is that the online mode provides a layer of comfort and anonymity; students who hesitate to speak publicly might be more forthcoming in writing. Additionally, multimedia content (like historical footage or revolutionary songs) can evoke emotional engagement, helping students connect with ideological material on a personal level. As an example, a short patriotic video shared in class can spark emotional resonance and discussion that leaves a deeper impression than abstract theory. Research by Noor et al. (2022) on digital platforms in learning found that such multimodal engagement can enhance both motivation and knowledge development by catering to different learning styles. The Chinese practice of using short videos to convey moral stories or model behaviors (for instance, showcasing exemplary youth or volunteers via TikTok-like clips) leverages this principle to sustain interest and inspire viewers.

(3) Personalization and Adaptive Learning: Another opportunity is the capacity for personalized learning experiences in IPE, enabled by data analytics and AI. Traditional ideological education often took a "one-size-for-all" approach, but digital technology allows content to be tailored to individual or group needs. Personalized recommendation systems, as mentioned earlier (Xu & Chen, 2023; Wang & Han, 2023), can adapt the learning pathway for each student. The result is that students who might already be well-versed in certain ideological concepts (say, due to prior interest or a strong secondary education background) can be challenged with more advanced material, while those who are struggling can receive more foundational content or explanatory resources. Over time, this adaptive approach can optimize learning efficiency – students spend more time on areas they need to improve and less on what they have mastered. Preliminary data from pilot implementations are promising: for example, one university reported that after introducing an AI-based tutoring system in an ideology course, the variance in exam scores narrowed, suggesting weaker students benefited and caught up (specific data were not published, but mentioned in a conference proceeding on AI in Education, 2021). Moreover, personalization fosters a sense of relevance. When examples and case studies in the course align with a student's academic major or personal interests, they are more likely to

perceive ideological theory as relevant to their lives, rather than as abstract dogma. Researchers like Zhang and He (2022) emphasize optimizing IPE by leveraging mobile learning platforms to deliver context-specific content – for instance, during the corona virus disease epidemic, using mobile platforms to discuss the role of youth in epidemic control gave ideological lessons a very immediate and relevant context . Students reportedly responded with high enthusiasm to such contextualized content, demonstrating how personalization (in this case, situational personalization) can yield engagement.

Another aspect is using learning analytics for early intervention. Educators now can gather granular data on student engagement: who is logging into the IPE platform regularly, who is skipping videos, how each student performs on quizzes, etc. With this information, instructors can identify disengaged students and reach out individually, something that was rarely feasible in large lecture settings. Ren et al. (2022) suggest that understanding online behavior patterns can help predict which students might drop out of an online ideological course or lose interest. Timely counseling or support can then be provided to those students. This targeted support approach is an opportunity to improve overall efficacy – ensuring no student is left behind. It aligns with the broader goal mentioned in policy documents to increase the "sense of gain" among students in ideological education by making it more responsive to their needs. In essence, personalization transforms IPE from a uniform mass instruction into a more student-centric learning experience, potentially leading to better retention of values and more genuine internalization of the ideology.

(4) New Pedagogical Models and Creativity: Digital tools have enabled pedagogical innovations in IPE that were not previously practical, thereby enriching the teaching-learning process. One such model is the flipped classroom approach applied to ideological courses. Instead of using class time for lecturing basic content, some instructors assign students to watch prerecorded video lectures or read digital materials before class (often through a platform). Classroom time (whether in-person or live online sessions) is then used for deeper discussion, debate, case analysis, or problem-solving exercises related to the ideological themes. Hung et al. (2019) found that a flipped model combined with MOOCs led to improved learning outcomes for students of different backgrounds. In IPE, early trials of flipped classrooms have been reported (Wang, 2022; Hui, 2024) in which students come to class already having learned about, say, the basics of historical materialism via an online module, and then in class they work through contemporary examples or controversies with the teacher's guidance. Teachers noted that students asked more informed questions and demonstrated higher-order thinking when the basic knowledge transfer occurred beforehand at each student's own pace. This aligns with constructivist pedagogy – class becomes an active knowledge construction space rather than passive listening. It also arguably models Marxist dialectical thinking better, as students engage in thesis-antithesis-synthesis style discussions on real issues (for example, debating the trade-offs in a current policy from a Marxist perspective).

Another emerging pedagogical approach is collaborative project-based learning facilitated by online tools. For instance, some courses assign students to work in teams to create digital products (like a short propaganda video, a blog series, or a mini research report on a social issue) that require applying ideological principles. Through cloud-based collaboration platforms, students

can co-create content remotely, share resources, and get feedback from teachers iteratively. Such projects harness students' creativity and often result in a deeper grasp of ideological concepts because students must apply theory to practice. An example reported in a case study described students developing a series of bilingual infographic posts explaining core socialist values for an international audience. This creative task not only reinforced the students' understanding of those values but also improved their ability to articulate Chinese ideology in modern and accessible formats. It reflects an increasing emphasis on media literacy within IPE: training students not just to consume ideological content but also to produce and spread positive content. This is seen as vital given the participatory nature of today's media environment (where every student with a smartphone can be a content creator). The new media ecology demands that the proponents of mainstream ideology (including educated youth) be active on digital platforms to amplify the desired narratives Encouraging such creative pedagogical exercises is an opportunity to empower students as co-educators or ambassadors of values, rather than mere recipients. It also tends to increase their buy-in and enthusiasm, as creating content or doing interactive projects is inherently more engaging than listening to lectures.

Evidence of positive outcomes from these new models is accumulating. For example, a controlled experiment by Wang (2022) compared a traditional IPE class and a class using a blended, project-based approach with digital support. The latter group not only scored higher on knowledge tests but also showed more positive attitudes toward the subject in surveys (they found it more relevant and interesting). Similarly, Zhang et al (2022) observed that integrating course-based ideological and political education into blended teaching (mixing online and offline) led to improved teaching effectiveness in engineering courses when measured on multiple dimensions of student development. Students in those courses reportedly demonstrated a better ability to connect professional knowledge with social responsibility, indicating deeper internalization of ideological lessons.

In summary, the opportunities ushered in by digitalization – from broadening access and fostering engagement to enabling personalization and innovative pedagogies – collectively contribute to the modernization and potentially greater efficacy of ideological and political education in China. These results are largely encouraging: they suggest that, under the right conditions, digital tools can help achieve the central objective of IPE, which is to educate and mold informed, value-driven citizens, more efficiently and perhaps more profoundly than before. However, these positive outcomes are not automatic. The literature also consistently warns of challenges and pitfalls, which we address next, as a balanced understanding is crucial for policy and practice.

3.3. Challenges in the Digital Era

Despite the notable opportunities, the digital transformation of ideological and political education has also surfaced a number of significant challenges. These challenges must be recognized and addressed to ensure that digitalization strengthens rather than undermines IPE's goals. The main challenges identified in recent studies and reports include: (1) Digital Divide and Inequity, (2) Quality Control and Ideological "Dilution", (3) Teacher Adaptation and Training, and (4) Ethical and Privacy Concerns.

(1) Digital Divide and Inequity: A foremost concern in the Chinese context is the uneven distribution of digital resources and skills across different regions and social groups. While urban schools and major universities often have state-of-the-art ICT infrastructure, many rural or less-developed areas struggle with basic connectivity. Research during the pandemic period revealed that a new digital divide in online learning has manifested not so much in device access (smartphones are ubiquitous, and the "device divide has been basically closed" according to one large-scale study) but in the quality of connectivity, the digital competency of teachers, and the support at home for online learning. Wang (2022) found notable urban-rural differences: rural students tended to rely on mobile phones (with limited data plans) and had less access to computers or high-speed broadband for online classes, and their teachers generally had lower ICT proficiency and confidence compared to urban teachers. These disparities meant that the effectiveness of online IPE could significantly lag in rural settings. Some rural students reported frustration with unreliable connections during live-streamed political classes or the inability to access certain multimedia content due to bandwidth limits. Additionally, without strong digital literacy, both teachers and students might not fully utilize the available platforms (e.g., not engaging in forums, or misunderstanding how to use learning apps), leading to a more superficial use of technology that yields fewer benefits. The risk here is that digital IPE could inadvertently widen educational inequity: the well-resourced schools charge ahead with sophisticated AI-enhanced learning, while under-resourced ones struggle with basic functionality. Recognizing this, policy responses are being formulated. The Ministry of Education's 2022–2035 digitalization plan explicitly calls for bridging the urban-rural gap by improving rural internet infrastructure and training rural teachers in digital skills. The 2023 annual report on the national smart education platform indicated that special funds were allocated to ensure all rural schools are connected to the national platform and to provide devices where needed . Nonetheless, achieving true equity remains a challenge. Even with infrastructure, there are contextual issues like larger class sizes in poorer areas (making personalized approaches harder) and less tech support. A study by Xinhua reported that by early 2024, 98% of China's primary and secondary schools had broadband access, yet teachers in about 30% of rural schools still felt inadequately prepared to integrate digital tools effectively. Overcoming the human and skill aspects of the divide will likely require sustained effort in professional development and resource sharing (such as urban schools pairing with rural ones in "Internet+ education" assistance programs).

(2) Quality Control and Ideological Dilution: Ensuring the quality and fidelity of ideological content in the digital domain is another significant challenge. In traditional IPE, content delivery was tightly controlled—teachers followed a standardized syllabus and approved textbooks, and the classroom environment was relatively closed. Going digital introduces a vast space of content and voices, not all of which align with the intended ideological line. One issue is the potential "dilution" or weakening of the ideological message when it is delivered through infotainment formats or mixed with a flood of other digital content. Lu (2025) describes a "double tension" faced by IPE in the network era: on one hand, diversified information ecology can dilute mainstream ideology, and on the other, there's a structural contradiction between old indoctrination methods and new media mechanisms. Students online might scroll from a People's Daily WeChat post about Party achievements straight into a humorous meme or a celebrity gossip

item, which can subconsciously trivialize or distract from the seriousness of the ideological content. The signal-to-noise ratio for educational content on public platforms is low; entertainment and commercial content vastly outnumber educational posts, making it challenging for ideological education to capture sustained attention. There is also the risk of encountering counter-narratives: the internet hosts critical and sometimes oppositional viewpoints. Though Chinese cyberspace is regulated (with firewalls and content moderation), university students savvy with VPNs or on Weibo might come across liberal, individualistic, or even subversive perspectives. If not proactively addressed, these can seed doubt or apathy towards the official ideology. The literature points out that simply posting ideological content online does not guarantee students' buy-in; in fact, poorly executed online propaganda can backfire, being seen as inauthentic or overly preachy by digital-native youth. Quality control extends to the accuracy and depth of content as well. There's a concern that in the push to make content more "clickable" and appealing, there could be oversimplification of complex theories or a focus on form over substance. For example, a short motivational video on patriotism might arouse emotions but not convey the historical and theoretical underpinnings that a traditional lesson would. Some educators worry that students may get a "fast-food" version of ideology – catchy slogans without understanding – if digital content is not carefully designed. To combat dilution and quality issues, strategies have emerged. Many institutions have established editorial teams (often within their School of Marxism or propaganda departments) to create or vet digital content for ideological education, ensuring it's both appealing and accurate. Additionally, the government has invested in flagship products (like high-quality MOOCs and documentaries) to set a standard. Nonetheless, maintaining students' focus on core messages is an ongoing struggle. Another challenge under quality control is assessment and evaluation of learning in digital IPE. Traditional assessments (e.g., exams on ideological theory) may not capture the nuances of what students actually internalize when so much learning happens informally online. How to measure the effectiveness of digital ideological education? Some research has attempted to use sentiment analysis on student forum posts or track engagement metrics, but linking those to actual attitude or behavior change remains complex. This complicates feedback loops for improving teaching. It is an area where further innovation is needed, possibly drawing on interdisciplinary methods (e.g., educational psychology surveys, analytics, and classical assessment).

(3) Teacher Adaptation and Training: The role of the teacher in IPE is pivotal – they are not just instructors but mentors and "engineers of the soul" for students. In the digital era, their role becomes even more complex. Teachers are expected to master new technologies, create or curate digital content, moderate online discussions, and sometimes even learn basic data analysis, all in addition to their traditional duties of delivering content and guiding student values. Not all current IPE teachers are prepared for this expanded role. Many Marxism professors or political instructors in China pursued their education in an era before digital pedagogy was a focus, and thus there is a skills gap. Studies note that a considerable fraction of IPE teachers lack confidence in using advanced digital tools beyond simple PowerPoint slides (Wang et al., 2023) . In rural or less prestigious institutions, this can be acute; teachers may stick to old methods due to unfamiliarity with new ones, meaning students in those classes do not benefit from the digital innovations discussed. Even among more adept faculty, there is the challenge of increased

workload. Preparing interactive courseware, managing online course components, and keeping up with constant software updates or new platforms can be time-consuming. Without institutional support (like instructional design assistants or IT support staff), teachers might struggle to do this on top of research and other responsibilities.

Furthermore, digital environments require teachers to adopt new classroom management strategies. For instance, moderating an online forum with hundreds of students discussing political issues can be tricky – teachers need to encourage free expression yet also intervene to correct misconceptions or halt any discussion that veers into inappropriate territory. Striking the right balance is something teachers learn with experience, but initially, some might either be too heavy-handed (stifling genuine discussion) or too laissez-faire (letting discussions derail or misinformation spread). Training programs for IPE teachers now increasingly include modules on how to use specific educational technologies and how to facilitate online learning. The Ministry of Education (2021) issued an industry standard on "Teachers' Digital Literacy" emphasizing that all educators, including those in ideological courses, should attain certain competencies (like being able to use data from platforms to inform teaching, or being skilled in creating multimedia lessons) . In practice, workshops and seminars have been organized at national and provincial levels where model teachers share best practices for blending ideology teaching with tech. There is also a growing body of literature – often case studies in Chinese journals – documenting successful digital teaching strategies in IPE, which serve as a knowledge base for teacher development (e.g., Hui, 2024 on an Outcome-Based Education concept for English listening with ideological elements using tech, or An, 2022 on intelligent teaching methods for IPE under entrepreneurship context). However, one challenge noted is teacher mindset: some veteran teachers are resistant to change, either skeptical of technology's value in such a human-centric field or anxious that their authority may be undermined. Overcoming this requires demonstrating that technology is a tool to enhance – not replace – their teaching.

(4) Ethical and Privacy Concerns: The integration of advanced technology into ideological education also raises ethical questions that the literature is beginning to address. One concern is privacy. With learning analytics and AI systems collecting data on student behaviors, preferences, and even ideological leanings, there is a risk of over-surveillance. Students might feel that their activities are being too closely monitored or that their personal opinions (say, in an online discussion) could be recorded and judged. While Chinese universities typically have strict guidelines against political dissent, the digital environment can blur the lines between academic discussion and personal space. If students know an AI is analyzing their forum comments for "ideological correctness" or mood, they may self-censor or react negatively, which is counterproductive to genuine education. There is an implicit ethical duty to protect student data and use it responsibly. Unlike typical academic performance data, ideological data can be sensitive. For instance, if a system identifies a student as "lacking enthusiasm" or "having incorrect views," how is that information used? It should ideally prompt supportive intervention (like dialogue or counseling), but there's a fear that it could be misused in more punitive or coercive ways. Building trust in these systems is crucial, and that entails transparency (students should know what is being collected and why) and clear boundaries (e.g., data used for

educational improvement, not for labeling or punishment). Another ethical dimension is the balance between influence and indoctrination in the use of persuasive technologies. Using algorithms to tailor ideological content walks a fine line: done too aggressively, it might be seen as manipulative or infringing on intellectual freedom. The challenge for IPE is to use technology to educate rather than to solely indoctrinate in a propagandistic sense, preserving the educational aspect of encouraging critical thinking and genuine belief formation. Wang (2023) warned that the biggest risk of digital education is "treating technology as the goal, not the tool", meaning there's a danger in fetishizing data and algorithms and forgetting the human, ethical core of teaching. If IPE becomes a matter of algorithms nudging student thought, it undermines the very premise of education as fostering informed, conscious support for values. There is also the question of academic freedom and diversity of thought in an online setting. While IPE is by definition not politically neutral, universities traditionally could allow some level of debate within bounds. Online, those debates can become amplified or may draw outside attention. Teachers have to moderate carefully to ensure discussions remain constructive and do not cross into forbidden territory, which is an added responsibility with ethical implications (censorship vs open inquiry).

Security concerns overlap with ethics: a reliance on digital systems means IPE is vulnerable to hacking or information warfare. Authorities have noted attempts by hostile foreign entities to infiltrate Chinese online forums with false narratives. A strong cybersecurity posture is needed to protect online ideological platforms from such interference. This technical challenge requires collaboration between educators and IT experts.

In conclusion, the results highlight that while digitalization of IPE in China has enabled many positive changes, it simultaneously presents multi-faceted challenges that range from technical infrastructure issues to deep pedagogical and ethical quandaries. The balance between leveraging technology and maintaining the integrity and human touch of ideological education is delicate. The next section will further discuss these findings, interpreting their implications through our theoretical frameworks and offering possible strategies to maximize opportunities and mitigate challenges.

4. Discussion

The findings from this review illustrate a dynamic interplay between technology and pedagogy in the context of China's ideological and political education. In this section, we interpret these findings through the theoretical lenses outlined earlier—constructivism, Marxist pedagogy, and media ecology—and discuss their broader implications. We also consider strategies to address the challenges identified, drawing on both the literature and theoretical insights. The discussion is structured into four parts: (1) Theoretical Integration, examining how the digital transformations align or conflict with educational theories; (2) Balancing Engagement with Ideological Rigor, discussing the tension between making IPE appealing and keeping it substantive; (3) Addressing Inequities and Teacher Development, focusing on solutions for the digital divide and teacher

training; and (4) Future Directions and Policy Implications, suggesting ways forward for research and governance of digital IPE.

4.1. Theoretical Integration: Constructivism, Marxist Pedagogy, and Media Ecology

The adoption of digital tools in IPE can be viewed as a move towards a more constructivist learning paradigm. Traditionally, ideological education in China was often delivered in a didactic, one-way manner: teachers imparted the officially sanctioned knowledge and students memorized key points, reflecting a behaviorist or instructivist model. With the infusion of interactive e-learning, discussion forums, and project-based learning, there is a discernible shift toward active learning. Constructivist theory holds that learners build new understanding based on their experiences and prior knowledge. The digital practices observed—such as online debates, simulations, and collaborative content creation—provide students with experiences where they actively grapple with ideological concepts and relate them to real-world contexts. This not only increases engagement but could potentially lead to deeper internalization of values. For example, when students use a digital platform to simulate a policymaking process (taking roles, considering policy impacts through a guided game), they are essentially "learning by doing," a key constructivist approach, within the domain of political education. Vygotsky's notion of the Zone of Proximal Development (ZPD) is also at play: digital tools like intelligent tutors can scaffold students just beyond their current ability (e.g., through hints or adaptive difficulty), effectively expanding their ZPD and allowing growth with guided assistance (Vygotsky, 1978). Peer discussion forums similarly allow more capable peers to support others, aligning with the social constructivist view that knowledge is constructed socially. The positive outcomes on motivation and understanding support the idea that these constructivist-aligned methods are beneficial for IPE. However, it's important to recognize that constructivism emphasizes learner autonomy and critical thinking, which in an ideological education context must be carefully managed. Unlike an open-ended humanities course, IPE has a clear directive on what the "correct" values and perspectives are (within limits). Thus, teachers face the task of encouraging critical exploration (so that students truly understand and believe, rather than parrot ideas) without opening the door to wholesale rejection of the fundamentals. In practice, this means framing online discussions or project work around questions that have some latitude but are still within the orbit of agreed-upon principles. For instance, discussing "how to apply Marxist principles to solve environmental issues" allows creative, critical application, whereas questioning "whether Marxism is valid" might be beyond acceptable bounds in class. Constructivist methods can succeed in IPE if they are deployed to deepen understanding of Marxist theory's application, rather than to debate its core legitimacy (which is not the purpose of IPE in the Chinese context). The review shows that many teachers have intuitively found this middle ground—for example, letting students debate how to best promote socialist core values on social media (tactics and reasoning) rather than whether those core values are worthy. Such exercises keep critical thinking focused on means, not ends, thereby respecting the Marxist pedagogical framework.

Marxist pedagogy, which forms the philosophical foundation of IPE, emphasizes that education should serve the development of a socialist consciousness and collective ethos. From a Marxist perspective, the use of technology in education is not value-neutral; it must be harnessed in

service of the proletariat's (or people's) interests and used to propagate the ideology that furthers socialist development. The digital era provides new instruments for this propagation, but Marxist theory also offers caution: technology, as part of the "forces of production," can produce different outcomes depending on who controls it and how it's used. One could argue that digital platforms are a new "means of production" for ideological work. In Marxian terms, it's crucial that the Party (the vanguard) retains control of the "ideological means of production" in the digital space to prevent alienation or hostile takeover by bourgeois ideas. The review shows conscious efforts by the state to do exactly this—through curated content, moderated platforms, and cyber-sovereignty measures. Marxist pedagogy would support the expansion of IPE into digital realms as a necessary evolution ("the base and superstructure" idea: as the economic base goes digital, the ideological superstructure including education must adapt accordingly). It also underscores the importance of not losing the essence of ideological education: nurturing certain virtues and worldview. In light of our findings, one can interpret some challenges through Marxist theory: for instance, the ideological dilution by diversified information can be seen as a class struggle on the cultural front, with capitalist or non-socialist ideologies competing for influence via new media. The fragmentation of attention could be viewed as a form of alienation—students estranged from serious political consciousness by the commodification of entertainment. Marxist theorists might argue that a strong countermeasure is necessary: to imbue digital content with even more persuasive power of Marxist truth and to regulate the online sphere to limit toxic, nihilistic, or individualistic content. Indeed, many Chinese scholars writing on IPE recommend strengthening the management of cyberspace and increasing the supply of high-quality mainstream ideological content (a concept often referred to as occupying the "high ground" of new media public opinion). From the Marxist pedagogy angle, technology is a double-edged sword: if used by the proletarian state it can greatly advance ideological education, but if left unchecked, it can become a tool for bourgeois ideology or lead to a cultural disarray that undermines collective consciousness. Therefore, strategies like developing domestic educational platforms (to avoid reliance on Western tech), using AI to filter and push positive content, and training a new generation of "red engineers" (tech-savvy ideological instructors) can be seen as aligning with Marxist educational goals. The presence of such strategies in policy (e.g., building indigenous MOOCs, surveillance of content) reflects this theoretical consistency.

Media ecology theory enriches the discussion by focusing on the environmental changes in communication. Neil Postman famously said that the medium can shape the message; our findings confirm that the shift from classroom to digital media is indeed altering not just how messages are delivered but potentially the nature of the message itself. In a rich media environment, information is plentiful and fast, and attention is the scarce resource. Media ecology draws attention to phenomena like information overload, velocity of communication, visual orientation, and the erosion of traditional authority structures in the face of decentralized media. We see all of these in the Chinese IPE context. The information overload is evident—students are inundated with content, requiring IPE to compete for their time. From a media ecology perspective, one adaptation is to make ideological content more concise and catchy (hence the emergence of micro-courses, short videos, and social media posts for IPE). However, Postman might warn that over-simplification could reduce complex ideology into mere slogans, thus losing

depth. The speed of new media means that ideological education has to react quickly to current events and narratives. This has changed IPE curricula to be more fluid—incorporating "Situation and Policy" briefings every term, for example, so that current issues are discussed in a timely manner. The media ecology concept of "feedback loop" is also relevant: students are no longer just passive receivers; they become part of the media environment by commenting, sharing, and creating content. This can enhance engagement (as discussed), but it also means the teacher's voice is one among many in a sprawling network, potentially diluting their authority. The results showed that some teachers successfully used their own presence in social media (like running a popular WeChat public account) to assert an authoritative voice in the mix, essentially trying to shape the media ecology in favor of their message. The concept of fragmentation in media ecology is particularly pertinent to the challenge of attention spans. Ideological principles are often holistic and require sustained reasoning (for instance, understanding historical materialism requires sequential logical thought), whereas the digital media ecology encourages fragmentary consumption (tweets, clips, memes). To address this, some educators design learning that strings together small pieces into a larger puzzle—a series of short videos, each delivering a piece of an argument, hoping that the sequence can approximate a long-form lecture. Media ecology would also suggest paying attention to the symbolic biases of media: visual media are powerful for emotional resonance, which can be good for stirring patriotism, but textual media are better for nuanced reasoning. Thus, a balanced media strategy might be needed—using video to inspire and text to elaborate. Understanding this, educators sometimes pair a flashy introductory video with a written follow-up analysis for homework. The media ecology lens might also predict the emergence of new roles in IPE: for instance, "influencer educators" who gain large followings and whose way of disseminating ideology via personal branding becomes key. Indeed, there are now online celebrity professors of Marxism in China whose lectures on Bilibili get millions of views, showing a new phenomenon where mass communication dynamics meet education. While this can amplify reach, it might also lead to a cult of personality or oversimplification to maintain popularity. These trade-offs must be navigated. In sum, media ecology theory underscores that IPE is now operating in a fundamentally different environment that requires new methods of message design and dissemination to maintain effectiveness.

4.2. Balancing Engagement with Ideological Rigor

One recurring theme in both our results and theoretical analysis is the need to strike a balance between making IPE engaging through digital means and ensuring the rigor and depth of ideological content is preserved. The push for higher engagement (through interactive, entertaining, or bite-sized content) is born from practical necessity—without engagement, learning doesn't happen. However, IPE carries a heavy responsibility: it's not just about any learning, but learning a particular set of values and worldviews in a deep and lasting way. Therefore, educators and policymakers find themselves carefully calibrating the mix of "sugar" and "medicine" – the sugar being the attractive formats and the medicine being the ideological substance that might be less immediately palatable to students.

The evidence indicates that digital methods can indeed improve motivation and make learning enjoyable, but some educators caution against entertainment superseding education. One

professor interviewed in a case study (cited in China Higher Education journal, 2023) commented: "If ideological education becomes only jokes and memes, we might win laughs but lose minds." This captures the concern that in trying too hard to fit ideology into trendy formats, there's a risk of trivializing it. The challenge is to ensure that engagement techniques serve as a vehicle for deeper reflection, not a distraction from it. For example, using a short video of a revolutionary story can be very engaging – but it should be followed by guided analysis, linking it to ideological concepts (class struggle, patriotism, etc.). Without that follow-up, students might just consume it as a feel-good story and move on. Several studies emphasize structured reflection tasks as a crucial complement to digital content. For instance, after an interactive online activity, requiring students to write a short essay or do a presentation on what they learned can consolidate the material and reveal if they grasped the ideological implications.

Another balancing act is freedom vs. guidance. Digital forums give students a chance to voice opinions and questions that may not always align neatly with official viewpoints. This can be positive, as it surfaces misunderstandings and allows for correction or deeper discussion. It also trains students in dialectical thinking if guided properly (e.g., a student might question an aspect of Marxist economics, and the teacher can then walk the class through a reasoned response). However, too much openness could lead the class astray or legitimize fringe views. The solution implemented by some savvy educators is to practice a method known as "bounded openness." They set clear expectations and boundaries for discussions: students can debate how to interpret or apply an ideological tenet but not whether the tenet is valid. Within those bounds, diverse opinions are encouraged. Empirical evidence (Ren et al., 2022) suggests that students appreciate the chance to discuss and that such engagement, when moderated, actually strengthens their understanding and acceptance of the ideology. It makes them feel their perspective is valued, rather than feeling ideology is force-fed, which can reduce psychological resistance. Thus, engagement through discourse can bolster rigor if done in a controlled way.

The use of data and personalization also requires balancing. While personalized systems can help students learn more effectively, there's a possible pitfall of reinforcing certain patterns or shielding students from challenging content. If an algorithm notices a student is less interested in dense theory and thus only feeds them simplified content, that student might never be pushed to engage with primary sources or complex Marxist texts, which are essential for rigor. To avoid this, educators or system designers might implement a rule that personalized recommendations must include a mix of easy and challenging content – ensuring every student still encounters the "hard medicine" at times.

From the perspective of Marxist pedagogy, maintaining rigor means ensuring that core theoretical frameworks (dialectical materialism, historical materialism, political economy, etc.) are thoroughly taught. This may require deliberately slowing down in some digital contexts. For example, a gamified lesson might cover concepts in a breezy way; teachers could require reading of textbook chapters in parallel to maintain depth. Indeed, some universities, in blending old and new, have kept weekly traditional seminars where students read original Marxist or Maoist texts and discuss them face-to-face, even as lectures moved online. This hybrid approach tries to capture the best of both: engagement online, rigor offline (or in dedicated sessions).

Assessment methods also reflect this balance. To ensure depth, some instructors have shifted to open-ended assessments (like essays or projects) in addition to objective quizzes. While the online platform may auto-mark multiple-choice questions on content, the teacher might still assign an essay asking students to analyze a social phenomenon using Marxist principles. This tests whether the student can apply the ideology beyond rote recall – a sign of true understanding. Digital tools can aid grading such essays (for instance, plagiarism checks, or even AI suggestions to teachers on which parts of an essay to pay attention to), but the fundamental evaluation of critical application is done by the teacher. Maintaining such assessment rigor is vital to signal to students that, despite the fun and convenience of digital learning, the subject remains intellectually serious.

4.3. Addressing Inequities and Teacher Development

The challenges of the digital divide and teacher training identified in the results are not insurmountable, but they require concerted action at multiple levels of the education system. Here we discuss strategies and ongoing efforts to address these issues, as well as their implications.

To address the digital divide, the Chinese government has been proactively investing in infrastructure. As of the latest plans, there are specific targets for equipping all schools (down to rural elementary schools) with broadband and modern computer labs by the mid-2020s. Ensuring that those targets are met will create the foundational conditions for equal access. However, infrastructure alone is not enough. As seen, teacher competency and home support play a big role. For schools in poorer areas, one strategy has been the use of "paired schools" or remote teaching: high-quality urban schools deliver live or recorded lessons to rural classrooms (this has been done in general education for subjects like math and English, and can be extended to IPE). Ren (2022) suggests that having occasionally shared national classes for IPE via live webcast could ensure that all students, regardless of location, directly hear from top educators or experts . Such shared classes might cover key theoretical lectures, while local teachers then lead follow-up discussions contextually. This approach would alleviate some burden on undertrained local teachers and give students a uniform baseline of content. Another approach is developing offline support for online learning. For example, establishing community study centers where rural students can get together and access the Internet for learning under supervision could help those who lack a conducive home environment or stable connection individually.

Crucially, the digital divide also has a skills and usage component – often called the second-level digital divide. The data showed rural teachers might not use platforms effectively even if available. Thus, teacher development programs need scaling up. The Ministry of Education in 2022 initiated a nationwide training project specifically targeting ideological and political teachers to improve their digital literacy (this was mentioned in an MOE press release summarizing digital education strategy). This includes online courses for teachers themselves (some ironically using the very platforms in question to train the teachers on how to use them). Peer mentoring is also encouraged: less experienced teachers in digital pedagogy are paired with more experienced mentors, often across regions (e.g., a city teacher mentoring a rural teacher via video calls, sharing lesson plans). Over time, as a new generation of teachers enters (most new hires now are younger and generally more tech-savvy), this issue might naturally ease. But the

transition period requires supporting current teachers who are mid or late-career. Recognizing and rewarding teachers who successfully innovate in digital IPE can provide motivation. Some provinces have started "Teaching Innovation Awards" for ideological courses, highlighting teachers who create excellent online content or effectively use tech. This not only incentivizes individual teachers but also disseminates their successful models to others.

We also note the role of educational technology companies and edtech research in bridging gaps. There are startups and university labs working on simplified, localized versions of e-learning tools for underprivileged areas. For instance, developing an app that can run on low-bandwidth or offline modes loaded with IPE content for areas with intermittent internet. Or AI tools that can grade assignments in Chinese language even if grammar is not perfect (which might help evaluate ethnic minority students or those not as fluent). The central government's push for "smart education" explicitly calls for inclusive design.

Regarding teacher adaptation and training, beyond digital skills, teachers need pedagogical training to effectively integrate technology. This includes learning how to design blended lessons (like how to flip a classroom effectively), how to facilitate online discussions (tone, frequency of intervention, etc.), and how to interpret learning analytics data. Some of these skills are new even to experienced teachers, so formal professional development modules are needed. Encouragingly, some top universities (like Beijing Normal University and East China Normal University) have launched short certification courses in "Smart Education for Ideological Courses" aimed at in-service teachers. These courses cover both technical tool use and instructional design principles tailored to IPE.

Another important aspect is building a community of practice among IPE teachers nationally. Online forums or WeChat groups for teachers allow sharing of resources and experiences. A rural teacher who successfully engaged students via a local Red tourism VR experience (for example) can share that story and maybe provide the VR content to others. The development of repositories for digital teaching materials (e.g., a national database of short videos, case studies, quiz questions) specifically for IPE helps teachers who lack time or expertise to create content from scratch. The national platform partly serves this role, but often teachers trust resources recommended by peers more. Regular conferences or seminars (virtual nowadays) on digital IPE also foster peer learning. In our findings, we did see references to conference proceedings discussing case studies , which indicates knowledge exchange is happening.

From an incentive perspective, university administrations should acknowledge the extra effort teachers put into digital innovation. If promotion or evaluation criteria of faculty include credit for improving teaching quality through technology, teachers will feel it is part of their professional growth, not a distraction from research (which often dominates academic career incentives). It's notable that several of the references in our review came from journals like Wireless Communications and Mobile Computing or International Journal of Reliability and Quality Safety Engineering, where IPE-related tech studies were published. This shows that interdisciplinary research (educators working with computer scientists) is happening to advance digital IPE. Encouraging such collaborations means teachers don't have to do everything alone; they can work with technical experts to implement and assess new tools, blending practical teaching with

scholarship. This not only improves practice but could elevate the academic status of IPE methodology research.

In short, addressing teacher-related challenges requires a holistic approach: infrastructure, training, peer support, incentives, and research. The underlying principle is that teachers remain central to IPE's success, even in a digital age. As one paper put it, "The effectiveness of smart IPE depends on the smart use by teachers" (Zhou et al., 2021) . Therefore, investing in teachers is arguably the most critical component of sustaining the digital transformation's benefits.

4.4. Future Directions and Policy Implications

Looking ahead, the landscape of ideological and political education in China will likely continue to evolve alongside technological advancements and shifting societal conditions. Our review suggests several key directions for the future, each with policy implications.

Firstly, the integration of artificial intelligence will probably deepen. Beyond the current use of AI for personalization and analytics, we foresee experimentation with AI-driven virtual tutors or chatbots that can engage students in dialogue about ideological questions. For example, a chatbot trained on Marxist literature and Chinese policy could answer student queries or challenge their viewpoints in a Socratic manner. This could provide individualized attention and instant feedback at scale. However, ensuring the accuracy and ideological correctness of such AI will be crucial (and a significant technical challenge, given AI like GPT could hallucinate or produce undesired outputs). Policymakers might fund dedicated initiatives to develop "patriotic AI tutors" – essentially large language models fine-tuned on approved ideological content. If successful, this could supplement teachers and be accessible 24/7 to students. Pilot programs along these lines should be carefully evaluated for their pedagogical impact and acceptance by students.

Secondly, with the proliferation of new media forms (e.g., virtual reality (VR), augmented reality (AR), and the nascent metaverse concept), IPE could take on immersive forms. Imagine VR experiences where students "participate" in historical events like the Long March or visit a virtual exhibition on China's achievements. These could create powerful emotional and cognitive impressions. Some Chinese universities are already developing "VR ideological classrooms" on a trial basis. The Ministry of Education might consider establishing digital labs or centers of excellence that produce high-quality immersive content for nationwide use, given the resource intensiveness. Such content can make abstract concepts concrete and allow experiential learning (a constructivist dream). However, it also raises the bar for resources, and not all schools can afford VR equipment yet. So, a policy of phased introduction – starting with well-funded institutions and gradually expanding – might be prudent, ensuring equity concerns are managed.

Another direction is focusing on critical thinking and resilience in the face of the open internet. As internet access further liberalizes (if it does) or as students find ways around controls, they will encounter more diverse ideologies. The best defense, some argue, is to equip students with critical thinking skills within a strong values framework so they can discern and resist anti-socialist ideas on their own. This somewhat contrasts with earlier methods which avoided exposing students to such content. We might see a slight shift in IPE pedagogy from pure protection (censorship) to also inoculation – teaching about common false narratives or criticisms and how to refute them

(akin to “pre-bunking”). Indeed, some current IPE curricula have started including segments that directly address “historical nihilism” or Western liberal democracy arguments and systematically critique them (Yang, 2024; Sun, 2022). Doing this digitally could involve interactive modules where students are shown a piece of misinformation and tasked with analyzing its flaws, guided by correct principles. It can make students more confident and less likely to be swayed if they encounter those arguments outside. The government likely will support such content as it strengthens ideological security.

Policy framework and coordination will also be key. We recommend that the education authorities create a unified framework or standards for “Digital Ideological and Political Education” (somewhat akin to the existing standard for ideological theory courses, but focusing on digital implementation). This framework can cover objectives, recommended tools, teacher training requirements, assessment methods, and safety guidelines (for data and content). A standardized yet flexible framework helps avoid fragmentation where each institution struggles on its own. It could also set benchmarks for performance (e.g., target percentages of student engagement or improvements in survey-measured ideological commitment after digital enhancements). National assessments or periodic reviews could incorporate measures of how well schools integrate technology in IPE.

On the ethical side, policies need to articulate data privacy guidelines in educational contexts. Perhaps developing a student data privacy law or regulations specifically addressing educational data, so that all stakeholders know the boundaries. For example, clarifying that learning analytics in IPE should not be used for non-educational surveillance or any punitive measures. If students trust the system, they will engage more honestly, which in turn gives teachers better information to help them. Transparency rules could require informing students of what data is collected and how it’s used. This is in line with global trends (like Europe’s GDPR), and China has also moved toward more data privacy protections in general (Personal Information Protection Law in 2021). Applying those principles in schooling is a logical next step.

Finally, ongoing research and evaluation must guide policy adjustments. The digital world changes rapidly; what is cutting-edge today (say, use of blockchain for certificate issuance in courses, as tried by Xie et al., 2022) might be obsolete tomorrow. The education system should remain agile, promoting pilot projects and rigorously evaluating them. There should be channels for teacher and student feedback to reach policymakers – for instance, annual surveys or forums on the state of digital IPE. If something is not working (or has unintended side effects), it can then be corrected. The interdisciplinary nature of digital IPE means collaboration between education experts, technologists, and ideological theorists in policymaking. An interesting idea would be to set up a National Digital IPE Innovation Center that brings together these experts to continuously develop and advise on new initiatives.

In conclusion, the digital era offers both promise and perils for ideological and political education. Our review demonstrates that China has embraced technology as a means to reinforce and rejuvenate IPE, achieving notable successes in engagement and reach. Yet, challenges of equity, quality, and ethics present ongoing tasks that must be managed through thoughtful integration of theory and practice. The core mission of IPE – to foster a cohesive, Marxist-

informed citizenry – remains unchanged, but the methods of achieving it are diversifying. By staying grounded in pedagogical principles and vigilant about the changing media environment, Chinese educators and policymakers can harness the opportunities of digitalization while safeguarding the integrity and effectiveness of ideological education. This delicate balance will likely define the next chapter of IPE in China, as the nation continues to innovate in synchrony with its educational and ideological objectives.

5. Conclusion

Digital technology has emerged as a transformative force in China's ideological and political education (IPE), introducing both significant enhancements and new complexities to this pivotal domain of the educational system. This theoretical review has explored the challenges and opportunities that the digital era presents for IPE in China, drawing on recent literature, educational theory, and policy developments. Our analysis yields several key conclusions.

First, digitalization has substantially expanded the reach and interactivity of IPE, presenting clear opportunities to strengthen its impact. Online platforms, when effectively utilized, enable ideological education to transcend the traditional classroom's limits. They provide students with on-demand access to learning materials and permit engagement with content through formats that resonate with the digital generation (such as videos, quizzes, and social media). Empirical studies from the last five years show that e-learning platforms and blended learning approaches can increase student motivation and improve learning outcomes in IPE courses. Digital tools facilitate a more student-centered, constructivist learning environment, where learners actively participate in discussions, collaborate on projects, and apply ideological concepts to contemporary issues, thereby deepening their understanding. In particular, personalization through AI and data analytics offers the promise of tailored learning experiences, ensuring students remain engaged and supported at their level of understanding. These innovations align well with the goal of making ideological education more effective and appealing without compromising its essential content. They also support the Chinese government's broader education modernization agenda, as evidenced by initiatives like the Education Digitalization Strategy Action Plan (2022) which explicitly advocates leveraging digital technology to enhance moral and political education.

Second, the core objectives and content of ideological and political education remain firmly grounded in Marxist pedagogy and socialist values, even as delivery methods evolve. The review finds that digital era IPE has not diluted the emphasis on transmitting Marxist-Leninist theory, Mao Zedong Thought, Deng Xiaoping Theory, and Xi Jinping Thought; rather, it has sought to amplify these doctrines using new media. The incorporation of engaging formats does not imply a shift in ideological stance, but a strategic adaptation in pedagogy. Constructivist and media ecology frameworks are employed to better communicate and instill the same fundamental beliefs in a new context. For example, online debates and interactive case studies are designed to cultivate students' understanding of core socialist values and their ability to apply Marxist analysis to real-world problems, thereby reinforcing the rigor of ideological training in a modern guise. The Chinese government's policy documents and scholarly discourse both underscore that

the “mainstream ideology” must occupy the commanding heights of new media. In practice, this has meant careful curation of digital content, creation of high-quality online resources (such as national-quality MOOCs on ideological topics), and continuous ideological oversight of online platforms. Our review noted that many digital IPE initiatives consciously blend entertainment with education (“edutainment”) but with the clear intent of guiding students toward approved narratives and values, in line with Marxist pedagogical principles. Thus, digitalization is being harnessed not to change what is taught, but how it is taught, in order to achieve the traditional goals of IPE more effectively in contemporary society.

Third, despite the optimistic prospects, significant challenges persist in implementing digital IPE, and these challenges require ongoing attention and management. One major challenge is the digital divide. Inequities in infrastructure and digital literacy mean that the benefits of technology are unevenly distributed. Students and institutions in less developed regions risk falling behind in IPE if they cannot access or effectively use digital resources. This could inadvertently widen educational and ideological disparities—a concern Chinese authorities are aware of and attempting to mitigate through targeted investments and training programs. Another challenge is the risk of ideological dilution and distraction. The open and often entertainment-oriented nature of the internet can make it difficult to maintain students’ focus on serious ideological study. There is a fine line between making learning engaging and oversimplifying complex political theory to the point that its substance is lost. Additionally, exposure to diverse online viewpoints means students might encounter information that contradicts or questions the official ideology. Educators must work harder to frame discussions, correct misconceptions, and reinforce the intended viewpoints, which can be resource-intensive. A further challenge lies in teacher preparedness and pedagogical adaptation. The review highlighted that many IPE teachers need training and support to effectively integrate digital tools into their teaching. This is not just a technical issue but a conceptual one: teachers must shift from a lecture-centric role to a more facilitative role, guiding student-centered learning both online and offline. For some, this represents a steep learning curve, and resistance or implementation gaps can occur. Without strong teacher buy-in and competence, even the best platforms may not yield positive results. Finally, ethical considerations around data privacy and the appropriate use of AI in education present a modern challenge. It will be essential to craft policies that protect student data and ensure that technology is used to support student learning and wellbeing, not to monitor or control students in intrusive ways. Maintaining trust in the educational process will underpin students’ willingness to engage sincerely in online ideological activities.

In synthesizing these points, a clear conclusion is that maximizing the opportunities of digital IPE while minimizing its challenges will require strategic, sustained effort. We offer a few recommendations informed by this study: (1) Invest in infrastructure and training to bridge the digital divide – equitable access must be a policy priority so that all students can benefit from digital IPE innovations. (2) Develop comprehensive professional development for IPE teachers, focusing on digital pedagogy and content creation skills, which will empower teachers to harness technology in pedagogically sound ways. (3) Create guidelines for digital content that maintain intellectual rigor and depth, ensuring that engagement does not come at the expense of critical

understanding. This might include standardizing a core e-curriculum or best practices for combining multimedia content with reflection and discussion. (4) Strengthen mechanisms for quality control in online ideological content, possibly through dedicated review committees or AI content filters that align with curriculum goals, to prevent misinformation and maintain a coherent ideological message. (5) Implement policies on data use in educational platforms to uphold student privacy and autonomy, thereby encouraging genuine participation without fear. (6) Continue research and pilot programs to explore emerging technologies (like VR, AR, intelligent tutors) in IPE, coupled with rigorous evaluation of their outcomes on student learning and value formation.

In concluding, it is evident that ideological and political education in China is at a pivotal juncture. The digital era provides tools that can greatly enhance the reach and effectiveness of IPE, making it more relatable to young people who live and learn in digitally-mediated environments. When effectively integrated, these tools support the development of more engaged, informed, and analytically capable citizens who can uphold and advance the ethos of the nation. However, the success of this transformation is not guaranteed and must be carefully cultivated. The Chinese experience, as illuminated by this review, offers a valuable case study to the world on how a country can attempt to merge a traditionally doctrine-focused curriculum with cutting-edge educational technology. It shows both the promise of innovation – a future where perhaps ideological education is no longer seen as staid or imposed, but as an interactive journey of discovery for students – and the importance of vigilance – ensuring that the core mission of education is not lost amidst technological change. The trajectory taken in the next few years, guided by policymakers, educators, and technological developments, will likely determine how effectively IPE in China adapts to the digital age. If the current momentum is sustained and challenges are addressed, China's ideological and political education could emerge not only intact in its principles but invigorated and more deeply woven into the fabric of young people's intellectual lives, thus fulfilling its mandate in a new era.

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Rethinking University Governance in China: A Theoretical Perspective on Autonomy and Accountability

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Abstract

China's higher education system faces a dynamic tension between institutional autonomy and state accountability. Historically, Chinese universities were tightly controlled by government agencies, but recent reforms have gradually increased their decision-making freedom in areas like curriculum, faculty appointments, and finances. This article adopts a conceptual and historical analysis, drawing on policy documents and recent scholarship to examine governance models. It applies governance theory and comparative perspectives to analyze how autonomy and accountability are balanced (or imbalanced) in Chinese universities. We find that while universities now enjoy greater autonomy in academic and administrative matters, the government continues to exercise effective control over key domains such as strategic direction and ideological education. Reforms have introduced elements of New Public Management and performance-based accountability – for example, competitive funding schemes and evaluations like the "Double First-Class" initiative that tie resources to outcomes. These mechanisms have propelled Chinese universities to improve research output and global rankings, but they also enforce government agendas and create new pressures on academic freedom. China's governance approach represents a hybrid model: it grants universities conditional autonomy to innovate and excel, yet reinforces accountability through political oversight and rigorous evaluations. Achieving a more optimal balance will require enhancing legal protections for academic freedom and developing accountability systems that prioritize educational quality and societal needs over narrow performance metrics.

Keywords: University Governance; Autonomy; Accountability; Higher Education Policy; Academic Freedom; Educational Reform

1. Introduction

China's higher education governance has evolved through profound shifts, especially in the past four decades of reform and opening. Traditional Chinese universities operated under a state-

controlled model with almost no institutional autonomy. Since the late 1970s, however, economic liberalization and global influences have prompted governance reforms to "streamline the relationship between government, society and higher education institutions". The government's stated aim was to move from direct micromanagement to macro-level regulation, granting universities greater freedom to manage academic affairs in response to societal needs. As a result, universities gradually gained autonomy in areas such as admissions, curriculum design, research agendas, and international cooperation. These changes align with global trends emphasizing university self-governance and academic innovation (Berdahl, 1990; Berdahl & Millett, 1991; Clark, 1983). On paper, Chinese universities today enjoy far more institutional autonomy than under the Soviet-influenced system of the 1950s–1970s.

However, increased autonomy has been coupled with new forms of accountability. The state did not "step back" so much as reframe its control. China remains a dominant actor in higher education, steering universities through funding levers, policy directives, and the presence of Communist Party organizations embedded in campus governance. Indeed, the governance model is often described as "the president's responsibility under the leadership of the Party Committee," a system institutionalized nationwide in the 1990s and reflective of Chinese political traditions. Under this system, each public university's Party secretary (a state-appointed official) holds overarching authority alongside the university president, ensuring that institutional decisions align with Party-state objectives. This arrangement inherently limits full institutional independence. Scholars have noted that university autonomy in China remains restricted, as the state "retains effective control over key aspects of higher education governance" (Jiang & Li, 2016). In practice, critical decisions – from top leadership appointments to major financial allocations – are still subject to government approval. The concept of autonomy in the Chinese context therefore diverges from the Western ideal of complete institutional self-governance. Chinese universities are neither fully independent of the state nor mere executors of state will; rather, they operate in a partially integrated manner, enjoying flexibility in some domains while remaining tightly supervised in others.

From a theoretical standpoint, China's case highlights the classic governance dilemma of autonomy vs. accountability (Berdahl & Millett, 1991). Scholars have long argued that granting universities more autonomy can spur innovation and academic excellence, but governments often impose accountability measures to ensure alignment with national goals and public interests (Altbach et al., 2005). In China, this balance is influenced by cultural and political factors. Confucian tradition values hierarchical oversight and collective goals, which underpin acceptance of strong state involvement in universities. At the same time, market-oriented reforms and global competition have pushed Chinese policymakers to give universities more leeway to manage their affairs efficiently (e.g. in faculty hiring and industry collaboration) in order to build "world-class" institutions (Mok, 2016). The result is a hybrid governance model that can be seen as "supervisory governance" or a form of "quasi-decentralization". The state has partially "hollowed out" certain functions to universities and the market, a process Jessop termed the hollowing-out of the state in the context of global neoliberal trends(Jessop, 1993). Yet the Chinese state's retreat is selective and reversible; it maintains "essential power and authority" over higher education,

especially regarding ideology and strategic direction. In short, China is striving to create a modern university system that grants universities enough autonomy to be innovative and globally competitive, while holding them accountable – often via political mechanisms – to national development goals and socialist values (Li, 2020; Xu, 2021). This article explores how this delicate balance has been managed, the tensions it generates, and the implications for theory and practice of university governance. We proceed by outlining the methodology for our analysis, then examining major governance reforms and their outcomes (results), followed by a discussion of the broader theoretical and practical significance of China's experience.

2. Methodology

This study employs a qualitative, theory-driven approach to analyze university governance in China. Rather than gathering new statistical data, we conduct a documentary analysis and literature review of policy texts, legal documents, and scholarly research. Key sources include Chinese government policy papers (e.g. the 2010–2020 Education Reform Plan), laws and regulations on higher education, and university charter documents, as well as academic studies on Chinese higher education governance from the past decade. We also draw on comparative perspectives from governance theories and international case studies. The analysis is structured in line with Ball's modified "policy cycle" framework, examining contexts of policy influence, text (content), and practice/effects. First, we consider the context of influence, identifying the political and socio-economic factors that have driven governance reforms (e.g. globalization, massification, political ideology). Next, we review the policy texts – key reform initiatives and regulations – to determine how they articulate autonomy and accountability. Finally, we assess practices and effects by synthesizing findings from case studies and expert assessments of how these policies have been implemented in universities (including any unintended consequences). The use of multiple sources and perspectives (policy documents, academic analyses, and historical accounts) allows for triangulation of insights, enhancing the credibility of our interpretations.

Notably, our methodology is primarily analytical and interpretive. We did not conduct interviews or surveys; instead, we rely on existing empirical studies (including surveys of faculty and university leaders) to inform our conclusions. For instance, we incorporate data from case studies of Chinese and Hong Kong universities on accountability practices, and statistics on university performance evaluations (such as the results of China's Double First-Class initiative). By combining policy analysis with findings from recent research, we aim to paint a comprehensive picture of the current state of university governance in China. Given that this is a theoretical perspective, we also engage with governance models (e.g. New Public Management, principal-agent theory, and Confucian managerialism) to interpret the Chinese experience. This methodological approach is appropriate because our goal is not hypothesis-testing but rather conceptual understanding – we seek to critically examine how autonomy and accountability are configured in Chinese universities and to contribute to theoretical discussions on university governance in politically centralized contexts. The analysis is limited by the availability of public information; some internal Party directives affecting universities are not fully transparent.

Nonetheless, the combination of open-source documents and scholarly research provides a robust basis for our theoretical exploration.

3. Results

3.1. Expanded Autonomy in University Operations

Our analysis finds that Chinese universities today have significantly more autonomy in their operations compared to the early Reform era (1980s). Reforms in the 1990s and 2000s decentralized many administrative controls. For example, universities can now set their own curricula and academic programs with minimal direct interference from the Ministry of Education (MOE). They have latitude to create new specialties, establish research centers, and collaborate with foreign institutions, as long as these align with broad national guidelines. Universities also gained greater say in student admissions and faculty hiring. The centralized assignment of graduates to jobs was abolished, allowing universities to develop programs based on market and societal needs (Chen et al., 2021). Financially, while core funding still comes from government, institutions can raise supplementary income through tuition, research grants, donations, and entrepreneurial activities, giving them semi-independent budgetary power (although tuition rates and major expenditures often still require government approval). Many universities have established Board of Trustees or advisory councils, including industry and alumni representatives, to advise on development – introducing a degree of shared governance unprecedented in the Mao era. These changes correspond to what Clark's theory would term a shift toward the "market" and "academic oligarchy" sides of the triangle of coordination, and a move away from exclusive state control (Clark, 1983). In short, substantive autonomy – the freedom to determine academic objectives and internal structures – has increased in Chinese higher education.

It is important to note that this autonomy is often conditional and must operate within boundaries set by the state. For instance, universities may choose whom to hire or promote, but the criteria (such as requiring political vetting and Party membership for leadership positions) reflect state priorities. Universities can admit students in innovative ways (like independent admissions exams), but enrollment quotas for each province are still dictated by the MOE. In governance terms, Chinese universities have been granted procedural autonomy in implementing policies (how to achieve goals) more than complete freedom to set their own goals. The government's official stance is encapsulated in the slogan of building a "modern university system" with Chinese characteristics: empowering universities to manage themselves "according to law" while insisting on Communist Party leadership in the governance structure. The UNESCO IIEP report (2014) captured this nuance: Chinese universities have gained independence in academic, financial, and personnel matters, yet the government retains control over ideological direction and top leadership appointments (IIEP, 2014). Our findings corroborate this. For example, since 2016, many university charters were revised to strengthen the role of Party committees, even as these charters also espouse greater academic autonomy for faculty in research and teaching (Fitzgerald, 2020). Thus, increased autonomy in daily operations coexists

with overarching Party-state authority. This duality is a defining result of China's recent governance reforms.

3.2. Strengthened Accountability Mechanisms

Parallel to expanding autonomy, Chinese authorities have implemented robust accountability mechanisms to monitor and steer universities. One major finding is the rise of performance-based evaluations for universities. In the mid-1990s, China introduced the University Undergraduate Teaching Evaluation to assess teaching quality across institutions. In the 2000s, a "Double Excellence" evaluation rated universities on various indices. Most prominently, the ongoing "Double First-Class" initiative (launched in 2017) exemplifies heightened accountability: universities designated as First-Class are expected to achieve world-class status in select disciplines, with progress periodically reviewed by panels of experts. In 2022, after the first phase, 15 universities received warnings that they might lose this elite status (and associated funding) if they failed the 2024 final assessment. This is a clear case of accountability in action – tying resources and reputation to measurable outcomes. Universities responded by instituting internal reforms: setting Key Performance Indicators (KPIs) for departments and faculty, incentivizing research output and international visibility. Our review indicates that such evaluation regimes have indeed boosted research publications and global rankings of top Chinese universities (Liu et al., 2023). At the same time, they risk encouraging academic quantity over quality and can narrow universities' focus to indicators that are measured (e.g. SCI-indexed papers), a classic downside of audit culture noted in other contexts (Zhang & Li, 2025).

Another dimension of accountability is ideological and administrative oversight. Every university faculty member is subject to periodic evaluations that include not only teaching/research performance but also adherence to Party ideology and ethics. In 2016, the MOE issued guidelines requiring faculty to "firmly uphold the Party's line" and punishing the spread of any "harmful ideas" in classrooms. This reflects what John Fitzgerald (2020) calls the Party's "ideological accountability" regime in higher education – professors and administrators are held to account for contributing to the Party's mission, such as by incorporating socialist core values into curricula (Fitzgerald, 2020). Such measures go beyond what is seen in Western accountability systems (which tend to focus on academic outcomes and financial compliance); they are unique to China's political context. From a governance perspective, this indicates that accountability in China is not only managerial (about efficiency and quality) but also political. University leaders must regularly report to government/Party authorities on both kinds of targets. Indeed, the Party Secretary at each institution serves as an internal overseer, ensuring that the university's direction is aligned with national and Party directives (Jiang & Li, 2016). Our analysis underscores that this dual accountability – to market/academic standards on one hand and to Party-state mandates on the other – is a distinctive feature of Chinese university governance.

For example, Hong Kong's Research Assessment Exercise (RAE) and teaching quality reviews influenced practices in Mainland China. Several elite universities in China have implemented their own internal "mini-RAE" to allocate resources to departments based on research productivity, mimicking global best practices for accountability in research. The idea of competitive funding (where universities compete for special research grants or project 985/211

funding in the 2000s) introduced market-like accountability – universities must prove their merit to secure funding. Additionally, transparency measures have improved: universities now publicly release annual reports and undergo audits, addressing financial accountability to stakeholders. The state's role has thus transformed into what some scholars call a "regulatory state" or "evaluative state" in higher education (as seen in Europe and elsewhere) – it evaluates and regulates more, even if it manages less directly. Our findings show that Chinese universities have set up extensive data collection and institutional research offices to track performance indicators, reflecting an "accountability culture." For instance, at Nanjing University (a case study example), departments are ranked by publications and grants; those underperforming face administrative consequences. Such practices align with New Public Management principles that China has selectively adopted to improve efficiency and global competitiveness (Su, 2025). However, a side effect reported in studies is increased pressure and even reduced academic freedom, as faculty may avoid controversial research that could jeopardize evaluations (Fitzgerald, 2020; Yang, 2020). In summary, the results of governance reforms include a more autonomous yet more rigorously monitored university sector – a paradoxical outcome where universities are empowered to act, but within closely watched parameters.

3.3. Governance Outcomes and Ongoing Challenges

The combined effect of increased autonomy and strengthened accountability has been both positive and problematic. On the positive side, Chinese universities have rapidly improved in global standings. Many are now ranked in world top 100 lists – an outcome the government uses to justify its policies. Greater autonomy in academic matters has allowed institutions to innovate with new programs (for example, interdisciplinary research hubs, entrepreneurship centers, international joint colleges) which likely would not have emerged under the old command structure. Accountability mechanisms have helped instill a culture of striving for excellence; universities intensely focus on improving teaching quality and research output when they know they will be evaluated (and compared) by the MOE or international agencies. There is evidence that student outcomes (such as employment rates and satisfaction) have improved at many institutions in the past decade, partially due to such performance monitoring (Chen et al., 2021; Grebennikov & Shah, 2013). Furthermore, the diversification of funding has made universities more responsive and agile – they engage more with industry and society to attract funds, which in turn makes them more accountable to stakeholders beyond the government (Tight, 2019). These outcomes align with the government's objective of creating a more dynamic, globally competitive higher education system that still serves national priorities (Wang, 2016).

Another challenge is balancing quantitative and qualitative goals. The strong emphasis on measurable outputs (publications, patents, rankings) as accountability metrics may overshadow broader educational goals like critical thinking, civic education, and moral development. There are concerns that Chinese universities are becoming too focused on "countable" performance – sometimes dubbed an "evaluation obsession." Faculty lament the pressure to publish quickly and frequently, fearing that a dip in numbers could hurt their department in evaluations (Tight, 2019; Wang & Liu, 2011). This can discourage risk-taking in research or teaching innovation that doesn't immediately show up in metrics. Additionally, regional and lesser-known institutions feel

strained by one-size-fits-all accountability standards. Our review of policy documents suggests that while elite universities thrive under competitive accountability (given their resources), some local colleges struggle to meet the same indicators and face funding cuts or merger pressure as a result. This could widen inequalities in the higher education system, a trend noticed by Xu (2021) as China moves into a post-massification stage(Xu, 2021). Accountability is necessary, but if not differentiated, it might punish institutions serving disadvantaged communities. The government has started to address this by developing more nuanced evaluation frameworks (e.g., allowing teaching-focused universities to be evaluated on different criteria than research universities), but implementation is uneven.

Finally, a challenge lies in the area of global collaboration and norms. As Chinese universities engage internationally, differences in governance expectations can create friction. Global academic partners often expect institutions to uphold academic freedom and collegial governance (Fitzgerald, 2020). Cases of scholars being censored or foreign faculty contracts not renewed for political reasons have drawn international criticism. Such incidents suggest that if the Chinese governance model is perceived as overly centralized, it may constrain the global trust and soft power China aims to cultivate through educational exchange. The challenge for China is to demonstrate that its universities can be world-class not just in output, but also in upholding universal academic values – all while maintaining a Chinese governance style. Addressing this will require careful recalibration of how autonomy and accountability are defined in Chinese higher education moving forward. Our results section thus paints a picture of significant achievements in system expansion and excellence, tempered by structural tensions that remain unresolved. These findings set the stage for a deeper discussion on their implications for theory and practice.

4. Discussion

The Chinese experience with university governance offers rich insights for theoretical debates on autonomy and accountability in higher education. One key takeaway is the viability of a hybrid governance model that does not fit neatly into Western categorizations of either state control or complete institutional autonomy. In China, we see a “dual governance system”: universities operate with managerial and academic autonomy in many daily functions, yet a parallel hierarchy embeds accountability and control. From a comparative perspective, this reflects what some scholars call an “East Asian model” of university governance, seen to varying degrees in places like Singapore and Vietnam, where the state remains deeply involved even as universities gain autonomy (Mok, 2016). What distinguishes China is the scale and explicitness of Party involvement, which is ideologically driven. Theoretically, this suggests that autonomy and accountability are not strictly opposing poles, but can be configured in layered ways. Chinese universities have operational autonomy but strategic accountability – they can decide how to teach and research, but the state sets the direction (e.g., emphasizing STEM fields, or Marxist theory courses) and monitors compliance. This challenges the classic notion that real autonomy only exists when external accountability is minimized. China’s case indicates a spectrum or continuum rather than a binary.

From the lens of principal-agent theory, one could view the Chinese government as the principal using various mechanisms to ensure its agent (the university) fulfills desired objectives. Traditional principal-agent models stress that too much control (monitoring, punishing) can demotivate the agent and stifle initiative, whereas too little control risks goal divergence. China's evolving practices – such as performance contracts, targeted funding, and evaluation exercises – can be seen as attempts to fine-tune the incentive structure. The Double First-Class policy, for instance, is effectively a contract: universities receive extra funding in exchange for commitment to reach world-class status by certain metrics, with the threat of losing status if they underperform. This introduces a quasi-market accountability within a state framework, which principal-agent theorists might argue creates more alignment of goals without direct micromanagement. Our discussion posits that this approach has yielded results in efficiency and output, but at some cost to the agent's intrinsic motivation (some Chinese academics express that their work is increasingly driven by metrics rather than curiosity). The theory would predict such an outcome if extrinsic incentives become too dominant. Balancing intrinsic academic values with extrinsic accountability pressures remains a challenge, consistent with global experiences under New Public Management in higher education.

Another discussion point is how China's governance reforms align with the concept of "good governance" in higher education. Good governance is often defined (by the World Bank, UNESCO, etc.) by principles like transparency, participation, effectiveness, rule of law, and responsiveness. China has made strides in some of these areas – e.g., introducing more transparent evaluation criteria, and even experimenting with faculty participation in decision-making through academic committees. University governance bodies, such as academic boards, exist, but ultimate decisions frequently rest with Party or administrative leaders. This could be critiqued from a good governance perspective as lacking full stakeholder participation (for example, students and rank-and-file faculty have little say in strategic decisions). On rule of law, China did enact the Higher Education Law (1998) which codifies university rights and obligations, moving governance onto a legal basis rather than pure administrative fiat. That is a positive from a governance standpoint. However, the law also enshrines the leadership of the Party in universities, blending legal-rational authority with political authority. The duality of legal and political control in Chinese university governance might be conceptually unique. This invites a rethinking of how we evaluate governance quality: perhaps conventional Western criteria need adaptation to fully understand the Chinese model's strengths and weaknesses.

Our findings also resonate with Jun Li's notion of the "Zhong-Yong model" or Chinese University 3.0, which proposes that Chinese universities are developing an indigenous form of autonomy that emphasizes self-mastery in service to the state. In this cultural perspective, a university can be autonomous in managing itself (self-mastery) while still fundamentally oriented towards state-defined missions – a balance informed by the Confucian ideal of Zhong-Yong (the Golden Mean of moderation) (Li, 2020). Our discussion finds this framework quite apt: Chinese universities have not sought complete separation from the state (as some Western models imply), but rather negotiated a space where they pursue academic excellence in a way that also bolsters state goals (e.g., economic development, technological innovation, national pride). The

"pragmatic Confucian concept of zhong-yong" underpins an acceptance that some sacrifice of "autonomous freedom" is made in exchange for state support and social stability. This may ultimately allow Chinese universities to "unfold their potentialities" dramatically – as evidenced by their rapid advancements – but with the caveat that certain freedoms are curtailed. Whether this model is sustainable in the long run is debatable. As global norms in higher education increasingly value academic freedom and institutional independence (see, for example, the Bologna Process in Europe), Chinese universities might confront external and internal pressures to loosen political controls if they aim to be truly global institutions.

Finally, we must consider what lessons the Chinese case offers to other systems and to governance theory. One lesson is that accountability needs to be multi-dimensional. China's emphasis on hard metrics and ideological conformity showcases extremes that other systems might avoid, but it also shows the importance of aligning university activities with societal needs. Many Western systems struggle with universities that have autonomy but are accused of being unaccountable to the public (tuition increases, esoteric research, etc.). China's model demonstrates a powerful tool of ensuring universities contribute to national objectives – something developing countries might see as attractive. On the flip side, China's experience warns of the dangers of over-accountability: when everything is audited and politicized, creativity and critical inquiry can suffer. A theoretical implication is that there is an optimal zone of autonomy-accountability balance that maximizes innovation and public value. The Chinese case, still unfolding, provides data points to theorize this balance. As Su (2025) metaphorically put it, education needs both "roots" (grounding in local context and national purpose) and "wings" (the freedom to explore and innovate). Chinese university governance is essentially an attempt to grow both roots and wings – deepening accountability to the nation while expanding academic autonomy – though not without friction. Our discussion underscores that achieving this ideal requires continuous adjustment. Policies like differentiated evaluations (different metrics for different university types) and incremental increases in faculty governance could help. In essence, rethinking university governance in China involves reconciling two valid aspirations: universities as engines of independent knowledge creation, and universities as instruments for collective national progress. How China manages this reconciliation will remain a pivotal question for the coming years.

5. Conclusion

China's pursuit of a high-performing yet state-aligned university system is a compelling experiment in higher education governance. This article examined the theoretical and practical interplay of autonomy and accountability in Chinese universities. We found that China has built a hybrid governance model: universities are granted notable autonomy in academic and managerial domains, but this autonomy operates under a vigilant accountability framework dominated by the state and Communist Party. The Chinese case demonstrates that autonomy and accountability need not be mutually exclusive – they can be orchestrated in a calibrated way to drive rapid improvements in higher education. Indeed, the past two decades have seen Chinese universities thrive on conditional autonomy: when given leeway to make decisions, they have innovated and

excelled, yet the guiding hand of the state has kept them oriented toward national objectives. This has contributed to achievements such as China's rise in global university rankings, its expanding research output, and its increasing role as a destination for international students.

At the same time, the Chinese model raises cautionary flags about the costs of an overbearing accountability regime. The ever-present weight of political oversight and stringent evaluations may inhibit the very creativity and critical thinking that define world-class universities. The removal of phrases like "academic freedom" from university charters and the emphasis on ideological conformity are reminders that too heavy a hand can stifle the intellectual vibrancy of campuses. As China aims to build globally leading universities, it may need to allow a greater degree of intellectual freedom and protect scholarly autonomy, even as it maintains reasonable accountability for outcomes and public mission. Striking this balance is no easy task. It requires policymakers to trust academic institutions and tolerate a diversity of viewpoints, and it requires university leaders to act responsibly and transparently so that increased autonomy does not lead to complacency or detachment from society.

In conclusion, the trajectory of university governance in China exemplifies a "bargain" in which autonomy is expanded in exchange for meeting heightened accountability demands. Whether this bargain is sustainable will depend on adaptive governance: the ability to reform evaluation systems that have unintended negative effects, to empower internal governance bodies (like academic committees) for more bottom-up input, and to possibly relax certain political controls as universities mature. The theoretical implication is that governance is not a zero-sum between autonomy and accountability; it is about finding an equilibrium that fits the socio-political context. China's current equilibrium has driven success but is under strain, evidenced by internal calls for more freedom (Fitzgerald 2020). As we rethink university governance in China, a truly benign governance ecology would be one that gives universities the "wings" to explore knowledge freely while keeping them rooted in accountability to the public good, rather than to just bureaucratic targets or political doctrine. Achieving that will require careful, ongoing adjustments – a dance, perhaps, toward enlarging the cage or eventually removing some of its bars. The Chinese experience thus offers both inspiration and caution, providing valuable lessons for higher education communities worldwide about how powerful the synergy of autonomy and accountability can be, and how important it is to get that synergy right.

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Managing Massification: Challenges of Expansion and Equity in Chinese Higher Education

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Abstract

China's transition from elite to mass higher education over the past two decades represents one of the most rapid expansions of tertiary education in history. This article examines how the massification of Chinese higher education-marked by a gross enrollment ratio rising from under 10% in 1998 to nearly 60% in 2021-has created new opportunities and complex challenges. We review the policies and outcomes of the post-1999 enrollment expansion, highlighting its positive impact on access and human capital formation alongside persistent inequities and quality concerns. Drawing on national data and extensive literature, we find that expanded college access has benefitted millions of students and propelled China into the stage of universal higher education. At the same time, disparities by region, urban-rural origin, and socioeconomic status remain stubbornly entrenched, and the surge in graduates has intensified pressure on educational resources and labor markets. The analysis foregrounds equity issues-including rural underrepresentation and stratification of elite institutions-as central challenges in managing massification. It also discusses government initiatives aimed at mitigating inequality (such as targeted admission programs and funding reforms) and improving quality amid rapid growth. We conclude that achieving both expansion and equity requires balancing quantitative growth with policy measures to ensure inclusion and quality. China's experience offers lessons on the promises and perils of massification for other developing higher education systems.

Keywords: Higher Education Expansion; Massification; Educational Equity; Access And Inequality; Graduate Employment

1. Introduction

In the latter half of the 20th century, many countries experienced a shift from elite to mass higher education, as described by Trow (1973) in his seminal work on the transition to universal access (Trow, 1973). This worldwide trend toward *massification* – rapid growth in enrollment and participation rates – has been especially pronounced in Asia (Altbach, 2015; Marginson, 2016).

Nowhere is this phenomenon more evident than in the People's Republic of China. Over the past two decades, China's higher education system has expanded at an unprecedented scale, growing from an elite system (with under 10% gross enrollment in the late 1990s) to a mass system approaching universal access (over 57% enrollment by 2021). In absolute terms, college and university enrollments ballooned from about 6 million in 1998 to 44.3 million students in 2021, giving China the world's largest higher education system. This dramatic expansion – initiated by deliberate government policy in 1999 – is often referred to as China's *Great Enrollment Expansion* or *massification drive* (Bie & Yi, 2014).

The massification of Chinese higher education has occurred in the context of broader economic and social transformations. In the reform era, Chinese came to view higher education as pivotal for economic development and global competitiveness (Altbach, 2015). The decision to massively expand college enrollments in 1999 was spurred by multiple goals: to stimulate domestic consumption and ease youth unemployment in the short term, and to build human capital for a knowledge-based economy in the long run (Postiglione, 2020). As a result, new admissions to colleges and universities were abruptly increased by over 50% in 1999, with further large increases in the early 2000s (Wang, 2007). The number of new entrants jumped from just over 1 million in 1998 to 3.4 million in 2001, marking 1999 as a historic turning point in Chinese higher education. This policy-driven "great leap forward" in higher education is unparalleled in scale and speed (Zha, 2009). By 2012, the gross enrollment ratio (GER) exceeded 30%, and by 2021 it reached 57.8%, signaling the transition to a stage of near-universal access. Such an expansion in a relatively short period has understandably attracted substantial scholarly attention to its outcomes and impacts (Luo, Guo, & Shi, 2018; Ou & Hou, 2019).

While the expansion has successfully broadened access, it has also brought *challenges of equity and quality* to the forefront. International research on high-participation systems suggests that massification often produces paradoxical effects: it increases overall educational opportunity but can also reproduce or even widen stratification *within* the system (Marginson, 2016; Hannum & Wang, 2007). In China's case, the question of whether higher education expansion has promoted greater equality of opportunity or exacerbated inequalities is actively debated (Luo et al., 2018). Moreover, the sudden influx of students put strains on infrastructure, faculty, and funding, raising concerns about educational quality and graduate outcomes (Mok & Jiang, 2017; Ying, 2011). Managing this tension between *expansion* and *equity/quality* has become a central policy challenge in China's higher education development (Mohrman, Geng, & Wang, 2011). The Chinese government has implemented various measures – from financing reforms to targeted admission programs – to address these issues, but their effectiveness remains a topic of analysis (Yan & Ma, 2013; Zhang, 2022).

In this article, we critically examine the trajectory of Chinese higher education massification and its implications for equity. We synthesize data and findings from a range of academic studies, policy reports, and statistical sources to evaluate how expansion has altered the landscape of opportunity in China. Key questions include: *Who* has benefitted from massification in terms of access and attainment? Has the rapid growth reduced or reinforced disparities (such as the urban–rural gap or regional imbalances)? How has China managed the quality of provision amid

enrollment surges? And what strategies are being employed to ensure a more equitable and inclusive system going forward? By addressing these questions, our aim is to illuminate the achievements and remaining challenges of China's expansion, and to draw lessons relevant to other countries undergoing similar transitions from elite to mass higher education.

The rest of the paper is organized as follows. Section 2 provides an overview of the expansion process and policy measures since the late 1990s, highlighting the scale of growth and the driving policies. Section 3 discusses the positive outcomes of massification, including increased access and enrollment of previously under-served groups, as well as improvements in educational attainment and human capital. Section 4 then examines the challenges and inequities that have accompanied expansion: quality assurance issues, resource constraints, and persistent inequalities by region and social background. Section 5 reviews policy responses aimed at addressing these challenges – such as funding reforms, quality initiatives, and affirmative action programs for rural students – and assesses their impact. Finally, Section 6 concludes with reflections on managing massification in the future, arguing that China needs to continue balancing growth with equity-oriented policies to fully reap the benefits of an educated society.

2. The Expansion of Chinese Higher Education Since 1999

China's higher education system remained relatively small and elite throughout the early reform period (1980s–1990s). In 1998, only about 1 in 10 college-aged youth in China was enrolled in some form of higher education (Gross Enrollment Ratio ~9.8%). This scenario changed dramatically when the Chinese government launched a bold expansion initiative in 1999. This section outlines the *massification process* – key policies, enrollment growth, and structural changes – from the late 1990s to present.

2.1. Policy Drivers of Massification

Several policy decisions in the 1980s and 1990s set the stage for the 1999 expansion. The 1985 "Decision on Reforming the Education System" and the 1993 "Outline for Education Reform and Development" endorsed the ideas of decentralizing higher education management and diversifying funding (National Education Commission, 1995). Universities were encouraged to seek local government and private financing, and tuition fees were gradually introduced in the 1990s (Hanson, 1998). These reforms weakened the fully state-funded model of the Mao era and allowed higher education to grow with more flexible support (Hanson, 1998; Qian & Verhoeven, 2004). Notably, the 1995 "Education Law" and 1999 "Higher Education Law" provided legal frameworks for expanding and regulating higher education, including permission for establishing private (minban) colleges (Cheng & Zheng, 2005). By the late 1990s, the groundwork was laid for a major scale-up: universities had autonomy to expand enrollment and charge tuition, and non-government providers could help absorb demand (Wei & Zhang, 1995; Cheng & Zheng, 2005).

The immediate trigger for mass expansion was a combination of economic and social considerations in the late 1990s. In the aftermath of the Asian financial crisis, Chinese saw higher education expansion as a Keynesian stimulus measure to spur domestic consumption (by investing in university infrastructure and enrolling more fee-paying students) and as a way to

alleviate youth unemployment by keeping more high school graduates in school (Postiglione, 2020; Ou & Hou, 2019). Thus, in mid-1999 the State Council announced a sudden large increase in university admission quotas. Universities were instructed to enroll an additional 330,000 students beyond original plans in 1999, on top of a prior expansion of 220,000 earlier that year. This represented a more than 50% increase in new admissions compared to 1998. The expansion continued in subsequent years: from 1999 to 2005, freshman enrollment grew at an average annual rate of over 20% (Zha, 2009). By 2005, China's higher education entering class was about 4.7 million, roughly four times the size in 1998 (National Bureau of Statistics, 2007).

2.2. Scale and Pace of Growth

The effects of these policies on enrollment numbers were dramatic. *Figure 1* illustrates the trajectory of higher education expansion in China. Total tertiary enrollments (including undergraduate and junior college students) climbed from 6.4 million in 1998 to 23 million in 2005, and further to 32 million by 2010 and 44.3 million in 2021 (National Bureau of Statistics, 2007; Ministry of Education, 2022). The Gross Enrollment Ratio (GER) – the proportion of college-aged (18–22) population in higher education – rose from 9.8% in 1998 to 26% in 2005, reaching 48.1% by 2018 and 57.8% in 2021 (Ministry of Education, 2022). This exceeds the 50% threshold commonly used to define "universal" access (Trow, 1973). According to the Ministry of Education, China met its goal of transitioning from an elite to a universal access system by 2020, entering what some call the "post-massification" era. In absolute terms, China now accounts for over 1/5 of all tertiary students in the world (Altbach, 2015). Several dimensions of the expansion are noteworthy:

(1) Institutional expansion and differentiation: The number of higher education institutions (HEIs) also grew, though not as quickly as enrollments. Many existing universities merged or absorbed colleges to expand capacity (e.g., the creation of larger multi-disciplinary universities in early 2000s), and numerous new vocational and private institutions were established (Mohrman et al., 2011). The total count of HEIs (including universities and colleges) increased from 1,022 in 1998 to over 2,600 by 2020 (Ministry of Education data). Particularly important was the growth of the private sector: from virtually zero in the early 1980s, private (minban) colleges grew to enroll around 20% of undergraduates by the 2010s (Cheng & Zheng, 2005; Wei & Zhang, 1995). This privatization provided additional capacity and is considered a key aspect of China's massification strategy. *However*, the private institutions generally have lower prestige and resources, contributing to a stratified system (Huang, 2018).

(2) Introduction of higher fees and funding changes: To finance the expansion, China shifted more of the cost burden to students and families. Tuition and fees were instituted nationwide by the early 2000s, typically accounting for 20–30% of university revenue (Yan & Ma, 2013). Government funding also increased substantially in aggregate, but on a per-student basis it did not keep pace with enrollment growth (Zhang, 2022). The higher education budget roughly doubled between 1998 and 2003, yet enrollments more than tripled, leading to tighter funding per student (Yan & Ma, 2013). This mass expansion with constrained resources has had implications for educational quality, as discussed in Section 4.

(3) Examination and admission reforms: China's highly competitive national entrance exam (Gaokao) remained the main pathway to college, but policies evolved to accommodate more students. Admission cutoff scores were lowered as capacity increased, enabling a broader segment of high school graduates to qualify (Luo et al., 2018). The system also expanded the tiers of institutions: students who previously might not get into a regular university could enroll in newly expanded diploma programs, adult higher education, or private colleges. This ensured that expansion reached beyond the top academic performers (Luo et al., 2018). Over time, special admission tracks were introduced (e.g., affirmative action-like programs for rural students in elite universities, see Section 5), though the Gaokao remains central (Liu, 2018).

In summary, since 1999 China has achieved a *quantum leap* in higher education participation. Such rapid massification has been enabled by strong state direction, market-oriented funding reforms, and the mobilization of non-state sectors (private colleges, local governments) to share the load (Huang, 2018; Mok & Jiang, 2017). The expansion was quantitatively successful, meeting or exceeding government targets ahead of schedule (the GER target of 40% by 2020 was surpassed by 2015). Yet, these achievements came with *qualitative trade-offs*. The next sections explore the outcomes of massification, both positive and negative, with a focus on equity and quality.

3 .Outcomes of Massification: Increased Access and Attainment

The mass expansion of higher education in China has undoubtedly broadened educational opportunities for the population. We first examine the positive outcomes: greater access for previously under-represented groups, higher overall educational attainment, and related social benefits. In many respects, China's experience confirms the expected benefits of moving toward universal higher education (Altbach, 2015; Marginson, 2016). At the same time, some inequalities have proven persistent or even shifted in form, which will be addressed in Section 4.

3.1. Increased Enrollment of Under-Represented Groups

One major outcome of massification is that groups who historically had limited access to college – including those from rural areas, poor regions, and ethnic minorities – are now enrolling in higher numbers (Luo et al., 2018; Liu, 2018). The sheer expansion of seats meant that many students who would have been left out under the older elite system could now attend college. For instance, *rural students* in China have long faced an access gap, but their absolute numbers in college have risen markedly. Wu and Zhang (2010) found that from 1990 to 2005, educational inequality (measured by urban-rural differences in college attainment) narrowed modestly in the initial years of expansion – evidence that the policy opened doors to more rural youth. By the 2010s, hundreds of thousands of rural students were entering college annually, including some admission into top universities via special programs (Liu, 2018). Although disparities remain (see Section 4), the probability of a rural Chinese student attending some form of higher education is far higher today than it was two decades ago (Luo et al., 2018). Similarly, students from western and central China (traditionally under-developed regions) have benefitted from new institutions and quotas targeted at those regions (Yan & Ma, 2013). The establishment of new universities in

inland provinces and the expansion of enrollment in existing ones have somewhat reduced the regional imbalance in college seats per capita (Ministry of Education, 2022).

Another indicator of expanded inclusivity is the *gross enrollment ratio* for females versus males. Female enrollment has grown slightly faster, and women now make up about 52% of college students, compared to roughly 40% in the early 1990s (Liu, 2018). The one-child policy's effects and changing societal norms, coupled with mass expansion, have led to women achieving parity and even slight majority in higher education – a significant stride toward gender equity in Chinese education (Ye Liu's studies document this "women rising as half the sky" phenomenon). Ethnic minority students have also increased in number through dedicated support programs and minority-focused colleges, although they still constitute a small percentage of total enrollment (Ministry of Education, 2022). Overall, massification has *democratized* higher education access in the sense that it is no longer the exclusive domain of the urban elite. By 2021, a majority of youth can expect to go on to post-secondary education, a scenario almost unimaginable in earlier generations.

3.2. Higher Educational Attainment and Human Capital

The expansion has led to a rapid increase in China's educated workforce. The share of the working-age population with tertiary education more than doubled from 1998 to 2018 (World Bank data). By 2020, over 240 million Chinese had received a higher education (including graduates of two- and four-year programs). This mass supply of graduates has been instrumental in China's shift up the value chain economically. Studies suggest that the expansion contributed to economic growth by supplying more skilled labor and boosting productivity (Li, Whalley, Zhang, & Zhao, 2008). Importantly, despite concerns about "over-education," the earnings premium for college graduates has generally *increased* over the reform era, indicating strong demand for higher skills (Zhang, Zhao, Park, & Song, 2005). In urban China, the return on investment in a college education rose from the 1990s into the 2000s, partly because economic reforms created new opportunities for skilled workers (Zhang et al., 2005; Heckman & Li, 2004). Even with the surge of graduates after 1999, research finds that graduate wage premiums have remained significant, although they leveled off in recent years (Chi & Zhu, 2022). This suggests that massification has not yet led to a collapse in returns to education – a positive sign for the value of the degrees awarded.

From a societal perspective, the broadening of higher education has numerous ancillary benefits. A more educated populace can contribute to innovation, better health outcomes, and more civic engagement. While China's global research output and university rankings are driven largely by a subset of elite universities (thanks to initiatives like Project 985 and "Double First-Class"), the overall system's expansion has also supported regional development by producing local college graduates (Postiglione, 2020). Many new or upgraded institutions focus on applied fields needed in local economies, thus aligning massification with development goals (Yan & Ma, 2013). Another benefit is the emergence of a sizable middle class of college-educated citizens, which may foster social stability and mobility. Some scholars argue that expanded higher education in China has moderately increased intergenerational mobility by giving talented youth from less-privileged backgrounds a shot at upward mobility (Wu & Zhang, 2010). Although this

point is debated (see Section 4), it is clear that *absolute* mobility – the proportion of people achieving higher education than their parents – has risen sharply in the massification era.

3.3. Diversification of Higher Education System

Massification has also transformed the structure of Chinese higher education, bringing more diversity in institutions and educational pathways. Prior to the expansion, the system was relatively homogenous and focused on a few elite universities and specialized colleges (Huang, 2018). Now, the system includes a wide array of institution types: research universities, teaching-focused universities, vocational and technical colleges, private colleges, and open universities (distance education). This diversification is partly a response to mass enrollment – not all students have the same goals or academic preparation, so a one-size university model would not fit the masses (Zha, 2009). The Chinese government actively promoted the *binary system* of academic vs. vocational higher education. Enrollment in short-cycle (3-year) higher vocational programs expanded significantly, especially after 2004, accounting for roughly half of undergraduate-level enrollment by the 2010s (Ministry of Education, 2022). These programs aim to produce technicians and practical professionals and have absorbed many students who might not have entered a traditional university. By widening the range of options, massification has allowed higher education to cater to different aptitudes and market needs, which is a positive outcome (Huang, 2018).

Private institutions have introduced further diversity, often focusing on fields like business, IT, and foreign languages that are in high demand (Cheng & Zheng, 2005). They frequently adopt innovative curricula or pedagogy (to attract students) and sometimes partner with foreign institutions, contributing to the system's internationalization. The growth of transnational education (e.g., joint degree programs, Sino-foreign universities) is another facet of expansion in the 2000s that has enriched opportunities for Chinese students (Mok & Jiang, 2017). For example, by 2007 there were over 1,000 joint programs with foreign universities, something that barely existed in earlier decades.

In summary, from the perspective of access and aggregate educational attainment, China's massification drive has been highly successful. Tens of millions of additional students – including women, rural youth, and those from interior provinces – have obtained higher education who would not have under the old system. The nation's pool of human capital has deepened, supporting economic modernization. The higher education system itself has become more heterogeneous and responsive. These are real accomplishments of which policymakers in China often remind the public. However, this is only part of the story. The expansion has also brought *new challenges and inequalities*, which we examine next.

4. Challenges of Expansion: Equity and Quality Concerns

Despite its impressive achievements in expanding access, the massification of Chinese higher education has been accompanied by significant challenges. Chief among these are concerns about equity – whether the benefits of expansion have been distributed fairly across different social groups – and quality – whether educational standards and outcomes have been maintained with

the rapid influx of students. This section delves into these issues, drawing on research that highlights the persistent disparities and emerging problems in China's post-expansion higher education landscape.

4.1. Persistent Urban–Rural and Regional Inequalities

One of the most scrutinized issues is the enduring gap between urban and rural students in higher education. Historically, urban students (especially those in major cities) dominated university admissions due to better-resourced secondary schools and quota allocations favoring local applicants at top universities (Hannum & Wang, 2006). The expectation was that mass expansion would narrow this urban–rural gap by creating more room for rural candidates. In absolute terms, as noted, far more rural students attend college today than before. However, *relative* inequalities remain pronounced. Studies find that rural youth are still significantly less likely to attend four-year universities, especially elite institutions, compared to their urban counterparts (Liu, 2018; Luo et al., 2018). For instance, Luo et al (2018) report that although college participation rates for rural students increased after 1999, the *difference* in odds of attending a university between urban and rural students did not shrink substantially. The expansion largely benefited urban students too, as they were better prepared and positioned to seize new opportunities (Hannum & Wang, 2006). As a result, the composition of the student body at prestigious universities remains skewed: students from big cities and key high schools are over-represented, while those from poor rural counties are under-represented (Wu & Zhang, 2010; Liu, 2018).

A related inequity is regional imbalance. China's top universities (the "985" and "211" project schools) are concentrated in Eastern provinces (Beijing, Shanghai, etc.), and admission policies historically favored local students in those regions via provincial quota systems. During massification, eastern provinces often expanded enrollment faster than poorer western provinces, because they had more resources (Yan & Ma, 2013). Although the central government did allocate special funds to develop universities in central/western China and mandated some quota shifts, a child from an inland province still faces stiffer competition for a university seat than one from Beijing. For example, cut-off Gaokao scores for admission are much higher in provinces like Henan or Gansu than in Beijing for the same tier of university, reflecting an inequitable distribution of opportunities (Liu, 2018). *Regional GER disparities* illustrate this: by 2015, Beijing had an adjusted tertiary enrollment rate above 70%, whereas some western provinces were around 30–40% (Yan & Ma, 2013). Thus, massification has not fully evened out regional access gaps – many rural and interior areas still lag behind the national average in higher education participation.

Why did inequalities persist despite expansion? Research suggests several structural factors. First, quality differentials in K-12 education mean rural students often score lower on the Gaokao, limiting their university options (Hannum & Wang, 2006). Massification did not automatically equalize school quality. Second, expansion primarily created new opportunities at *non-elite* institutions (e.g., local colleges, vocational institutes), whereas the number of seats at elite universities grew more slowly (Altbach, 2015). Urban middle-class students have disproportionately filled the new elite seats that did appear, while students from disadvantaged

backgrounds more often enter lower-tier colleges (Luo et al., 2018). This leads to a stratified system where expansion can even increase social stratification *within* higher education – a phenomenon Marginson (2016) observed globally. In China's case, Ou and Hou (2019) term it "bigger pie, but not an evenly bigger slice" for the disadvantaged: the overall pie of enrollment grew, yet wealthier/urban groups often took a larger share of the best slices (top programs). Third, financial barriers, while reduced by loans and subsidies, still deter some low-income youth. Tuition fees introduced during expansion (typically ¥5,000–¥10,000 per year for public universities) are heavy for poor rural families (Yan & Ma, 2013). This can influence whether a student chooses to attend a lower-tier college far from home. Surveys indicate that cost and perceived benefits cause some rural students to opt out or choose shorter vocational programs over expensive university degrees (Liu, 2018).

4.2. Stratification and Quality Gaps

Alongside inequities in access, China's rapid expansion has led to concerns about educational quality and the stratification of the higher education system. The doubling and tripling of enrollment put enormous pressure on universities' facilities and faculty. Class sizes swelled in many institutions, student–teacher ratios increased, and resources per student declined, particularly in the early 2000s (Yan & Ma, 2013). Faculty hiring and training often lagged behind enrollment growth, raising questions about the *quality of instruction* received by the influx of students (Zhang, 2022). While elite universities maintained relatively high standards (and benefited from targeted government excellence funds like Project 985), many second- and third-tier institutions struggled to accommodate the surge without diluting quality (Mok & Jiang, 2017). There are anecdotal and survey reports of crowded lecture halls, less individualized attention, and stretched laboratory and library resources during the peak expansion years around 2000–2010 (Mohrman et al., 2011). The Ministry of Education instituted evaluations and quality assurance programs to address these issues (Ying, 2011), but results have been mixed. According to Ying (2011), the "985 Project" substantially improved research capacity at a handful of top universities, yet the gap between those and the bulk of other institutions widened in terms of funding and faculty qualifications. Thus, massification has been accompanied by horizontal stratification: a widening divergence between elite and non-elite colleges.

Such stratification can exacerbate inequality, because students from less-privileged backgrounds are concentrated in the lower-tier institutions which have fewer resources and often lower market value (Luo et al., 2018). Employers in China place great weight on institutional prestige; graduates of top universities have a clear advantage in the labor market, whereas those from newly established local colleges or private institutions may struggle with underemployment (Mok & Jiang, 2017). This dynamic potentially undermines the equity gains of simply *entering* higher education – it matters *where* one studies. Research on graduate employment indicates that many graduates from lower-tier institutions face difficulties finding high-skill, well-paid jobs, sometimes referred to as the "Ant Tribe" phenomenon of underemployed college graduates living in poor conditions in cities (Mok & Jiang, 2017). The overall graduate employment rate remained high officially (often over 90% securing some job within six months of graduation), but underemployment and mismatch are common issues, signaling quality concerns in learning and

career preparation (Mok & Jiang, 2017; Li et al., 2014). In short, China's massification has produced a *hierarchy* of institutions and outcomes, raising the question of how to ensure quality and value across the board.

4.3. Economic and Labor Market Pressures

The flood of new graduates each year – now around 8 to 9 million – has also altered China's labor market dynamics. One concern is that the supply of graduates may outpace the creation of high-skilled jobs, leading to a decline in the college wage premium or unemployment among young graduates (Chi & Zhu, 2022). Some evidence points to a *moderation* of returns to education for the cohorts who graduated after the expansion peak. Chi and Zhu (2022) find that the great expansion did contribute to an increase in the college-educated labor force and initially to rising skill premiums (due to concurrent economic growth), but more recently the glut of graduates has started to put downward pressure on wages in certain fields. Graduate unemployment, while still relatively low, ticked upward in the early 2010s, with media reports of record numbers of jobless or underemployed graduates each summer. For example, the term kenlao zu, referring to young adults relying on parental support gained popularity, reflecting societal worries that a college degree no longer guarantees a good job.

It is important to note that these pressures are uneven: they are most acute for graduates of less prestigious institutions or those with generic majors. Surveys show employers remain keen to hire graduates from elite universities, but those from newer mass institutions often must settle for lower pay or jobs that might not require a degree (Mok & Jiang, 2017). This underemployment indicates an efficiency challenge – resources spent on producing graduates who cannot fully utilize their skills. Some scholars argue that China's expansion was too *speedy* to align with industrial upgrading, resulting in a temporary oversupply of general graduates. In response, the government has been pushing innovation, entrepreneurship training, and vocational skills to improve graduate employability (Ministry of Education, 2022). Still, the class of 2022 faced notable job market difficulties (exacerbated by the pandemic), illustrating that managing the *quantity-quality* balance of graduates remains an ongoing challenge.

4.4. The Equity-Efficiency Trade-off

A deeper issue underlying these challenges is the policy trade-off between *equity* and *efficiency (excellence)* in the massification process. China pursued both mass expansion and world-class university initiatives simultaneously. On one hand, it rapidly expanded *quantity*; on the other, it invested heavily in a select few universities (through Project 211, 985, Double First-Class) to boost *quality* at the top end (Ying, 2011). While this two-pronged strategy achieved some of each goal – many more graduates system-wide and a few globally ranked universities – it arguably widened inequalities between institutions (Ying, 2011; Mohrman et al., 2011). Students who attend the well-funded elite universities receive a very different education (small classes, top faculty, better facilities) than those at an average local college. This inequality in educational experience can translate into inequality in outcomes. Some researchers describe the situation as a *bifurcated system*: a relatively small elite segment and a large mass segment with lesser resources

(Huang, 2018). The challenge for China is how to raise the quality of the mass segment without sacrificing the strides made in the elite sector.

Moreover, equity is not only about *access to college*, but also about access to *success within and after college*. If rural or first-generation students disproportionately attend poorer-quality institutions and then struggle in the job market, the expansion's social mobility benefits are constrained. Luo et al. (2018) found that students from low socioeconomic backgrounds in China not only enroll at lower rates, but even when they do enroll, they tend to be sorted into lower-tier institutions, a pattern that perpetuates inequality. Huang (2018) highlight a paradox: expansion has improved equality in formal access (more students from all backgrounds go to college), but it may have *reduced* equality in outcomes because advantaged students reap greater benefits from the system (by concentrating in better institutions and programs). This suggests that massification alone, without complementary equity policies, can only do so much to level the playing field.

4.5. Quality of Education and Learning Outcomes

Beyond employment, there are quality concerns regarding what students are learning. The rapid expansion led to concerns about academic preparedness and performance of the enlarged student intake. Professors at some universities reported having to adjust curriculum expectations as more average students (compared to previously highly select cohorts) entered classrooms (Mohrman et al., 2011). There has been criticism that rote learning and limited faculty time hinder the development of critical thinking and practical skills for many undergraduates (Mok & Jiang, 2017). International assessments or employer surveys occasionally suggest Chinese graduates (outside top-tier ones) may lack certain soft skills or innovative capabilities. The government has recognized this and pushed pedagogical reforms, including more undergraduate research opportunities and smaller class pilot programs, but scaling these improvements across thousands of institutions is difficult (Ying, 2011). Ensuring *quality assurance* in such a huge system is a formidable task. The Ministry of Education implemented a teaching evaluation system in the mid-2000s which actually resulted in the closure of some substandard private colleges and the consolidation of others (Ying, 2011). This indicates efforts to curb the lowest-quality outliers, yet raising average quality remains a work in progress.

In summary, while massification achieved its primary aim of expanding access, it left a complex legacy of challenges. Urban-rural and regional disparities in higher education participation persist, highlighting that deeper systemic inequalities in primary/secondary education and economic development carry through into the higher education stage (Hannum & Wang, 2006). The quick growth stretched resources, potentially affecting the quality of education provided, especially in non-elite settings. The burgeoning number of graduates introduced new pressures in the labor market, including underemployment and skill mismatches for some. And internally, the higher education system became more stratified even as it became more accessible, raising concerns about a tiered society of haves and have-nots in educational terms. These challenges do not negate the real gains of massification, but they do signal that expansion needs to be managed with careful policy interventions to ensure that the benefits are equitable and sustainable. The next section will discuss what measures China has taken and can take to address these issues of equity and quality in the era of mass higher education.

5. Policy Responses and Strategies for Equity in the Massification Era

Recognizing the challenges outlined above, Chinese policymakers and educators have introduced a range of initiatives aimed at managing the negative side-effects of massification and promoting a more equitable, high-quality system. This section reviews some of the key policy responses in recent years that target equity and quality concerns: special admission programs for disadvantaged students, increased funding and financial aid, quality assurance and curricular reforms, and efforts to better align higher education with labor market needs.

5.1. Targeted Admission and Support Programs

To narrow the urban–rural gap in elite university access, China launched several *affirmative action-style* programs in the 2000s and 2010s. One prominent initiative is the "Special Program for Rural Students", also known as the *National Rural Student Enrollment Program*, introduced around 2012. This program allocates a certain number of seats at top universities specifically for students from rural or poor areas (often requiring they come from counties designated as impoverished) (Liu, 2018). Participating universities (including many Project 985 schools) set somewhat lower Gaokao score thresholds for rural applicants under this program. The impact of the special program has been modest but positive: it has enabled hundreds of rural youths each year to enter elite institutions who might otherwise have been excluded by a narrow exam score margin (Liu, 2018). However, due to its limited scale relative to overall admissions, it alone cannot bridge the urban–rural enrollment divide; it is more of a symbolic and incremental improvement (Luo et al., 2018).

Another set of programs is the "College Enrollment Cooperation Plans" between eastern and western provinces. Under these, top universities (mostly in eastern China) increase their recruitment quotas for students from central and western provinces, beyond the normal quota determined by province population. For example, universities in Beijing might reserve additional spots for applicants from Xinjiang, Tibet, or Guizhou (Yan & Ma, 2013). This policy aims to even out regional representation. Data suggest it has slightly improved the chances of high scorers from under-developed provinces to attend better universities, but some eastern provinces have resisted large quota reallocations due to local pressures (educational opportunities are a politically sensitive resource) (Yan & Ma, 2013).

On the support side, student financial aid has been greatly expanded to ensure that admitted poor students can afford to attend. Starting in 2007, China rolled out a national student loan system and scholarship/grant programs (state stipends, "green channel" tuition deferment, etc.) (Yan & Ma, 2013). By 2020, millions of students from low-income families were receiving grants or subsidies. This has reduced financial barriers: surveys indicate that tuition is less of a reason for dropping out now than in the early 2000s (when some rural students admitted to college could not enroll due to cost) (Liu, 2018). Financial aid, combined with targeted admissions, is meant to improve not just access but also *completion* rates for disadvantaged students.

5.2. Improving Quality and Differentiation

The government has implemented quality assurance measures to address the strain on educational quality. A major initiative was the Teaching Quality Assessment of undergraduate

programs, which ran cycles of evaluations for all higher education institutions (Ying, 2011). Institutions that performed poorly were warned or, in a few cases, prevented from expanding further. Additionally, curricula have been revised to make learning more student-centered and skills-oriented, especially in vocational colleges (Mok & Jiang, 2017). The Ministry of Education encouraged universities to update teaching methods, introduce elective courses, and emphasize practical training as a way to enhance the competencies of graduates beyond rote knowledge (Ying, 2011).

To tackle graduate underemployment, career services and entrepreneurship education have been ramped up. Universities now host job fairs, career counseling, and incubators for student start-ups on a much larger scale than before (Ministry of Education, 2022). The concept of "mass entrepreneurship and innovation" has been promoted at campuses nationwide, aiming to help graduates create employment opportunities and adapt to a changing economy. This is partly a response to the saturation of traditional graduate jobs – encouraging students to be flexible and even start their own businesses (Mok & Jiang, 2017). Early evaluations suggest these efforts have had mixed success; while entrepreneurial interest has risen, it is often the more privileged students who can afford to take risks in start-ups. Nonetheless, integrating employability skills into the curriculum is an acknowledged priority.

Another strategic response is continued higher education differentiation. China is refining a tiered system where different institutions have different missions: some focus on cutting-edge research and postgraduate training (the elites), while others focus on applied learning and vocational skills (the majority). The introduction of *University of Applied Sciences* pilots and conversion of some universities into *vocational undergraduate* institutions are recent moves to better align graduates' skills with market needs (Huang, 2018). By clearly delineating academic vs. vocational tracks (while ensuring each track has quality standards), policymakers hope to avoid a scenario where all institutions chase research prestige at the expense of teaching or where students receive an academic education ill-suited for available jobs. Germany's dual-track system is often cited as a model in these reforms. Of course, the challenge is to elevate the status and quality of vocational programs so that they are not seen as second-class. The government has increased funding for vocational higher education and is involving industry in curriculum design to improve outcomes (Ministry of Education, 2022).

5.3. Funding Reforms for Equity

Ensuring adequate and equitable funding per student remains critical. In the 2010s, public funding for higher education increased substantially in absolute terms, in part due to programs aimed at lifting up non-elite institutions. For example, the Central and Western Universities Infrastructure Improvement Plan provided special grants to universities in poorer provinces to upgrade facilities and hire faculty (Yan & Ma, 2013). Also, provinces with weaker higher education bases have received targeted support under the "Double High Plan" for vocational colleges and "One Province, One University" initiatives. These investments are attempts to reduce the resource gap between coastal and inland institutions. While elite projects (211/985) got the limelight, more recent policies like the "Double First-Class" initiative (2017) include universities from various regions and also emphasize disciplines (not just whole institutions) to

spread resources more widely (Postiglione, 2020). For instance, a provincial university might receive funds to build a "first-class" specialty in, say, agriculture or mining engineering that serves local development, even if the university itself is not top-tier nationally. This can indirectly benefit local students who attend those programs.

Additionally, the government has worked on standardizing funding formulas to ensure each public institution gets a baseline per-student allocation. Previously, funding was often negotiated or historical, leading to big disparities. New formulas account for enrollment numbers, fields of study (expensive lab-based fields get more), and local price levels (Yan & Ma, 2013). While elite schools still get extra funds for research, the basic teaching funds per student have seen some equalization. Financial aid budgets have also grown; by 2020, over 30% of college students reportedly received some form of aid, indicating improved support for those in need (Ministry of Education, 2022). These measures help remove economic hurdles and improve conditions at less-funded schools, both of which contribute to equity.

5.4. Monitoring Outcomes and Adjusting Policies

Chinese have been closely monitoring outcomes of massification – from employment statistics to regional enrollment data – and adjusting policies accordingly. For example, when graduate employment became a prominent issue, the Ministry of Education capped enrollment in certain majors deemed oversaturated and encouraged expansion in emerging fields where labor demand is high (Mok & Jiang, 2017). Some universities in recent years have reduced intake for majors like business administration or law, while increasing quota for engineering or vocational programs, to better align with market needs. This responsive planning is aimed at avoiding severe oversupply in the graduate job market. Likewise, when data showed continuing low enrollment from central/western regions in top universities, the central government nudged top institutions to further raise their allocated seats for those regions and initiated outreach and preparatory programs for rural students (Liu, 2018). Several elite universities now have partnerships with specific poor counties to identify and train promising students (for instance, summer bridge courses before college entry), helping them adapt and succeed in the elite academic environment.

Moreover, the concept of "education poverty alleviation" has gained traction. It involves using higher education as a tool to break intergenerational poverty. Universities have sent faculty to assist high schools in impoverished areas, offered distance education opportunities, and created special scholarship programs for students from poor families (Liu, 2018). These targeted efforts, though small in scale, reflect a policy ethos that massification should translate into upliftment of disadvantaged communities, not just produce more graduates in aggregate.

5.5. Remaining Gaps and Future Directions

Despite these initiatives, significant gaps remain. Urban students, especially from affluent families, continue to have disproportionate advantages in accessing top-quality higher education and, subsequently, top jobs. The Gaokao system, though meritocratic in form, still reflects underlying inequalities in basic education quality – a fundamental issue that higher education policies alone cannot fix (Hannum & Wang, 2006). The government has acknowledged that true equity in higher education is linked to reforms in earlier educational stages (e.g. improving rural

schools), as well as broader social policies to reduce the urban–rural divide. In recent policy documents (e.g., China's Education Modernization 2035 plan), there is an emphasis on "balanced development" and ensuring that every province has at least a few high-level universities (to curb talent drain and uneven development).

Quality assurance also remains an ongoing effort. There is discussion of implementing learning outcome assessments (similar to the OECD's AHELO pilot) to directly measure what students are learning across different institutions. If such assessments were adopted, they could highlight gaps and press universities to improve teaching. The Ministry of Education's new round of "Double First-Class" evaluations will also consider undergraduate teaching quality, not just research, to ensure that even research-focused universities pay attention to educating the influx of undergraduates effectively (Postiglione, 2020).

Finally, China is exploring international cooperation and benchmarking as part of managing massification. By learning from systems in other countries that have gone through massification (the United States, mass European systems, other Asian countries like Korea), Chinese policymakers seek insights into tackling issues like graduate employment and institutional equity. For instance, the concept of community colleges or short-cycle higher education drawing from the US model has been considered in tweaking the vocational track. The country's participation in global assessments and university rankings also puts pressure on maintaining quality while expanding access.

In summary, China's policy response to the challenges of massification has been multi-faceted: affirmative programs to broaden who benefits, funding and curricular reforms to bolster quality, and a continuous fine-tuning of expansion to socio-economic needs. While it is too early to declare all issues resolved, these strategies have shown some effectiveness. For example, by the late 2010s, the urban–rural gap in enrollment *rates* did start to narrow slightly (as rural GER caught up) and the employment situation for graduates stabilized with the economy's shift to services and innovation (Chi & Zhu, 2022). However, inequities in *where* students enroll and what outcomes they achieve persist, indicating that policy efforts must persist as well.

6. Conclusion

China's experience with higher education massification offers a rich case study of the opportunities and challenges inherent in expanding educational access on a grand scale. On one hand, the post-1999 enrollment boom has been an unqualified success in quantitative terms: tens of millions of additional students have attended college, transforming China from a country of elite higher education into one approaching universal participation. This expansion has produced a more educated workforce and opened doors for many who would previously have been denied tertiary education. The very aspiration of higher education has become normalized for the majority of Chinese families, reflecting a profound cultural shift.

On the other hand, the Chinese case underscores that *expansion alone does not guarantee equity*. Pre-existing inequalities – between urban and rural areas, coastal and inland regions, rich and poor families – have continued to manifest in the higher education arena, albeit in modified

ways. The *mass* system that emerged is markedly stratified: a hierarchy where elite institutions (mostly benefiting the already advantaged) coexist with a mass of second- and third-tier colleges enrolling the bulk of students (often from less-privileged backgrounds). This stratification means that while access has widened, outcomes (such as quality of education, graduation prospects, and employment opportunities) remain unequal. As noted by Marginson (2016), high-participation systems tend to reproduce social stratification unless strong corrective measures are in place.

China has shown awareness of these issues and has taken steps to manage the consequences of massification. Policies such as rural student admission programs, increased financial aid, and institutional support for less-developed regions represent efforts to steer the system toward greater inclusion. At the same time, initiatives to improve teaching quality and align education with market demands aim to maintain the credibility and utility of a Chinese college degree. The balancing act between *quantity* and *quality* is ongoing. Notably, the Chinese case reveals a deliberate strategy to couple expansion with excellence initiatives (massification *and* world-class university building). This dual approach has yielded world-renowned universities and a globally competitive research output, but it also risked widening internal gaps. The policy challenge ahead is to reconcile these twin goals by spreading excellence more evenly – for example, by creating "world-class disciplines" at a wider range of institutions and strengthening vocational and regional universities.

From a theoretical perspective, China's massification highlights the continuing relevance of Martin Trow's stages of higher education (elite–mass–universal) in the 21st century, while also suggesting refinements. Trow emphasized that as systems grow, they must undergo structural and value changes, including how they define merit and handle diversity of student preparation. We see this in China as the Gaokao-centric meritocracy is being supplemented with more holistic or targeted criteria to ensure diverse representation (e.g., rural background considered in special admissions). The values of the system are gradually shifting from "exclusion" to "inclusion," although societal attitudes can lag, still placing outsized prestige on elite institutions. Managing public expectations – that not every college graduate will have an elite outcome – is part of the social adjustment to massification.

In conclusion, China's journey from elitism to massification in higher education is a remarkable story of transformation, one that is still unfolding. It demonstrates the power of public policy to rapidly increase human capital and educational participation. However, it also serves as a caution that expanding access, while celebrated, must be accompanied by vigilant attention to quality and fairness. Other countries seeking to massify their higher education can learn from China's successes (strong government commitment, resource mobilization, diversified provision) and its struggles (inequities and quality issues). The Chinese case reinforces that *"massifying" education is not simply an administrative scaling-up; it is a social project* that requires rethinking resource allocation, pedagogy, and the purpose of higher education in society. As China moves deeper into the universal stage, the challenge will be to provide inclusive excellence – to not only educate the masses, but to do so in a way that each student, regardless of background, can achieve their potential and contribute meaningfully to society. Achieving that ideal remains the next horizon for managing massification in Chinese higher education.

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Virtual Reality in Sustainable Development Education: Insights from Finnish Classrooms

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Abstract

This paper investigates the integration of virtual reality (VR) in teaching sustainable development within various educational contexts in Finland. VR offers immersive, experiential learning opportunities that enhance students' understanding of complex concepts, fostering both cognitive and affective learning. Key challenges include field-specific adoption, second-language learner support, and logistical constraints. A case study on ThingLink's VR tool highlights its strengths and limitations in fostering systemic thinking. The paper concludes with recommendations for improving VR pedagogy and enhancing its impact on interdisciplinary education.

Keywords: Virtual Reality; Virtual Pedagogy; Sustainable Development Education; Experiential Learning; Systemic Thinking; Interdisciplinary Education; Digital Pedagogy

1. Introduction

Integrating virtual reality (VR) into educational practices has emerged as a powerful tool for enhancing learning outcomes, particularly in complex interdisciplinary subjects like sustainable development. VR allows students to engage in immersive, multi-sensory learning environments that offer unparalleled opportunities to interact with foreign environments, historical events, and natural phenomena in real-time. As educational systems globally seek innovative methods to improve student engagement and comprehension, the Finnish model of VR in vocational education presents a compelling case for further examination and adaptation in diverse international contexts (Finnish Museum Association, 2024; Lee et al., 2020).

This paper examines the pedagogical potential of VR in sustainable development education, focusing on Finland's vocational education system as a case study. Finland has implemented VR to simulate environments and experiences that would be difficult or impossible to access in

traditional classroom settings. This technology enables learners to experience real-world applications of sustainable development principles, fostering deeper understanding through interaction and experiential learning (Johnson et al., 2021; Xie & Li, 2023). Previous research has highlighted VR's ability to increase students' motivation and concentration, as it transforms abstract concepts into engaging and tangible experiences (Mills et al., 2019).

The article not only explores the application of VR in the Finnish context but also aims to provide a broader framework for integrating such technologies into global educational practices. By examining the results of empirical studies and pilot programs conducted in Finland, this research provides insights into the effectiveness of VR in fostering cognitive and affective learning in sustainability education (Johnson et al., 2021). The paper also discusses the challenges and limitations encountered during the deployment of VR in education, contributing to the ongoing discourse on the role of digital technologies in shaping the future of teaching and learning.

Ultimately, this paper aims to inspire educational practitioners and policymakers worldwide to consider the potential of VR as an innovative pedagogical tool. As sustainability becomes an increasingly urgent global concern, the need for effective teaching strategies that can translate theoretical concepts into practical understanding is paramount.

2. Key Concepts and Theoretical Framework

2.1. Virtual Reality

The concept of virtual reality (VR), while seemingly contemporary, dates back to 1987 when it was coined by Jaron Lanier. Lanier, a pioneering figure in the field, conducted extensive research and developed numerous products that laid the foundation for VR technology (Lowood, 2024). His research company was instrumental in advancing 3D graphics and immersive interaction, contributing to the development of some of the earliest commercially available VR devices, such as VR headsets and data gloves (Berkman, 2024).

A key factor driving the early progress of VR research and technological development in the United States was the significant role played by government agencies such as the Department of Defense's National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA). These agencies funded numerous projects carried out by university-affiliated research laboratories, which led to the formation of a robust talent pool specializing in fields such as computer graphics, simulation, and virtual environments. This collaboration between academic, military, and commercial sectors not only propelled VR innovation but also fostered a network that continues to influence the development of immersive technologies (Lowood, 2024).

2.2. Virtual Pedagogy

Integrating virtual reality (VR) into educational practices is often examined in the context of pedagogical theories, particularly those related to situated learning and knowledge transfer. One persistent critique of traditional teaching methods is the difficulty students face in applying what

they learn in the classroom to real-life situations. Research has demonstrated that even high-performing students frequently struggle to transfer classroom knowledge into practical, real-world applications (Dede, 2019). Although classroom settings are rarely authentic, teachers can leverage simulations and VR to create more realistic learning experiences, thereby improving the transferability of skills and knowledge (Hemminki-Reijonen, 2021).

VR offers learners the ability to engage with tasks in a realistic, hands-on manner, providing a space to practice skills that require physical interaction and motor coordination. The immersive nature of VR allows students to engage multiple senses and utilize muscle memory through the use of motion detection devices and interactive controls, which in turn helps to reduce cognitive load (Hemminki-Reijonen, 2021). This immersive environment not only aids in skill acquisition but also helps bridge the gap between theoretical knowledge and practical application.

Constructivist learning theory is closely aligned with VR-based simulations (Aiello, D'Elia, Di Tore, & Sibilio, 2012; Hemminki-Reijonen, 2021). In many ways, constructivism shares principles with situated learning, as it emphasizes that students construct knowledge based on their own experiences within a structured environment (Dede, 2017). According to constructivist theory, learners build knowledge through personal experiences, which are shaped by their developmental level, socio-cultural context, and prior knowledge (Dede, 2019). The OECD Future of Education and Skills Report (2018) highlights the importance of creating interdisciplinary connections between various subjects, and VR provides an innovative tool to facilitate these links by allowing students to engage with complex, multi-dimensional problems (Hemminki-Reijonen, 2021).

When incorporating VR technology into sustainability education, it is crucial to recognize that addressing the complexities of sustainability challenges requires a new kind of expertise. While constructivist thinking remains crucial, it must be complemented by transformative learning—an approach that encourages individuals to critically evaluate and change deeply ingrained assumptions. Transformative learning involves not only intellectual reflection but also the capacity to empathize with others, even those who hold opposing viewpoints (Silvonen et al., 2022). VR technology is particularly well-suited to support transformative learning by enabling learners to navigate diverse environments and engage with dynamic scenarios. In these immersive virtual environments, the consequences of learners' choices are made explicit, enhancing both the transformative and experiential dimensions of the learning process.

3. Applications of Virtual Reality in Education

Virtual reality is a fully immersive space accessed through devices such as goggles, helmets, or glasses, which allows users to experience and interact with a simulated environment that is distinct from the physical world. For example, smartphone applications can utilize augmented reality (AR) by adding virtual elements to the real-world environment using the device's camera. In contrast, mixed reality (MR) blends both real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist. Collectively, these three

technologies—VR, AR, and MR—are often referred to under the broader term extended reality (XR) (Wang & Li, 2024).

3.1. Learning Through Immersive Environments

One of the key benefits of VR in education is its ability to create immersive learning environments. Immersive learning refers to learning experiences that fully engage students' senses, helping them concentrate on the subject matter by eliminating common distractions, such as notifications from smartphones or social media (Fraser, 2012). In these environments, VR serves as a user interface that immerses learners in real-time simulated experiences, allowing them to explore and interact with virtual settings through multiple senses (Vesisenaho et al., 2019). Research shows that immersive learning can lead to better engagement and understanding, especially in complex subjects such as sustainable development.

On top of enhancing engagement and experience, multisensory learning environments offered by VR improve the educational process by engaging various senses—sight, sound, and touch—simultaneously. This multi-modal approach enriches the learning experience and helps students better retain information. For example, studies suggest that students learning Finnish as a second language through VR-based sustainable development courses perform significantly better than those in traditional face-to-face settings (Hemminki-Reijonen, 2021). The ability to simulate real-world scenarios in a controlled virtual environment not only enhances learning outcomes but also enables the practice of behaviors and skills in a safe, adaptable space (Bailenson, 2018).

VR also offers unique opportunities for collaborative learning and feedback. Special tracking devices monitor users' movements in real-time, allowing instructors to observe and mirror their actions on tablets or computers (Hemminki-Reijonen, 2021). This ability to receive immediate feedback while interacting with other students enhances the collaborative nature of learning. In this way, VR facilitates both individual and group learning, making it a versatile tool for modern education.

3.2. Learning through experiments

Moreover, VR fosters experiential learning, a concept that emphasizes learning through direct experience. Virtual environments allow students to actively participate in tasks that would be difficult to organize in real life. For instance, learners can manipulate objects that would otherwise be impossible to handle, such as large machinery or delicate ecosystems like rainforests, expanding the boundaries of the traditional classroom (Dede, 2017). This aligns with the theory of experiential learning, where the direct involvement in learning tasks fosters deeper understanding and retention (Kolb, 1984).

Thus, as educational spaces increasingly incorporate digital technologies, VR has proven to be a valuable pedagogical tool, opening new possibilities for learning experiences that are both immersive and practical. As sustainable development education and other interdisciplinary subjects grow in importance, VR can play a significant role in fostering not only cognitive but also affective learning, driving behavioral change that transcends the classroom.

3.3. VR Learning in Finnish High Schools

The table illustrates the varied applications of Virtual Reality (VR) across Finnish high schools, demonstrating its versatility in enhancing educational experiences across diverse subject areas. From science and technology to language learning, art, and ethics, VR is used to immerse students in complex environments and interactive scenarios that are otherwise difficult to replicate in traditional classrooms. Notably, VR in special education and sustainability studies highlights its role in fostering inclusivity and promoting critical global awareness. These examples showcase how Finnish schools are leveraging VR not only to improve subject-specific comprehension but also to enhance systemic thinking, problem-solving, and ethical reasoning skills, preparing students for both local and global challenges.

Table 1. Virtual classroom setup in a finnish high school using VR for interactive learning

High School	Specific Use of VR	Subject Area
Etelä-Tapiola High School	VR for science education, including biology and geography.	Science
Helsingin normaalilyseo	VR for language immersion and history lessons.	Language, History
Oulun Lyseon Lukio	VR in sustainability education and environmental science.	Environmental Science
Tampereen teknillinen lukio	VR for technology and engineering education.	Technology Engineering
Kerttuli Upper Secondary School	VR in art and design education.	Art and Design
Sammon keskuslukio	VR for special education and inclusive learning environments.	Special Education
Espoo International School	VR for global studies and intercultural education.	Global Studies
Turun normaalikoulu	VR for science, particularly physics and chemistry.	Physics, Chemistry
Jyväskylän Lyseon Lukio	VR for creative writing and storytelling.	Creative Writing
Helsingin Suomalainen Yhteiskoulu (SYK)	VR in ethics and philosophy lessons.	Ethics, Philosophy

3.3. Virtual Reality to Support the Learning of Neurodivergent Students

Neuropsychiatric symptoms (often referred to as nepsy symptoms) arise from malfunctions in the brain's neural networks, which can significantly hinder everyday functioning. These symptoms are common, affecting approximately 15 percent of the Finnish population, with

prevalence rates continuing to rise (ADHD: Käypä hoito -suositus, 2019). While these symptoms are most commonly observed in children and adolescents, a growing number of adults are also being diagnosed with neuropsychiatric disorders (Neuropsychiatric Disorders, 2021).

Individuals on the neurodivergent spectrum, particularly those with conditions such as ADHD and autism spectrum disorder, often struggle with adapting to sudden changes, managing disappointment, and processing sensory experiences. Daily routines that involve social interaction and other stimuli can be overwhelming. Sudden, unexpected changes may exacerbate these challenges, making predictable and structured routines essential for the smooth functioning of daily life. Various interventions have been employed to support individuals with neuropsychiatric symptoms, one of which is the use of virtual reality (VR).

VR has shown promising results in both the rehabilitation and educational settings for neurodivergent individuals. It provides a controlled environment where sensory stimuli can be managed, allowing users to focus on specific tasks without being overwhelmed by extraneous distractions. By directing attention to one task or scenario at a time, VR helps mitigate the inattentiveness often experienced by neurodivergent individuals, which may manifest as difficulty following instructions, making repeated mistakes, or struggling to organize activities. The immersive nature of VR enables individuals to concentrate on learning in an environment tailored to their sensory and cognitive needs, reducing the cognitive overload caused by excessive sensory input (Digi as a Resource for Families Project, 2023).

3.4. Virtual Reality in Sustainable Development Education

Digitalization provides a wide array of tools and opportunities to enhance the teaching of sustainable development at the secondary level. These digital tools can significantly promote students' environmental awareness and prepare them to actively participate in promoting sustainable development. One particularly promising tool in this regard is virtual reality (VR), which enables immersive and interactive learning experiences that can make complex and abstract concepts more tangible.

The primary goal of sustainable development education is to foster students' critical thinking skills, enabling them to assess both current and future development paths. This critical evaluation includes analyzing the potential impacts of various alternatives on the environment, society, and economy. In this context, teaching should go beyond theoretical knowledge and help students develop practical skills that they can apply in real-world scenarios. These skills include resource conservation, ecological design, sustainable eating, and responsible consumption practices, all of which are vital to fostering a sustainable future. In addition, ethical reflection is a key component of sustainable development education. Students should be encouraged to critically reflect on their own values and ethical principles, especially concerning the environment and societal well-being.

In the context of sustainable development education, VR can simulate complex environmental, economic, and social systems, enabling students to experiment with decision-making processes and observe the outcomes of their actions. These hands-on, immersive simulations allow learners to better understand the systemic relationships between human actions and environmental outcomes.

(1) Virtual Reality in Promoting Systematic Thinking

One of the greatest challenges in teaching sustainable development is cultivating students' systemic thinking—the ability to understand the interrelatedness of various factors and their mutual effects. Systemic thinking is a holistic and comprehensive way of viewing problems and phenomena, emphasizing that each component of a system affects the others. For example, when addressing sustainable development, students need to consider the complex interactions between environmental sustainability, social justice, and economic viability (Arnold & Wade, 2015; Siivonen et al., 2022). Understanding these intricate relationships is not always intuitive for students, especially when long-term effects and abstract concepts are involved. These challenges are compounded when attempting to illustrate the global nature of sustainability issues, making it difficult for educators to convey the complexity of global interactions and the far-reaching consequences of local actions.

(2) Virtual Reality in Building Eco-social Civilization

Looking beyond, systematic thinking is also one of the most essential competencies for fostering a sustainable future and building an eco-social civilization (Salonen & Bardy, 2015; Siivonen et al., 2022). Eco-social civilization refers to a societal structure that recognizes the limitations of natural resources and operates sustainably, prioritizing both the well-being of the planet and its inhabitants. It integrates the values of freedom and responsibility in balancing human needs with environmental stewardship. Promoting such a mindset among students is crucial, as it prepares them to navigate and address the multifaceted challenges of sustainability.

Given the complexity of sustainable development, it is essential to create a motivating and inclusive learning environment that supports the development of systemic thinking. Teaching strategies must encourage students to explore sustainability challenges from a holistic perspective and to propose solutions that take into account the interconnectedness of various factors. This is where virtual reality becomes a particularly powerful tool.

Virtual reality has proven to be highly effective when teaching complex phenomena, especially those that involve intricate cause-and-effect relationships. In a VR environment, students can navigate through time—both forward and backward—enabling them to see how decisions in the present affect outcomes in the future. This dynamic interaction helps make the often abstract and long-term consequences of sustainable development more concrete and comprehensible. Moreover, VR allows students to observe the smallest details of a system that might otherwise go unnoticed, thereby transforming passive knowledge into active understanding (Aaltonen et al., 2021). By immersing students in these interactive experiences, VR fosters a deeper grasp of systemic thinking, making it an invaluable tool for teaching the principles of sustainable development.

As such, virtual reality is exceptionally well-suited for illustrating the complex relationships inherent in sustainable development. It helps bridge the gap between theoretical knowledge and practical application, allowing students to experience first-hand the systemic nature of sustainability issues. This, in turn, equips them with the skills and insights needed to navigate the complexities of sustainable development in the real world.

4. Case Study: Challenges and Limitations in Utilizing ThingLink's Scenario Tool in Finland

ThingLink is a widely used digital tool that allows educators to create interactive learning experiences through virtual tours and 360-degree environments. In Finland, ThingLink has been adopted by several educational institutions to enhance vocational education, providing students with immersive, real-world learning scenarios. The ThingLink VR scenario tool enables educators to design engaging, interactive content where students can explore different environments, interact with objects, and complete exercises, all within a virtual setting (ThingLink, 2023). This tool has been especially useful in sectors like vocational training, where hands-on experience is essential but sometimes difficult to simulate in a traditional classroom setting.

As part of a larger effort to explore the potential of virtual reality (VR) in education, Finnish vocational schools integrated ThingLink into their curriculum. In particular, schools such as Omnia Education Partnerships, in collaboration with ThingLink, implemented the VR tool to simulate real-world environments for students in fields like real estate, cleaning services, and healthcare (ThingLink, 2023). The goal of the project was to assess how ThingLink's VR scenario tool could enhance students' learning experiences by providing immersive, practical simulations. However, the case study revealed several challenges and limitations in its adoption.

4.1. Field-Specific Challenges in Adopting VR Tools

One of the primary challenges in utilizing ThingLink's scenario tool was the variation in adoption across different professional fields. Students in fields like cleaning and real estate services adapted more quickly to using VR glasses, as the tool provided realistic simulations of everyday tasks, such as inspecting property or managing cleaning services. However, students in the social and health sectors faced greater difficulties in using the technology. For these students, whose professions require more interpersonal and hands-on care, the virtual simulations felt less applicable to their real-world tasks (Aaltonen et al., 2021). This disparity highlighted the need for customized VR applications that are better aligned with the specific needs of different vocational fields.

4.2. Challenges for Second Language Learners

Another significant limitation arose in the case of second language (S2) learners, who encountered difficulties navigating the exercises due to language barriers. While S2 students demonstrated a general willingness to engage with the VR technology, the exercises themselves were not fully tailored to accommodate their language needs. The instructions and content within ThingLink's scenarios were not adapted for learners whose first language was not Finnish. Consequently, these students struggled to complete the exercises independently, relying heavily on group support or additional assistance from instructors (Digi as a Resource for Families Project, 2023). This emphasizes the importance of developing language-specific content or offering multilingual support within VR tools to ensure inclusivity for diverse student populations.

4.3. Familiarity with VR Technology

A common challenge across all student groups was the lack of familiarity with VR equipment. Although many students were enthusiastic about the prospect of using VR in their learning, a considerable number struggled to effectively use the ThingLink scenario tool due to limited prior exposure to VR technology. Students who had never interacted with VR before found it difficult to navigate the virtual environments, which negatively impacted their learning outcomes. Moreover, the amount of time allocated for familiarizing students with the VR equipment was insufficient, limiting their ability to fully engage with the exercises. For future implementations, it is essential to provide students with more time and guidance to adapt to VR technology, ensuring that they can focus on the content rather than the mechanics of using the tool (Aaltonen et al., 2021).

5. Discussions and Conclusions

The integration of virtual reality (VR) into teaching and learning environments shows great promise, particularly as digitization continues to advance. VR presents unique opportunities for enhancing pedagogical practices, offering immersive and interactive experiences that engage students in ways that traditional learning environments cannot. However, it is important to emphasize that the successful implementation of VR in education relies on careful attention to the pedagogical framework and the continuous development of VR-specific devices and programs. Ensuring that educators receive adequate training and acquire experience with VR technology is critical to achieving versatile and effective use in different educational contexts.

One of the key findings in this study is that the opportunities for using VR in teaching can vary significantly depending on the specific goals and contexts in which it is implemented. Although the application of VR in education holds considerable potential, several challenges persist. These include the cost and availability of equipment and software, as well as the logistical hurdles associated with introducing new technologies into classrooms. Despite these challenges, it is essential for teachers to have opportunities to experiment with different VR tools and exercises across diverse student groups. This enables educators to evaluate various methods and devices, helping them to identify the most effective ways to integrate VR into their own teaching practices.

The benefits of VR, particularly in relation to improving concentration, are notable. In the testing of ThingLink's VR tool for teaching sustainable development, the findings corroborated those of previous studies, which have shown that VR can enhance students' ability to focus on tasks by reducing distractions and creating more immersive learning environments. This demonstrates the potential of VR to support students with attentional difficulties or cognitive overload by providing structured, controlled environments that focus attention on specific learning objectives.

Looking forward, the future development of digital competence and virtual reality pedagogy will be crucial to maximizing the potential of VR in education. Special attention should be given to fostering systemic thinking among students, enabling them to better conceptualize abstract concepts and engage with complex, psychologically challenging issues more experientially. VR's

immersive and visually rich environments not only boost motivation toward the subject matter but also offer unique advantages in helping students concentrate on performing the exercises. This makes VR an invaluable tool for addressing both cognitive and attentional challenges in diverse learning contexts.

6. Limitations

This study, while offering important insights into the use of virtual reality (VR) for teaching sustainable development, has several limitations. One key limitation is the absence of direct, in-person observations. The research relied on secondary data and external reports, which may not fully capture the nuances of the classroom dynamics and the day-to-day practical challenges encountered by educators and students when using VR tools in real-world settings.

Another limitation is the context-specific nature of the study. The research focuses primarily on vocational education in Finland, where the use of digital tools like VR is relatively advanced. As such, the findings may not be fully generalizable to other educational systems, particularly in countries with less-developed technological infrastructures or different pedagogical priorities. The unique characteristics of the Finnish education system, such as its emphasis on student-centered learning, may also have influenced the results in ways that are not easily transferable to other settings.

Lastly, this study does not explore in depth the financial and logistical constraints that often accompany the adoption of new technologies like VR. Issues such as the high cost of VR equipment, the need for ongoing technical support, and the availability of appropriate content and training for educators are critical factors that could limit the widespread integration of VR in education. While this research acknowledges these barriers, a more detailed analysis of these challenges is needed to provide a complete understanding of VR's potential limitations in educational environments.

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The Role of Intelligent Security Prevention Technology in Crime Prevention — A Crime Deterrence Based on Technological Means

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Abstract

With the rapid development of technology, smart security technology is playing an increasingly important role in the field of crime prevention. This article explores the deterrent effect of technological means on crime, and delves into the application and effectiveness of smart security technology in crime prevention. By analyzing various smart security technologies such as intelligent monitoring, biometric recognition, big data analysis, etc., this article elaborates on how they can achieve early warning, accurate identification, and effective prevention and control of criminal behavior. Based on practical cases in Chinese society, demonstrate the significant effects of smart security technology in reducing crime rates and enhancing public safety. At the same time, exploring the challenges and future development trends faced by current smart security technology provides theoretical support and practical reference for further improving the level of social security prevention and control.

Keywords: Smart Security Technology; Crime Prevention; Crime Deterrence; Public Security

1. Introduction

Crime has always been an important factor affecting social stability and development. Traditional security measures are gradually showing their limitations in dealing with increasingly complex and changing criminal situations. Liu et al (2018) pointed out that in the face of the increasingly complex application of artificial intelligence technology in criminal activities and the social public safety situation, traditional crime prevention strategies, means, and technologies are no longer able to meet the requirements of reality. With the rapid development of high-tech such as information technology, artificial intelligence, and the Internet of Things, smart security technology has emerged and shown great potential in the field of crime prevention. Smart security technology integrates multiple advanced technologies to achieve real-time perception, intelligent analysis, and rapid response to security situations. It can form a strong deterrent against potential criminal behavior, effectively reduce the possibility of crime, and provide strong support for the

upgrading of the social security prevention and control system. Thoroughly studying the role of smart security technology in crime prevention is of great practical significance for enhancing social governance capabilities and ensuring the safety of people's lives and property.

2. Overview of Smart Security Technology

2.1. Intelligent Monitoring Technology

Intelligent monitoring technology is a core component of smart security. As a basic device, high-definition cameras have high-resolution imaging capabilities and can clearly capture details of people and objects in the monitoring area. Some cameras have a resolution of up to 4K or even 8K, providing high-quality images under different lighting conditions regardless of day or night, laying the foundation for subsequent intelligent analysis and event tracing. At the same time, the camera has multiple shooting modes, such as panoramic, close-up, and pan tilt rotation, which can flexibly adjust the shooting range and angle according to monitoring needs.

Video intelligent analysis utilizes deep learning algorithms to perform real-time analysis on video images captured by cameras. It can recognize personnel behavior, such as whether they are running, falling, wandering, or abnormally gathering. For example, in public places, when the system detects a sudden gathering of people and abnormal behavior, it will immediately issue a warning, prompting security personnel to go and check, effectively preventing possible conflicts or stampedes. In addition, video intelligent analysis can also perform vehicle recognition, identify license plate numbers, vehicle brands, colors, and other information, and provide timely warnings for situations such as illegal parking and vehicles entering prohibited areas.

2.2. Biometric Recognition Technology

Biometric recognition technology mainly includes fingerprint recognition, facial recognition, iris recognition, etc. Fingerprint recognition technology confirms identity by collecting and comparing fingerprint feature points, which has uniqueness and stability, and is widely used in fields such as access control systems and attendance management. Facial recognition technology has developed rapidly in recent years, and it performs identity recognition by analyzing facial feature information. In the field of security, facial recognition can be used for personnel access control. For example, in transportation hubs such as airports and train stations, facial recognition systems can quickly verify passenger identities, improve traffic efficiency, and effectively identify wanted criminals, suspicious individuals, etc. Iris recognition utilizes the unique texture of the human iris for identity recognition, with extremely high accuracy. It is commonly used in places that require high security, such as financial institutions' vault access control.

2.3. Big Data Analysis Technology

Big data analysis technology plays a crucial role in smart security. It can integrate multi-source data from intelligent monitoring devices, sensors, police systems, etc., and conduct deep mining and analysis. By establishing a data model, the system can comprehensively determine whether a security incident has occurred based on feedback from different devices and automatically make corresponding decisions. For example, when the intrusion detection sensor triggers an alarm and

the camera captures suspicious personnel activity images, the big data analysis system can quickly link nearby lighting devices to turn on, deter criminals, and send detailed alarm information to the mobile terminals of security personnel, including the location of the incident, on-site images, etc., so that security personnel can respond quickly. In addition, big data analysis can also predict crime trends by analyzing historical crime data, personnel flow data, socio-economic data, etc., to identify patterns and potential risk areas of criminal activities, providing a basis for the police to deploy police forces in advance and formulate prevention and control strategies.

2.4. Internet of Things Technology

The Internet of Things technology connects various security devices into a massive network, achieving interconnectivity and information sharing between devices. In smart security systems, devices such as smart sensors, cameras, and access control systems collaborate with each other through technology. For example, intrusion detection sensors use infrared, microwave and other technologies to detect whether there are abnormal objects entering the monitoring area. Once an alarm is triggered, the signal will be immediately transmitted to relevant devices through the Internet of Things. For example, the camera will automatically adjust the shooting angle to align with the alarm area for real-time monitoring, while notifying security personnel. Smoke sensors, temperature sensors, and other sensors can monitor fire hazards in real time. Once an abnormal increase in smoke concentration or temperature is detected, a fire warning can be quickly issued, and through the Internet of Things, firefighting equipment can be linked to activate the fire extinguishing program, buying time for timely firefighting and personnel evacuation. The Internet of Things technology has transformed the security system from a traditional isolated device operation mode to an intelligent and collaborative whole, greatly improving the efficiency of the security system.

3. The Mechanism of Smart Security Technology in Crime Prevention

3.1. Early Warning of Criminal Behavior

Smart security technology can monitor various abnormal situations in the environment in real time through intelligent sensors, video intelligent analysis and other means, achieving early warning of criminal behavior. For example, intrusion detection sensors installed in communities, commercial venues, and other areas can monitor illegal intrusion behavior in real time. When someone tries to climb over the fence or pry open the lock to enter the building, the sensor will immediately capture abnormal signals and send alarm information to security personnel or relevant police platforms. The video intelligent analysis system can identify abnormal behavior of personnel, such as when someone is wandering or sneaking around for a long time on an unmanned street at night, the system can automatically determine their abnormal behavior and issue a warning. Big data analysis technology predicts the likelihood of crime occurrence by mining and analyzing massive amounts of data. For example, by analyzing recent changes in personnel flow, frequency of security incidents, social media public opinion, and other data in a

certain area, if abnormal fluctuations are detected, possible criminal events can be alerted in advance, enabling the police to take timely preventive measures.

3.2. Accurate Identification of Criminal Subjects

The combination of biometric technology and intelligent monitoring technology can achieve precise identification of criminal subjects. The widespread application of facial recognition technology in public places enables the police to compare personnel in surveillance footage with information in crime databases in real time. When the wanted criminals and key personnel with criminal record enter the monitoring area, the system can quickly identify and send an alarm to help the police grasp the whereabouts of the suspect in time. Fingerprint recognition, iris recognition and other technologies are used in specific places such as bank vaults and important document storage locations for personnel identity verification, ensuring that only authorized personnel can enter and effectively preventing internal personnel from committing crimes or external personnel from impersonating and entering to commit crimes. The license plate recognition technology in the intelligent monitoring system can accurately identify vehicles, detect and track fake license plates, vehicles involved in cases, etc. in a timely manner, and provide strong support for cracking down on vehicle related crimes.

3.3. Effective Prevention and Control of Criminal Space

Smart security technology achieves effective prevention and control of criminal spaces by building a comprehensive and multi-level security network. At the urban level, by installing a large number of intelligent monitoring devices in key areas such as major roads, transportation hubs, and public places, a tight monitoring network is formed to monitor urban space in real-time, supported by big data analysis and artificial intelligence technologies. Any illegal or criminal behavior is difficult to hide under this network, as suspicious activities can be rapidly identified and traced. At the community level, the construction of smart security communities will connect devices such as smart door locks, real name access control, and video security with the ‘smart security’ platform to form an integrated management system. Residents enter the community through facial recognition, fingerprint recognition, and other methods, while outsiders need to register with their real names and purposes of visit. The system records and analyzes the entry and exit of personnel in real time. Once abnormal situations are detected, such as frequent entry and exit of strangers or prolonged wandering in the community, the system can automatically report to the property management and police, enabling timely intervention. At the same time, the intelligent surveillance cameras in the community monitor the public areas 24 hours a day, effectively preventing criminal activities such as theft and robbery from occurring in the community and enhancing residents’ sense of security. In commercial places, intelligent security systems monitor key areas such as entrances and exits, product display areas, and cash registers to prevent theft, fraud, and other criminal activities. In addition, through technology, security devices in different places are connected to achieve joint prevention and control between regions, supporting coordinated law enforcement responses and further expanding the spatial scope and effectiveness of crime prevention and control.

4. Case Study on the Application of Smart Security Technology in Crime Prevention

4.1. Urban Smart Security System Reduces Crime Rate

The Guangzhou Public Security Bureau has established four precise policing networks, including intelligent perception, dynamic deployment, element control, and emergency response. By installing a multi-dimensional intelligent front-end perception system, covering key areas of the city and complex public security places, advanced analysis technology is used to monitor and evaluate potential risks in real time, achieving rapid response to abnormal behavior. The intelligent perception network utilizes big data and artificial intelligence technology to analyze massive amounts of data, predict and identify crime patterns, and take preventive measures in advance. Dynamically deploying defense networks to develop customized security strategies based on different regions and security needs. These measures have significantly improved the social security control capability of Guangzhou, and the construction of a safe Guangzhou is at the forefront of the province, effectively reducing crime rates and enhancing citizens' sense of security.

4.2. Smart Security Communities Reduce Community Crime

5098 "Zhi'an" residential areas will be built to high standards in Suzhou, Jiangsu Province. Intelligent devices such as AI recognition system, intelligent combustible gas alarm, and emergency rescue service "one click alarm" are applied in the community. The elevator AI recognition system can identify safety hazards 24 hours a day, and relevant information is synchronously transmitted to the property duty room and community police room. 537 smart security communities and buildings in Kunshan city have deepened the construction of the "Safe Micro Sculpture" project, creating a smart control mode of "self declaration+front-end perception+back-end comparison", and achieving "zero cases" since 2023. The construction of smart security communities effectively prevents the occurrence of security accidents such as theft and fires, and enhances the sense of security of community residents' lives.

4.3. Intelligent Security Monitoring Helps Prevent Theft in Commercial Places

A large shopping mall has installed an intelligent security monitoring system, deploying high-definition cameras and intelligent sensors in various entrances, exits, stores, corridors, and other areas of the mall. The video intelligent analysis system monitors customer behavior in real-time through advanced algorithms and data processing technologies. When it detects someone staying in the product display area for a long time and making abnormal movements, such as attempting to hide the product in clothing, the system automatically issues a warning and notifies security personnel to go and check immediately. The intrusion detection sensor is activated after the mall is closed to prevent criminals from prying open the door and breaking the lock to enter and steal from the mall. Since the installation of the intelligent security monitoring system, the incidence of theft cases in shopping malls has significantly decreased, improving overall operational efficiency, ensuring the safety of merchants' property, and providing customers with a safer shopping environment.

5. The Challenges Faced by Smart Security Technology in Crime Prevention

5.1. Technical Vulnerabilities and Misjudgments

Despite the continuous development of smart security technology, there are still technical loopholes. For example, intelligent monitoring systems may be affected by factors such as severe weather and changes in lighting, resulting in inaccurate image recognition. Facial recognition technology may result in recognition errors when facing situations such as facial occlusion and plastic surgery. Intelligent analysis algorithms are not perfect either, and may mistake normal behavior for abnormal behavior, leading to false positives. These technical vulnerabilities and misjudgments not only pose challenges to security work, but may also lead to a decrease in public trust in smart security systems.

5.2. Difficulties in Data Security and Privacy Protection

The smart security system will collect a large amount of personal data during operation, such as facial images, fingerprint information, vehicle driving trajectories, etc. The secure storage and use of these data face serious challenges. Once data is leaked, it will cause serious infringement on personal privacy and may even be used by criminals for fraud, theft, and other criminal activities. Meanwhile, how to collect, use, and protect personal data in a reasonable and standardized manner while ensuring security needs is an urgent issue that needs to be addressed in the field of smart security. The imperfection of relevant laws and regulations also leads to a lack of strong institutional guarantees for data security and privacy protection.

5.3. System Compatibility and Integration Difficulties

Smart security systems are typically composed of multiple devices and software from different brands and types, and there are compatibility issues between these devices and software. For example, smart sensors and monitoring systems produced by different manufacturers may not be seamlessly integrated, resulting in poor data transmission or inability to work together. In addition, integrating existing smart security systems with public security systems, urban management systems, etc. also faces many difficulties. Data sharing and business collaboration between systems are hindered, making it difficult to fully utilize the overall effectiveness of smart security systems.

5.4. High Construction and Maintenance Costs

The construction of a smart security system requires a significant investment of funds, including equipment procurement, installation and debugging, software development, network construction, and other related expenses. Moreover, with the continuous updating and upgrading of technology, the maintenance and upgrade costs of the system are also quite high. Lv and Zhang (2022)'s research shows that currently, the funding for public security research and innovation projects is mostly based on tens of thousands of yuan, which limits the development of projects. Even some underdeveloped areas' public security organs have been in a low investment state in scientific and technological innovation work due to a lack of funding support, seriously restricting the development of police technology and slowing down the process of police modernization.For some economically underdeveloped areas or small businesses, high construction and maintenance

costs may become obstacles to promoting the application of smart security technology, limiting its widespread adoption.

6. The Development Trend of Smart Security Technology in Crime Prevention

6.1. Deep Application of Artificial Intelligence Technology

In the future, artificial intelligence technology will be more deeply applied in the field of smart security. Zhao (2024) shows that using IoT technology, various devices can be closely interconnected to form an intelligent network, providing more comprehensive and accurate support for community policing work. Through continuous exploration and innovative technological applications, community policing intelligent assistance systems can maintain a leading position in grassroots social governance and better respond to the increasingly complex community safety situation. Translate Zhao's research shows that by utilizing IoT technology, various devices can be closely interconnected and form an intelligent network, providing more comprehensive and accurate support for community policing work. By continuously exploring and innovating technological applications, the community policing intelligent assistance system can maintain a leading position in grassroots social governance and better respond to the increasingly complex community security situation.

Intelligent analysis algorithms will continue to optimize and be able to more accurately identify abnormal behavior and criminal signs in various complex scenarios. For example, by learning from a large amount of crime case data, artificial intelligence systems can predict the probability of different types of crimes occurring in specific time periods and regions, providing more accurate warning information for the police. At the same time, artificial intelligence will also enable autonomous decision-making and collaborative work of security equipment. When a security incident occurs, the system can automatically allocate resources, such as intelligently scheduling nearby patrol police forces, activating relevant emergency equipment, etc., to improve the efficiency and accuracy of responding to crimes.

6.2. Multi Technology Integration and Collaborative Innovation

Smart security technology will develop towards the direction of multi technology integration. Intelligent monitoring technology, biometric technology, big data analysis technology, Internet of Things technology, etc. will be further deeply integrated to form a more complete and efficient security system. For example, by connecting smart monitoring devices with smart home devices through IoT technology, when the monitoring system detects abnormal situations in the home, it can automatically control the smart home devices to take corresponding measures, such as closing doors and windows, activating alarms, etc. At the same time, technologies from different fields will undergo collaborative innovation, such as applying blockchain technology to security data storage to ensure data security and immutability; Combining 5G communication technology with intelligent security devices to achieve real-time and fast transmission of high-definition videos, improving the timeliness and smoothness of monitoring.

6.3. Combination of Cloud Based and Edge Computing

The intelligent security system will gradually realize the combination of cloud based and edge computing. Cloud storage and computing can provide powerful data processing capabilities and storage space for smart security systems, enabling centralized management and analysis of data. At the same time, edge computing technology can preliminarily process and analyze data on the device side, reduce data transmission and improve system response speed. For example, after collecting video images, the intelligent camera uses edge computing technology to analyze the images in real time locally, and then uploads the key information to the cloud after identifying the abnormal behavior. The cloud carries out further in-depth analysis and decision-making. This combination of cloud based and edge computing can not only give full play to the powerful computing power of the cloud, but also meet the real-time requirements of the security system.

6.4. Standardization and Standardization Construction Strengthening

To address issues such as system compatibility and integration difficulties, standardization and normalization will be strengthened in the field of smart security in the future. The relevant departments will develop unified technical standards and interface specifications to ensure that different brands and types of security equipment and software can achieve interconnectivity and collaborative work. Zhu (2023) mentioned that early technical planning standards, mid-term technical testing and operation standards, and later technical support standards are all essential. At the same time, strict standards and procedures will be established for the data collection, storage, and use of smart security systems to ensure data security and privacy protection. In terms of construction and operation, corresponding standards and specifications will also be introduced to reduce construction and maintenance costs, and improve the construction quality and operation efficiency of smart security systems.

7. Conclusion

Smart security technology plays a crucial role in crime prevention with its advanced intelligent monitoring, biometric recognition, big data analysis, Internet of Things and other technological means. By achieving early warning of criminal behavior, precise identification of criminal subjects, and effective prevention and control of criminal space, smart security technology has formed a strong deterrent effect on potential criminal behavior, significantly reducing crime rates, improving social security prevention and control levels, and enhancing public safety. However, smart security technology also faces many challenges in the development and application process, such as technical vulnerabilities and misjudgments, data security and privacy protection, system compatibility and integration, and high construction and maintenance costs. Meng (2020) stated that the highly integrated and coordinated functional modules achieve the "intensity integration, high sharing, and deep application" of police information, which is a new concept and model for the development of Chinese policing.In the future, with the deep application of artificial intelligence technology, multi technology integration and collaborative innovation, the combination of cloud computing and edge computing, and the strengthening of standardization and standardization construction, intelligent security technology will continue to improve and

develop, play a more important role in the field of crime prevention, and provide solid scientific and technological support for building a safe, harmonious and stable social environment. Therefore, the government, enterprises, and all sectors of society should work together to increase support for the research and application of smart security technology, actively respond to challenges, and promote the widespread application and continuous innovative development of smart security technology in crime prevention.

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Research on the Measurement and Improvement Path of Airport Economic Development Efficiency

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Abstract

This paper adopts the super-efficiency SBM model to evaluate the efficiency of core airports in 17 airside economic demonstration zones during the period from 2019 to 2023, and employs the Malmquist index to analyze the dynamic changes in their output efficiency. The results indicate that among these 17 core airports, Ningbo Lishe International Airport, Shanghai Hongqiao International Airport, and Guangzhou Baiyun International Airport achieved the highest efficiency levels, whereas Beijing Daxing International Airport, Qingdao Jiaodong International Airport, and Guiyang Longdongbao International Airport exhibited relatively low efficiency. Over the five-year period, the overall productivity of all airports has witnessed a significant improvement. On the one hand, technological progress has played a driving role in enhancing overall efficiency; on the other hand, most airports maintain high scale efficiency, which has exerted a positive impact on overall productivity. Finally, this paper proposes targeted paths for improving the development efficiency of the airside economy from the dual perspectives of airport management and policy formulation.

Keywords: Airport Economic; Development Eficiency; SBM-Malmquist Index Model

1. Introduction

Within China's transportation system, which follows the principle of "taking railways as the backbone, highways as the foundation, and fully leveraging the comparative advantages of water transportation and civil aviation", air transportation plays a pivotal role in advancing regional economic development, facilitating industrial upgrading, and accelerating urbanization. Moreover, the development efficiency of airports serves as a crucial driving force for promoting the high-quality development of the airport economy and boosting regional economic growth.

Airport efficiency is a crucial reflection of the quality of airport construction and development. The *14th Five-Year Plan for Civil Aviation Development* points out that the national

comprehensive airport system serves as a vital foundation for supporting the construction of a strong civil aviation country. It is imperative to further increase investment and construction efforts, expand high-quality supply, address hub capacity constraints, improve the national comprehensive airport system, and advance its pursuit of higher-quality development. The *Plan for the Development of a Modern Comprehensive Transportation System*, issued by the State Council during the 14th Five-Year Plan period, clearly indicates that China's comprehensive transportation development faces issues of unbalanced and inadequate growth, with significant disparities among various transportation networks. It is essential to achieve balanced and coordinated development of facilities and services, promote the deep integration of transportation with economic and social development, and comprehensively advance the high-quality development of transportation. Therefore, exploring the development efficiency and improvement paths of the airport economy holds certain reference value for enhancing the coordinated development of airports and urban economies, as well as promoting the integration of airports and cities.

Regarding the evaluation methods for the development efficiency of the airport economy, most scholars at home and abroad adopt the combined weighting-TOPSIS model, data envelopment analysis (DEA) model, and three-stage data envelopment analysis network method, with model adjustments made according to the research objects. The establishment of an airport operational efficiency evaluation system mainly starts from four dimensions: flight operation efficiency, passenger boarding efficiency, aircraft taxiing efficiency, and coordination efficiency, and constructs 11 indicators including the jet bridge utilization rate, jet bridge turnover rate, and flight stand change ratio (Hu Jie & Bao Fan, 2023).

For the evaluation of airport operational efficiency models, scholars often employ the combined weighting-TOPSIS model, three-stage data envelopment analysis network method, and super-efficiency DEA (CCR)-Malmquist model (Wei Ming, 2023). The results indicate that the development of China's airport industry mainly relies on scale efficiency, while technology remains relatively backward (Chu Yanchang & Chen Feichao, 2019).

Concerning the impact of technical efficiency on airport efficiency, the specific measurement of overall technical efficiency, pure technical efficiency, and scale efficiency has revealed that airport scale, low-cost carriers, and cargo transportation exert a significant influence on the technical and scale efficiency of Italian airports (Carlucci, Cirà, & Coccorese, 2018).

Based on the aforementioned analysis, this study collected relevant data from the core airports of 17 national-level air-transportation related economic zones over the period 2019–2023. A super-efficiency SBM model was established, and appropriate input and output indicators were selected to conduct calculation and static analysis of the airport economy's development efficiency. Furthermore, the Malmquist productivity index was employed to explore the dynamic changes in airport efficiency from 2022 to 2023. Finally, targeted and effective suggestions for improvement paths were proposed. The research findings are conducive to airports optimizing their scale structure, emphasizing technological progress, and advancing intelligent transformation and development. Moreover, they hold significant implications for airports

enhancing their international competitiveness, improving comprehensive functions, and promoting regional economic development.

2. Research and Design

2.1. Indicator System Construction and Data Sources

This study takes the core airports of 17 national-level air-transportation related economic zones in China as the research objects. Input indicators include the number of airport runways, the number of aircraft stands, and the airport's floor area, while output indicators consist of the number of flight takeoffs and landings, passenger throughput, and cargo and mail throughput. Considering the interaction between airports and regional economies, the regional gross domestic product (GDP) is incorporated as an environmental variable or external factor affecting efficiency, and its correlation with airport performance is explored in subsequent analyses. Based on this, an evaluation index system for airport efficiency is constructed, as shown in Table 1, to study airport efficiency during the period from 2019 to 2023. Data on airport-related indicators are derived from the *Annual Business Volume of Civil Aviation Airports in East China*, and data on regional GDP are sourced from the *Statistical Communique on National Economic and Social Development* of each region.

Table 1. Core Input and Output Indicators of Airport Economy

Indicator type	Metric Name	Index Unit
Investment indicators	Number of runways at the airport	strip
	Number of aircraft positions	Unit
	Airport area	Square km
Output indicators	Flight takeoff and landing	Ten thousand times
	Passenger Throughput	Ten thousand people
	Cargo and mail throughput	Ten thousand tons
	Regional GDP	100 million yuan

2.2. Model Specification

(1) The Super-Efficiency SBM Model

Kaoru Tone (2001) proposed a slacks-based measure (SBM) model with undesirable outputs, which is widely applied to measure the economic efficiency of decision-making units (DMUs) with multiple inputs and multiple outputs. This model enables a comprehensive evaluation of regional economic efficiency from both desirable and undesirable output perspectives, effectively

addressing the issues of input-output slack and congestion arising from the radial and angular characteristics of traditional models.

The super-efficiency SBM model is a further refinement of the data envelopment analysis (DEA) model, designed to overcome the limitation that standard DEA and SBM models cannot differentiate between DMUs with an efficiency value of 1. By allowing the efficiency values of some DMUs to exceed 1, this model can more precisely distinguish among units deemed equally efficient in traditional DEA models. The core objective of the super-efficiency SBM model is to further relax the constraints on efficient DMUs while retaining the non-radial and non-angular properties of the conventional SBM model, thereby quantifying excess efficiency.

In this study, the super-efficiency SBM model was employed to analyze and assess the relative efficiency of 17 DMUs (i.e., airports). This model can effectively identify units with higher efficiency and further rank those that have reached the production possibility frontier, facilitating the identification of the best-performing units and the provision of corresponding improvement recommendations.

Assume there are n decision-making units (DMUs), with each DMU having m input variables and s output variables. The objective of the conventional SBM model is to minimize input slack and maximize the reduction of output shortfalls. The basic structure of the model is presented as follows:

$$\boldsymbol{Min\ \rho} = \frac{1-\frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_i}}{1+\frac{1}{s}\sum_{r=1}^{s}\frac{s_r^+}{y_r}} \qquad (1)$$

Among them, s_i^- is input redundancy, and s_r^+ is output insufficient.

The super-efficiency SBM model permits efficiency values to exceed 1. It measures the relative efficiency of a decision-making unit (DMU) by excluding the evaluated DMU from the production possibility set, while retaining other DMUs as the reference benchmark.

Mathematically, it can be expressed by the following formula:

$$\boldsymbol{Min\ \rho^*} = \frac{1-\frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_i}}{1+\frac{1}{s}\sum_{r=1}^{s}\frac{s_r^+}{y_r}} \qquad (2)$$

Under this model, if $\rho^* > 1$, it means that the efficiency of the decision unit exceeds the production possibility boundary.

(2) The Malmquist Index Method

The super-efficiency SBM model is a static efficiency evaluation method. To capture the dynamic changes in the input-output efficiency of decision-making units (DMUs), this study incorporates the Malmquist index approach — a method that requires no assumptions about decision-maker behaviors or evaluation objectives and allows for complete and effective decomposition. As a dynamic efficiency evaluation tool, the Malmquist productivity index can not only quantify the overall productivity changes of DMUs across different time periods, but also enable researchers to explore the underlying mechanisms driving productivity fluctuations by

decomposing the index into technical efficiency change and technological progress change. In this research, the Malmquist productivity index will serve as a crucial analytical framework for examining the productivity dynamics of the target sample. Fare et al. (1994, hereinafter referred to as FGNZ) further decomposes the Malmquist index into three components, namely technical efficiency change, technological progress, and scale efficiency change. Due to the redundancy and complexity of mathematical formulas, this paper focuses on exponent decomposition, and therefore only presents the FGNZ decomposition model used in this study.

Its mathematical model is:

$$M\ (x^t,\ y^t,\ x^{t+1},\ y^{t+1}) = \frac{D_V^{t+1}\ (x^{t+1},\ y^{t+1})}{D_v^t\ (x^t,\ y^t)} \times \left(\frac{D_c^t\ (x^t,\ y^t)}{D_c^{t+1}\ (x^t,\ y^t)} \frac{D_c^t\ (x^{t+1},\ y^{t+1})}{D_c^t\ (x^{t+1},\ y^{t+1})}\right)^{1/2} \times \frac{D_c^{t+1}\ (x^{t+1},\ y^{t+1})\ /D_V^{t+1}\ (x^{t+1},\ y^{t+1})}{D_c^t\ (x^t,\ y^t)\ /D_v^t\ (x^t,\ y^t)} = TE\Delta_{FGNZ} \times T\Delta_{FGNZ} \times S\Delta_{FGNZ} \quad (3)$$

Among them, M is the Malmquist productivity index, t is time, D is the distance function, C and V are two different possible sets, x is input, y is output, and TEΔ, TΔ, and SΔ represent changes in technical efficiency, technological progress, and returns to scale, respectively.

3. Empirical Analysis

3.1. Static Evaluation of Airport Economy Development Efficiency

This section employs the super-efficiency SBM model and utilizes MATLAB software to conduct a year-by-year calculation of the development efficiency of 17 core airports spanning the period from 2019 to 2023. The empirical results are presented in Tables 2 and 3.

As indicated in Table 2, in terms of the number of DEA-efficient core airports in each year during 2019−2023, an average of six core airports attained a DEA-efficient state, namely, their efficiency values exceeded 1. According to the data in Table 3, Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, and Ningbo Lishe International Airport maintained an efficient operational status with efficiency values above 1 for five consecutive years. Furthermore, Chengdu Shuangliu International Airport and Xi'an Xianyang International Airport achieved efficiency values exceeding 1 in four out of the five years, demonstrating a high level of operational efficiency. Changsha Huanghua International Airport and Hangzhou Xiaoshan International Airport sustained high efficiency for two consecutive years.

The empirical data suggest that these airports can convert their existing infrastructure investments into relatively optimal outputs corresponding to their business volumes. In addition to possessing advanced operation and management systems, these airports also exhibit significant economies of scale and strong market competitiveness.

Table 2. Effective Areas for Development Efficiency of Seventeen Core Airports (2019–2023)

Year	DEA valid area
2019	Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Chengdu Shuangliu International Airport, Ningbo Lishe International Airport, Xi'an Xianyang International Airport, Beijing Capital Airport
2020	Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Chengdu Shuangliu International Airport, Ningbo Lishe International Airport, Xi'an Xianyang International Airport
2021	Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Chengdu Shuangliu International Airport, Changsha Huanghua International Airport, Ningbo Lishe International Airport, Xi'an Xianyang International Airport
2022	Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Chengdu Shuangliu International Airport, Changsha Huanghua International Airport, Xiaoshan International Airport, Ningbo Lishe International Airport, Changchun Longjia International Airport
2023	Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Xiaoshan International Airport, Ningbo Lishe International Airport, Xi'an Xianyang International Airport

Table 3. Efficiency Measurement Results of 17 Core Airport Economic Zones (2019–2023)

Airport/Year	2019	2020	2021	2022	2023	Mean
Zhengzhou Xinzheng International Airport	0.530108525	0.63399583	0.573669292	0.560453722	0.312763805	0.522198235
Beijing Daxing International Airport	0.0190181	0.191264365	0.35356374	0.264179687	0.311222749	0.227849728
Qingdao Jiaodong International Airport	0.457439123	0.43231917	0.44403903	0.461011004	0.258411903	0.410644046
Chongqing Jiangbei International	0.572001868	0.658487668	0.653172191	0.660476568	0.392584256	0.587344511

Airport						
Guangzhou Baiyun International Airport	1.038007122	1.116435914	1.125002907	1.150353877	1.169441424	1.119848249
Shanghai Hongqiao International Airport	1.144410251	1.152446392	1.171173317	1.106866446	1.129627146	1.14090471
Chengdu Shuangliu International Airport	1.050794216	1.120816622	1.098239718	1.0712536	0.427573279	0.953735487
Changsha Huanghua International Airport	0.718363571	0.787267239	1.000850922	1.025663424	0.749290241	0.856287079
Hangzhou Xiaoshan International Airport	0.620620309	0.753131287	0.754307175	1.077792691	1.289518966	0.899074086
Ningbo Lishe International Airport	1.099229273	1.151848115	1.124903266	1.231818137	1.222298291	1.166019416
Xi'an Xianyang International Airport	1.165367542	1.120930725	1.112368513	0.59825248	1.065435777	1.012471007
Nanjing Lukou International Airport	0.641594266	0.684455583	0.594798265	0.706482083	0.464289094	0.618323858
Beijing Capital Airport	1.111118436	0.716870279	0.714968421	0.574211545	0.366849169	0.69680357
Changchun Longjia International Airport	0.499851949	0.527166279	0.559755786	1.000913469	0.456409369	0.60881937

Nanning Wuxu International Airport	0.50719101	0.515769032	0.50669282	0.600735988	0.418079045	0.509693579
Fuzhou Changle International Airport	0.616585434	0.615496683	0.633301623	0.559813731	0.383738572	0.561787209
Guiyang Longdongbao International Airport	0.274382428	0.29603446	0.283077011	0.263411736	0.209728037	0.265326734
Mean	0.709769613	0.733807979	0.747287294	0.759628835	0.625133007	/

Drawing on average efficiency and operational stability, this paper classifies the sample airports into three tiers with distinct characteristics.

First is the high-efficiency and stable type (Tier 1), mainly including Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, and Ningbo Lishe International Airport, whose efficiency values have remained consistently high (i.e., ≥ 1 in most years). The shared attributes of these airports lie in their mature hub status and optimized air transport network structures. As a global aviation hub, Guangzhou Baiyun International Airport leveraged its prominent scale economies and strong market appeal to maintain high resource throughput and conversion efficiency even during the pandemic period. Benefiting from its core geographical location in the Yangtze River Delta and high-value business-oriented passenger flow, Shanghai Hongqiao International Airport achieved intensive and efficient resource utilization. As a regional hub for both passenger and cargo transportation, Ningbo Lishe International Airport demonstrated superior output efficiency underpinned by its specialized operational model.

Second is the fluctuating development type (Tier 2), encompassing regional hub airports such as Chengdu Shuangliu International Airport, Xi'an Xianyang International Airport, Hangzhou Xiaoshan International Airport, Chongqing Jiangbei International Airport, and Beijing Capital International Airport. Their efficiency values exhibit notable phase-specific fluctuations, which are usually directly associated with major structural adjustments. The sharp efficiency decline of Chengdu Shuangliu International Airport in 2023 was directly triggered by the policy of relocating all international flights to Chengdu Tianfu International Airport under the "one city, two airports" framework, representing a strategic reallocation of aviation resources within the metropolitan area. Hangzhou Xiaoshan International Airport surged to the top of the efficiency rankings in 2023, primarily driven by the commissioning of a new terminal to accommodate the Hangzhou Asian Games; this infrastructure upgrade substantially boosted its operational capacity and passenger volume in the short term, reflecting the synergistic effect of mega-events and infrastructure expansion. The efficiency decline of Xi'an Xianyang International Airport in 2022,

in addition to the impact of extreme weather events, also exposed potential long-term operational bottlenecks in runway operation schemes and taxiway capacity, which constrained the full utilization of its resource endowments.

Finally is the potential development type (Tier 3), primarily represented by airports with relatively low average efficiency levels, such as Zhengzhou Xinzheng International Airport, Qingdao Jiaodong International Airport, Nanjing Lukou International Airport, and Guiyang Longdongbao International Airport. These airports are mostly in the stage of hub function cultivation or are confronted with fierce regional competition. Despite possessing advanced infrastructure in some cases, the route network density, flight frequencies, and passenger-cargo aggregation effects of these airports have not yet been fully realized, leading to suboptimal utilization of existing resources. This phenomenon reflects a certain time lag in the transformation of "infrastructure investment" into "operational efficiency output".

From a longitudinal perspective, the overall average efficiency of the sample airports exhibited a moderate upward trend from 2019 to 2022, indicating that airports continued to explore operational potential during the pandemic through route network optimization and operational process refinement. Nevertheless, the decline in overall average efficiency in 2023 reflects that airports were confronted with heterogeneous challenges in the post-pandemic recovery phase, including disparities in the restoration pace of international routes, short-term disruptions induced by major hub layout adjustments, and the asynchronous recovery of regional economies.

In summary, the efficiency performance of an airport is not merely an isolated outcome of operational management, but rather a result of structural interaction between its internal capabilities and the external environment. Sustained high efficiency is often contingent on a mature hub network, a balanced passenger-cargo traffic structure, and in-depth integration with the regional economy. Conversely, significant efficiency fluctuations are closely associated with changes in core structural variables, such as national-level aviation resource allocation policies, large-scale infrastructure investment projects, and bottlenecks in airspace resources and ground support systems.

3.2. Dynamic Efficiency Evaluation of Airport Economy Development

The Malmquist index is capable of analyzing changes in production efficiency from period t to period t+1, and is widely applied in the fields of economics and production efficiency evaluation. Through multi-dimensional decomposition, this index can elaborate on the specific sources of efficiency changes for a given production unit across different time periods. These dimensions include five core components: technological change (TC), pure technical efficiency change (PEC), scale efficiency change (SEC), technical efficiency change (EC), and total factor productivity change (TFP).

Technological change (TC) measures the shift of the technology frontier: a TC value greater than 1 indicates technological progress, while a value less than 1 denotes technological regression. Pure technical efficiency change (PEC) reflects changes in management or organizational efficiency: a PEC value greater than 1 signifies improved management efficiency, whereas a value less than 1 indicates a decline in management efficiency. Scale efficiency change (SEC)

assesses whether the production scale is moving closer to the optimal scale: an SEC value greater than 1 implies enhanced scale efficiency, while a value less than 1 indicates reduced scale efficiency. Technical efficiency change (EC) is defined such that a value greater than 1 indicates an improvement in technical efficiency, and vice versa. Total factor productivity change (TFP) integrates the above three indicators (PEC, SEC, and TC) to reflect changes in overall production efficiency: a TFP value greater than 1 indicates an improvement in overall efficiency, while a value less than 1 denotes a decline.

Table 4. Malmquist Index Measurement Results of 17 Core Airports (2022–2023)

Core Airport/Efficiency Value	Technological Change (TC)	Pure Technical Efficiency Change (PEC)	Scale Efficiency Change (SEC)	Technical Efficiency Change (EC)	Total Factor Productivity Change (TFP)
Zhengzhou Xinzheng International Airport	3.965375301	0.562780325	0.991602981	0.558054648	2.212896117
Beijing Daxing International Airport	3.042003937	1.29524481	0.909536332	1.178072213	3.58370031
Qingdao Jiaodong International Airport	3.909454741	0.560624536	0.999836809	0.560533047	2.191378578
Chongqing Jiangbei International Airport	3.152781498	0.4498234	1.321397318	0.594395434	1.873998926
Guangzhou Baiyun International Airport	1.660136911	0.854729634	1.189373482	1.016592761	1.687683166
Shanghai Hongqiao International Airport	1.808440028	1.030278044	0.990570645	1.020563186	1.845627317
Chengdu Shuangliu International Airport	3.214456772	0.415241963	0.961207226	0.399133575	1.282997623
Changsha Huanghua International	2.512257291	0.680485629	1.073559822	0.730542031	1.835309543

Airport					
Xiaoshan International Airport	2.709818339	1.20139574	0.995878628	1.196444341	3.242146818
Ningbo Lishe International Airport	1.60307102	1.031081393	0.962360216	0.992271712	1.590682025
Xi'an Xianyang International Airport	1.926448636	1.394493649	1.277103891	1.780913265	3.430837929
Nanjing Lukou International Airport	3.022237766	0.656551199	1.000964629	0.657184528	1.986167899
Capital Airport	4.681427724	1.011453637	0.63164002	0.638874596	2.990845245
Changchun Longjia International Airport	3.835483115	0.990727367	0.460260662	0.455992834	1.748952814
Nanning Wuxu International Airport	3.14638923	0.991456914	0.701941477	0.69594473	2.189713004
Fuzhou Changle International Airport	2.915046229	0.886217389	0.773484547	0.685475455	1.998192641
Guiyang Longdongbao International Airport	3.438223797	0.799303121	0.996115879	0.796198531	2.737508735

Drawing on the data presented in Table 4, this section conducts a comprehensive analysis of the Malmquist index for each core airport over the period from 2022 to 2023.

In terms of the technological change (TC) indicator, all sample airports registered notable technological improvements. This finding reflects that these airports have made substantial headway in introducing emerging technologies and optimizing operational models, which constitutes a critical driver of overall efficiency enhancement. From the perspective of pure technical efficiency change (PEC), Beijing Daxing International Airport, Shanghai Hongqiao International Airport, Hangzhou Xiaoshan International Airport, Ningbo Lishe International Airport, Xi'an Xianyang International Airport, and Beijing Capital International Airport all exhibited positive performance. This indicates that the synergistic effects of comprehensive management upgrading and technological advancement have played a productivity-promoting

role, with their management efficiency improved significantly. In contrast, Zhengzhou Xinzheng International Airport, Qingdao Jiaodong International Airport, Chongqing Jiangbei International Airport, and Chengdu Shuangliu International Airport underperformed in management efficiency, implying potential issues such as inadequate optimization of management processes and irrational resource allocation schemes.

Regarding scale efficiency change (SEC), Chongqing Jiangbei International Airport, Guangzhou Baiyun International Airport, Changsha Huanghua International Airport, Xi'an Xianyang International Airport, and Nanjing Lukou International Airport achieved scale efficiency gains. This demonstrates that their operational scales have moved closer to the optimal level, and scale efficiency has exerted a positive effect on productivity growth. By comparison, Changchun Longjia International Airport displayed low scale efficiency, suggesting a suboptimal operational scale. Based on the technical efficiency change (EC) data, Beijing Daxing International Airport, Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Hangzhou Xiaoshan International Airport, and Xi'an Xianyang International Airport witnessed technical efficiency improvements, while the remaining airports recorded mediocre technical efficiency performance.

Overall, the total factor productivity change (TFP) indicator reflects a marked increase in the overall productivity of all core airports, with Beijing Daxing International Airport and Xi'an Xianyang International Airport registering the most prominent growth.

In summary, most airports have achieved remarkable outcomes in technological progress, yet there exists a substantial disparity in management efficiency and technical efficiency across individual airports, which directly constrains the improvement of total factor productivity. The relatively stable performance of scale efficiency indicates that the scale expansion of most airports has been implemented in a rational manner. To further enhance the comprehensive efficiency of each airport, it is imperative to prioritize the improvement of management efficiency, thereby ensuring that technological progress can be effectively translated into gains in overall productivity.

4. Paths to Improve the Development Efficiency of Airport Economy

Drawing on the analysis of efficiency values and Malmquist index results for each core airport, the pathways to enhancing airport efficiency can be refined and optimized from two dimensions: airport management and policy formulation.

4.1. The Airport Management Dimension

From the management perspective, optimize management processes and enhance management efficiency. Specifically, for airports with subpar management efficiency, such as Zhengzhou Xinzheng International Airport, Qingdao Jiaodong International Airport, Chongqing Jiangbei International Airport, and Chengdu Shuangliu International Airport, systematic reviews and optimization of existing management processes should be conducted. Meanwhile, lean management methodologies ought to be introduced to elevate resource utilization efficiency;

correspondingly, resource allocation and scale-based management should be optimized accordingly. For airports with inadequate scale efficiency, on the one hand, their expansion plans should be re-evaluated to ensure that newly added production capacity is aligned with actual demand, thereby avoiding resource wastage. On the other hand, airport infrastructure, particularly runways, terminals, and logistics facilities, should be upgraded to improve their carrying capacity and operational efficiency, thus optimizing resource allocation in turn.

From the technology perspective, strengthen technological research, development and introduction, and advance technological innovation and application. For airports that have achieved notable technological progress, such as the 17 core airports examined in this study, it is necessary to continuously increase investment in the R&D and introduction of emerging technologies, especially in domains including automation, artificial intelligence, and the Internet of Things, to elevate the intelligent operation level of airports. Additionally, the digital transformation of airports should be promoted, with big data analytics applied to optimize key operational links such as flight scheduling, passenger flow management, and security inspection procedures, so as to enhance overall operational efficiency and service quality.

From the talent perspective, strengthen talent cultivation. To this end, specialized training programs should be conducted for airport managers to improve their capabilities in modern airport management, crisis response, and digital transformation. Furthermore, a sound performance appraisal mechanism should be established to incentivize managers to continuously upgrade their management proficiency. In addition, cooperation should be forged with universities to cultivate and deliver high-caliber talents to the airport industry.

4.2. Policy Formulation

First and foremost, put forward diversified development policies and promote regional coordinated development. Specifically, based on the current development status and functional positioning of each airport, differentiated development policies should be formulated in light of local conditions. For instance, for airports with subpar management efficiency, the government ought to provide guidance and support to assist them in optimizing management processes; while for airports with rapid technological progress, the government should focus on supporting them to further expand their technological advantages and enhance their overall competitiveness. Meanwhile, the government should attach importance to regional cooperation, strengthen inter-airport collaboration within the region, accelerate resource sharing and coordinated development, and thus avoid redundant construction and resource waste among airports, ultimately realizing the coordinated development of the regional aviation economy.

Secondly, establish special funds to support technological innovation and R&D. To this end, the government should encourage airports and related enterprises to invest in technological R&D and innovation by setting up special funds or offering tax incentives, particularly in fields such as green aviation, environmental protection, intelligent transportation, and digital transformation of the aviation industry. Additionally, consideration should be given to constructing a technological innovation cooperation platform to promote collaboration between airports, universities, research

institutions, and enterprises, thereby facilitating the rapid application and promotion of new technologies.

Thirdly, promote green and sustainable development and strengthen environmental protection policies. Regarding the environmental impact of airport operations, the government should formulate stringent environmental protection policies to urge airports to make improvements in green energy utilization, waste disposal, and carbon emission reduction. Meanwhile, through policy guidance, promote collaboration between airports and airlines in energy conservation and emission reduction technologies. Furthermore, guide sustainable development investment, and attract social capital to invest in the construction of airport green infrastructure — such as green buildings and renewable energy facilities — through policy support, so as to enhance the environmental friendliness of airports.

5. Conclusion

Drawing on the relevant data of the 17 core airports in national-level Airport Economic demonstration zones spanning the period from 2019 to 2023, this paper selects the number of runways, the number of aircraft stands, and airport apron area as input indicators, and adopts flight take-off and landing movements, passenger throughput, cargo throughput, and urban GDP as output indicators to construct a super-efficiency SBM model. On this basis, the paper conducts a static analysis of airport development efficiency, further calculates the Malmquist productivity index, and performs a dynamic analysis of airport development efficiency accordingly. The key findings are summarized as follows: (1) On average, six out of the seventeen sample airports have achieved DEA efficiency, with their efficiency values exceeding 1. (2) Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, and Ningbo Lishe International Airport have maintained efficient operation for five consecutive years; Chengdu Shuangliu International Airport and Xi'an Xianyang International Airport have demonstrated relatively high efficiency, while Beijing Daxing International Airport, Qingdao Jiaodong International Airport, and Guiyang Longdongbao International Airport have registered relatively low efficiency levels. (3) All seventeen airports have achieved significant technological improvements from 2022 to 2023; the management efficiency of Beijing Daxing International Airport, Shanghai Hongqiao International Airport, Hangzhou Xiaoshan International Airport, Ningbo Lishe International Airport, Xi'an Xianyang International Airport, and Beijing Capital International Airport has been significantly enhanced; Zhengzhou Xinzheng International Airport, Qingdao Jiaodong International Airport, Chongqing Jiangbei International Airport, and Chengdu Shuangliu International Airport have underperformed in terms of management efficiency; Chongqing Jiangbei International Airport, Guangzhou Baiyun International Airport, Changsha Huanghua International Airport, Xi'an Xianyang International Airport, and Nanjing Lukou International Airport have realized scale efficiency improvement, while Changchun Longjia International Airport has remained at a low scale efficiency level; Beijing Daxing International Airport, Guangzhou Baiyun International Airport, Shanghai Hongqiao International Airport, Hangzhou Xiaoshan International Airport, and Xi'an Xianyang International Airport have achieved technical

efficiency enhancement, whereas the remaining airports have shown mediocre technical efficiency performance; the overall productivity of all core airports has been significantly improved, with Beijing Daxing International Airport and Xi'an Xianyang International Airport recording the most prominent growth.

Based on the above analysis, this paper puts forward optimization paths from two dimensions: airport operation and management, and policy formulation. The specific measures are as follows: (1) Optimize management processes and enhance management efficiency. (2) Strengthen technological research, development and introduction, and promote technological innovation and application. (3) Intensify talent cultivation efforts. (4) Introduce diversified development policies and promote regional coordinated development. (5) Establish special funds to support technological innovation and R&D initiatives. (6) Promote green and sustainable development and tighten environmental protection policies.

Author Contributions:

Conceptualization, Bo Lin.; methodology, Jiaxin Liang.; software, Jiaxin Liang.; validation, Jiaxin Liang.and Jie Tang.; formal analysis, Jiaxin Liang.; investigation, Jiaxin Liang.; resources, Jiaxin Liang.; data curation, Jiaxin Liang.; writing—original draft preparation, Jiaxin Liang.; writing—review and editing, Jiaxin Liang.,Bo Lin. and Jie Tang.; visualization, Jiaxin Liang.; supervision, Bo Lin.; project administration, Bo Lin.,Jie Tang.,; funding acquisition, Bo Lin. All authors have read and agreed to the published version of the manuscript." Please turn to the credit taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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Conflict of Interest:

The authors declare no conflict of interest.

Data Availability Statement:

Data availability status	Recommended Data Availability Statement
Data available in a publicly accessible repository	The original data presented in the study are openly available in 2019-2023 Zhengzhou Resident Population Main Data Bulletin at https://tjj.zhengzhou.gov.cn; Daxing District 2019-2023 National Economic and Social Development Statistical Bulletin at https://www.bjdx.gov.cn; East China Civil Aviation Airports 2019-2023 Civil Aviation Transport Production Situation in East China at http://hd.caac.gov.cn; Jiutai District, Changchun 2019-2023 National Economic and Social Development Statistical Bulletin at http://www.jiutai.gov.cn/dzxx/; Nanning 2019-2023 National Economic and Social Development Statistical Bulletin at https://tj.nanning.gov.cn/tjsj/tjgb/; Fuzhou 2019-2023 National Economic and Social Development Statistical Bulletin at http://tjj.fuzhou.gov.cn/zwgk/tjzl/; Guiyang 2019-2023 National Economic and Social Development Statistical Bulletin at http://tjj.guiyang.gov.cn/2020_zwgk/2020_zdlygk/2020_sjfb/tjgb/index.html; 2019-2023 Yubei District Statistical Yearbook at http://www.ybq.gov.cn/bm/qtjj/zwgk_70831/fdzdgknr_70834/ysjs_108648/; Seventh National Population Census Data: Aviation Zone Population at https://www.gov.cn/guoqing/2021-05/13/content_5606149.htm; 2019-2023 Huadu District, Guangzhou National Economic and Social Development Statistical Bulletin at https://www.gz.gov.cn/zwgk/sjfb/; 2019-2023 Changning District, Shanghai National Economic and Social Development Statistical Bulletin at https://www.shcn.gov.cn/col5727/index.html; Civil Aviation Administration of China, "2023 National Civil Transport Airport Production Statistical Bulletin" at http://www.caac.gov.cn/big5/www.caac.gov.cn/PHONE/XXGK_17/XXGK/TJSJ/202403/P020240320504230898437.pdf; Jiutai District People's Government, Changchun - Jiutai District Overview at http://www.jiutai.gov.cn/?id=237;
3rd Party Data	Restrictions apply to the availability of these data. Data were obtained from "Civil Aviation 2020 from a Statistical Perspective", and are available from Xiukai Xu ISBN：9787536477803.
Dataset available on request from the authors	The raw data supporting the conclusions of this article will be made available by the authors on request.

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Unmet Care Needs and Influencing Factors in Older Adults with Disabilities and Chronic Conditions

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Abstract

To examine the prevalence and determinants of unmet care needs among older adults with disabilities and chronic conditions, with the aim of mitigating the adverse effects of these unmet needs and providing a theoretical foundation for enhancing long-term care services for this population. Based on data from the 2018 China Health Survey of the Elderly, Anderson's health behavior model was applied, and binary logistic regression was used for data analysis. Fifty percent of older adults with disabilities and chronic conditions experienced unmet care needs. Factors influencing these unmet needs included rural versus urban household registration (hukou), degree of disability, economic status, adequacy of living resources, and primary caregivers' willingness. Professional care should be provided for older adults with moderate to severe disabilities and chronic conditions. Hypertension awareness education should be strengthened. Particular attention should be paid to older adults with disabilities and chronic conditions facing economic hardship in rural areas, and efforts should focus on enhancing primary caregivers' willingness.

Keywords: Older Adults with Disabilities and Chronic Conditions; Care; Unmet Needs; Influencing Factors; Anderson's Model

1. Introduction

China has entered an ageing society, with a continuously increasing population of elderly individuals suffering from chronic diseases. Certain chronic conditions can lead to physical functional decline in the elderly, subsequently impacting their ability to perform activities of daily living (Chen, 2005) and progressing to disability. Concurrently, the physiological functional decline associated with ageing also increases the risk of developing chronic diseases. The older adults with disabilities and chronic conditions population often coexists with one or more chronic diseases, resulting in varying care requirements.

Existing domestic and international research primarily addresses factors contributing to unmet care needs among older adults with disabilities and chronic conditions individuals (Deng et al., 2022) , with limited exploration of unmet care needs among those concurrently affected by chronic diseases and disability. This study focuses on the specific cohort of older adults with disabilities and chronic conditions, investigating their unmet care needs and influencing factors. This holds significant importance for identifying high-risk groups with unmet community needs, mitigating the adverse effects of unmet care demands among older adults with disabilities and chronic conditions chronic disease patients, and improving long-term care services for this population.

2. Data and Methods

2.1. Data Source

This study utilised the 2018 Community-based Long-term Health and Loneliness Survey (CLHLS) data. The original dataset covered 500 sample areas across 22 provinces, municipalities, and autonomous regions nationwide, surveying individuals aged 65 years and above. The total sample size was 15,874 cases, from which 10,528 elderly individuals with chronic diseases were selected.The study population comprised older adults with chronic conditions and functional impairment.Using the Activities of Daily Living (ADL) assessment method, individuals unable to independently perform one or more of the following six tasks were defined as functionally impaired: bathing, dressing, indoor mobility, toileting, eating, and bowel/bladder control. This criterion identified 2,408 eligible samples of older adults with disabilities and chronic conditions.

2.2. Variable Selection

2.2.1. Dependent Variable

The degree of care dependency was selected as the dependent variable.For older adults with disabilities and chronic conditions chronic disease patients, if the response to "Who is your primary helper when you require assistance with bathing, dressing, toileting, indoor mobility, continence management, or eating?" was "No one assists me," this was defined as a completely unmet need. If assistance was reported, participants were further asked: "Do you consider the assistance you currently receive with these six daily activities sufficient to meet your needs?"Responses of "unsatisfied" or "not fully satisfied" were classified as partially unmet needs, while "fully satisfied" indicated fully met needs. Both fully unmet and partially unmet needs were defined as unmet needs (assigned value 1), whereas fully met needs constituted met needs (assigned value 0).

2.2.2. Independent Variables Predisposing Factors

Age, gender, marital status, place of household registration, years of education, pre-retirement occupation; Enabling Factors: Degree of disability, type of chronic illness; Containing Factors: Per capita household income, independence of livelihood sources, adequacy of livelihood sources, possession of at least one social security benefit, ownership of housing under the respondent's or spouse's name;Social Support: Whether the community provides at least one social service for the

elderly; number of cohabiting family members; number of children.

For assessing limitations in activities of daily living (ADLs), only responses of "no assistance required" on the ADLs assessment scale were considered free of functional impairment; otherwise, limitations in performing the daily activity were deemed present.The degree of disability was categorized as follows: mild (requiring assistance with 1–2 ADLs), moderate (requiring assistance with 3–4 ADLs), and severe (requiring assistance with 5–6 ADLs).

2.2.3. Statistical Analysis Data analysis

Statistical Analysis Data analysis was conducted using SPSS. Descriptive analysis employed sample size and composition ratio indicators, while difference analysis utilised chi-square tests. Factor analysis was based on a binary logistic regression model, with $\alpha=0.05$ as the significance level.

3. Results

3.1. General Characteristics of older adults with disabilities and chronic conditions

The total sample comprised 2,408 older adults with disabilities and chronic conditions, with females accounting for 65% and males 35%. Age distribution showed: 1.5% aged 65–70 years, 7.4% aged 71–80 years, 21.7% aged 81–90 years, and 69.4% aged 90 years or older.Regarding marital status, 19.1% were married with a spouse, while 80.9% were unmarried without a spouse. In terms of educational attainment, 32.3% had attended school, and 57.1% had not received any schooling. For occupations prior to age 60, 27.7% held formal employment, 46.9% were farmers, 1.7% were self-employed, and 23.8% engaged in other occupations.

Regarding urban-rural composition, 40.5% held urban household registration while 59.5% held rural registration; 65% resided in urban areas and 35% in rural areas. Economically, 18.4% were affluent, 67.5% were of moderate means, 12.5% faced hardship, and 1.6% were undeclared.Regarding livelihood sufficiency, 83.1% reported adequate resources, 16.2% reported insufficient resources, and 0.7% were unsure. 96.1% possessed at least one form of insurance, 2.4% had no insurance, and 1.6% were unaware of their insurance status.

Regarding housing arrangements, 82.6% owned their residence while 8.4% did not; 7.8% lived alone, with 92.2% sharing accommodation;1.1% lived with no one, 27.8% lived with one person, and 55.4% lived with two or more people. Regarding community factors, 65.4% resided in communities providing elderly care services, while 34.6% resided in communities without such services.

Among the survey participants, 37.3% of elderly individuals had one chronic condition, while 62.7% had two or more chronic conditions. Mild disability affected 44.1%, moderate disability 22.9%, and severe disability 33.0%.The primary carers for older adults with disabilities and chronic conditions were family members in 87.7% of cases, friends or neighbours in 0.2%, social services in 2.9%, and domestic helpers in 8.4%. 1.3% responded that they did not

know.Regarding primary carers' willingness: 88.2% were willing; 2.1% were unwilling; 4.9% were willing but felt unable to cope; 4.8% did not know.

Table 1. Unmet Care Needs Among Elderly Individuals with Chronic Conditions and Disabilities

Variable		Total	Unmet Needs	Satisfied Needs	x^2	*P*
Predisposing Factor						
Gender	Male	843 (35)	423 (17.6)	420 (17.4)	1	0.874
	Female	1565 (65)	780 (32.4)	785 (32.6)		
Age	65–70	37 (1.5)	22 (0.9)	15 (0.6)	3	0.052
	71–80	177 (7.4)	104 (4.3)	73 (3.0)		
	81–90	522 (21.7)	261 (10.8)	261 (10.8)		
	90 and above	1672 (69.4)	816 (33.9)	856 (35.5)		
Household Registration	Urban	975 (40.5)	396 (16.4)	579 (24.0)	1	0.000
	Rural	1433 (59.5)	807 (33.5)	626 (26.0)		
Marital Status	Married	461 (19.1)	249 (10.3)	212 (8.8)	1	0.053
	No spouse	1947 (80.9)	954 (39.6)	993 (41.2)		
Educational status	Attended School	778 (32.3)	348 (14.5)	430 (17.9)	2	0.001
	No schooling	1375 (57.1)	732 (30.4)	643 (26.7)		
	Don't know	255 (10.6)	123 (5.1)	132 (5.5)		
Occupation before age 60	Regular employment	667 (27.7)	273 (11.3)	394	3	0.000
	Farmers	1129 (46.9)	641 (26.6)	488 (20.3)		
	Freelancer	40 (1.7)	20 (0.8)	20 (0.8)		
	Other	572 (23.8)	269 (11.2)	303 (12.6)		
Demand factors						
Number of chronic	1 condition	898 (37.3)	455 (18.9)	443 (18.4)	1	0.591

conditions						
	Two or more	1510 (62.7)	748 (31.1)	762 (31.6)		
Number of chronic conditions						
Presence of hypertension	Yes	1261 (52.4)	603 (25.0)	658 (27.3)	2	0.001
	No	1008 (41.9)	511 (21.2)	497 (20.6)		
	Don't know	139 (5.8)	90 (3.7)	49 (2.0)		
Diabetes	Yes	279 (11.6)	125 (5.2)	154 (6.4)	2	0.015
	No	1861 (77.3)	926 (38.5)	935 (38.8)		
	Unknown	268 (11.1)	153 (6.4)	115 (4.8)		
Do you have heart disease?	Yes	675 (28.0)	305 (12.7)	370 (15.4)	2	0.003
	No	1502 (62.4)	767 (31.9)	735 (30.5)		
	Don't know	231 (9.6)	132 (5.5)	99 (4.1)		
History of stroke or cerebrovascular disease	Yes	585 (24.3)	299 (12.4)	286 (11.9)	2	0.322
	No	1587 (65.9)	778 (32.3)	809 (33.6)		
	Don't know	236 (9.8)	127 (5.3)	109 (4.5)		
Do you have bronchitis, asthma, emphysema or pneumonia?	Yes	436 (18.1)	209 (8.7)	227 (9.4)	2	0.025
	No	1687 (70.1)	832 (34.6)	855 (35.5)		
	Don't know	285 (11.8)	163 (6.8)	122 (5.1)		
Degree of disability	Mild	1062 (44.1)	426 (17.7)	636 (26.4)	2	0.000
	Moderate	551 (22.9)	278 (11.5)	273 (11.3)		
	Severe	795 (33.0)	499 (20.7)	296 (12.3)		
Enabling factors						
Place of residence	Urban	1564 (65.0)	733 (30.5)	830 (34.5)	1	0.000
	Rural	844 (35.0)	469 (19.5)	375 (15.6)		
Home ownership	Yes	1990 (82.6)	999 (41.5)	991 (41.2)	2	0.636

	No	203 (8.4)	95 (3.9)	108 (4.5)		
	Don't know	215 (8.9)	109 (4.5)	106 (4.4)		
Living alone	Yes	189 (7.8)	107 (4.4)	82 (3.4)	1	0.057
	No	2219 (92.2)	1096 (45.5)	1123 (46.6)		
Economic status	Affluent	444 (18.4)	136 (5.6)	308 (12.8)	3	0.000
	Average	1625 (67.5)	835 (34.7)	790 (32.8)		
	Difficult	301 (12.5)	216 (9.0)	85 (3.5)		
	Don't know	38 (1.6)	16 (0.7)	22 (0.9)		
Is your income sufficient?	Yes	2001 (83.1)	926 (38.5)	1075 (44.6)	2	0.000
	No	390 (16.2)	265 (11.0)	125 (5.2)		
	Don't know	17 (0.7)	12 (0.5)	5 (0.2)		
At least one form of insurance	Yes	2313 (96.1)	1150 (47.8)	1163 (48.3)	2	0.257
	No	57 (2.4)	29 (1.2)	28 (1.2)		
	Don't know	38 (1.6)	24 (1.0)	14 (0.6)		
Number of people living in the household	0	27 (1.1)	13 (0.5)	14 (0.6)	3	0.231
	1	670 (27.8)	321 (13.3)	349 (14.5)		
	2 persons or more	1333 (55.4)	663 (27.5)	670 (27.8)		
	Don't know	378 (15.7)	206 (8.6)	172 (7.1)		
Community provides elderly care services	Yes	1574 (65.4)	771 (32.0)	803 (33.3)	1	1.189
	No	834 (34.6)	432 (17.9)	402 (16.7)		
Primary Carer	Family Member	2098 (87.1)	1048 (58.5)	1050 (43.6)		
	Friends and Neighbours	5 (0.2)	3 (0.1)	2 (0.0)	4	0.115
	Social services	71 (2.9)	38 (1.6)	33 (1.4)		
	Nannies	203 (8.4)	93 (3.9)	110 (4.6)		

	Don't know	31 (1.3)	22 (0.9)	9 (0.4)		
Primary Carer's Preference	Willing	2125 (88.2)	971 (40.3)	1154 (47.9)	3	0.000
	Unwilling	50 (2.1)	42 (1.7)	8 (0.3)		
	Willing but unable to do so	118 (4.9)	102 (4.2)	16 (0.7)		
	Not sure	115 (4.8)	89 (3.7)	26 (1.1)		

3.2. Analysis of Care Needs Differences Among Older Adults with Disabilities and Chronic Conditions Chronic Disease

Patients Care needs among older adults with disabilities and chronic conditions chronic disease patients were 50% met and 50% unmet. Among predisposing factors, care needs showed significant differences based on rural vs. urban household registration (hukou), educational attainment, and occupation prior to age 60.Regarding demand factors, care needs varied significantly among elderly individuals with varying degrees of disability. Among enabling factors, care needs differed markedly based on place of residence, economic status, adequacy of livelihood resources, and the willingness of primary caregivers.

3.3. Regression Analysis of Care Needs for Older Adults with Disabilities and Chronic Conditions

To further analyse the factors influencing care needs among older adults with disabilities and chronic conditions, a binary logistic regression model was employed. Integrating the results of the differential analysis, eight key factors were incorporated into the model: rural vs. urban household registration (hukou), educational attainment, occupation prior to age 60, degree of disability, place of residence, economic status, adequacy of livelihood resources, and primary caregiver attitude.Results indicated a Hosmer-Lemeshow test (HL test) P-value of 0.628, demonstrating good model fit.

Among the predisposing factors, rural vs. urban household registration (hukou); among the demand factors, degree of disability; and among the enabling factors, economic status, adequacy of livelihood sources, and primary caregiver willingness were found to significantly influence care needs among older adults with chronic diseases and disability.Specifically: - older adults with disabilities and chronic conditions registered as rural residents had 1.675 times the unmet care needs compared to their urban counterparts. - Moderately older adults with disabilities and chronic conditions had 1.541 times the unmet care needs compared to mildly disabled individuals. - Severely older adults with disabilities and chronic conditions had 2.512 times the unmet care needs compared to mildly disabled individuals.Among older adults with chronic illnesses and disabilities, those with average economic circumstances had 1.947 times the unmet care needs of those with affluent economic circumstances. older adults with chronic illnesses and disabilities

experiencing economic hardship had 2.780 times the unmet care needs of those with affluent economic circumstances.Among elderly individuals with chronic illnesses and functional impairment, those with insufficient livelihood resources had 1.506 times the unmet care needs of those with adequate livelihood resources. Those uncertain about their livelihood sufficiency had 3.941 times the unmet care needs of those with adequate livelihood resources.

The unmet care needs of primary carers who were unwilling to provide care were 6.115 times greater than those who were willing. For those willing but unable to provide care, the unmet needs were 5.293 times greater than those who were willing. For those whose willingness was unknown, the unmet needs were 3.790 times greater than those who were willing.

Table 2. Logistic regression analysis of factors influencing unmet care needs among older adults with disabilities and chronic conditions

Characteristic		Control group	B	Standard Error	Wald	Significance	Exp(B)	95% confidence interval for Exp(B)
Predisposing Factor								
Household Registration								
	Rural	Urban	0.516	0.135	14.686	0.000	1.675	1.287–2.181
Educational status								
	Attended school	No schooling	0.041	0.114	0.130	0.718	1.042	0.833–1.304
	Unknown		-0.005	0.179	0.001	0.977	0.995	0.700–1.414
Occupation before age 60								
	Farmer	Formal employment	0.041	0.154	0.071	0.789	1.042	0.771–1.409
	Freelance		-0.170	0.364	0.219	0.640	0.843	0.414 -1.720
	Other		-0.232	0.161	2.068	0.150	0.793	0.579 -1.088
Demand factors								

Level of disability								
	Moderate	Mild disability	0.432	0.113	14.555	0.000	1.541	1.234–1.925
	Severe		0.921	0.104	77.981	0.000	2.512	2.047–3.082
Hypertension	No	Yes	0.082	0.097	0.725	0.394	1.086	0.898–1.312
	Unknown		0.587	0.243	5.836	0.016	1.799	1.117–2.898
Diabetes	No	Yes	0.013	0.147	0.008	0.930	1.013	0.760–1.351
	Unknown		-0.141	0.260	0.293	0.588	0.869	0.522 -1.446
Heart disease	No	Yes	0.119	0.106	1.253	0.263	1.127	0.914–1.388
	Unknown		0.090	0.258	0.122	0.727	1.094	0.660–1.814
Do you have bronchitis, asthma, emphysema or pneumonia?	No	Yes	-0.028	0.120	0.055	0.815	0.972	0.768–1.231
	Unknown		0.265	0.220	1.455	0.228	1.304	0.847–2.006
Enabling factors								
Place of residence								
	Rural	Urban	-0.027	0.113	0.059	0.808	0.973	0.780–1.214
Economic status								
	Average	Affluent	0.666	0.122	29.605	0.000	1.947	1.532 -2.476
	Difficult		1.023	0.196	27.187	0.000	2.780	1.893–4.084
	Unknown		-0.361	0.430	0.702	0.402	0.697	0.300-1.621
Is your income sufficient?								
	No	Yes	0.410	0.141	8.407	0.004	1.506	1.142–1.987

	Unknown		1.371	0.675	4.124	0.042	3.941	1.049–14.804
Primary Carer's Willingness	Unwilling	Willing	1.811	0.403	20.141	0.000	6.115	2.773 -13.486
	Willing but unable		1.666	0.282	34.956	0.000	5.293	3.046 -9.195
	Unknown		1.332	0.240	30.805	0.000	3.790	2.367 -6.066
Constant			-1.629	0.226	52.059	0.000	0.196	

4. Discussion

4.1. High Unmet Care Needs Among Older Adults with Disabilities and Chronic Conditions

Survey findings indicate that unmet care needs among older adults with disabilities and chronic conditions reach as high as 50.0%. Among these patients with unmet care needs, 62.2% suffer from two or more chronic diseases, 41.5% are severely disabled,23.1% were moderately incapacitated, and 35.4% were mildly incapacitated.

4.2. Degree of Disability Significantly Influences Care Needs

Survey findings indicate that the degree of disability significantly impacts unmet care needs. As disability severity increases, the probability of fully meeting care requirements for six activities of daily living decreases. Specifically, compared to mildly older adults with disabilities and chronic conditions, the degree of unmet care needs progressively increases among those with moderate and severe disabilities.Currently, family members remain the primary caregivers for moderately and severely older adults with disabilities and chronic conditions individuals in China. Findings indicate that among moderately older adults with disabilities and chronic conditions chronic disease patients, 87.8% receive care from relatives and 7.8% from domestic helpers. Among severely older adults with disabilities and chronic conditions chronic disease patients, 81.9% are cared for by relatives,and 13.0% by domestic helpers. Only a very small proportion of elderly individuals with moderate to severe disability receive care from professional social services.Elderly individuals with chronic illnesses and functional impairment often present complex healthcare needs, yet family carers frequently struggle to meet these demands due to a lack of specialised knowledge and skills (Deng et al., 2022) . Consequently, for those with moderate to severe impairment, professional care provision better addresses their care requirements and represents a superior option.

4.3. Relationship between Chronic Diseases, Disability, and Unmet Care Needs

There is no significant correlation between suffering from chronic diseases such as diabetes, heart disease, bronchitis, asthma, emphysema, or pneumonia and unmet care needs. However, elderly individuals with long-term chronic diseases are more prone to disability (Chen, 2015; Gao

et al., 2017; Gao et al., 2020) . Moreover, the degree of disability varies among elderly individuals with different chronic conditions. Comparing disability levels among elderly chronic disease patients with hypertension, diabetes, heart disease, stroke and cerebrovascular disease, as well as bronchitis, asthma, emphysema or pneumonia, those with stroke and cerebrovascular disease exhibited significantly different disability levels (p<0.05).Specifically, among those with stroke or cerebrovascular disease, mild disability accounted for 33.8%, moderate disability for 20.7%, and severe disability for 45.5%. In contrast, among those without stroke or cerebrovascular disease, mild disability accounted for 47.4%, moderate disability for 24.1%, and severe disability for 28.4%.This disparity may stem from chronic conditions such as hypertension, diabetes, heart disease, and chronic respiratory disorders not directly manifesting as disability. However, progression to stroke or cerebrovascular disease often results in physical functional deficits (Lai et al., 1998) , leading to markedly differing degrees of disability.

Furthermore, insufficient awareness of chronic conditions contributes to unmet care needs among the elderly. Survey findings indicate that disabled older adults with chronic conditions who were unaware of their hypertension had unmet care needs 1.799 times more frequently than those who knew they had hypertension.For elderly chronic disease patients, understanding the diagnostic criteria, risk factors, and common symptoms of hypertension—a prevalent chronic condition—enables more targeted care interventions. This facilitates hypertension prevention and control, thereby reducing complications. Consequently, enhancing hypertension awareness education among older adults with disabilities and chronic conditions chronic disease patients unaware of their condition can mitigate unmet care needs to some extent.

4.4. Economic Factors Correlate with Greater Unmet Care Needs

Compared to non-chronic-illness-afflicted elderly with disabilities, older adults with disabilities and chronic conditions incur higher healthcare expenditure due to regular medical appointments and medication requirements. Furthermore, their chronic conditions and disabilities create difficulties in accessing healthcare, increasing demands for transport assistance and thereby imposing heavier economic burdens.

Survey findings indicate that compared to affluent older adults with disabilities and chronic conditions individuals with chronic illnesses residing locally, those experiencing greater economic hardship exhibit higher levels of unmet care needs. Furthermore, older adults with disabilities and chronic conditions individuals with chronic illnesses who report insufficient income or uncertainty regarding their income adequacy demonstrate higher unmet care needs than those with fully adequate income.

Older adults with disabilities and chronic conditions individuals with chronic illnesses holding rural household registrations exhibited greater unmet care needs than their urban counterparts, potentially reflecting significantly lower living standards in rural areas (p=0.000). Overall, diminished economic resources among older adults with disabilities and chronic conditions individuals with chronic illnesses correlate with reduced access to care resources and heightened difficulty in meeting care requirements.In summary, economically disadvantaged elderly individuals with chronic illnesses and functional impairment in rural areas constitute a high-risk

group for unmet care needs. When establishing long-term care insurance systems, priority should be given to addressing the unmet care needs and insurance payment capacity of this vulnerable population in rural areas.

4.5. Primary Carer Attitude Proves Critical

Regarding carer factors, the primary carer's identity is not the key variable; rather, the primary carer's attitude is pivotal. Findings indicate that the more negative the primary carer's attitude, the greater the unmet care needs among elderly individuals with chronic illnesses and functional impairment.

Research indicates that the greater the degree of disability and the number of illnesses, the more time, physical effort and financial expenditure required of carers, and the greater the pressure they experience (Lai et al., 1998). During the caregiving process, potential cognitive differences between the older adults with disabilities and chronic conditions and their carers, coupled with the physical, psychological, and financial burdens of caregiving alongside role conflicts, place carers in a state of prolonged overload. Conversely, the greater the intensity of social support, the better carers can cope with heightened physical and psychological stressors (Xu, 2016) .

Therefore, for carers—particularly those who are willing but unable or unwilling—the state and society must provide social support. This includes respite services, education on the physiological, psychological, and social processes of ageing and death(Ikeda-Sonoda et al., 2020),emotional support, establishing standardised care schedules to facilitate carer replacement and rotation, and offering professional information on home care.

5. Conclusion

This study examined the prevalence and determinants of unmet care needs among older adults with disabilities and chronic conditions in China, utilizing a nationally representative sample from the 2018 CLHLS survey. The findings reveal that half of the sampled population experienced unmet care needs, underscoring a significant gap in the long-term care system for this vulnerable group.

The analysis identified several key influencing factors rooted in Andersen’s behavioral model. Predisposing factors such as rural household registration (hukou), demand factors like the severity of disability, and enabling factors including economic hardship, inadequate livelihood resources, and primary caregivers’ unwillingness or inability to provide care were all significantly associated with higher odds of unmet needs. Notably, caregiver attitude emerged as a critical determinant, with unwilling or uncertain caregivers corresponding to substantially elevated unmet needs.

The study offers both theoretical and practical contributions. Theoretically, it validates and contextualizes Andersen's behavioral model within the framework of China’s aging population and socio-economic disparities. Practically, the findings highlight priority areas for intervention:

Systemic Support: There is an urgent need to develop and subsidize professional care services,

especially for those with moderate to severe disabilities who currently rely heavily on family caregivers lacking specialized skills.

Geographic and Economic Targeting: Policies should prioritize rural and economically disadvantaged older adults, who face compounded barriers to accessing adequate care. Integrating long-term care insurance with poverty alleviation initiatives could mitigate financial constraints.

Caregiver Empowerment: Enhancing social support for caregivers—through respite services, training, financial assistance, and emotional counseling—is essential to sustain caregiving willingness and capacity.

Health Education: Strengthening hypertension awareness and chronic disease management education among older adults and their families can help prevent disability progression and reduce care burdens.

This study has several limitations. The cross-sectional design prevents causal inference. The reliance on self-reported data may introduce recall or social desirability bias. Furthermore, the measure of unmet needs was based on perceived sufficiency of assistance, which may not fully capture objective care deficits. Future longitudinal research is needed to trace the dynamics of care needs and evaluate the impact of policy interventions.

In summary, addressing the unmet care needs of older adults with disabilities and chronic conditions requires a multi-faceted approach that integrates health services, social protection, and community support. By focusing on high-risk groups and strengthening both formal and informal care systems, policymakers and practitioners can work toward equitable and sustainable long-term care for China’s aging population.

Author Contributions:

Conceptualization, Xiangyu Chen; methodology, Wanting Lin; validation, Wanting Lin, ; formal analysis, Luyao Pan; investigation, Wanting Lin; resources, Luyao Pan.; data curation, Xiangyu Chen; writing—original draft preparation, Wanting Lin; writing—review and editing, Xiangyu Chen; visualization, Luyao Pan; supervision, Xiangyu Chen; project administration, Wanting Lin; funding acquisition, Luyao Pan.

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The authors declare no conflict of interest.

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Data available in a publicly accessible repository.The original data presented in the study are openly available in [CHARLS] at or [2018 CHARLS Wave 4].

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The Impact of Artificial Intelligence on Strategic Technology Management: A Mixed-Methods Analysis of Resources, Capabilities, and Human-AI Collaboration

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Abstract

This paper investigates the effective integration of artificial intelligence (AI) into Strategic Technology Management (STM) practices to enhance the strategic alignment and effectiveness of technology investments. The study aims to understand how AI fundamentally transforms STM under conditions of uncertainty and what organizational prerequisites are necessary for successful adoption. A mixed-methods approach was employed, combining quantitative analysis of survey data (n=230) with qualitative insights derived from expert interviews (n=14). This methodology addressed three critical research questions: the success factors AI introduces for STM roadmap formulation, the resources and capabilities required for AI-enhanced STM, and the optimal design principles for human-AI interaction in complex STM tasks. The findings demonstrate that AI transforms STM by enabling data-driven strategic alignment and continuous adaptation, with success depending upon cultivating proprietary data ecosystems, specialized human talent, and robust governance capabilities. The research synthesizes these elements into the AI-based Strategic Technology Management (AIbSTM) conceptual framework, structured across strategic alignment, resource-based view, and human-AI interaction layers. The research concludes that the most viable integration trajectory is human-centric augmentation, where AI serves as a collaborative partner to human judgment rather than an autonomous replacement. This work extends the Resource-Based View to AI contexts and offers a prescriptive framework for practitioners navigating AI integration in strategic technology management.

Keywords: Strategic Technology Management; Artificial Intelligence; Human-AI Collaboration; Resource-Based View; Technology Roadmapping

1. Introduction

The persistent challenge of underperforming technology investments poses a substantial problem for contemporary organizations. Research by Gartner reveals that less than half of

organizations achieve expected value from their Information Technology investments, (Stegman, Guevara et al., 2023) an issue amplified by the increasing budgets allocated to technological initiatives. This failure rate in technology investments derives primarily from suboptimal Strategic Technology Management (STM) practices, particularly the misalignment between business objectives and technology strategies.

Strategic Technology Management - the process of aligning an organization's technology with its corporate-level business strategies to create and sustain competitive advantage (Sahlman and Haapasalo, 2012) - has become increasingly complex in the digital age. The rapid integration of artificial intelligence across various domains presents both an unprecedented opportunity and a fundamental challenge for organizations seeking to enhance their STM structures and practices. As AI technologies mature from experimental applications to core business capabilities, organizations face a transformation for which many are inadequately prepared.

This research addresses a critical gap in literature: despite extensive work on AI's technical aspects and broader strategic applications, there exists no unified, integrated framework for its systematic embedment within STM practices. This deficit highlights a fundamental challenge - how to transition from conceptual understanding of AI's capabilities to pragmatic and strategic implementation within existing operational frameworks. The significance of this research comes from recognizing AI not merely as another technological tool, but as a catalyst requiring a fundamental shift in how organizations approach strategic technology management.

The research is motivated by a central paradox: while AI promises to address human attention scarcity and enhance decision-making capabilities, it simultaneously creates new demands for human oversight, particularly in verifying outputs for complex strategic tasks. This tension is further complicated by divergent perspectives on AI's ultimate role. One perspective positions AI as augmenting human capabilities, enabling strategists to focus on higher-value activities like ethical oversight and creative problem-solving. Conversely, a more transformative vision explores pathways toward greater automation through AI agents, exemplified by concepts like the "Agentic CTO".

The primary aim of this study is to identify how organizations can leverage AI to enhance the value of their technology investments by analysing what barriers AI can reduce to improve managerial productivity and their ability to implement successful strategic technology management roadmaps. This investigation addresses three interconnected research questions:

RQ1: What critical success factors does AI innovate for formulating the STM roadmap under conditions of creativity and uncertainty?

RQ2: What resources and capabilities should organizations have to enhance their STM roadmap formulation in complex scenarios with AI?

RQ3: How should the interaction between humans and AI be designed to enhance the performance of complex STM tasks?

Through a comprehensive mixed-methods approach combining literature review, quantitative survey data, and qualitative expert interviews, this research develops the AI-based Strategic

Technology Management (AIbSTM) conceptual framework. The framework serves as both a theoretical contribution and practical guide, synthesizing the technical capabilities of AI with the essential human and organizational aspects of STM.

The paper is structured as follows: Section 2 reviews relevant literature across three core themes - STM success factors, the Resource-Based View applied to AI, and human-machine interaction dynamics. Section 3 outlines the mixed-methods methodology. Section 4 presents findings from both quantitative and qualitative phases. Section 5 discusses these findings in relation to the research questions. Finally, Sections 6 concludes with theoretical and practical implications of AI in strategic technology management.

2. Literature Review

2.1. Strategic Technology Management and Success Factors

Strategic Technology Management involves planning, organizing, leading, and controlling technology implementations to support organizational business strategy (National Research Council, 1987; Roberts, 2001). It contributes to formulating and executing long-term goals by allocating necessary strategic technology resources (Sahlman, 2010; Deutsch and Berényi, 2023).

The literature identifies several critical success factors for effective STM. Strategic technology decisions prove most effective when aligned with business and competitive strategies, ensuring technology choices provide significant cost advantages or create highly valued stakeholder capabilities (Sahlman and Haapasalo, 2012). Success is influenced by broader organizational factors including industry context, inter-organizational strategies, cross-functional collaboration, and human resource management practices (Meer and Calori, 1989). Additionally, competitive environment, management control style, and incentive systems play significant roles in guiding strategic choices (Sands, 1991).

Effective leadership and supportive organizational culture emerge as integral success factors. Leaders guide problem definition and solution development while establishing change-receptive cultures. However, research often overlooks how leader behaviours, collaboration, and processes directly influence organizational technology innovation (Kurzhals et al., 2020). Cooper (2024) advocates for a "four-point dialectic" that evenly distributes attention among strategist, technology, customer, and industry trends. Successful technology adoption requires integrating new technologies with existing culture (Borkovich et al., 2015) and accumulating knowledge through experience and "learning by doing" to enhance technological capabilities over time (Kharbanda, 2001).

As organizations navigate cultural integration and learning challenges, particularly in volatile, uncertain, complex, and ambiguous (VUCA) environments, the proliferation of large language models and evolution of AI-based agents increasingly create opportunities for achieving strategic alignment (Krishnan, 2025) through their ability to simulate scenarios and analyse vast datasets (Holmström and Carroll, 2024, Alexander, 2025). AI transforms alignment by linking organizational goals and technology roadmaps through data, enhancing adaptability through

scenario simulation. Its predictive capabilities improve decision-making, enabling organizational ambidexterity - exploring new opportunities while exploiting existing strengths (Daskalopoulos and Machek, 2025).

A core AI benefit is accelerating insight generation from extensive datasets, enabling bold, evidence-based strategies moving beyond intuition (Biloslavo et al. 2024). Real-time data analysis and predictive foresight maintain alignment in rapidly changing environments (Schrage et al., 2024). AI addresses operational challenges like "blank page syndrome" by generating creative starting points and structuring unstructured data, preserving human judgment while enhancing dynamic decision-making capabilities (Yun et al., 2025).

2.2. Resource-Based View and AI Capabilities

The Resource-Based View (RBV) postulates that firms achieve sustained competitive advantage through possessing and deploying resources that are valuable, rare, inimitable, and non-substitutable (VRIN) (Wernerfelt, 1984; Barney, 2001). This framework proves particularly relevant for analysing AI adoption, as its uneven implementation across firms can be explained by differences in their access to AI-related VRIN resources and capabilities.

Resources encompass tangible or intangible assets firms own or control, while capabilities represent the ability to effectively combine, deploy, and leverage these resources strategically. AI requires specific resources including powerful computational hardware, natural language processing capabilities (Krishnan et al., 2019), and large datasets for effective decision-making (Jones and Wray, 2006, Massoudi et al., 2024). However, resources alone prove insufficient. Organizations must develop capabilities enabling collaboration with AI researchers through open innovation while retaining distinct internal execution strategies (Haefner et al., 2021; Agarwal, 2025).

The scaling law of AI performance critically influences resource requirements, demonstrating that improvements depend on jointly expanding data, compute, and model size (Kaplan et al, 2020). This creates resource asymmetries predicted by RBV to underpin competitive advantage. However, when AI capabilities are commoditized as services, smaller firms can compete by leveraging unique data niches, domain expertise, or inimitable governance routines (Alexander , 2025; Diyin and Bhaumik, 2025).

Governance capabilities emerge as particularly critical, encompassing data-driven workflow management, role definition, human-AI collaboration fostering, and strategic AI positioning (Perifanis and Kitsios, 2023). Effective governance necessitates data ownership, curation capabilities, ethical frameworks, risk assessments, and lifecycle compliance automation (Floridi et al., 2025; IBM, 2025). It is worth noting that legislation and regulations such as the EU AI Act may transition governance from a differentiating capability to a market prerequisite.

Human talent represents another differentiating resource, valuable for specialized, often tacit knowledge. Integrating AI with strategic management demands "fusion skills" combining domain expertise with AI literacy (Purdy and Williams, 2023; Mäkelä and Stephany, 2024) and requiring middle management to acquire AI skills for bridging the communication between AI adopters and

inhibitors (Rowe et al., 2024). Organizations necessitate integrated approaches including targeted hiring, reskilling, and workforce reconfiguration to position AI talent as an effective differentiator.

Organizational culture proves foundational for success. A data-centric culture establishes robust governance for quality and privacy while promoting data-driven decision-making. Agile cultures respond effectively to AI-driven changes, developing digital competencies and enabling operative AI tool usage (Čižo et a., 2025; Li, 2025). Cultural readiness requires proactive change management and AI literacy programs securing stakeholder buy-in (Abdullah et al., 2025).

However, cultural readiness alone proves insufficient given AI's unprecedented pace of innovation. With AI technology rapidly evolving, organizations require dynamic capabilities - organizational processes enabling environmental adaptation (Teece et al.m 1997) - prove essential for sustained AI advantage. These include sensing opportunities, seizing resources for promising initiatives, and transforming workflows and structures (Owusu and Agbesim 2025). Self-improvement capabilities represent an advanced frontier, with techniques like automated quality control loops and AI-enabled R&D allowing dynamic strategy adjustments (Lu et al., 2024, Kokotajlo et al., 2025).

2.3. Human-AI Interaction in Strategic Contexts

Integrating AI into organizational decision-making introduces significant complexities requiring well-thought-out strategies (Davenport, 2021; Kesting, 2024) with boundary between successful AI integration and non-successful AI integration scenarios forming a "jagged technological frontier" where optimal approaches remain incompletely understood (Dell'Acqua et al., 2023). AI adoption depends fundamentally on human-AI relationships, requiring an understanding of motivations, emotions, behaviours, and attitudes (Chernov et al., 2020, Haefner et al., 2021), with technology leaders playing a crucial role in guiding organizations through the transformation toward cognitive economies where intelligent machines become central to the workforce (Naqvi, 2017; Schrage et al., 2024).

Culturally, organizations should address leadership resistance by demonstrating AI value through executive training that enables collaborative data interrogation and scenario exploration. Human-AI integration models designed to deliver tangible benefits should include safeguards to prevent task polarization, whereby simple tasks become simpler while complex tasks grow more complex (Simkute et al., 2024), creating a paradox in which high human attention is required for verifying AI outputs despite AI being intentionally engaged to address human attention scarcity (Eriksson et al., 2020; Woodruff et al., 2024).

In the literature, augmentative patterns where AI supports iterative refinement and knowledge acquisition emerge as predominant. Regarding complex tasks, avoiding paradoxes necessitates designing co-creation cycles, explanatory dialogues, and verification mechanisms that position AI as a collaborative companion (Accenture, 2025; Handa et al., 2025). 'Copiloting' exemplifies this complexity, structuring work around natural language interactions and benefitting from AI's content creation capacity (Banh et al., 2025).

Trust emerges as a cornerstone of collaboration with the "black box" nature of sophisticated AI models eroding confidence (Floridi, 2023). While Explainable AI addresses aspects of this

opacity through human-centred explanations and has proven successful in high-stakes fields (Bila et al., 2025), building trust extends beyond explainability to encompass privacy, bias, and control concerns. Trustworthy AI frameworks emphasize human oversight, demonstrated competence, and uncertainty reduction (Li et al., 2024), built on techniques such as multi-stage reasoning and Introspective Uncertainty Quantification that enable AI self-critique and provide consistent uncertainty estimates (Mei et al., 2025).

Despite these advances, significant risks persist in adopting a 'Copiloting' model. These range from AI facilitating labour exploitation through "growth without calories" - where firms expand without hiring (Galloway, 2024) - to over-reliance risks that lead to cognitive degradation, undermining motivation and critical thinking. In response, recent research (Singh et al., 2025; Wu et al., 2025) suggests reframing the human role as "steward," one who actively verifies outputs and refines prompts (Collins et al., 2025; Lee et al., 2025), representing a more effective and valuable human-AI collaborative model.

3. Methodology

3.1. Research Philosophy and Design

This study employed a pragmatic mixed-methods design to investigate AI's impact on Strategic Technology Management. The methodology was grounded in critical realist ontology, which recognizes that reality exists independently of our perception, while also acknowledging that human understanding shapes how we know that reality (Saunders and Lewis, 2017). This philosophical approach allowed the exploration of both objective organizational structures and subjective individual experiences within those structures.

The adopted mixed-methods approach is a sequential explanatory one, beginning with quantitative data collection to establish broad foundations, followed by qualitative inquiry providing contextual depth (Creswell, 2021). This structure ensured initial quantitative findings informed and directed subsequent qualitative investigation, yielding richer, more nuanced understanding. The strength of the adopted mixed-methods approach lay in its ability to provide explanations that neither method could achieve alone.

3.2. Quantitative Phase: Online Survey

The first quantitative phase used an online survey through Google Forms between November 2024 and February 2025. The survey was designed to test findings and address gaps from existing literature while measuring the prevalence of AI adoption among the broader professional population.

3.2.1. Survey Design

The survey comprised 21 sections containing 120 single-choice questions, predominantly utilizing 5-point Likert scales. Sections addressed themes including AI adoption in STM practices, trust levels, cultural readiness, human-AI interaction, resources, skills, and investment priorities. Questions were structured to operationalize abstract constructs such as perceived workload

associated with AI output verification, trust in AI systems, and organizational AI governance preparedness. The instrument underwent pilot testing to ensure question neutrality and minimize response bias.

3.2.2. Sampling and Data Collection

The study employed convenience and snowball sampling through professional networks. Initial distribution to LinkedIn Groups reached potential audience of 7 million accounts, yielding limited responses. Subsequently, distribution to the researcher's personal LinkedIn network (1,726 users) proved more effective, generating 278 responses with 230 valid completions (82.7% validity rate).

3.2.3. Statistical Analysis

Quantitative data underwent rigorous statistical analysis including:

- Reliability testing using Cronbach's Alpha ($\alpha = 0.906$ for 53 items), demonstrating high internal consistency
- Descriptive statistics calculating means and standard deviations for Likert-scale items
- Pearson correlation analysis investigating relationships between variables
- Linear regression analysis examining predictive relationships.

Statistical analysis revealed significant relationships, including positive correlation between AI's strategic action definition role and uncertainty handling ability ($r=0.52$, $p<0.01$), and predictive relationship between perceived AI effectiveness and future adoption intentions ($\beta=0.63$, $p<0.001$).

3.3. Qualitative Phase: Expert Interviews

Following quantitative analysis, the study transitioned to qualitative inquiry using semi-structured interviews with 14 industry experts. This phase employed purposive sampling to select participants who could provide rich, contextual insights based on their specific expertise.

Four distinct professional groups were targeted with the aim of obtaining a broad perspective on strategic technology management decision-making: (1) those responsible for making strategic technology decisions (Chief Technology Officers/Chief Information Officers/IT Directors); (2) those providing AI tools (Strategic Portfolio Management Product/Service Vendors); (3) those designing AI architectures (AI Platform Architects); and (4) those developing conceptual models to support such decisions (Academic Researchers).

Response rates varied across groups, with approximately 10% of all professionals contacted participating in the interviews - a rate reflecting expected executive-level engagement patterns - providing sufficient data for rich qualitative analysis.

3.4. Interview Protocol

The semi-structured interview guide drew on survey findings to explore emerging themes in greater depth. The protocol addressed six key themes:

- AI adoption and readiness in strategic management
- Critical resources for AI integration in technology strategy decision-making

- Speculative views on autonomous and automated AI in STM (the "Agentic CTO" concept)
- Balance between human expertise and AI capabilities
- Strategic roadmap formulation under VUCA conditions
- Trust, accountability, and ethical concerns

Interviews were conducted remotely via Microsoft Teams between April and June 2025, with sessions digitally recorded and transcribed using automated services. The semi-structured format allowed flexibility to explore emergent topics while maintaining consistency across core themes.

3.5. Data Analysis and Integration

3.5.1 Qualitative Analysis

Interview transcripts underwent systematic analysis using NVivo software. Initial open coding generated 651 distinct codes, which were subsequently clustered according to the research questions and further refined into 20 categories directly linked to those questions.

3.5.2 Data Triangulation

Integration of quantitative and qualitative data occurred at the interpretation stage. The mixed-methods design enabled meta-inferences (Tashakkori and Teddlie, 2010) greater than individual parts' sum. Quantitative findings provided broad landscape understanding, while qualitative data offered contextual depth necessary for interpretation. For example, survey results showing low AI adoption for strategic functions were explained through interviews revealing organizational barriers and cultural resistance.

This triangulation enhanced validity and reliability by ensuring patterns observed in one dataset could be validated or contextualized by another. The convergence of findings from diverse sources provided robust, well-substantiated conclusions about AI's impact on STM.

4. Findings and Analysis

The empirical findings of the research are presented by combining both the quantitative survey results and the qualitative insights generated from expert interviews. The purpose of this structure is to align with the sequential explanatory design of the study: the survey establishes broad patterns and relationships in organisational practice, while the interviews provide depth, context, and interpretation. Together, these complementary phases create a robust evidence base on which meta-inferences can be drawn.

Figure 1 and Table 1 below provide information about participants' demographics, including professional roles, industries, and geographic distribution, for the quantitative survey respondents and semi-structured interview participants, respectively.

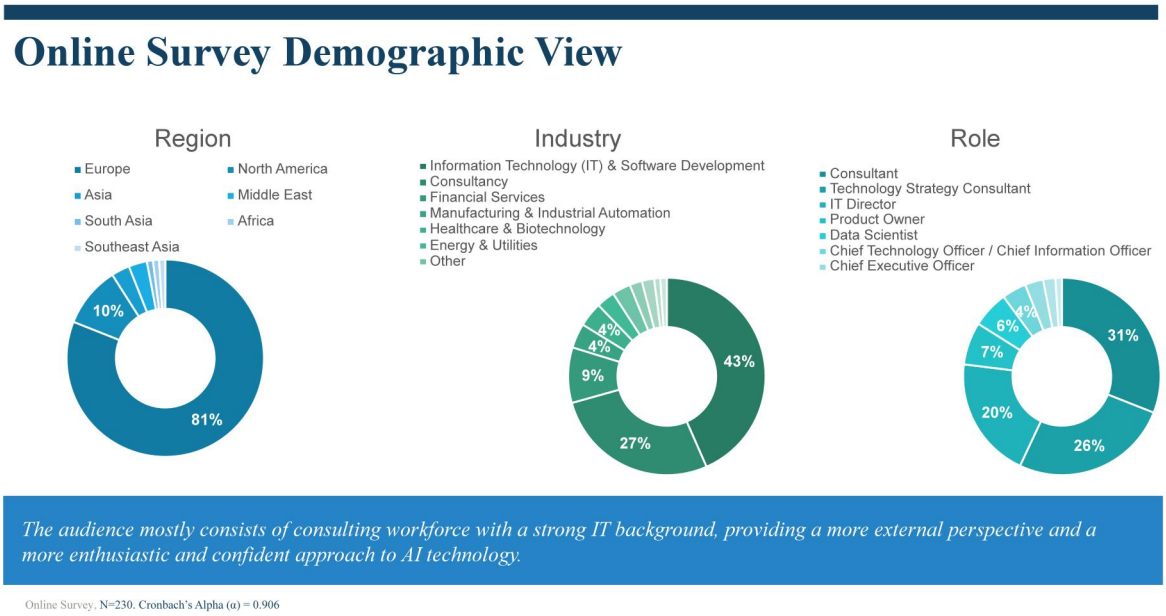

Figure 1. Overview of the Online Survey respondents' demographics

Table 1. Semi-structured expert interviewees list

Interview #	Geography	Job Role / Position	Years of Experience
Interview 1	North America	Finance CIO, Managing Director, Global IT at a leading Consulting Firm	>20
Interview 2	South America	Professor of Technology and Innovation Management	>15
Interview 3	North America	AI for IT CIO, Senior Manager at a leading Consulting Firm	>25
Interview 4	South Asia	Strategy and Business Operations Lead	>15
Interview 5	Europe	IT Strategy and Execution Lead	>40
Interview 6	Europe	CTO, Chairman and Board Member	>35
Interview 7	North America	CISO and Adjunct Professor	>30
Interview 8	North America	CTO and Head of Software Development	>35
Interview 9	North America	CTO and co-funder	>25
Interview 10	North America	CTO and Product Engineering Lead	>15
Interview 11	North America	GenAI Consultant	>10

Interview 12	North America	Founder, AI Governance and CTO	>20
Interview 13	Middle East	Technology Executive at a leading SPM and EA platform vendor	>25
Interview 14	Southeast Asia	Futurist and Board Advisor	>40

4.1. Strategic Alignment and the AI factor

4.1.1. Survey Findings on AI's Role in STM

The quantitative analysis (visualized in Figure 2) revealed AI's moderate yet evolving impact on strategic technology roadmap formulation. AI demonstrated strongest value in providing leadership advisory functions (M=3.24, SD=0.99), suggesting effectiveness in integrating data-driven insights into strategic formulation. However, AI's capability to navigate VUCA scenarios remained limited (M=3.08, SD=1.04), indicating current inability to fully manage unpredictability inherent in uncertain environments. AI proved most effective in tactical roadmap aspects, particularly defining "Know WHAT" (M=3.47, SD=1.00) and "Know HOW" (M=3.54, SD=1.00). Conversely, effectiveness diminished for higher-level strategic elements as strategic intent "Know WHY" (M=3.14, SD=1.00) and timing "Know WHEN" (M=3.00, SD=1.00).

Limited data availability and quality (M=4.06, SD=1.00) directly impact the reliability of AI in providing recommendations under uncertainty. This relationship is evidenced by a strong positive correlation between AI's role in strategic action definition and its uncertainty handling ability ($r=0.52$, $p<0.01$), with the highest correlation observed for the "Know WHY" dimension ($r=0.49$, $p<0.01$).

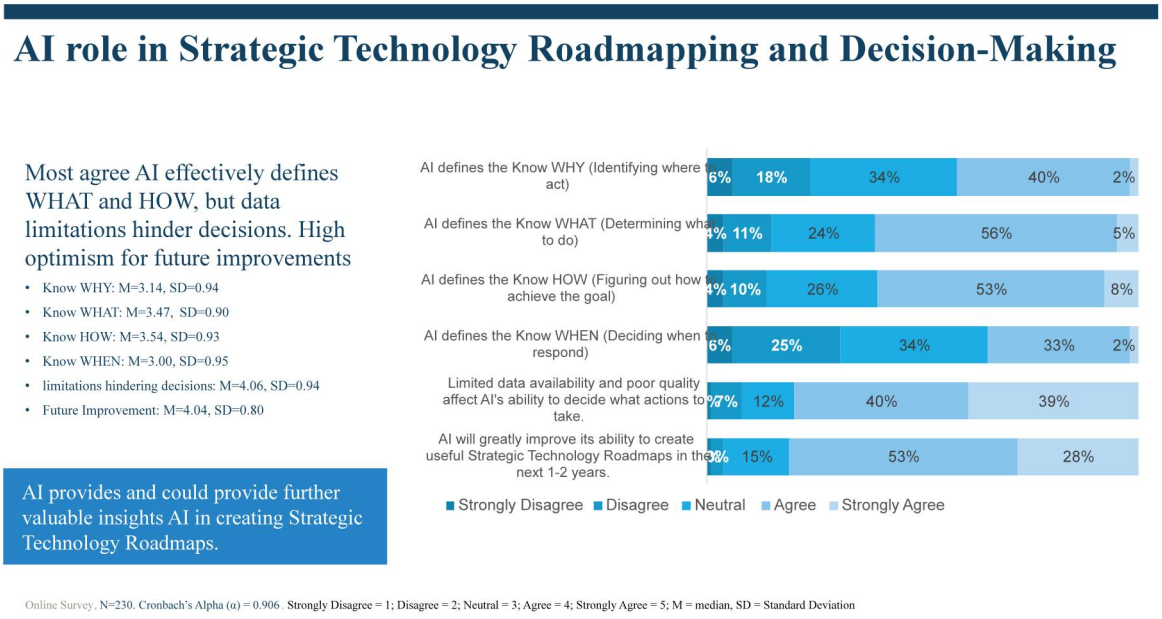

Figure 2. AI role in Strategic Technology Roadmapping and Decision-Making

Organizational challenges significantly impeded AI adoption, particularly weak leadership mandates (M=2.75, SD=1.00) and organizational resistance to change (M=3.48, SD=1.00). Nevertheless, despite these current limitations, respondents remained optimistic about AI's potential for VUCA management, anticipating substantial improvements within 1-2 years (M=3.84, SD=0.85).

4.1.2. Expert Perspectives on Strategic Alignment

Interview analysis revealed that AI's role extends beyond operational optimization to enable enhanced strategic clarity. Experts consistently emphasized the necessity of defining clear business objectives prior to any AI deployment. As one CTO articulated: "Creating what I call a business architectural definition of what it is that I'm trying to achieve" is fundamental to successful alignment regardless of AI. Seeking strategic clarity should influence how organizations evaluate their AI investments. Rather than relying solely on traditional ROI metrics, respondents indicated a need to assess AI initiatives based on their capacity to enable outcomes that were previously unattainable. As one expert explained, AI enables companies to "achieve goals that were not achievable before," representing a "huge opportunity." However, respondents emphasized that realizing these goals requires rigorous alignment between investments and well-defined business capabilities, cautioning against fragmented initiatives that pursue "silver bullet" solutions without sufficient organizational maturity.

Interviews revealed AI's profound limitations in authentic strategic cognition. Multiple experts warned of AI's inability to capture subjective strategic elements - the "air" in strategic workshops encompassing unspoken nuances, cultural DNA, and accumulated leadership intuition. One interviewee cautioned that AI-generated strategies risk being "inauthentic and disingenuous," technically correct but lacking embedded human context vital for true alignment.

The "Agentic CTO" concept, inspired by NVIDIA CEO Jensen Huang's vision of AI agents replacing human technology leadership (NVIDIA, 2025), was largely rejected by interviewees. One expert suggested this narrative primarily serves commercial agendas: "I think it's useful for him to maintain a certain narrative that drives consumption of GPUs." Another distinguished between operational automation feasibility and strategic planning complexity: "There's an awful lot of standard automation that can be done... but to get to a point where you fit into process understanding... that's not feasible."

4.2. Resources and Capabilities Through the RBV Lens

4.2.1. Quantitative Assessment of AI Resources

Survey findings (visualized in Figure 3) revealed clear prioritization hierarchies among AI resources. Computational power emerged as a commodity resource (M=1.62, SD=1.16), with low strategic value indicating a "Buy" orientation through cloud providers. In contrast to this commoditized view of computational infrastructure, three core resources emerged as significant differentiators requiring a "Build" orientation.

Foremost among these strategic resources was proprietary data (M=3.81, SD=1.33), which respondents valued most highly due to its uniqueness and context-specificity. Similarly valued

was human talent (M=3.68, SD=1.27), recognized for the specialized, tacit knowledge necessary to translate generic AI tools into strategic assets. AI governance (M=3.83, SD=1.36) was equally prioritized as a complex, organization-specific capability essential for building trust and ensuring responsible deployment.

However, despite the high perceived value of governance capabilities, current investment levels revealed concerning gaps (M=3.20, SD=1.06), though future investment intentions were notably stronger (M=3.88, SD=0.88). Algorithms occupied a middle position in the strategic hierarchy (M=3.07, SD=1.50), suggesting that their strategic value depends on integration with proprietary resources.

These perceptions translated into distinct investment priorities for the next 1-2 years, with data (M=3.75, SD=1.29) and human talent (M=3.54, SD=1.35) receiving clear emphasis. By comparison, computational power (M=2.54, SD=1.41) received lower priority, consistent with its commodity status. Notably, AI governance (M=2.89, SD=1.42) also received lower near-term investment priority despite its recognized long-term importance.

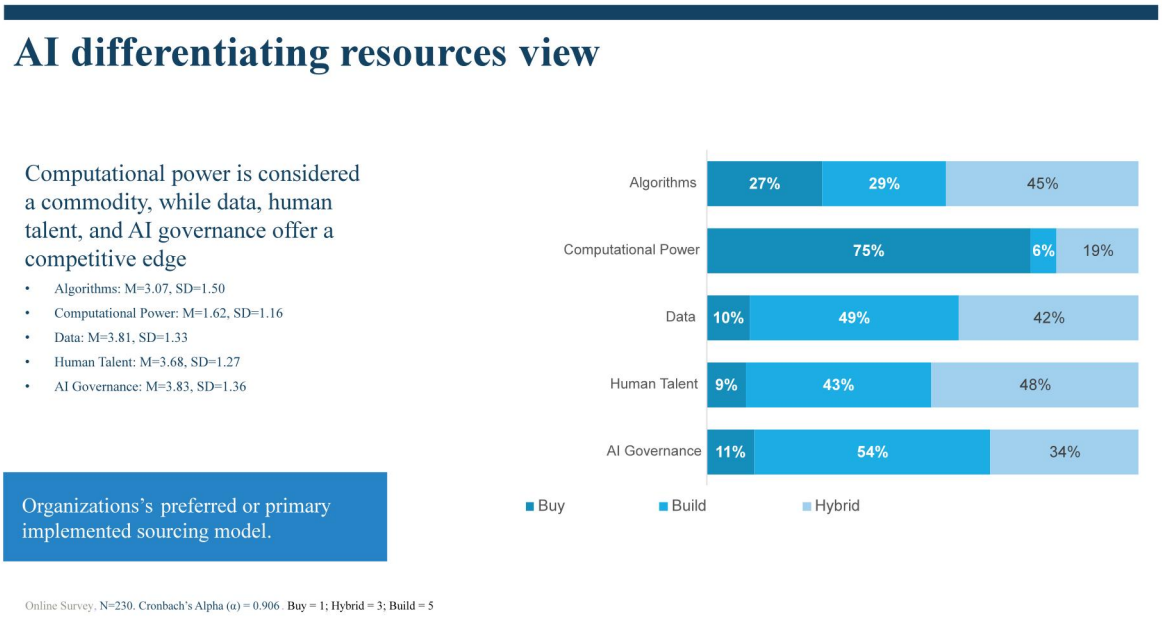

Figure 3. AI differentiating resources view

4.2.2. Qualitative Insights on Critical Capabilities

Expert interviews validated and elaborated upon these survey findings, providing deeper insight into how organizations approach these prioritized resources. Consistent with the high valuation of proprietary data in the survey results, data accessibility emerged as a foundational capability in the interviews. As one CIO emphasized: "It is data accessibility that is critical. We have structured governance to direct AI initiatives and ensuring data is accessible and of high quality."

However, interviews revealed a critical tension inherent in data management that the survey metrics alone could not capture: the competing imperatives of open knowledge sharing and proprietary data protection. One expert proposed radical accessibility, suggesting that "to achieve AI's Nirvana... we would have to create a world where we're accepting that our LLM knowledge can be publicly shared with anyone," while others emphasized protective approaches for maintaining competitive advantage. Accessing data resources proves insufficient without technical orchestration capabilities. Interviews iterated that organizations require unifying structured and unstructured data at scale, transforming core processes, and managing current AI limitations as hallucinations, unpredictable costs, and rapidly evolving models. Operational challenge as scalability concerns - “can technology support the volume? How would we be able to scale up?" - demonstrate why resource acquisition alone cannot guarantee strategic value

This tension helps explain why governance capabilities prove particularly complex in practice. The interviews illuminated specific governance challenges that account for the gap between perceived importance and current investment levels identified in the survey. Leadership disengagement emerged as a major barrier, with one expert noting "failure at the top" in understanding and embracing technology governance responsibilities. Effective governance requires dynamic capabilities: integrated feedback loops, adaptive compliance frameworks balancing ethical standards across jurisdictions, and continuous oversight mechanisms.

4.3. Human-AI Interaction Design

4.3.1. Survey Evidence on Collaboration Patterns

Survey respondents expressed cautiously optimistic yet constrained views regarding current human-AI collaboration. The majority acknowledged AI's potential to enhance human capabilities, particularly through "only when needed" support ($M=3.81$, $SD=0.80$), framing AI primarily as an augmentation tool rather than a true collaborative partner. The path toward deeper symbiotic relationships faces significant barriers, including ethical concerns ($M=3.30$, $SD=1.04$) and interaction difficulties, which tempered expectations for rapid evolution toward genuine human-AI symbiosis within 1-2 years ($M=2.99$, $SD=1.09$).

Despite these systemic barriers, practitioners demonstrated notably proactive stances toward individual skill development ($M=3.99$, $SD=0.78$), coupled with moderate confidence in interpreting AI outputs ($M=3.48$, $SD=0.92$). The progress toward enhanced capabilities is impeded by organizational resource constraints ($M=3.43$, $SD=0.99$), respondents expressed strong strategic commitment to future investments in human-AI capabilities ($M=3.99$, $SD=0.89$), with regression analysis revealing a significant predictive relationship between perceived AI effectiveness and future adoption intentions ($\beta=0.63$, $p<0.001$).

Trust-building initiatives, including transparent policies ($M=3.47$, $SD=1.05$) and ethical frameworks ($M=3.61$, $SD=1.00$), showed positive correlation with adoption rates ($r=0.43$, $p<0.01$). However, critical trust deficits persisted, particularly due to challenges in implementing effective audit mechanisms ($M=3.40$, $SD=0.89$) with trust concerns manifested by the overwhelming rejection of delegating accountability (see Figure 4) to AI systems ($M=2.13$, $SD=1.01$), reinforcing the continued requirement for human oversight.

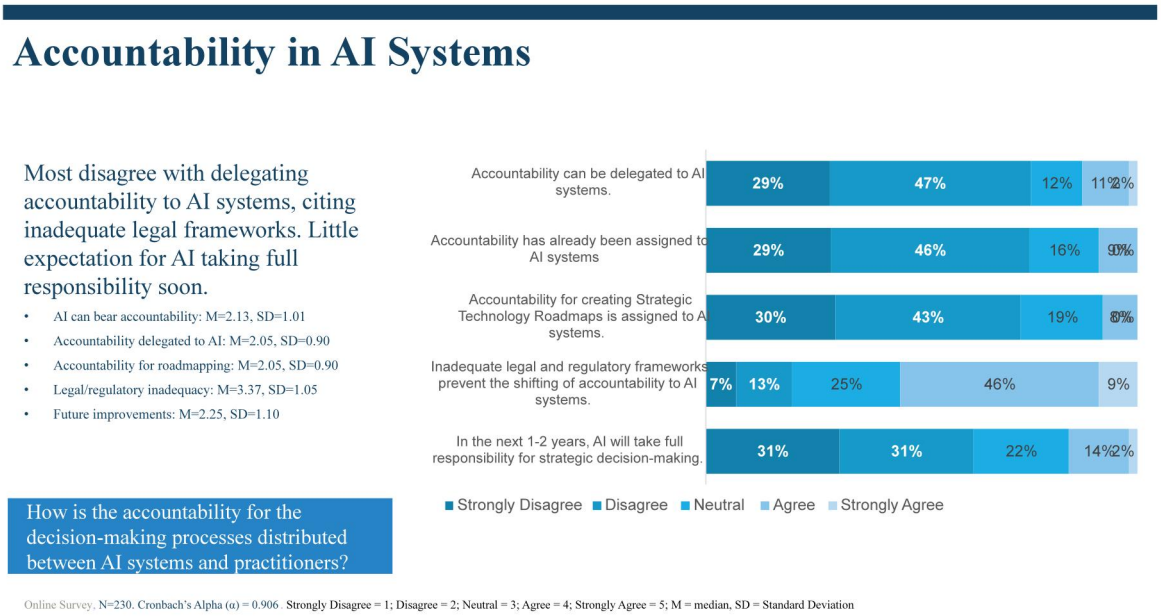

Figure 4. Accountability in AI Systems

4.3.2. Expert Views on Augmentation Models

Interview analysis reinforced the survey's positioning of AI as a strategic augmenter rather than replacement. Experts described AI's value in automating labor-intensive groundwork, with one noting that AI delivers "75-90% of drafting" while requiring human oversight for contextualization within organizational nuances and strategic intent. The interviews revealed that effective human-AI collaboration requires iterative co-creation. AI serves as a dynamic partner providing real-time insights and challenging assumptions, while humans refine direction and make final judgments.

The interviews elaborated on the trust concerns identified in the survey findings. AI "black box" nature creates fundamental barriers that transparent policies and ethical frameworks alone cannot fully resolve. Experts emphasized that building trust requires not only transparency and consistent performance but also user involvement in collaborative design. Organizations must focus on "celebrating successes" to build familiarity and confidence.

Interviewees conveyed that organizations must develop critical thinking competencies to evaluate AI outputs and formulate effective prompts. Successful AI-supported decision-making depends on "being able to articulate those [strategic] questions" to ensure AI responses align with organizational context and strategic objectives. The theme emerging from interview requires organizations moving beyond aspirational adoption toward evidence-based assessment of AI's impact on specific operational processes. Human expertise should be strategically reallocated from routine tasks toward complex decision-making activities that demand contextual judgment and strategic integration.

5. Discussion

5.1. RQ1: AI Innovation in STM Success Factors

The findings establish that AI fundamentally transforms two critical success factors for STM roadmap formulation under conditions of uncertainty and complexity.

First, AI enables a paradigm shift from intuition-based to evidence-based strategic alignment, providing data-driven insights that compel organizations to define clear business purposes and robust architectures before implementation. In this sense, AI acts primarily as a catalyst that forces strategic clarity rather than directly solving the alignment problem. AI's ability to process vast datasets and generate predictive insights addresses the long-standing challenge of cognitive bias in strategic planning. The correlation between AI's effectiveness in defining strategic actions and handling uncertainty demonstrates AI's potential for managing volatile environments. However, as the expert interviews reveal, this potential is realized only when organizations exhibit already the discipline and maturity necessary for pursuing strategic alignment.

Second, AI's ability to process high volumes of data at speed enables a shift from static STM roadmaps to continuous strategic planning - an "infinite game" approach fundamentally reconceptualizes STM, replacing rigid multi-year plans with fluid, adaptive frameworks.

However, significant limitations persist. Experts warn of a "mirage of alignment," where AI generates superficially impressive yet inauthentic strategies, underscoring the persistent importance of human judgment. The gap between AI's tactical strengths (Know WHAT/HOW) and strategic weaknesses (Know WHY/WHEN) requires human strategists to provide contextual intelligence and navigate organizational complexities beyond AI's grasp.

5.2. RQ2: Essential Resources and Capabilities

The research provides a comprehensive answer to the question of what resources and capabilities organizations require for AI-enhanced STM, revealing a clear hierarchy that challenges conventional assumptions about AI adoption. The findings definitively establish that competitive advantage derives not from technological resources themselves but from organization-specific capabilities to orchestrate the resources effectively.

The shift from technology to capability has concrete implications. Most notably, computational power - while necessary - has become commoditized and therefore strategically insignificant. The research suggests that organizations pursuing competitive advantage through computational accumulation are fundamentally misallocating resources, a finding that strikes with the current race to build powerful data centres (Kinder, 2025). Instead, the research identifies three categories of truly differentiating resources: proprietary data ecosystems, specialized human talent, and robust governance capabilities.

Among these differentiators, governance presents a particular paradox. Despite its recognized importance, it suffers from significant underinvestment, creating a substantial implementation gap deriving from leadership disengagement, rapidly evolving technology that outpaces governance frameworks, and the inherent difficulty of governing poorly understood systems. The urgency of

addressing this implementation gap is amplified by governance's transition from competitive differentiator to regulatory prerequisite, as exemplified by the EU AI Act.

The data reveals a further disconnect between organizational perception and strategic reality. The surprising undervaluation of algorithms in both survey and interview contrasts sharply with the literature's emphasis on pre-trained domain models, suggesting organizations may be overlooking strategic opportunities in developing specialized algorithmic capabilities tailored to their specific contexts.

5.3. RQ3: Designing Human-AI Interaction

This research reveals that human-AI collaboration remains constrained by fundamental trust and transparency barriers rather than technological capability. The overwhelming rejection of AI accountability reflects persistent concerns about black box reasoning, inadequate audit mechanisms, and unclear ethical. While AI automates substantial groundwork, organizations refuse to delegate strategic authority, positioning AI strictly as an augmentation tool rather than collaborative partner.

The gap between individual skill development and organizational investment signals a fundamental misalignment: AI integration is treated as a competency problem rather than systemic transformation. Effective collaboration demands reconstructing how organizations allocate cognitive labor and developing capabilities to formulate strategic questions that align AI outputs with organizational context. The predictive relationship between perceived effectiveness and adoption intentions reveals that transformation emerges through experiential learning rather than advance planning, requiring iterative capability reconfiguration rather than predetermined implementation strategies.

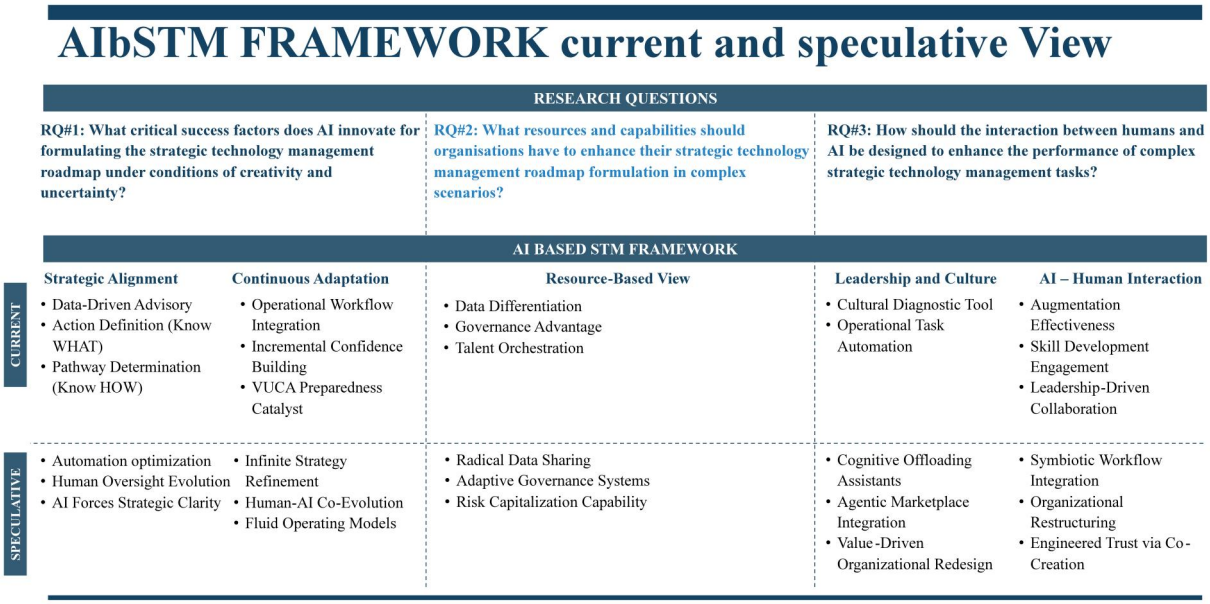

Figure 5. AIbSTM Framework highlighting the current practices across each dimension of the framework and the speculative view for evolutionary directions

5.4. Synthesis and Implications

The AIbSTM framework, visualized in Figure 5, synthesises the insights emerged in the discussion by providing both theoretical advancement and practical guidance. Its three-layered structure - strategic alignment/continuous adaptation, resource-based view, and leadership/culture/interaction - maps directly onto the research questions while offering actionable pathways for implementation. The framework's value lies not just in describing current practices but in prescribing the organizational transformations necessary for successful AI integration.

6. Contribution and Limitations

6.1. Theoretical and Practical Contributions

The research advances Resource-Based View theory by demonstrating that AI-driven competitive advantage derives not from computational resources - which are increasingly commoditized - but from organization-specific capabilities in data governance, specialized talent development, and ethical AI leadership. The study establishes governance frameworks and dynamic leadership as critical theoretical constructs, addressing both the socio-technical chasm (trust, cultural readiness) and the cognitive chasm (human judgment versus algorithmic processing) that impede AI value realization. By reconceptualizing AI integration as a capability-building effort requiring symbiotic human-AI collaboration, the research extends RBV beyond traditional resource acquisition toward dynamic capability cultivation.

The AIbSTM framework synthesizes these theoretical insights into actionable guidance through its three-layered structure: strategic alignment enabling continuous adaptation through real-time analytics; resource orchestration; and human-AI interaction design preserving human judgment while leveraging AI's analytical power. The framework practical value extends beyond prescriptive guidance by enabling organizational self-assessment. Using the conceptual framework checklist in Appendix A, leaders can evaluate their organization's AI readiness across multiple dimensions, identify capability gaps, and prioritize interventions that ensure AI investments yield strategic rather than merely tactical value.

6.2. Limitations

This study acknowledges some methodological limitations. The convenience and snowball sampling via LinkedIn may introduce selection bias toward technology-forward professionals. The cross-sectional design captures a single snapshot of rapidly evolving AI practices, precluding longitudinal examination of how trust, capabilities, and structures develop over time. While the qualitative sample (n=14) provides rich insights, its size limits generalizability may underrepresent critical perspectives. Self-reported survey data also presents potential response bias. These limitations were addressed through mixed-methods triangulation and transparent acknowledgment in interpreting findings.

7. Conclusion

This research establishes a comprehensive framework for understanding AI's transformative impact on strategic technology management. Addressing the persistent challenge of underperforming technology investments, the study demonstrates that AI's value lies not in automating strategy but in catalysing organizational transformation. The rejection of autonomous AI leadership in favor of human-centric augmentation represents a crucial finding with immediate practical implications.

The journey toward AI-enhanced strategic technology management requires continuous co-evolution between human and artificial intelligence rather than linear technological progress. Organizations must focus not on replacing human judgment but on creating synergetic relationships where AI's analytical power complements human creativity, contextual intelligence, and ethical reasoning. The introduced AIbSTM framework's provides both theoretical advancement and practical guidance for integrating AI into strategic decision-making in ways that enhance rather than diminish human contribution to organizational success.

Appendix A. Checklist and speculating view for the AIbSTM conceptual framework dimensions for AI facilitating STM

Strategic Alignment	
Observed behaviours and checklist	Data-Driven Leadership Advisory - AI provides insights to leadership, informing strategy decisions through analysed data. Validated by AI-powered drafted strategy: using generative AI to streamline initial strategic planning and documentation. This includes crafting tailored strategies, goals, and objectives based on user input, which allows for more adaptable workflows and cross-verification of information.
	Action Definition (Know WHAT) - AI identifies specific strategic actions needed based on analysis. Validated by Scenario simulation: simulate scenarios like market shifts and competitor actions to make strategies more adaptable and proactively test strategic options.
	Pathway Determination (Know HOW) - AI outlines implementation methods and technological pathways for strategic initiatives. Validated by Automated portfolio management: enablement of [or deployment of tools to provide] AI based support portfolio management by providing real-time insights, modelling what-if scenarios, and optimizing portfolios for strategic prioritization.
Speculating – how AI could support higher strategic alignment	Agentic CTO Evaluation - AI autonomously performing core CTO functions (strategy synthesis, roadmap creation). More feasible for specific hierarchical/digital-native cultures with low ethical constraints.
	Human Oversight Evolution - Human roles shift from direct control to phased supervision of AI agents. Requires structured roadmaps (from controls to supervision) and tolerates non-

	linear progression.
	AI Forces Strategic Clarity - AI reinforcing unprecedented precision in business purpose, objectives, and translation to technology. Still success depends on robust organization' business architecture and overcoming measurement.
Continuous Adaptation	
Observed behaviours and checklist	Operational Workflow Integration - AI effectively handles routine tasks, establishing a foothold in daily processes despite strategic hesitancy. Validated by Integrate AI into Workforce Planning: using AI for scenario planning to anticipate skill gaps, automate talent allocation, and identify reskilling pathways.
	Incremental Confidence Building - Gradual AI adoption in low-risk areas fosters organizational trust for future strategic scaling. Validated by Integrate Human-AI Bidirectional Learning: creating a continuous feedback loop where AI adapts to human feedback, and humans adjust to AI insights.
	VUCA Preparedness Catalyst - AI enables early-stage volatility monitoring, providing data-driven signals for proactive adaptation. Validated by Integrate Dynamic What-if Scenarios: using AI to model and test strategic options, ensuring continuous adaptation to market and competitor changes.
Speculating – how AI could define and facilitate continuous adaptation	Infinite Strategy Refinement - AI could enable real-time roadmap updates weekly/monthly. Requires human oversight to prevent "superficial outputs".
	Human-AI Co-Evolution - AI as symbiotic partner navigating VUCA uncertainties. "Cultural inertia" may obstruct equitable collaboration.
	Fluid Operating Models - Self-adjusting workflows where AI reconfigures strategies dynamically. Demands "structured change management" to avoid tool redundancy.
Resource-Based View	
Observed behaviours and checklist	Data Differentiation - Proprietary data is leveraged as a rare, valuable asset for unique AI insights, enabling competitive differentiation. Validated by Integrate AI Resources and Capabilities Checklists: to evaluate the key resources and capabilities as proprietary data ecosystems, specialized human talent, and robust governance capabilities.
	Governance Advantage - Robust AI governance is a non-substitutable capability building trust, mitigating unique risks, and enabling responsible, strategic AI deployment. Validated by AI Governance model: to manage data workflows and establish ethical frameworks, roles, and compliance.
	Talent Orchestration - Specialized human talent possesses tacit knowledge crucial for

	contextually developing, deploying, and managing AI effectively within the organization. Validated by Hybrid Talent model: integrate "fusion" skills with AI capabilities for strategic alignment.
Speculating – what new resources will determine a competitive advantage in an AI driven STM	Radical Data Sharing - Public sharing of proprietary data/knowledge (e.g., "publicly shared LLM knowledge") could unlock unprecedented AI value, redefining exclusivity. This requires balancing conservative views who fiercely protect proprietary data ("very protective") as a core strategic asset.
	Adaptive Governance Systems - Dynamic, embedded feedback loops and "polished frameworks" will continuously evolve governance, replacing static compliance. Requires overcoming leadership disengagement ("failure at the top") and ethical ambiguity for effective implementation.
	Risk Capitalization Capability - Organizations will strategically cultivate "healthy risk appetite" as a core capability, tolerating operational risk for speed/innovation. Must rigorously balance this with mitigating existential threats (e.g., breaches, reputational damage) highlighted as critical.
Leadership and Culture	
Observed behaviours and checklist	Cultural Diagnostic Tool - AI monitors organizational culture, identifies alignment/friction points via sentiment analysis. Validated by Culture and Leadership Diagnostic Tool: assess and guide organizational culture and leadership to effectively manage AI integration and human-AI interactions.
	Operational Task Automation - AI handles routine operational "dirty work", freeing human capacity for higher-value activities. Validated by Value Creation guidelines: define the value tree, linking business objectives to measurable key performance indicators (KPIs).
Speculating – how AI could change strategic technology leadership and culture	Cognitive Offloading Assistants - AI as "digital mentors/coaches" elevating human work. Requires workflow redesign to prevent value loss.
	Agentic Marketplace Integration - Marketplaces enable accessible AI agents for task execution. It requires managing "Extremely messy" unvetted agents risk ethics/alignment.
	Value-Driven Organizational Redesign - AI enables human-AI workflows focusing talent on strategy. It requires managing resistance to structural change hinders adoption.
AI – Human Interaction	
Observed behaviours and checklist	Augmentation Effectiveness - AI successfully automates groundwork (data/code generation), freeing humans for strategy/validation. Validated by Design for co-creation: design for co-creation cycles, explanatory dialogues, and verification mechanisms, positioning AI as a collaborative partner.
	Skill Development Engagement - High practitioner upskilling activity driven by leadership

	mandates on critical AI competencies. Validated by Establish human judgment checkpoints: preserve human expertise by creating verification points for AI-generated outputs.
	Leadership-Driven Collaboration - Leaders actively promote AI-human collaboration to boost decision-making performance in specific workflows. Validated by Checklist for AI-Assisted Decision Making: integrate AI to mitigate human bias, enhance foresight, and improve strategic decision-making. It should include validation for Bias Mitigation; Enhanced Foresight; Data and Insights; Interactive Loop; Dynamic Roadmaps.
Speculating – how AI and human will engage in an AI driven STM	Symbiotic Workflow Integration - AI evolves into a dynamic co-creator, providing real-time insights and challenging assumptions iteratively within tasks. It requires removing ethical and trust barriers.
	Organizational Restructuring - Shift to "diamond-shaped" teams with AI agents handling execution, reducing low-level roles and enabling fractional leadership. It requires moving [partial] accountability from human to machine developing new legal frameworks covering AI responsibility.
	Engineered Trust via Co-Creation - Trust built through explainable AI, low-risk pilots, user co-design, and celebrating joint successes to overcome "black box" fears. It requires reducing effectiveness gaps; and to address ethics concerns reducing trust.

Author Contributions:

Conceptualization, Massimo Fascinari; methodology, Massimo Fascinari; software, not applicable; validation, Vincent English; formal analysis, Massimo Fascinari; investigation, Massimo Fascinari; resources, Massimo Fascinari; data curation, Massimo Fascinari and Vincent English; writing—original draft preparation, Massimo Fascinari; writing—review and editing, Massimo Fascinari; visualization, Massimo Fascinari; supervision, Vincent English; project administration, Massimo Fascinari; funding acquisition, not applicable. All authors have read and agreed to the published version of the manuscript.

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The raw data supporting the conclusions of this article will be made available by the corresponding author on request.

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