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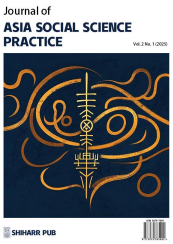

RESEARCH ARTICLE

TRAUMA AND POSTCOLONIAL ECOFEMINISM: J.M.COETZEE'S *AGE OF IRON*

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ABSTRACT

This paper examines the representation of trauma in J. M. Coetzee's Age of Iron through a postcolonial ecofeminist lens, highlighting the intersections of bodily suffering, colonial violence, and environmental degradation. It argues that trauma in the novel manifests as both physical deterioration and moral conflict, reflecting the enduring scars of apartheid and colonial oppression. Mrs. Curren's cancer-ridden body parallels the deterioration of the land, illustrating the entanglement of human suffering and ecological devastation. Through an analysis of trauma witnessing, ethical dilemmas, and the loss of identity, this study reveals how Coetzee intertwines individual and collective trauma within a postcolonial ecofeminist framework. By foregrounding the ecological dimensions of trauma, this paper expands existing postcolonial and feminist critiques, highlighting the underexplored intersections between bodily affliction and environmental violence. It further explores the rupture caused by ecological destruction and colonial dispossession, ultimately questioning whether healing and regeneration are possible within Coetzee's postcolonial ecofeminist vision. This study contributes to trauma studies, postcolonial criticism, and ecofeminism by elucidating Coetzee's critique of colonial legacies and the interwoven nature of trauma and ecological crisis.

1. INTRODUCTION

J. M. Coetzee's Age of Iron (1990), set against the backdrop of apartheid in South Africa, narrates the story of Elizabeth Curren, a retired white female professor of classical literature

diagnosed with cancer. Written as a first-person letter to her daughter in the United States, the novel chronicles Curren's final days as she confronts her impending death and engages with the harsh realities of racial injustice and societal decay. The novel begins when Mrs Curren finds a homeless man, Vercueil staying in her garage. As time goes by, their relationship deepens and Vercueil becomes Mrs Curren's companion. Mrs Curren witnesses the cruel consequences of the apartheid.Through Mrs Curren's letter to her daughter, Coetzee displays the brutal realities and trauma caused by the apartheid and its lasting impact upon individuals and the South African society.

This paper examines the representation of trauma in Age of Iron from a postcolonial ecofeminist perspective. Postcolonial ecofeminism is a multidisiplinary framework, which examines the colonial and patriarchal oppression upom women and nature. Vandana Shiva (1988) and Maria Mies (1986) argues that the violence resulted from colonial and capitalist systems against wome and nuture is deely interrelated. In Age of Iron, Mrs Curren's cancer is an analogy to the degradation of South Africa's natural environment, which intertwines Mrs Curren's personal sufferings with South African ecological degradation and displays that personal trauma within the postcolonial context is the result of the societal, historical and environmental oppression

Trauma theory lays a fundamental framework for understanding Mrs Curren's experiences. Cathy Caruth (1996) argues "Trauma is not simply an effect of destruction but also, fundamentally, an enigma of survival"(p. 11). Based on these concepts, Rothberg (2009) proposed the concepte of "multidirectional memory", which focuses on examing the diverse historical traumas caused by colonial histories and their legacies. Craps (2013) further stressed the significance of exploring the unique experiences of the marginalized and colonized peoples like South Africans, who suffered a lot from traumatic experiences.

This paper examines the the dual oppression of women and nature under apartheid by exploring the protagonist's traumatic experiences from a postcolonial ecofeminist perspective. Mrs Curren's personal trauma is interrelated with South African societal and ecological destruction, which resulted from its colonial history and patriarchal system. By Mrs. Curren's self-reflective narrative, Coetzee highlights the interconnection of personal sufferings and the environmental issues and reveals how colonial and apatheit violences devastate both individuals and the natural world. Ultimately, this study seeks to illuminate the complex and multifaceted nature of trauma within the colonial/postcolonial context, contributing to a deeper understanding of Coetzee's critique of apartheid and its enduring legacies.

2. LITERATURE REVIEW

As a novel that deeply reflects the impact of violence and political turmoil during South Africa's apartheid period on individuals and society, Age of Iron has ignited enduring scholarly discussions since its release in 1990. Existing research has explored multiple dimensions, including racial trauma, political violence, body and identity, ethical dilemmas, and postcolonial feminist perspectives. However, there remains a gap in systematically analyzing the intertwined relationship between female trauma and environmental destruction from a

postcolonial ecofeminist perspective. The following sections review the key literature in these areas to provide a foundation for this study.

Scholars have extensively examined the representation of racial segregation and its violent consequences in Age of Iron. Jęczmińska (2022) analyzes the living conditions of white and black communities in Cape Town, arguing that the novel reveals the profound impact of racial divisions on social structure and visions of the afterlife. Similarly, Urama (2023) explores Coetzee's representation of post-apartheid violence, highlighting how both white and black South Africans are victims of apartheid. He emphasizes the novel's potential to guide readers toward harmonious coexistence, addressing the lingering wounds of violence. While these studies illuminate the socio-political dimensions of apartheid, they do not delve into the intersection of racial trauma with gendered or ecological concerns.

The body narrative in Age of Iron has received widespread attention. Belgacem (2018) asserts that Coetzee's representation of the body as subject to dismemberment counters the colonial representation of the other's body as exotic and erotically-charged. Helaly (2023) compares Mrs Curren's body and the the apartheid system to the decay and downfall of South African and propses displacement as a coping mechanism for the oppressed. Lin (2001) focuses on Coetzee's use of "simultaneity rhetoric" and argues that Coetzee aligns the colonial and postcolonial experiences within a single narrative framework. This technique enables a dialogue between history and contemporary reality and discusses the complex ethical issues such as power, resistance, and human relationship. These studies provide valuable insights into trauma from the physical and symbolic aspects. However, they ignore the interconectedness between trauma and the environmental destruction or feminist concerns.

There are scholars who explore Age of Iron from Postcolonial feminist perspective. Salih & Janoory (2020) argue that Coetzee contributes to discourses on identity, resistance, and empowerment by partraying the black women's resilience and agency in the face of systemic injustice. Eze (2011) emphasizes the ethical responsibility implanted in maintaining memory and connections with others through examing the novel's exploration of empathy and moral judgment in the apartheit society. These perspectives stress the importance of female experiences in the novel, but they take no notice on the relationships between the environmental degradation and the female trauma.

Some scholars are attracted by Coetzee's ethical philosophy. Basing the argument on Levinas's ethical theory, Moosa-Mitha (2015) emphasizes the preservation of alterity by exploring the the encounters between the self and the Other in Age of Iron. Attridge (2021) explores themes of trust, betrayal, and human connection, using the protagonist's relationships to illuminate ethical responsibility toward the Other. Dong (2018) analyzes dysfunctional family dynamics and motherhood in the novel, interpreting Coetzee's portrayal of home as a complex interplay of biographical, national, ethical, and political factors. While these studies highlight ethical and familial dimensions, they do not fully address the interconnectedness of trauma, gender, and ecology.

In summary, existing literature has extensively explored Age of Iron from multiple dimensions, including racial trauma, political violence, social injustice, and ethical dilemmas. However, research on female trauma, particularly from the perspective of postcolonial ecofeminism, remains limited. Few studies have systematically analyzed the intersection of female trauma and environmental destruction in the novel. This study addresses this gap by examining Elizabeth Curren's trauma through a postcolonial ecofeminist lens, exploring the deep connections between the natural environment and character trauma. By doing so, it not only fills a critical gap in Age of Iron scholarship but also contributes to broader discussions on the intersectionality of gender, ecology, and colonial violence.

3. DISCUSSION

In the special historical context of apartheid in South Africa, trauma not only permeates individuals' psychology and bodies, but also runs through the overall ecosystem of society, culture, and nature. J. M. Coetzee's Iron Age vividly depicts the interweaving of individual and collective traumas in a delicate and complex narrative style, as well as how traumas are generated, continued, and reconstructed in postcolonial and ecological contexts. This chapter aims to explore the manifestation and multiple dimensions of trauma in novels from the perspective of the intersection of trauma theory and postcolonial ecofeminism.

In *Age of Iron*, Mrs. Curren, as a witness to the violence of racial segregation, not only observes direct acts of brutality but also witnesses the broader devastation of apartheid society through group violence. These events profoundly impact her psyche, leaving her with a painful internal conflict between feelings of powerlessness, guilt, and a sense of moral responsibility. She endures the dual trauma of witnessing violence. On one hand, confronting the injustice and pain caused by racial violence; on the other, her role as a "witness" imposes moral and emotional responsibilities. As Cathy Caruth (1996) states, to study psychological trauma means to bear witness to horrible events.

In the novel, Bheki and his friends are pursued by the police for resisting racially segregated schooling. As they cycle down Skender Street, they are closely followed by a police car that had been tracking them. A shocking event then occurs: the police car deliberately chases Bheki's bicycle, knocking him and his friend to the ground before speeding away as if nothing had happened. Mrs. Curren is shocked and frozen. She "screamed in a shrill voice that, hanging in the air…wanted to move but could not. There was a coldness in my limbs, and the word 'fainting' occurred to me" (Coetzee, 1990, p. 55). Two children are injured, especially Bheki's friend, whose forehead wound bleeds profusely: "Blood flowed in a sheet into the boy's eyes and made his hair glisten; it dripped onto the pavement; it was everywhere(Coetzee, 1990, p. 57)". Mrs. Curren "stared at it, fascinated, afraid, drawn into a veritable stupor of staring" (Coetzee, 1990, p. 58). All these descriptions capture the physical and psychological freezing that violence induces in witnesses. Mrs. Curren's paralysis in the face of violence exemplifies the traumatic impact, as Caruth (1996) argues: trauma not only affects the victim but deeply scars the psychological structure of witnesses as well.

In sharp contrast to Mrs. Curren's shock at the incident, Florence's response appears strikingly composed. When Mrs. Curren instinctively sought to provide assistance and informed Florence that an ambulance was on its way, Florence firmly refused: "We do not need the ambulance, said Florence (Coetzee, 1990, p. 57)… We do not want to be involved with the police, Florence repeated. There is nothing you can do against the police" (Coetzee, 1990, p.60). Her reaction underscores the profound trauma endured by black women under the apartheid system. Florence's refusal is not merely an individual response but a reflection of a broader historical reality in which interactions with state institutions, particularly law enforcement, often resulted in further violence and oppression for black communities. Her calm behavior in the face of crisis is actually a survival strategy shaped by systemic injustice, which displays South African women's distrust and fear that the colonial and apartheid history infused into them.

For Mrs. Curren, the ambulance represents the official medical assistance and the possibility of timely treatment for the boy. However, for Florence, the police and healthcare systems are the instruments of oppression and violence. Her rejection of official aid expresses the systemic trauma that the black women in South Africa have long endured. Florence's response is not only an immediate survival tactic but also a manifestation of deep-rooted historical trauma. This trauma extends beyond the direct violence inflicted by colonialism and apartheid policies to encompass structural injustice—black communities are systematically deprived of medical resources, state-sanctioned violence pervades daily life, and black women, in particular, are both witnesses to and victims of this pervasive oppression.

Felman & Laub (1992) suggest that witnessing violence is, in itself, a traumatic event, particularly when the witness feels powerless. This form of alternative trauma is also evident in Mrs. Curren's experience of witnessing brutal violence in Guguletu. As she describes:

> A man in a black overcoat swung an axe. With a crash, a window burst. He attacked the door… a woman with a baby in her arms flew out of the house, followed by three barefoot children… A stone came sailing out of the crowd and fell with a clatter on the roof of the burning shack. Another hit the wall, and another landed at the feet of the man with the axe. He gave a menacing shout. (Coetzee, 1990, p. 88)

Upon witnessing these scenes, Mrs. Curren's "heart pounded, pains shot through my chest… I was gasping" (Coetzee, 1990, p.88). She cannot fully believe the horror unfolding before her. Mrs. Curren's reflection upon her experiences in Guguletu illustrates the ripple effect of suffering: the pain of others inevitably impacts those who bear witness (Eze, 2011). She was traumatized by her acute awareness of the pervasive suffering caused by apartheid, especially the destruction of lives and dignity.

The final stage of Mrs. Curren's direct confrontation with violence occurs when she learns of Bheki's death. She finds his body:

> Against the far wall, shielded from the worst of the rain, were five bodies neatly laid out. The body in the middle was that of Florence's Bheki. The rain beat down on their bodies, and their eyes and mouths were filled with sand… His

> eyes were open and staring, his mouth open too… In the corners of his eyes there were grains of sand. There was sand in his mouth. (Coetzee, 1990, p. 94)

Felman and Laub (1992) argue that the psychological fragmentation of witnesses often stems from the contradictory mindset of wanting to take responsibility yet feeling powerless to change the situation. The death of Bheki deeply shocks Mrs. Curren. Wherever she turns, the image of the black boy lingers: "His eyes open in the look of childish puzzlement with which he had met his death" (Coetzee, 1990, p. 96). Reflecting on the deaths of the black children, Mrs. Curren declares, "This is the worst thing I have witnessed in my life… Now my eyes are open and I can never close them again" (Coetzee, 1990, p.93). She internalizes this conflict, even applying it to her own body: "It lives inside me and I live inside it… I thought: My life may as well be waste. We shoot these people as if they are waste, but in the end, it is we whose lives are not worth living" (Coetzee, 1990, pp. 93-96). This traumatic realization reveals her deep distrust and self-contempt for her white identity and its complicity in South Africa's colonial violence.

Faced with the chaos and violence in the townships, the corrupt of South African police force, and the indifference of security forces, Mrs. Curren's psychological suffering reaches a critical point. Our era, as Luckhurst (2013) points out, is one of witnessing. In this age, witnessing itself becomes a profound trauma. Although Mrs. Curren is not a direct victim of racial segregation policies, as a white witness, she is forced to confront the history and consequences of this violence. The trauma of witnessing does not stem solely from the events themselves but also from her empathy for the suffering of others and her reflection on racial inequality. Moreover, it highlights the psychological trauma caused by witnessing violence. K. T. Erikson (2012) emphasized that individual trauma often exists within the context of collective trauma, with the suffering of a group amplifying individual trauma through historical memory and social connections. Mrs. Curren, as both a victim of trauma (witnessing the helplessness of violence) and a perpetrator of trauma (through her complicity in oppressive systems), embodies Caruth's ethical responsibility of bearing witness to atrocities.

Herman (2015) asserts that witnessing the suffering of others creates a profound burden of conscience, especially when one is unable to intervene. In *Age of Iron*, Mrs. Curren's continuous exposure to violence and injustice leaves her tormented by guilt and shame. As Coetzee (2016) asserts, we have troubled histories behind us, which sometimes haunt us. Her emotional turmoil reflects the broader historical and ethical dilemmas faced by individuals who bear witness to systemic oppression, further highlighting the entanglement of personal conscience and collective trauma. Mrs. Curren recognizes her complicity in the apartheid system due to her privileged position as a white South African: "We all participated in this violence, whether by action or silence" (Coetzee, 1990, p. 45). Her acute awareness of her role as both a bystander and an indirect participant in systemic violence heightens her ethical conflict, epitomized in her lament: "I, a white... When I think of the whites, what do I see? I see a herd of sheep... milling around on a dusty plain under the baking sun" (Coetzee, 1990, p. 80). Coetzee's vivid imagery captures Mrs. Curren's existential struggle as an individual caught between moral responsibility and personal impotence. In describing herself as "a dodo... the last of the dodos, old, past egg-laying" (Coetzee, 1990, p. 28), Mrs. Curren embodies not only a personal sense of obsolescence but also the tension between her fading moral aspirations and the oppressive

forces that render her powerless. The "dodo" metaphor, traditionally representing extinction and irrelevance, becomes an existential symbol of a woman who feels detached from the transformative social movements around her, yet remains morally engaged, trapped in a conflict between self-awareness and the inability to act. The metaphor of "a locust horde... devouring lives" (Coetzee, 1990, pp. 28-29) starkly conveys the political and social devastation wrought by the apartheid system, suggesting a relentless force that consumes both individuals and communities. This emotional paradox, framed within the broader context of personal and national dissolution, underscores the tragic fate of a generation caught between historical trauma and the ethical demand for change.

Mrs. Curren's inner reflection on the violence of racial segregation reveals her acute awareness of historical trauma and her recognition of complicity within an oppressive system. However, her self-awareness does not alter the power asymmetry between her and the Black characters. Having long employed a black maid named Florence, she was accustomed to exerting dominance in their relationship. Mrs. Curren tries to alleviate her anxiety about her privilege through economic aid, seeking to show moral resistance to racial inequality. Yet, she cannot fully comprehend Florence's anger and struggle against racial oppression. When Florence speaks of the threats to her children due to racial violence, Mrs. Curren feels only "distant anger", which demonstrates she couldn't fully comprehend Florence's anger, as her suffering is driven more by personal emotions than by a genuine critical reflection on the white supremacist system. As Walsh (2010) notes, Mrs. Curren struggles to comprehend or imaginatively appropriate the suffering across the apartheid divide, which reflects her internal conflict and her inability to fully empathize with the suffering of others.

Mrs. Cullen's interaction with Vercueil still remained within the framework of white centrism and failed to truly establish an equal relationship. In the novel, Mrs Curren's relationship with Vercueil is uncomfortable from the beginning. She is disturbed by "An unsavoury smell about him: urine, sweet wine, mouldy clothing, and something else too. Unclean"(Coetzee, 1990, p. 3), and "Green eyes, animal eyes" (Coetzee, 1990, p. 3). Nonetheless, the relationship between the two deepens. As she understands Vercueil more her attitude toward him begins to shift. "The worst of the smell comes from his shoes and feet. He needs socks. He needs new shoes. He needs a bath. He needs a bath every day; he needs dean underwear; he needs a bed, he needs a roof over his head, he needs three meals a day, he needs money in the bank." (Coetzee, 1990, p. 17) The considerationof Vercueil's neediness moves Mrs Curren to a contemplation of salvation. However, this perceived "redemption" is not rooted in equality and respect but rather in the anxiety surrounding her own identity. Brennan (2013) *Emotional Exhaustion Theory* suggests that the privileged class often mitigates its own anxiety through expressions of "sympathy" toward marginalized groups. To some extent, such sympathy serves as a means of alleviating personal distress and inner conflict. Her moral anxiety and self-reflection position her as a "sympathetic witness" in her interactions with Vercueil and Florence. As Coetzee (1992) argues, the relationships shaped by colonialism create "deformed and studied" interactions that have psychological ramifications, and Mrs. Curren's struggles reflect this distorted inner life.

However, this sympathy does not alter the underlying power asymmetry between them. As Yeoh (2003) argued, the ethic ambiguities and prejudices underlying Curren's narration indicate that she is engaged in self-deception rather than adhering to a Levinasian ethics of responsibility to the other. In her conversation with Mr. Vercueil, she said "I am talking about resolve, about trying to hold on to my resolve and failing. I confess, I am drowning ... I am sitting here next to you and drowning" (Coetzee, 1990, p. 111). However, this confession did not prompt her to take substantive decolonization actions, which resonates with what Limes-Taylor Henderson & Esposito (2019) observe: a subject's recognition of her or his own complicity comes through an act of intuition or representation, but such recognition does not necessarily translate into action. Spivak (2023) criticizes the colonial discourse system for putting white liberals in a predicament when facing racial injustice - they realize their moral responsibility, but have never truly transcended their privileged position in the colonial structure.This also aligns with Arendt's (2006) concept of the "banality of evil". She argues evil does not solely stem from extreme malice; it can also arise from obedience, indifference, or the evasion of responsibility by ordinary individuals within systems of institutionalized violence. Although Mrs. Curren did not actively support apartheid, her compliance and silence rendered her complicit in its perpetuation. While she recognized the injustices of the system, her resistance remained confined to self-reflection rather than meaningful action. She attempted to show her concern fo the black people. However, she could not fully comprehending the suffering of the black due to her perspective of the privileged class. Therefore, she could not alter her position within the colonial and apartheid system by the way of self-reflection.

As Hannah Arendt (2006) argues, the "banality of evil" stems from from obedience, routine, and intellectual complacency in everyday life insteand of obvious hatred. Mrs. Curren's former silence and apathy and present sense of powerlessness makes her a "passive conspirator" in the apartheid regime. Therefore, her dilemma lies on her failure to question and resist the oppressive system which provides her with the white privilege. Mrs. Curren's personal dilemma and trauma reflects the collective guilt of white South Africans when confronting the atrocities of apartheid. This sense of guilt prevents individuals from easily breaking off with the past and forces them to confront their roles in institutionalized violence, which as a result contributes to the continuity of trauma. Therefore, trauma refers not only to the the experience of victims but also encompasses the perpetrators' and bystanders' moral dilemmas.

As Attridge (2021)describes, Mrs. Curren's guilt-stricken predicament occurs within a site of "acute ethico-political trauma" (2021), where individual struggles are deeply rooted in broader historical conditions. She strives to reconcile her cynical attitude towards the apartheid with her pursuit of ideal morality, which highlights the ethical dilemmas faced by the white privilege in South Africa. Attridge (2021) argues that a meaningful ethical response to such systemic violence is a a "living-through" of the tensions it produces instead of condemnation or approval. As a result, Mrs. Curren's unresolved trauma and moral conflict serve as a microcosm of the postcolonial world's endemic value conflicts and represent the continuity of trauma upon the individuals.

In *Age of Iron*, the racial violences compel Mrs. Curren suffer from trauma and the ethical dilemas and at the same time make her undergo a profound crisis of identity. E. Erikson (2005)

argues in *The Eight Stages of Man* that identity is an ongoing process of construction throughout an individual's life, especially during adulthood, when questions of self-recognition often arise in the context of societal and historical conditions. For members of the privileged white class, like Mrs. Curren, this struggle becomes particularly acute as they confront the intertwining of violence and moral conflict.

After witnessing the death of Bheki and his friends, who die in their resistance to apartheid, Mrs. Curren's internal conflict is further stirred by a debate with Mr. Thahane, which prompts her self-reflection:

> But now I ask myself: What right have I to wish Bheki and his friend had kept out of trouble? To have opinions in a vacuum, opinions that touch no one, is, it seems to me, nothing. Opinions must be heard by others, heard and weighed, not merely listened to out of politeness. And to be weighed they must have weight. Mr. Thahane does not weigh what I say. It has no weight to him. Florence does not even hear me. To Florence what goes on in my head is a matter of complete indifference, I know that. (Coetzee, 1990, p. 148)

This monologue reflects Mrs. Curren's increasing sense of powerlessness in her ability to express meaningful views in a world governed by racial oppression. She recognizes that her opinions, as a white liberal, hold no real weight in the context of the black struggle. This reflects her sense of identity loss under apartheid. From the perspective of the theory of power, Mrs. Curren is not only entangled in moral dilemmas but also subjected to the regulation and suppression of her identity and discursive authority by entrenched social power structures. Foucault posits that power is not merely a mechanism of unilateral oppression; rather, it is internalized by individuals through discourse, norms, and social structures, fostering self-discipline (Foucault, 1975). Mrs. Curren's internalization of power manifests in a deepening uncertainty regarding her own beliefs and existential purpose. She experiences not only a sense of helplessness in relation to the black struggle but also an increasing loss of self within the broader colonial power system.

She confesses to Mr. Vercueil: "A crime was committed long ago. How long ago? I do not know. But longer ago than 1916, certainly. So long ago that I was born into it. It is part of my inheritance. It is part of me, I am part of it" (Coetzee, 1990, p. 164). This awakening deepens her inner turmoil and leaving her unable to escape the moral weight of her actions. This crisis is further evident in her confession to her daughter, where she states, "I do not love this child, the child sleeping in Florence's bed. I love you but I do not love him. There is no ache in me toward him, not the slightest" (Coetzee, 1990, p. 136). Her confession underscores the extent to which colonial structures inscribe themselves upon the subject, not merely through overt oppression but through the subtle and pervasive mechanisms of internalized power. This condition reveals the insidious ways in which colonial discourse governs emotions, perceptions, and self-conceptions, compelling individuals to navigate an existential dilemma wherein their sense of self is perpetually torn between complicity and resistance.

Mrs. Curren's conflict is emblematic of the trauma she experiences. Her interactions with black characters and her attempts to understand their pain underscore the profound effect of

racial violence on her sense of self. As Eze (2011) points out, "she sees the evil that was not meant to be seen. Henceforth she can no longer claim ignorance; she is within the ambits of moral judgment; she is responsible. To know is to be responsible" (p. 31). Different from Mrs. Curren's philosophy identity crisis, Vercueil's homelessness signifies a powerful symbol of the erasure of the black people's identity. As a black, Vercueil is excluded from the white society, but at the same time, the black community thinks "he is rubbish. He is good for nothing" (Coetzee, 1990, p. 45). This demonstrates that the apartheit policies systematically strips his automomy and sense of social belonging. Similarly, Bheki and John's resistance against the systemic oppression exemplifies the trauma of racial segregation and its reshaping of the youth's identity. The institutional violence reshapes their identity by making them the instruments of resistance, which they actually seek to dismantle. This dynamic displays that trauma, institutional oppression and the struggle for suvival can lead to broken identities.

4. INTERPLAY OF TRAUMA AND POSTCOLONIAL ECOFEMINISM

In Age of Iron, except for exploring the trauma resulted from the apartheit violence, J.M. Coetzee examines how the destruction of the natural world deepens the protagonist's psychological trauma. As South African ecofeminist Denise Ackermann (2003) argues, environmental abuse in the country is interrelated to its social injustice. In her letter to her daughter, Mrs. Curren describes that "There is an alley... Now it is a dead place, waste, without use, where windblown leaves pile up and rot" (Coetzee, 1990, p. 1). She further describes, "The garden was left unpruned... the fruit was rotating" (Coetzee, 1990, p. 20). These descriptions contrast a once-thriving homeland with the current desolation through words like "dead place", "waste", "unpruned", and "rotating". From a psychological perspective, this depiction not only conveys the deterioration of the material environment but also reflects the cognitive and emotional effects of prolonged exposure to trauma. As Caruth (1996) argues, traumatic experiences profoundly shape an individual's emotions and cognition, manifesting in their perception and narration of the external world, thereby transforming the environment into a symbolic representation of their inner pain. Mrs. Curren's portrayal of decay—characterized by stagnant spaces and rotting fruit—mirrors her own internal suffering, as she remains unable to detach herself from the loss and violence that surround her. Moreover, this portrayal positions her as an ecological witness, with her trauma further compounded by the environmental destruction that unfolds alongside her personal disintegration.

This deprivation is also reflected in the decay of the house: "This house is tired of waiting for the day, tired of holding itself together. The floorboards have lost their spring. The insulation of the wiring is dry, friable, the pipes clogged with grit… cold, inert now, ready to die" (Coetzee, 1990, p. 74). The house, both a physical and symbolic space, mirrors Mrs. Curren's deteriorating mental state. Albrecht (2012) concept of "solastalgia" – the distress caused by the degradation of one's familiar environment – offers further insight into her psychological condition. The loss of the familiar landscape intensifies her emotional pain, heightening her sense of displacement and helplessness. As the natural world around her shrinks, so too does her hope, with the external world's destruction serving as a profound metaphor for her inner turmoil. The gradual decay of the house, like the surrounding land, parallels Mrs. Curren's experience of racial segregation and psychological violence, reinforcing her feelings of powerlessness and despair. In

this way, both her physical environment and her emotional state become inseparable, illustrating how the breakdown of one reflects and exacerbates the collapse of the other.

Environmental violence is particularly evident in black communities. Mrs. Curren is taken to a shantytown by Mr. Tabana, where she witnesses:

> a landscape of scored earth, blackened trees... a continuous stretch of garbage and ash. Shreds of plastic, old iron, glass, animal bones scattered... the shanties started, the lowest-growing cluster surrounded by water, floored. Some built sturdy of wood and iron, others no more than skins of plastic shearing over frames of branches . (Coetzee, 1990, pp. 86-87)

Coetzee portrays the environmental devastation inflicted on black communities by apartheid policies through images of plastic waste, polluted water, and burnt shacks. These destructions are not merely physical; they symbolize violence that exacerbates racial inequality by depriving these communities of resources and environmental control. Environmental psychology research suggests that prolonged exposure to degraded landscapes fosters *ecological grief*, a deep psychological distress linked to environmental loss (Cunsolo & Ellis, 2018). Mrs. Curren, witnessing this devastation, does not simply register it as an external reality but internalizes it, reinforcing her sense of helplessness. This is evident in her physical reaction: "My heart pounded, pains shot through my chest. I stopped, bent over, gasping" (Coetzee, 1990, p. 88). Research on post-traumatic stress disorder (PTSD) has shown that "fear and stress are triggered predominantly in response to a dangerous event, followed by a series of bodily changes, including increased blood pressure, heart rate, and breathing due to the release of adrenaline" (Ho et al., 2021). Mrs. Cullen's physical pain serves as a clear example of the "somatization" of trauma. This physical response extends beyond her individual experience, symbolizing how environmental destruction exacerbates social injustice, rendering it impossible for both the oppressed and bystanders to escape its effects. In other words, Coetzee illustrates through her bodily reactions how environmental violence contributes to the formation of "systemic trauma" within the context of institutional oppression. This trauma not only impacts direct victims but also permeates the broader social structure, affecting all individuals within it.

Coetzee also highlights the link between environmental destruction and racial oppression through the natural landscape. Mrs. Curren observes : "A land taken by force, used, despoiled, spoiled, abandoned in its barren late years" (Coetzee, 1990, p. 23). She also describes "a wildness of grey dual sand and Port Jackson Willow, and a litter of garbage and ash. Shreds of plastic, old iron, glass, animal bones" (Coetzee, 1990, p. 86). These scenes not only depict the exploitation of natural resources by colonizers but also metaphorically show how colonial power consolidates its dominance by controlling the environment. LaCapra (2001) emphasizes that trauma is symbolically manifested through the transmission of memory and history, with the deterioration of the environment often reflecting the internal breakdown of the traumatized individual. Mrs. Cullen's portrayal of South African society and its natural environment functions as a psychological projection, shaped by her prolonged exposure to trauma. The decline of the material environment and her internal suffering are intricately intertwined, illustrating the historical and emotional trauma from which she is unable to escape.

From the perspective of environmental psychology, her description can be understood through the concept of eco-anxiety, defined as "a chronic fear of environmental doom" (Clayton & Karazsia, 2020, p. 68) and "the generalized sense that the ecological foundations of existence are in the process of collapse" (Albrecht, 2012, p. 250). Eco-anxiety refers to a state in which individuals experience chronic stress and fear for their survival due to environmental degradation. Mrs. Cullen's sense of impending collapse—that both the land and the people have reached a critical point—is consistent with ecological trauma, where she mourns the irreversible damage inflicted on the surrounding environment. Simultaneously, she becomes aware that the pain she witnesses is deeply influenced by gender. The burning shacks, the piled-up garbage, and the chaotic resource management symbolize the social trauma resulting from colonial rule.

Ecological feminist theorists, such as Mies (1986) and Shiva (1988), argue that colonialism and patriarchy have historically exploited both women's bodies and natural resources, treating them as sites of extraction and control. This connection symbolizes the dual invasion of colonialism, affecting both individuals and the natural environment. In the novel, as Mrs. Curren reflects in her monologue, when she describes him, she describes herself; when she describes dogs, she describes herself; and when she describes houses, she describes herself. This reveals an intrinsic connection between people, land, and all living beings, suggesting that the experiences of individuals are inseparable from the world around them. Similarly, Mrs. Curren views her cancer as a physical mutation, describing it as:

> The sickness that now eats at me is dry, moodless, slow and cold, sent by Saturn. There is something about it that does not bear thinking of. To have fallen pregnant with these growths, these cold, obscene swellings… to have carried and carried this brood beyond any natural term, unable to hear them, unable to sate their hunger: children inside me eating more every day, not growing but bloating, toothed, flawed, forever cold and ravenous. Dry, dry: to feel them turning at night in my dry body, not stretching and kicking as a human child does but changing their angle, finding a new place to gnaw. Like insect eggs laid in the body of a host, now grown to grubs and implacably eating their host away. (Coetzee, 1990, p. 50)

This metaphor of bodily mutation resonates with the colonial history of South African land. Through this vivid portrayal, Mrs. Curren compares the pain of her body to the uncontrolled growth of a tumor, symbolizing the unchecked spread of colonial systems. These "tumors" are not only foreign entities within her body but also represent the colonizers' brutal occupation of both land and people. In Patriarchy and Accumulation on a World Scale, Mies (2014) argues that colonial expansion views both women and land as as resources to be exploited. Similarly, Vandana Shiva (1988) asserts that the degradation of nature parallels the exploitation of women under colonial and capitalist system. Therefore, Mrs. Curren's cancer represents the trauma of both colonial occupation and patriarchal oppression upon women and South African land.

Spivak (2023) argues that the trauma of colonial history is multilayered in social, historical, and cultural dimensions. Mrs. Curren's body is a microcosm of South African societal pathology

and signifies the interconnectedness between her personal suffering and the colonial and apartheit system. In *Illness as metaphor and AIDS and its metaphors*, Sontag (2013) argues that illness often symbolizes social disorder and traumatic memory. Mrs. Curren's physical illness signifies the profound and lasting impact of the colonial and apartheit legacies, which has caused multidimensional trauma upon the South African people and land. The decay of Mrs. Curren's body mirrors the deterioration of the nation itself, as she describes how her body is decaying inside, much like the land. This line not only conveys her awareness of personal trauma but also reflects her vigilance regarding the decline of the social and environmental landscape. For Mrs. Curren, her illness is intertwined with the nation's fate, as she acknowledges that cancer symbolizes not only the end of her life but also the end of the country. Her trauma, then, is not solely physical but represents the broader decline of South African society, history, and the environment.

Mrs. Curren's trauma is multidimensional, affecting both her physical and psychological well-being. However, healing from trauma is not merely a physiological process but a psychological journey of reflection and self-expression. She engages in self-healing through letter writing, which allows her to release personal emotions while reflecting on societal and historical issues. In one of her letters, she writes: "I am not writing these letters for you, but for myself, hoping to find some comfort" (Coetzee, 1990, p. 25). For Mrs. Curren, the letter to her daughter is acturally a way of healing from the traumatic experiences. Her healing process is deeply interwined with her reflection on the social and historical realities. She realizes the need for social and historical changes in South Africa.

5. CONCLUSION

By exploring the trauma from a postcolonial ecofeminist perspective, Mrs. Cullen's experience serves not only as a microcosm of historical trauma but also as a reflection of contemporary society's concerns about environmental degradation, identity anxiety, and historical responsibility. As the global ecological crisis intensifies, issues of environmental justice, racial restoration, and gender equality have become increasingly urgent. As Ackerman (1997) observe, "we are a society critically in need of healing in every aspect of our relationships: with ourselves, with one another, with God, and most urgently, with the earth" (p. 121). Mrs. Cullen's story reminds us that genuine restoration requires confronting not only the psychological trauma caused by historical violence but also addressing the deep-rooted issues of ecological trauma and social structural injustice. Therefore, literary criticism functions not only as a tool for text analysis but also as a vital means of examining reality, seeking justice, and healing social wounds.

CONFLICT STATEMENT

The authors declare no conflict of interest.

COOPERATION STATEMENT

Author contributed equally to this work and approved the final manuscript.

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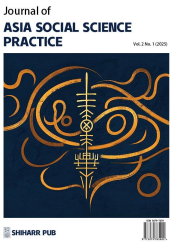

RESEARCH ARTICLE

MARKET ACCESS REGULATIONS FOR FOREIGN INVESTMENT IN CROSS-BORDER E-COMMERCE: A COMPARATIVE STUDY BETWEEN CHINA AND MALAYSIA

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ABSTRACT

This study conducts a systematic comparative analysis of market access regulations for foreign investment in cross-border e-commerce between China and Malaysia. Drawing on current regulatory frameworks and implementation practices, the research identifies significant patterns of convergence and divergence in how these two countries regulate foreign participation in their digital economies. Malaysia has adopted a relatively open framework characterized by streamlined registration procedures, liberal foreign equity policies, and trans-parent enforcement mechanisms, positioning itself as a gateway to ASEAN markets. In contrast, China maintains a more complex regime with multi-layered approval requirements, significant sectoral restrictions, and interventionist enforcement practices, reflecting its emphasis on digital sovereignty and state-directed economic development. The research highlights specialized eco-nomic zones—Malaysia's Digital Free Trade Zone and China's Cross-Border E-Commerce Pilot Zones—as key instruments of regulatory innovation in both countries. Case studies of Chinese e-commerce platforms entering Malaysia and Malaysian digital businesses entering China reveal asymmetric market access conditions with practical implications for investors. This comparative analysis contributes to our understanding of how different legal traditions and regulatory philosophies shape digital economy governance, while offering strategic in-sights for investors navigating these complex

regulatory environments and policymakers seeking greater.

1. INTRODUCTION

The digital economy has emerged as a pivotal frontier in bilateral relations between China and Malaysia, with cross-border e-commerce representing an increasingly significant proportion of trade flows. According to the General Administration of Customs of China (2024), the overall trade volume between China and Malaysia reached approximately 2120 billion USD in 2024, with China maintaining its position as Malaysia's largest trading partner for 16 consecutive years. Within this robust commercial relationship, digital transactions have exhibited exponential growth, accelerated by shifts in consumer behavior and business models following global disruptions to traditional trade channels.

The strategic importance of this digital trade corridor has been formally recognized through what Wang (2024) terms the "Five-Pronged Approach" framework for China-Malaysia e-commerce cooperation. This comprehensive framework emphasizes policy coordination, infrastructure connectivity, unimpeded trade, financial integration, and people-to-people bonds—all essential elements underpinning the digital silk road initiative connecting Chinese digital platforms with Malaysian markets and vice versa. However, the realization of this ambitious vision depends critically on navigating the complex regulatory landscape governing market access for foreign investors in both jurisdictions.

The regulatory architecture for cross-border e-commerce operates at the intersection of multiple policy domains, including foreign investment law, digital economy governance, and consumer protection frameworks. As Wan et al. (2023) observe, these regulatory structures are not merely technical instruments but reflect deeper cultural, historical, and economic priorities that shape trade relationships. Their research demonstrates how cross-border e-commerce has fundamentally altered traditional trade structures between China and Malaysia, necessitating adaptive regulatory responses from both governments.

Despite the growing economic significance of digital trade between these nations, there remains insufficient academic inquiry into the legal dimensions of market access requirements from a cross-jurisdictional perspective. While studies such as Ismail and Masud (2020) have examined the broader challenges of e-commerce connectivity in Malaysia, and Li et al. (2024) have analyzed China's cross-border e-commerce pilot zones, few scholars have undertaken systematic comparative analysis of the market entry regimes across both jurisdictions. This represents a critical gap in knowledge for investors, policymakers, and legal practitioners navigating this dynamic domain.

This research addresses this gap by examining how China and Malaysia regulate foreign e-commerce investments through market access thresholds, including registration requirements, foreign equity limitations, and operational prerequisites. Such analysis has acquired greater urgency in the context of negotiations toward an upgraded ASEAN-China Free Trade Agreement (ACFTA 3.0), which Chen et al. (2024) suggest could potentially address persistent market access barriers in the digital economy. The substantial conclusion of ACFTA 3.0

negotiations in October 2024 marks a significant milestone in this process, with the agreement set to include provisions on digital economy, supply chain connectivity, and customs facilitation (Ministry of Trade and Industry Singapore, 2024).

The significance of this research extends beyond academic inquiry. For Chinese e-commerce platforms seeking to expand into Southeast Asian markets, Malaysia represents a strategic gateway, but one with distinct regulatory requirements that Qu (2024) notes present significant compliance challenges. Conversely, Malaysian digital businesses eyeing China's vast consumer market must navigate what Zhu and Chen (2025) describe as a complex web of market entry regulations, negative lists, and pilot zone schemes. This study will provide actionable insights for both cohorts of investors by systematically mapping convergences and divergences in market access frameworks.

Additionally, this research contributes to broader scholarly discourse on digital special economic zones, which Chaisse (2023) identifies as increasingly important instruments of digital trade governance. By analyzing Malaysia's Digital Free Trade Zone and China's Cross-Border E-Commerce Pilot Zones as comparative case studies, this paper will examine how such specialized regulatory environments impact market access conditions and investment flows. Neilson's (2022) analysis of Alibaba's experience in Malaysia's Digital Free Trade Zone offers particularly valuable insights into the practical implementation challenges faced by foreign investors navigating these novel regulatory structures.

This paper will focus exclusively on market access regulations, deliberately excluding broader questions of data governance and compliance requirements. This scope limitation ensures analytical depth rather than superficial coverage of multiple dimensions. Specifically, the research seeks to answer: How do China and Malaysia's regulatory approaches to market access for foreign investment in cross-border e-commerce compare, and what implications do these approaches have for investors and potential regulatory harmonization?

The subsequent sections will first establish a theoretical framework for analyzing market access regulations, followed by a methodological overview. The paper will then examine the respective e-commerce regulatory frameworks of Malaysia and China before undertaking systematic comparative analysis across defined dimensions of market access regulation. Case studies will illustrate practical implementation challenges before the paper concludes with implications and recommendations for investors and policymakers alike.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The scholarly literature on market access regulations for cross-border e-commerce between China and Malaysia reflects a diverse yet fragmented body of work, with most studies focusing on either single-country analyses or broader regional frameworks rather than bilateral comparative approaches. This review synthesizes existing knowledge while identifying theoretical frameworks that inform our understanding of market access regulations in the digital economy.

2.1. Current State of E-commerce Connectivity

Ismail and Masud (2020) offer a comprehensive assessment of e-commerce connectivity in Malaysia, identifying both significant opportunities and persistent challenges. Their analysis reveals that while Malaysia has made substantial progress in developing digital infrastructure and supportive policy frameworks, regulatory barriers continue to impede cross-border e-commerce growth. They note that "complex procedures, high compliance costs, and fragmented regulatory requirements" represent significant obstacles for foreign e-commerce platforms seeking to enter Malaysia (Ismail & Masud, 2020, p. 82). Their work provides valuable insights into the Malaysian regulatory landscape but lacks comparative analysis with China's approach.

Complementing this Malaysian perspective, Li et al. (2024) examine China's Cross-Border E-Commerce Pilot Zones as specialized regulatory environments designed to facilitate digital trade. Their empirical analysis demonstrates how these zones have created "experimental regulatory spaces" where market access requirements are streamlined compared to China's standard foreign investment regime. Their research shows that these pilot zones significantly impact urban carbon emissions efficiency through altered logistics patterns and technological adoption, with implications for both economic and environmental outcomes. This multi-dimensional impact framework helps explain why China has rapidly expanded its pilot zone program, with 165 zones established by 2022 (State Council of China, 2022).

The evolving nature of China-Malaysia trade relations through digital channels is thoroughly explored by Wan et al. (2023), who examine how cross-border e-commerce has fundamentally altered traditional trade structures. Their research demonstrates that "e-commerce has created new channels for market access that bypass traditional barriers" while simultaneously generating "novel regulatory challenges for both governments" (Wan et al., 2023, p. 145). Particularly valuable is their analysis of how cultural factors influence regulatory approaches, with China emphasizing centralized control while Malaysia adopts a more market-oriented framework influenced by Islamic financial principles.

2.2. Theoretical Approaches to Market Access Regulation

Several theoretical frameworks offer valuable lenses for analyzing market access regulations in cross-border e-commerce. The concept of digital sovereignty provides a foundational framework for understanding how nations assert control over their digital economies while participating in global digital trade. Digital sovereignty originates from the broader principle of state sovereignty, asserting a state's authority to govern data within its territory without external interference (InCountry, 2024). In China, digital sovereignty has been elevated to the level of national security, representing a non-negotiable aspect of its approach to digital trade governance (Centre for International Governance Innovation, 2022).

Although not explicitly addressing Malaysia and China, Chan (2024) examines how digital sovereignty concerns shape Malaysia's regulatory approach to digital payments, data governance, and artificial intelligence. Chan argues that Malaysia's regulatory framework

reflects a "balanced approach between openness to foreign digital investment and protection of national economic interests" (Chan, 2024, p. 83). This framework helps explain Malaysia's willingness to establish the Digital Free Trade Zone in partnership with Chinese tech giant Alibaba in 2017, while simultaneously strengthening its regulatory oversight through measures like the 2024 Cyber Security Bill (U.S. Department of Commerce, 2024).

A second theoretical perspective particularly relevant to this study is Chaisse's (2023) framework of digital special economic zones. Chaisse conceptualizes these zones as "specialized regulatory environments where digital economy activities benefit from differentiated rules compared to the general economy" (Chaisse, 2023, p. 201). This theoretical construct provides valuable analytical tools for comparing Malaysia's Digital Free Trade Zone with China's Cross-Border E-Commerce Pilot Zones as distinct market access pathways. Chaisse argues that these zones represent "regulatory sandboxes where governments can experiment with liberalized market access conditions while containing potential risks" (Chaisse, 2023, p. 205). This framework helps explain why both Malaysia and China have established specialized regulatory environments for cross-border e-commerce rather than simply liberalizing their general foreign investment regimes.

The cultural dimensions of regulatory approaches are theorized by Wan et al. (2023), who develop a framework for understanding how "cross-border e-commerce culture" influences trade structures and regulatory responses. Their research demonstrates how "cultural values shape regulatory priorities," with China's emphasis on "orderly development" contrasting with Malaysia's focus on "inclusive growth" (Wan et al., 2023, p. 150). This theoretical lens helps explain divergent approaches to market access regulation beyond purely economic or legal considerations.

Wenyang et al. (2024) contribute theoretical insights into the relationship between economic growth, foreign investment, and e-commerce development. Their analysis suggests a "mutually reinforcing relationship where e-commerce growth attracts foreign investment, which in turn accelerates digital infrastructure development" (Wenyang et al., 2024, p. 117). This theoretical framework helps explain why both Malaysia and China have progressively liberalized market access for foreign e-commerce platforms while maintaining certain strategic restrictions.

2.3. Regional Integration Frameworks

Beyond bilateral relations, broader regional integration initiatives provide important context for understanding market access regulations. Chen et al. (2024) analyze the potential for ASEAN-China Free Trade Agreement 3.0 (ACFTA 3.0) to address digital economy barriers, including market access restrictions. The substantial conclusion of ACFTA 3.0 negotiations in October 2024 represents a significant milestone, with the new agreement set to cover nine new areas including digital economy, green economy, supply chain connectivity, and customs facilitation (South China Morning Post, 2024). This agreement will include "the integration of digital infrastructure and electronic payment systems," providing a framework for addressing persistent market access barriers in the digital economy (South China Morning Post, 2024).

The concept of the Digital Silk Road, examined by Neilson (2022) through the case study of Alibaba's Digital Free Trade Zone in Malaysia, offers another regional framework for understanding market access dynamics. Neilson argues that the Digital Silk Road represents "not merely infrastructure connectivity but regulatory alignment to facilitate Chinese digital platforms' expansion" (Neilson, 2022, p. 3). This perspective illuminates how geopolitical considerations influence market access regulations beyond purely economic or legal factors. The establishment of Malaysia's Digital Free Trade Zone in March 2017, with Alibaba founder Jack Ma appointed as Malaysia's digital economy adviser (PwC, 2017), exemplifies the practical implementation of this concept.

2.4. Research Gaps and Analytical Framework

Despite these valuable contributions, significant gaps persist in the literature. First, most studies focus on either Malaysia or China individually, with limited systematic comparison of market access regulations across both jurisdictions. Second, existing research tends to emphasize either legal frameworks or economic impacts, with insufficient integration of these perspectives. Third, while special economic zones have received scholarly attention, comparative analysis of Malaysia's Digital Free Trade Zone and China's Cross-Border E-Commerce Pilot Zones remains underdeveloped.

To address these gaps, this research develops an analytical framework that examines market access regulations across five dimensions: (a) market entry requirements, including registration and licensing procedures; (b) foreign equity restrictions; (c) operational requirements, including local presence mandates; (d) special economic zones and incentive structures; and (e) enforcement mechanisms. This framework enables systematic comparison while accommodating the distinct legal traditions and regulatory philosophies of Malaysia and China.

This analytical approach draws upon the theoretical perspectives discussed above, particularly Chaisse's (2023) concept of digital special economic zones and Wan et al.'s (2023) emphasis on cultural dimensions of regulatory approaches. By integrating these theoretical lenses with systematic comparative analysis, this research will generate new insights into the convergence and divergence of market access regulations between Malaysia and China while contributing to broader scholarly discourse on digital trade governance in emerging economies.

3. METHODOLOGY

This study employs a systematic comparative legal methodology to analyze market access regulations for foreign investment in cross-border e-commerce between China and Malaysia. The comparative approach is particularly appropriate for this research given the distinct yet parallel regulatory frameworks developed by both jurisdictions to govern their rapidly evolving digital economies.

3.1. Research Design

The research design adopts a functional comparative approach, examining how different legal mechanisms address similar regulatory challenges across jurisdictions. As Chaisse (2023) observes, comparative legal analysis enables identification of both explicit regulatory differences and implicit functional equivalents within each legal system. This approach acknowledges that while China and Malaysia may employ different regulatory instruments, they often seek to achieve similar policy objectives regarding market access control and economic development.

This study primarily employs qualitative legal analysis, supplemented by policy document analysis to contextualize legal provisions within broader governance objectives. This mixed-methods approach allows for triangulation of findings and comprehensive understanding of both formal legal frameworks and their practical implementation. The comparative framework examines regulatory convergence and divergence across the five dimensions identified in the analytical framework: market entry requirements, foreign equity restrictions, operational requirements, special economic zones, and enforcement mechanisms.

3.2. Data Sources

The research draws upon three categories of data sources:

Primary Legal Sources: These include statutes, regulations, and administrative measures governing cross-border e-commerce in both jurisdictions. Key documents include Malaysia's Electronic Commerce Act 2006 and China's E-Commerce Law of 2019, along with subsidiary regulations governing foreign investment. Official regulatory guidelines and interpretation documents from Malaysian and Chinese authorities provide additional primary source material, particularly those issued by the Malaysian Investment Development Authority (2020, 2024b, 2024a) and China's Ministry of Commerce (2024).

Secondary Literature: Academic scholarship on digital trade regulation and e-commerce governance provides theoretical context and analytical insights. The works of Wan et al. (2023), Chaisse (2023), and Chen et al. (2024) are particularly valuable for their theoretical frameworks. Industry reports and government white papers, including those cited in the reference list, offer contextual understanding of policy objectives and implementation challenges.

Case Studies: Documented experiences of foreign investors navigating market access regulations provide crucial insights into practical implementation. Neilson's (2022) analysis of Alibaba's experience in Malaysia's Digital Free Trade Zone offers a particularly valuable case study, while the Ministry of Commerce of the People's Republic of China (2024) provides comparative insights on Malaysian market entry for Chinese investors.

3.3. Analytical Approach

The analytical approach employs structured qualitative comparison across the defined dimensions, enabling systematic identification of regulatory similarities and differences. The

research utilizes legal hermeneutics to interpret statutory provisions within their systemic context, while employing functional analysis to identify how different legal mechanisms achieve similar regulatory objectives across jurisdictions.

Particular attention is paid to identifying not only formal legal requirements but also administrative practices and implementation realities that affect market access. This approach recognizes that formal legal provisions may diverge significantly from practical implementation, as noted by Ismail & Masud (2020) in their analysis of Malaysian e-commerce connectivity challenges.

3.4. Limitations

This methodology faces several limitations that warrant acknowledgment. First, access to certain regulatory documents, particularly internal administrative guidelines, may be limited. Second, language barriers present challenges in accurately interpreting Chinese regulatory texts, though official translations are utilized where available. Third, the rapidly evolving nature of digital economy regulations means that certain provisions may change during the research period. Finally, the methodology cannot fully account for informal or unwritten practices that may influence market access decisions. Despite these limitations, the structured comparative approach provides valuable insights into regulatory convergence and divergence between these important trading partners.

4. OVERVIEW OF E-COMMERCE REGULATORY FRAMEWORKS

4.1. Malaysia's E-commerce Regulatory Landscape

Malaysia has established a comprehensive regulatory framework for e-commerce activities, balancing economic development objectives with consumer protection concerns. The Electronic Commerce Act 2006 provides the foundational legal structure governing digital transactions in Malaysia, establishing the validity and legal recognition of electronic contracts and digital signatures. This legislation sought to create certainty in the online business environment, an essential prerequisite for foreign investment in e-commerce (Ismail & Masud, 2020).

Complementing this foundation, the Consumer Protection (Electronic Trade Transactions) Regulations 2012 establish specific requirements for online sellers, including comprehensive information disclosure obligations. As noted by the Ministry of Commerce of the People's Republic of China (2024), these regulations impose strict information disclosure obligations on e-commerce operators, requiring them to disclose comprehensive business and product information, and establish proper transaction procedures to protect buyers from operational errors. Non-compliance can result in significant penalties, including fines up to 50,000 ringgit (approximately 15,600 USD) or imprisonment up to three years, or both.

Foreign investments in Malaysia's digital economy are regulated primarily by the Malaysian Investment Development Authority (MIDA). According to MIDA's equity policy, Malaysia has progressively liberalized foreign investment regulations since 2009, eliminating

the Foreign Investment Committee Guidelines that previously restricted foreign acquisitions and mergers of Malaysian companies (Malaysian Investment Development Authority, 2024a). In most sectors, including many e-commerce categories, foreign investors can now hold 100% equity. However, specific sectors maintain equity limitations, with foreign investors permitted only up to 70% ownership in certain telecommunications-related categories, though they may hold 100% equity as application service providers (U.S. Department of State, 2024).

Malaysia's digital economy regulation has been further strengthened by the introduction of the Cyber Security Bill 2024, which establishes a robust regulatory framework to protect the nation's critical information infrastructure against emerging cyber threats. This legislation also creates the National Cyber Security Committee, chaired by the Prime Minister, to advise the government on cybersecurity issues (U.S. Department of Commerce, 2024). Despite these strengthened security measures, Malaysia maintains its commitment to digital trade facilitation, with no data localization or data residency requirements under its Personal Data Protection Act 2010.

A distinctive feature of Malaysia's approach has been the establishment of the Digital Free Trade Zone (DFTZ), launched in March 2017 as a collaborative initiative between the Malaysian government and Alibaba Group. As Neilson (2022) observes, the DFTZ represents a specialized regulatory environment designed to facilitate cross-border e-commerce through streamlined customs procedures, preferential tax treatments, and dedicated logistics infrastructure. The DFTZ established what Chaisse (2023) characterizes as a "regulatory sandbox" where market access requirements are more liberal than in the broader economy, creating an experimental space for cross-border e-commerce regulation.

The DFTZ comprises three key components implemented in different stages: an e-fulfillment hub and satellite hub as physical zones, and e-services as virtual zones (ASEAN Briefing, 2021). The e-fulfillment hub is strategically located near Kuala Lumpur International Airport Aeropolis, providing logistics advantages for cross-border shipments. SMEs established in the DFTZ benefit from a geographically strategic location, unified government services platform, integrated digital e-services platform, and access to traffic from Alibaba's marketplaces such as Tmall and Taobao.

Malaysia's regulatory approach must also be understood within the context of its National e-Commerce Strategic Roadmap, which explicitly aims to position the country as a regional e-commerce hub. This strategic framework has influenced regulatory developments, encouraging a generally liberalized approach to foreign investment in e-commerce while maintaining specific protections in sectors deemed strategically important (Chan, 2024).

4.2. China's E-commerce Regulatory Landscape

China's regulatory approach to cross-border e-commerce has evolved significantly over the past decade, reflecting both economic development priorities and sovereignty concerns. The E-Commerce Law, implemented in 2019, provides the cornerstone of China's regulatory framework, establishing comprehensive requirements for e-commerce operators, including

registration, taxation, consumer protection, and intellectual property safeguards. This legislation applies to both domestic and foreign e-commerce entities operating in China, though with distinct provisions for cross-border activities (Ma et al., 2024).

Foreign investment in China's digital economy is governed by the Foreign Investment Law, which replaced previous regulations in 2020, introducing a more streamlined approach. However, this liberalization operates alongside China's negative list system, which specifies sectors where foreign investment is either prohibited or restricted. While the negative list has progressively shortened in recent years, certain digital economy sectors remain subject to investment restrictions, particularly those involving data collection, internet publishing, and certain telecommunications services (Ministry of Commerce of the People’s Republic of China, 2024).

China's approach to digital sovereignty is embodied in its comprehensive data regulations, including the Cybersecurity Law (2017), Data Security Law (2021), and Personal Information Protection Law (2021). These laws establish stringent requirements for data processing and cross-border data transfers, reflecting China's emphasis on maintaining control over data generated within its territory. In March 2024, the Cybersecurity Administration of China introduced the Provisions on Promoting and Regulating the Cross-border Flow of Data, which eased some requirements for cross-border data transfers while maintaining core sovereignty principles (InCountry, 2024).

A distinctive feature of China's approach has been the establishment of Cross-Border E-Commerce Pilot Zones, which have expanded from the initial zone in Hangzhou in 2015 to cover multiple cities across China. By November 2022, China had approved 165 such zones across the country, including a seventh batch of 33 zones focused on central and western China and border areas (State Council of China, 2022). Li et al. (2024) demonstrate how these zones function as specialized regulatory environments where cross-border e-commerce activities benefit from simplified customs procedures, preferential tax policies, and streamlined regulatory compliance requirements. These zones operate as what Wang (2024) describes as "policy laboratories" where regulatory innovations can be tested before potential nationwide implementation.

China's pilot zones have demonstrated significant economic impact, with cross-border e-commerce import-export volumes growing by 15.6% in 2023 to reach RMB 2.38 trillion (approximately USD 331 billion) (China Briefing, 2024). This growth was driven by government initiatives to optimize comprehensive pilot zones and advance the "Silk Road e-commerce" initiative under the Belt and Road Initiative. The pilot zones have also shown positive effects on enterprise innovation, with research indicating that they promote digital technology innovation by alleviating financing constraints, facilitating digital transformation, and encouraging producer service industry agglomeration (ScienceDirect, 2024).

China's cross-border e-commerce regulation also employs a positive list approach for retail imports, specifying categories of goods eligible for preferential treatment when imported through official cross-border e-commerce channels. This list has expanded over successive

iterations, reflecting China's gradual opening to cross-border e-commerce while maintaining control over sensitive or strategic product categories (Ma et al., 2024).

The regulatory landscape for cross-border e-commerce in China cannot be fully understood without recognizing its embeddedness in broader strategic initiatives such as the Digital Silk Road. As Chen et al. (2024) observe, China's approach to cross-border e-commerce regulation increasingly reflects its regional economic integration objectives, particularly regarding ASEAN markets. This strategic dimension influences not only domestic regulatory developments but also China's approach to bilateral and regional trade agreements affecting digital commerce.

4.3. Comparative Observations

These regulatory frameworks reveal both significant similarities and notable differences in approach. Both countries have established specialized regulatory environments (Malaysia's DFTZ and China's Pilot Zones) to facilitate cross-border e-commerce while maintaining broader regulatory frameworks to govern general e-commerce activities. Both have also progressively liberalized foreign investment regulations while maintaining specific restrictions in sectors deemed strategically important.

However, China's approach emphasizes centralized administrative oversight and positive lists, while Malaysia employs a more market-oriented approach with fewer sectoral restrictions. China's commitment to digital sovereignty manifests in stricter data localization requirements and more extensive approval processes, while Malaysia's balanced approach seeks to attract foreign digital investment while protecting national interests. These differences reflect distinct regulatory philosophies and development objectives that will be explored in greater detail in subsequent sections.

5. COMPARATIVE ANALYSIS OF MARKET ACCESS REGULATIONS

5.1. Market Entry Requirements

The initial gateway for foreign e-commerce investors seeking to enter either the Malaysian or Chinese market is navigating the respective registration and licensing procedures. In Malaysia, the registration process for foreign e-commerce entities follows a relatively streamlined approach. According to the Ministry of Commerce of the People's Republic of China (2024), foreign e-commerce businesses must register with the Companies Commission of Malaysia (SSM), typically as a private limited company (Sdn Bhd). This process requires standard documentation including company constitution, director information, and registered office address. Notably, the registration process can be completed online in approximately 3-5 business days, reflecting Malaysia's commitment to procedural efficiency in business registration, a commitment that dates back to the implementation of the Electronic Commerce Act in 2006 (Mahwengkwai, 2022).

In contrast, China's market entry requirements for foreign e-commerce operators involve multiple layers of approval across different governmental agencies. Foreign investors must first

secure approval from the Ministry of Commerce, followed by registration with the State Administration for Market Regulation (SAMR), and subsequently obtain an Internet Content Provider (ICP) license from the Ministry of Industry and Information Technology (MIIT) if the platform hosts content within China (Ma et al., 2024). This multi-tiered approach creates what Qu (2024) describes as a "complex regulatory maze" requiring careful navigation and significant compliance resources.

Capital requirements constitute another dimension of market entry regulation. Malaysia has progressively eliminated minimum capital requirements for most business categories, including e-commerce operations. As noted by the Malaysian Investment Development Authority (2024a), while a nominal paid-up capital of 1 MYR (approximately 0.24 USD) is technically required, in practice, MIDA recommends foreign companies maintain sufficient capital to fund their operations adequately. This flexible approach contrasts with China's more structured requirements, where registered capital minimums vary by business scope and location, with cross-border e-commerce operations typically requiring a minimum of 1 million RMB (approximately 141,000 USD) (Zhu & Chen, 2025).

Documentation requirements further illustrate regulatory divergence. Malaysia's approach emphasizes transparency and simplicity, requiring standard corporate documents translated into Bahasa Malaysia or English. In comparison, China's documentation requirements are more extensive, including feasibility studies, articles of association, and detailed business plans, all requiring certified Chinese translations (Ministry of Commerce of the People's Republic of China, 2024). This heavier documentation burden reflects China's more cautious approach to foreign investment screening.

Sectoral restrictions represent a significant dimension of market entry regulation in both jurisdictions, though with different emphases. Malaysia maintains relatively few sector-specific restrictions for e-commerce operations, with limitations primarily in telecommunications infrastructure and certain categories of retail distribution. According to the U.S. Department of State (2024), Malaysia's restricted sectors are clearly enumerated and relatively limited compared to regional peers. China, in contrast, maintains a more extensive negative list system that explicitly identifies restricted or prohibited sectors for foreign investment. While recent iterations have reduced restrictions, significant limitations remain in internet publishing, online news, audiovisual content, and certain categories of telecommunications services (Ministry of Commerce of the People's Republic of China, 2024). This more restrictive approach reflects China's greater emphasis on information control and digital sovereignty considerations.

The application timelines and predictability of outcomes also diverge significantly. Malaysia's market entry procedures typically conclude within 1-3 months, with relatively predictable outcomes for compliant applications (Malaysian Investment Development Authority, 2024a). China's approval process, by comparison, can extend to 6-12 months with less predictable outcomes, particularly for applications involving sensitive or newly emerging digital business models (Qu, 2024). This timeline difference has significant implications for foreign investors' market entry strategies, potentially favoring Malaysia for initial market entry in the ASEAN region.

5.2. Foreign Equity Restrictions

Foreign equity limitations represent a critical dimension of market access regulation, directly affecting investment structures and corporate control. Malaysia has adopted a progressively liberalized approach to foreign equity in the digital economy. According to the Malaysian Investment Development Authority (2024a), foreign investors can hold 100% equity in most e-commerce operations, reflecting Malaysia's policy shift away from mandatory local partnership requirements. However, telecommunications-related services maintain certain equity restrictions, with foreign investors limited to 70% ownership in network facilities or network service providers, though they may hold 100% equity as application service providers (U.S. Department of State, 2024).

China's approach to foreign equity restrictions in e-commerce reflects a more nuanced and controlling regulatory philosophy. While China has relaxed foreign ownership restrictions in certain e-commerce categories, particularly for retail-focused platforms, significant equity limitations persist in related digital economy sectors. Value-added telecommunications services, including certain categories of online data processing and e-commerce, are limited to 50% foreign ownership, while internet publishing, online news, and audiovisual services remain either prohibited or heavily restricted (Ministry of Commerce of the People's Republic of China, 2024). These persistent restrictions reflect what Wang (2024) characterizes as China's "graduated opening" approach to digital economy sectors, with progressive liberalization in less sensitive areas while maintaining strict controls over information-related services.

The enforcement of these equity restrictions also differs notably between jurisdictions. Malaysia's approach tends toward transparency and consistency, with clearly articulated equity limitations and relatively predictable regulatory interpretations (Malaysian Investment Development Authority, 2024a). China's implementation, by contrast, involves greater administrative discretion and evolving interpretations of regulatory categories. As noted by Qu (2024), the classification of digital business models within China's regulatory framework remains fluid, creating uncertainty about applicable equity restrictions, particularly for innovative or hybrid business models.

These divergent approaches to foreign equity restrictions shape investment structures in both markets. In Malaysia, wholly foreign-owned e-commerce operations are increasingly common, while in China, variable interest entity (VIE) structures and joint ventures remain prevalent strategies for navigating equity limitations (Zhu & Chen, 2025). These structural differences affect not only corporate governance but also operational flexibility and investment returns.

5.3. Operational Requirements

Beyond initial entry and equity considerations, ongoing operational requirements significantly impact foreign e-commerce investors' market access. Local presence mandates represent a primary operational constraint in both jurisdictions, though with differing emphases. Malaysia requires foreign e-commerce entities to maintain a registered office within the country

but does not mandate substantial physical operations beyond this minimum requirement (Malaysian Investment Development Authority, 2024a). This relatively flexible approach allows for operational centralization across ASEAN markets, with limited Malaysia-specific infrastructure.

China imposes more extensive local presence requirements, including data localization mandates that effectively require significant in-country operations. As Ma et al. (2024) observe, China's Cybersecurity Law and related regulations require operators of "critical information infrastructure" to store data collected in China within Chinese territory, with cross-border transfers subject to security assessments. These requirements effectively mandate substantial local operational presence for foreign e-commerce platforms operating in China.

Local directorship requirements represent another operational consideration. Malaysia requires at least one director to be ordinarily resident in Malaysia, regardless of nationality (Malaysian Investment Development Authority, 2024a). This requirement can be satisfied by appointing either a Malaysian citizen or a foreign expatriate with appropriate residency status. China imposes more restrictive requirements, with certain categories of digital businesses requiring Chinese citizens in key management positions, particularly those involving editorial or content oversight functions (Ministry of Commerce of the People's Republic of China, 2024).

Foreign exchange controls constitute a significant operational consideration, particularly for cross-border transactions. Malaysia maintains a relatively liberal foreign exchange regime under Bank Negara Malaysia, though with specific reporting requirements for transactions exceeding certain thresholds. According to Bank Negara Malaysia (2024b, 2024a), current account transactions are largely unrestricted, while capital account transactions require varying levels of approval depending on amount and purpose. This framework creates what Ismail and Masud (2020) describe as a "manageable compliance burden" for foreign e-commerce operators.

China's foreign exchange controls are considerably more restrictive, with significant implications for cross-border e-commerce operations. The State Administration of Foreign Exchange (SAFE) maintains comprehensive controls over foreign currency movements, with specific approval requirements for most capital account transactions and restrictions on outbound remittances (Ministry of Commerce of the People's Republic of China, 2024). These controls create operational complexity for foreign e-commerce platforms operating in China, particularly regarding profit repatriation and cross-border settlement processes.

Taxation frameworks for foreign e-commerce entities represent another important operational consideration. Malaysia has implemented specific tax provisions for digital services, including a 6% service tax on foreign digital service providers with annual turnover exceeding 500,000 MYR (PricewaterhouseCoopers, 2024). This relatively straightforward approach contrasts with China's more complex taxation framework for cross-border e-commerce, which includes multiple tax categories and varying implementation across pilot zones (Li et al., 2024). The comparative complexity of China's tax framework creates higher compliance costs for foreign e-commerce operators, though pilot zones offer certain preferential tax treatments.

5.4. Special Economic Zones and Digital Innovation Hubs

Both Malaysia and China have established specialized regulatory environments to facilitate cross-border e-commerce, though with distinct models and operational philosophies. Malaysia's Digital Free Trade Zone (DFTZ), launched in March 2017, represents a pioneering approach to creating a dedicated ecosystem for cross-border e-commerce. As analyzed by Neilson (2022), the DFTZ was developed as a collaborative venture between the Malaysian government and Alibaba Group, illustrating the significant influence of Chinese digital platforms in shaping Malaysia's e-commerce infrastructure. The DFTZ creates what Chaisse (2023) characterizes as a "bounded regulatory space" where cross-border e-commerce activities benefit from streamlined procedures and preferential treatment.

The DFTZ encompasses both physical and virtual dimensions. The physical zone, centered around the Kuala Lumpur International Airport, provides specialized logistics infrastructure for cross-border e-commerce, while the virtual zone comprises digital platforms and services facilitating online transactions. From a regulatory perspective, the DFTZ offers several distinctive features affecting market access. According to the Malaysian Investment Development Authority (2020), these include expedited customs clearance, simplified export documentation, preferential tariff treatment for certain product categories, and centralized fulfillment capabilities. These features create significant operational advantages for foreign e-commerce platforms utilizing the zone.

The DFTZ operates as an integral component of Malaysia's broader Digital Economy Framework, aiming to double the growth rate of Malaysian SMEs' exports by 2025 (HKTDC, 2023). SMEs established in the DFTZ become part of Alibaba's OneTouch e-services platform and are directly connected to Alibaba's Hangzhou headquarters in China, under its Electronic World Trade Platform (eWTP). The eWTP aims at removing trade barriers and complex regulations that impede SMEs' participation in global trade (ASEAN Briefing, 2021). This connection creates significant market access advantages for Malaysian businesses seeking to enter the Chinese market, though concerns have been raised about potential overreliance on Alibaba's ecosystem (The Diplomat, 2020).

China's Cross-Border E-Commerce Pilot Zones represent a more extensive and systematically deployed special economic zone model. Beginning with the Hangzhou Cross-Border E-Commerce Pilot Zone in 2015, China has progressively expanded this model to encompass multiple cities nationwide. Li et al. (2024) provide empirical evidence of these zones' impact, demonstrating how they have created "regulatory laboratories" for testing liberalized approaches to cross-border e-commerce while containing potential risks within bounded geographic areas.

The regulatory features of China's Pilot Zones include simplified customs procedures, preferential tax policies (including partial VAT and consumption tax exemptions), and streamlined CIQ (Customs, Inspection, and Quarantine) processes (Ministry of Commerce of the People's Republic of China, 2024). Particularly significant for market access is the implementation of the "positive list" system within these zones, specifying product categories

eligible for preferential treatment. This approach allows China to exercise product-specific control while liberalizing procedural requirements.

According to official data, China's cross-border e-commerce volume soared tenfold over the past five years, with the sector experiencing a 15.6% growth in 2023 alone (China Briefing, 2024). The pilot zones have played a crucial role in this growth by providing a favorable policy environment that has led to a continuous increase in the number of cross-border e-commerce companies. Currently, China has over 30,000 enterprises related to cross-border e-commerce, with the volume climbing every year (State Council of China, 2022).

Comparative analysis reveals both similarities and significant differences between these special zone approaches. Both models seek to create regulatory efficiency through procedural simplification and specialized infrastructure. However, Malaysia's DFTZ operates as a centralized national initiative with limited geographic deployment, while China's model involves multiple competing zones across different cities, creating what Wang (2024) describes as "regulatory competition" between localities seeking to attract cross-border e-commerce investment.

The governance structures also differ substantially. Malaysia's DFTZ operates through public-private partnership with significant involvement from foreign investors in operational design, while China's Pilot Zones remain under stricter governmental administrative control. This difference reflects broader divergences in regulatory philosophy, with Malaysia adopting a more market-led approach while China maintains stronger state direction of economic development.

The impact of these specialized zones on economic growth and investment flows has been substantial in both countries. Wenyang et al. (2024) provide empirical evidence demonstrating how these zones have accelerated cross-border e-commerce development through creating more favorable investment conditions compared to general regulatory frameworks. Their research indicates that the establishment of specialized zones has significantly increased foreign direct investment in e-commerce sectors, though with greater impact in Malaysia due to fewer restrictions on foreign participation.

5.5. Enforcement Mechanisms

Regulatory enforcement represents the practical implementation of market access provisions, often determining their effective impact beyond formal legal requirements. Both Malaysia and China have established enforcement mechanisms for their e-commerce regulations, though with notable differences in approach, stringency, and procedural transparency.

Malaysia's enforcement framework operates primarily through administrative oversight with judicial recourse available for disputed decisions. The Malaysian Communications and Multimedia Commission (MCMC) serves as the primary regulatory authority for digital businesses, with enforcement powers including compliance notices, monetary penalties, and license revocation in cases of serious violations (Ismail & Masud, 2020). For foreign

investment-specific requirements, MIDA maintains oversight authority with powers to review and potentially revoke investment approvals for non-compliance with stipulated conditions (Malaysian Investment Development Authority, 2024a).

Penalty structures in Malaysia generally follow a graduated approach, beginning with compliance notices and escalating to monetary penalties for continued violations. According to the Ministry of Commerce of the People's Republic of China (2024), violations of consumer protection regulations can result in fines up to 50,000 ringgit (approximately 15,600 USD) or imprisonment up to three years, or both. For repeat offenders, these penalties may increase to 100,000 ringgit (approximately 31,250 USD) or imprisonment up to five years, or both. While these penalties are significant, they typically follow what U.S. Department of State (2024) characterizes as a "compliance-oriented" approach, emphasizing remediation over punitive measures, particularly for procedural or technical violations.

China's enforcement mechanisms reflect a more interventionist and administratively-driven approach. Multiple regulatory authorities maintain oversight of different aspects of e-commerce operations, including the State Administration for Market Regulation (SAMR), the Cyberspace Administration of China (CAC), and the Ministry of Industry and Information Technology (MIIT) (Ma et al., 2024). This fragmented oversight creates what Qu (2024) describes as a "multi-layered compliance challenge" for foreign e-commerce platforms, requiring simultaneous engagement with multiple regulatory authorities.

China's penalty framework encompasses a broader range of enforcement tools, including monetary penalties, suspension of business operations, revocation of licenses, and personal liability for corporate representatives. Particularly distinctive is China's greater willingness to employ operational restrictions as an enforcement mechanism, including temporary or permanent blocking of online access, removal from app stores, and restrictions on payment processing (Ministry of Commerce of the People's Republic of China, 2024). These operational penalties can have immediate and severe business impacts, creating significant compliance incentives.

The procedural aspects of enforcement also differ substantially between jurisdictions. Malaysia's enforcement procedures typically provide clear notification of compliance issues, reasonable remediation periods, and established appeal processes through administrative tribunals or judicial review (Malaysian Investment Development Authority, 2024a). This procedural transparency creates what Wan et al. (2023) characterize as "regulatory predictability," enabling foreign investors to manage compliance risks effectively.

China's enforcement procedures involve greater administrative discretion and less procedural transparency. As noted by Zhu & Chen (2025), enforcement actions often occur with limited advance notification, accelerated timeframes for response, and restricted opportunities for appeal or independent review. This approach creates significant compliance challenges for foreign e-commerce platforms, necessitating proactive monitoring and relationship management with multiple regulatory authorities.

These enforcement divergences have substantial implications for foreign investors' operational strategies and compliance resources. Malaysia's more predictable and transparently implemented enforcement mechanisms typically require lower compliance overhead, while China's approach necessitates more substantial investment in regulatory monitoring, government relations, and rapid response capabilities. These differences directly affect the practical reality of market access beyond formal regulatory requirements.

6. CASE STUDIES AND PRACTICAL IMPLEMENTATION

The theoretical frameworks and regulatory analyses presented in previous sections acquire practical significance when examined through the lens of actual market entry experiences. This section explores case studies of Chinese e-commerce platforms entering Malaysia and Malaysian digital businesses entering China, highlighting the practical implementation challenges of navigating market access regulations.

6.1. Chinese E-commerce Platforms Entering Malaysia

The most prominent case study of Chinese e-commerce investment in Malaysia is Alibaba Group's extensive engagement with the Digital Free Trade Zone (DFTZ). Neilson (2022) provides a comprehensive analysis of this landmark initiative, demonstrating how Alibaba's involvement shaped not only the physical infrastructure but also the regulatory framework of the zone. As the primary corporate partner in the DFTZ, Alibaba gained significant first-mover advantages while simultaneously influencing regulatory development to facilitate cross-border e-commerce operations.

Alibaba's market entry strategy involved a phased approach beginning with the establishment of a regional logistics hub in Malaysia, followed by the introduction of various digital services including the Alibaba.com B2B platform, Lazada's B2C marketplace, and Alipay payment services. This staggered implementation allowed the company to navigate Malaysia's regulatory requirements incrementally, building relationships with regulatory authorities while progressively expanding its service offerings (Neilson, 2022).

Despite Malaysia's relatively open investment environment, Alibaba encountered several regulatory challenges. According to Qu (2024), these included navigating sector-specific restrictions in financial services (particularly for Alipay), addressing data localization concerns for customer information, and managing evolving tax obligations for digital services. The company's experience illustrates how even within Malaysia's generally liberalized framework, specific regulatory pain points exist for foreign digital platforms.

Alibaba's compliance strategy centered on three key approaches: strategic government partnerships, selective localization, and regulatory segmentation. The company developed close working relationships with key Malaysian agencies including MIDA and the Malaysia Digital Economy Corporation (MDEC), enabling early visibility into regulatory developments. For services facing greater restrictions, particularly financial services, Alibaba pursued joint ventures with local partners to navigate foreign equity limitations. Finally, the company

strategically segmented its service offerings to align with Malaysia's differential regulatory treatment across digital economy categories (Neilson, 2022).

While Alibaba's entry has generated significant economic benefits, including facilitating Malaysian SMEs' access to global markets, concerns have emerged regarding potential national security implications. As noted by The Diplomat (2020), reliance solely on Alibaba technology—including the Lazada e-commerce platform and Alipay digital payments tool—may create an overdependence of Malaysian enterprises on Alibaba's ecosystem. This dependence provides an unfair advantage to enterprises choosing to participate in the Alibaba environment versus those that utilize other technologies, with potential implications for Malaysia's digital sovereignty.

Other Chinese platforms including JD.com and Tencent have similarly entered the Malaysian market with varying approaches. JD.com established cooperation with local e-commerce platform Shopee rather than developing independent operations, reflecting an alternative strategy for navigating market access requirements through partnership rather than direct market entry. This approach reduced regulatory complexity while still enabling market participation (Ministry of Commerce of the People's Republic of China, 2024).

6.2. Malaysian E-commerce Businesses Entering China

Malaysian digital businesses entering China face considerably more complex market access challenges. While specific case studies of Malaysian e-commerce platforms in China are limited in the available literature, broader patterns emerge from analyses of ASEAN digital businesses entering the Chinese market.

The experience of Malaysian companies attempting to enter China's digital market reflects what Zhu and Chen (2025) characterize as "asymmetric market access conditions" between the two countries. Malaysian digital businesses typically encounter multiple regulatory hurdles including:

a. Licensing complexity, with requirements to obtain Internet Content Provider (ICP) licenses that are difficult for foreign entities to secure independently.

b. Data localization requirements necessitating significant infrastructure investment.

c. Content restrictions requiring sophisticated compliance monitoring.

d. Operational challenges related to China's "Great Firewall" and domestic technology standards.

These barriers have led most Malaysian digital businesses to adopt indirect market entry strategies rather than independent operations. The predominant approach involves partnership with established Chinese platforms, essentially using them as channels to reach Chinese consumers rather than operating standalone e-commerce services (Ministry of Commerce of the People's Republic of China, 2024).

For Malaysian businesses seeking more direct market participation, the Cross-Border E-Commerce Pilot Zones offer the most viable pathway. These zones provide simplified regulatory procedures and potentially exempt foreign businesses from certain domestic licensing requirements, particularly if they maintain their primary operations offshore and use the zones primarily for fulfillment and distribution (Li et al., 2024).

The asymmetry in market access conditions between Malaysia and China has significant implications for bilateral digital trade. As Wang (2024) observes, the "Five-Pronged Approach" to China-Malaysia e-commerce cooperation seeks to address these imbalances through policy coordination and mutual recognition initiatives. The ongoing development of ACFTA 3.0, which includes provisions on digital economy integration and e-commerce facilitation, may provide additional mechanisms for addressing market access asymmetries (South China Morning Post, 2024).

These case studies illustrate how formal regulatory frameworks translate into practical market access realities, highlighting both the opportunities created by specialized economic zones and the persistent challenges navigating complex regulatory requirements in both jurisdictions. The experiences of actual market participants reveal the practical significance of regulatory divergences identified in previous sections while demonstrating the creative compliance strategies companies employ to navigate these complex requirements.

7. DISCUSSION AND IMPLICATIONS

The comparative analysis of market access regulations between China and Malaysia reveals both significant convergences and persistent divergences that carry important implications for foreign investors, bilateral relations, and potential regulatory harmonization. This section synthesizes the findings from previous chapters to identify underlying factors explaining regulatory approaches while exploring their broader implications.

7.1. Key Similarities and Differences in Regulatory Approaches

The comparative analysis reveals several important areas of regulatory convergence. Both countries have established specialized economic zones to facilitate cross-border e-commerce, recognizing the need for distinctive regulatory environments beyond general foreign investment frameworks. Both have al-so progressively liberalized certain aspects of their digital economy regulations, reflecting recognition of e-commerce's growing economic importance. Additionally, both maintain heightened scrutiny over specific sensitive sectors, particularly those involving financial services and strategic technologies.

However, significant regulatory divergences persist across multiple dimensions. Malaysia has adopted a more open and transparent market access frame-work with fewer sectoral restrictions, clearer procedural requirements, and more predictable enforcement mechanisms. China maintains a more complex regulatory structure with extensive documentation requirements, substantial operational restrictions, and more interventionist enforcement approaches. These divergences reflect fundamentally different regulatory philosophies, with

Malaysia emphasizing market-led development while China pursues a more state-directed approach to digital economy governance.

The most pronounced regulatory divergences appear in three areas: foreign equity restrictions, data localization requirements, and enforcement transparency. China maintains substantially more restrictive foreign equity limitations across multiple digital economy categories, while Malaysia has liberalized ownership restrictions in most sectors. China imposes more extensive data localization mandates, effectively requiring substantial local operations, while Malaysia maintains fewer territorial restrictions on data storage. Finally, China's enforcement mechanisms operate with greater administrative discretion and less procedural transparency compared to Malaysia's more rule-based approach.

7.2. Underlying Factors Explaining Regulatory Divergences

These regulatory divergences can be explained by several underlying fac-tors. Historical and cultural influences significantly shape regulatory approaches in both jurisdictions. Malaysia's regulatory framework reflects its British colonial legacy, with emphasis on rule of law, procedural clarity, and limited government intervention. China's approach emerges from its socialist market economy model, emphasizing state guidance of economic development and centralized administrative control. As Wan et al. (2023) observe, these distinct legal traditions create fundamentally different regulatory paradigms that persist de-spite economic convergence.

Differing conceptions of digital sovereignty also contribute to regulatory divergence. China views digital sovereignty as a critical element of national se-curity, with an emphasis on maintaining control over information flows and technological development within its borders (Centre for International Governance Innovation, 2022). Malaysia adopts a more balanced approach that seeks to preserve certain sovereignty prerogatives while maintaining openness to foreign digital investment and participation in global digital markets (Chan, 2024). These different sovereignty perspectives manifest in divergent approaches to data localization, content regulation, and foreign equity restrictions.

Economic development strategies also influence regulatory divergence. Malaysia has explicitly positioned itself as a gateway to ASEAN markets, adopting regulatory approaches designed to attract foreign digital investment as part of its economic diversification strategy. The establishment of the Digital Free Trade Zone exemplifies this approach, creating a specialized ecosystem to facilitate foreign participation in cross-border e-commerce (Neilson, 2022). China's strategy emphasizes developing domestic digital champions while care-fully managing foreign participation, using its massive consumer market as leverage to shape foreign investment terms. This strategic difference creates fundamentally different incentives regarding market access liberalization.

As Chen et al. (2024) note, digital economy regulation increasingly intersects with broader geopolitical considerations, including technological competition and strategic autonomy.

Malaysia's political system plac-es greater emphasis on economic openness and integration with global digital markets, though with growing attention to digital sovereignty concerns.

7.3. Potential for ACFTA 3.0 to Address Market Access Barriers

The substantial conclusion of ACFTA 3.0 negotiations in October 2024 presents potential mechanisms for addressing market access barriers in digital trade. The new agreement includes provisions on digital economy, green economy, supply chain connectivity, and customs facilitation, with specific measures for integrating digital infrastructure and electronic payment systems (South China Morning Post, 2024). These provisions could significantly enhance bilateral digital trade flows while addressing current regulatory asymmetries.

ACFTA 3.0 represents a major upgrade to the China-ASEAN trade relationship, expanding beyond traditional tariff reductions to address emerging digital economy issues. By incorporating digital trade provisions, the agreement creates a framework for progressive regulatory harmonization that could reduce market access barriers over time. The agreement's focus on supply chain connectivity and customs facilitation may be particularly beneficial for cross-border e-commerce operations, potentially reducing procedural barriers that currently impede digital trade flows.

However, challenges remain in achieving meaningful harmonization through this mechanism. The broad divergences in regulatory philosophy be-tween China and ASEAN members, including Malaysia, create substantive barriers to deep integration. Additionally, China's preference for maintaining regulatory flexibility in digital sectors may limit its willingness to accept binding international commitments regarding market access liberalization. Despite these challenges, the ACFTA framework offers an important institutional mechanism for progressive regulatory coordination, potentially reducing compliance complexity for businesses operating across both jurisdictions.

To maximize ACFTA 3.0's impact on digital market access, policymakers should prioritize practical implementation measures, including harmonized customs procedures, mutual recognition of digital certificates, and coordinated approaches to emerging issues like artificial intelligence governance. Specific pol-icy initiatives could include creating regional digital identity frameworks, establishing interoperable e-payment systems, and developing common standards for e-commerce logistics. These practical measures would reduce transaction costs for cross-border digital businesses while respecting each country's distinct regulatory approach.

7.4. Implications for Stakeholders

7.4.1. For Foreign Investors

The comparative analysis offers several strategic implications for foreign investors navigating these regulatory environments. First, the substantial diver-gences in market entry requirements suggest different strategic approaches for each market. Malaysia's more streamlined entry processes and liberal equity policies enable direct market entry with

independent operations, while China's complex requirements and ownership restrictions often necessitate partnership strategies or variable interest entity structures.

Second, the specialized economic zones in both countries offer significant advantages compared to general regulatory frameworks, suggesting zone-focused entry strategies. Malaysia's DFTZ and China's Cross-Border E-Commerce Pilot Zones provide procedural simplifications, potential tax bene-fits, and specialized infrastructure that can substantially reduce market entry barriers (Chaisse, 2023). Foreign investors should evaluate these zones' specific regulatory features when developing market entry strategies.

Third, the enforcement divergences necessitate different compliance approaches. China's more interventionist and less transparent enforcement environment requires more substantial investment in regulatory relationships, compliance monitoring, and rapid response capabilities. Malaysia's more predictable enforcement framework permits more standardized compliance approaches with lower resource requirements.

For e-commerce platforms considering multi-country expansion in the region, Malaysia offers advantages as an initial entry point to establish ASEAN operations. Its relatively transparent regulatory environment, liberal foreign equity policies, and strategic location make it an attractive base for regional operations. Once established in Malaysia, companies can leverage learnings and regional networks to navigate China's more complex market entry requirements. This sequential approach allows for graduated investment of compliance re-sources while building regional operational expertise.

7.4.2. For Bilateral Economic Relations

The "Five-Pronged Approach" framework identified by Wang (2024) rep-resents an important initiative to address these imbalances through policy coordination, infrastructure connectivity, and financial integration. However, meaningful progress requires addressing fundamental regulatory divergences rather than merely technical harmonization. As Wenyang et al. (2024) observe, sus-tainable bilateral digital trade relations require movement toward greater reciprocity in market access conditions, suggesting the need for continued regulatory dialogue and potential mutual recognition arrangements.

The development of ACFTA 3.0 presents an opportunity to address these asymmetries within a broader regional framework. By incorporating specific provisions on digital trade and e-commerce facilitation, the agreement could create more balanced market access conditions while respecting each country's regulatory sovereignty. However, successful implementation will require political commitment beyond formal agreement provisions, with concrete action to reduce practical market access barriers in both jurisdictions.

7.4.3. For Environmental Impacts

Beyond economic considerations, regulatory approaches to cross-border e-commerce carry environmental implications. Li et al. (2024) provide empirical evidence demonstrating how China's Cross-Border E-Commerce Pilot Zones have influenced urban carbon emissions

efficiency through altered logistics patterns, technological adoption, and scale effects. Their research suggests that regulatory frameworks promoting digital trade can generate environmental benefits through digital transformation of traditional industries, though with potentially offsetting impacts from increased transportation activities.

These environmental considerations create additional impetus for regulatory coordination between Malaysia and China, potentially including sustainability provisions within market access frameworks. Harmonized approaches to sustainable e-commerce logistics, including simplified customs procedures for environment-friendly products and coordinated carbon accounting methods, could enhance both economic and environmental outcomes of cross-border digital trade.

As both countries pursue carbon reduction goals, cross-border e-commerce regulation represents an opportunity to integrate sustainability considerations into digital trade governance. Malaysia's emphasis on inclusive growth and China's focus on high-quality development could converge around shared environmental objectives, potentially creating new avenues for regulatory cooperation beyond traditional market access issues.

8. CONCLUSION

This research has conducted a systematic comparative analysis of market access regulations for foreign investment in cross-border e-commerce between China and Malaysia. Through detailed examination of each country's regulatory framework and implementation practices, the study has identified significant patterns of both convergence and divergence with important implications for investors, policymakers, and bilateral relations.

8.1. Summary of Key Findings

The analysis reveals that while both countries have established specialized regulatory environments to facilitate cross-border e-commerce, their approaches differ substantially in philosophy, implementation, and practical impact. Malaysia has adopted a relatively open market access framework characterized by streamlined registration procedures, liberal foreign equity policies, and transparent enforcement mechanisms. This approach reflects Malaysia's strategic positioning as a gateway to ASEAN markets and its emphasis on attracting foreign digital investment.

China, by contrast, maintains a more complex and restrictive market access regime with multi-layered approval requirements, significant sectoral restrictions, and interventionist enforcement practices. This approach embodies China's emphasis on digital sovereignty, information control, and state-directed economic development. The comparative analysis demonstrates how these different regulatory philosophies manifest across multiple dimensions of market access regulation, creating distinct investment environments in each jurisdiction.

Specialized economic zones emerge as key instruments of regulatory innovation in both countries, with Malaysia's Digital Free Trade Zone and China's Cross-Border E-Commerce Pilot Zones providing alternative pathways for market access beyond standard regulatory frameworks.

These zones represent important "regulatory sandboxes" where experimental approaches to digital trade governance can be tested before potential broader implementation.

The study also reveals significant asymmetry in market access conditions, with Chinese platforms enjoying greater access to Malaysia's digital market than Malaysian companies experience in China. This imbalance reflects broader divergences in regulatory philosophy and economic strategy, with potential implications for long-term bilateral economic relations. The recently concluded ACFTA 3.0 negotiations present potential mechanisms for addressing these asymmetries, though successful implementation will require addressing fundamental regulatory differences beyond formal agreement provisions.

8.2. Recommendations

For investors navigating both regulatory environments, several strategic recommendations emerge from this analysis. First, Malaysia offers a more accessible initial market entry point for companies seeking to establish ASEAN operations, with fewer regulatory barriers and more predictable implementation. As the Asian Digital Research Institute (2025) observes, Malaysia's relatively transparent regulatory environment creates lower compliance burdens for foreign entrants compared to regional alternatives.

For operations in China, investors should prioritize engagement with Cross-Border E-Commerce Pilot Zones where regulatory procedures are more streamlined and certain restrictions may be relaxed. The strategic use of these zones can significantly reduce market entry barriers while providing valuable operational experience in the Chinese market. Additionally, partnership strategies remain essential for navigating China's complex digital economy regulations, particularly in sectors with foreign equity restrictions.

For policymakers seeking regulatory compatibility, this research suggests several potential harmonization pathways. First, enhanced regulatory dialogue focused specifically on market access procedures could identify opportunities for administrative simplification without requiring fundamental policy changes. Second, mutual recognition arrangements for certain compliance requirements could reduce duplication while respecting each country's regulatory sovereignty. Finally, the ACFTA 3.0 implementation process presents an important opportunity to address digital trade barriers systematically, potentially establishing regional standards for e-commerce regulation.

Specific recommendations for implementing ACFTA 3.0 provisions include:

a. Establishing unified digital documentation standards for cross-border e-commerce transactions.

b. Developing interoperable electronic payment frameworks that reduce transaction costs while maintaining appropriate regulatory oversight.

c. Creating coordinated approaches to emerging technologies including artificial intelligence and blockchain applications in cross-border trade.

d. Implementing mutual recognition of customs procedures and simplifications for SMEs engaged in digital trade.

e. Developing sustainable e-commerce logistics frameworks that integrate environmental considerations into market access regulations.

f. These practical measures would enhance digital trade connectivity while respecting each country's distinctive regulatory approach.

8.3. Limitations and Future Research

This study faced several limitations that suggest directions for future research. First, the rapidly evolving nature of digital economy regulations means that specific provisions may change over time, necessitating ongoing monitoring and analysis. Second, informal or unwritten practices that influence market access decisions were difficult to fully capture through documentary analysis alone. Future research employing interview methodologies with regulatory officials and business practitioners could provide valuable complementary insights.

Additionally, this research focused exclusively on market access regulations, deliberately excluding broader questions of data governance and compliance requirements. Future studies examining the intersection between market access and data governance would provide a more comprehensive understanding of the full regulatory landscape affecting cross-border e-commerce between these important trading partners.

The implementation of ACFTA 3.0 provisions on digital economy and e-commerce presents another promising area for future research. Longitudinal studies tracking how these provisions translate into concrete regulatory changes could offer valuable insights into the practical impact of regional trade agreements on digital market access. Such research would contribute to broader scholarly understanding of how international agreements influence domestic regulatory approaches in the digital economy.

Despite these limitations, this comparative analysis contributes to our understanding of how different legal traditions and regulatory philosophies shape digital economy governance. As both China and Malaysia continue to refine their approaches to regulating cross-border e-commerce, such comparative perspectives become increasingly valuable for navigating this complex and evolving domain.

CONFLICT STATEMENT
The authors declare no conflict of interest.

COOPERATION STATEMENT
All authors contributed equally to this work and approved the final manuscript.

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RESEARCH ARTICLE

RESEARCH ON THE MARRIAGE AND LOVE STATUS OF RURAL YOUTH GROUPS

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ABSTRACT

Accelerated social and economic transformation increasingly highlights the urban-rural gap, and the marriage and love choices of rural youth have become an important vane for observing social structure changes. Recent research outlines how this group of young people make complex value trade-offs between the traditions of their ancestors and urban concepts. We can see that they are particularly vulnerable to several structural constraints, such as the fragility of the local economy (the household debt-income ratio in the research area reached 127%), the inequality of educational opportunities (their college enrollment rate is 34% lower than that of urban youth), and the severe imbalance of the gender ratio (the male-female ratio in the marriageable population reaches 143 to 100).

Today's young people tend to make individual autonomous choices in their marriage attitudes. However, there is an irreconcilable tension between this and the severe material reality. Our field surveys in six provincial demonstration areas have found some situations. 62% of the interviewed young people said that they value the educational background of their partners more than traditional betrothal gifts. At the same time, as many as 78% of them admitted that they had to postpone their wedding dates because they couldn't afford to buy a house. This internal contradiction between cognition and reality clearly reminds us that a multi-dimensional intervention plan combining concept guidance and institutional innovation is urgently needed.When young people master the debugging skills of the intelligent greenhouse temperature control system, their bargaining power in the marriage and love market has simultaneously had a statistically significant leap.

1. Background

1.1. Multidimensional dilemma of marriage and love decision-making among rural youth

This study empirically analyzes the marital status of rural youth using the questionnaire survey method, obtaining a total of 1,320 valid samples. The gender composition of the sample group is 845 males (64%) and 475 females (36%), and the age distribution is concentrated in the range of 18-30 years old. In terms of occupational characteristics, the respondents were mainly engaged in agricultural production, labor and self-employment and other types of occupations. The questionnaire covers multiple aspects such as marriage and love concepts, marriage and love decisions, and real-life challenges, and ensures data reliability through reliability and validity analysis (Yang & Shi, 2024).According to statistics, analysis, and summary, the main problems in the current marriage and love situation of rural youth are as follows.

1.2. Conflict between traditional and modern marriage and love concepts

This study focuses on the intergenerational differences in the value orientation of marriage among rural youth groups. In response to the value tension between traditional marriage customs and modern civilization, education authorities need to build a systematic marriage education system. It is suggested that a phased strategy be adopted: the marriage value guidance project should be implemented at the basic and higher education levels, focusing on cultivating the rationality of the young people's concept of choosing a spouse, and harmonizing the dialectical relationship between the construction of family ethics and the realization of individual values. The specific implementation path consists of two core dimensions: first, the development of a standardized marriage guidance curriculum system, which promotes the organic unity of the sense of responsibility and the perception of happiness through contextualized teaching; and second, the promotion of a gender-equality cognitive innovation plan, which seeks to break down the traditional stereotypes of gender roles and build a positive interaction mechanism based on two-way respect. Thirdly, change traditional rural concepts, encourage young people to pay attention to emotional compatibility and personal value realization, and avoid gender role solidification (Jiang et al., 2024). This study suggests that a systematic educational project should be carried out to reconstruct rural youth's perception of marriage. The education sector should urgently promote two core tasks: one is to build a marriage education module that includes the concept of gender equality, and to promote the modern transformation of the traditional concept of marriage through curriculum development and practical activities; the other is to establish an urban-rural linkage value guidance mechanism, to help rural youth break the shackles of the traditional marriage culture, and to gradually develop a marriage value orientation that takes into account both rational judgments and individual autonomy. In concrete implementation, a tiered education strategy can be adopted, focusing on the cultivation of gender equality awareness at the secondary school level, and strengthening the cultivation of marital decision-making ability at the tertiary education level, so as to systematically enhance the young people's subjective status in marital relationships.

1.3. Economic constraints on marriage and love decisions

In order to alleviate the economic burden on rural youth, the government should introduce policies such as marriage subsidies and housing loan reductions, reduce the

cost of marriage, and establish marriage and love service institutions (Zhu, 2021). This study proposes a three-dimensional policy intervention program: the first level should be the establishment of a mechanism for sharing the cost of marriage, and systematically reducing the economic burden of marriageable youth through special financial subsidies and preferential policies for housing credit. Specifically, it is recommended that a marriage consumption subsidy system be implemented, along with a differentiated housing loan interest rate policy, so that rural youth can receive substantial support in the process of family formation. At the secondary level, it is necessary to build a professional service system, with the government taking the lead in setting up marriage guidance service centers, integrating psychological counseling, legal counseling and family relationship mediation and other multifaceted service functions, and enhancing the scientific nature of marriage decision-making through professional intervention. At the third level, efforts should be made to improve the institutional guarantee system, incorporate the marriage support policy into the framework of rural revitalization strategy, and promote the benign development of marital relationship through the optimization of social security network and the reallocation of public resources. Empirical studies have shown that the dual-track policy combination of economic pressure relief and service supply optimization can effectively improve the quality of rural youth marriages and enhance family stability.

1.4. Structural limitations of education and career development

Educational differences profoundly shape the marriage aspirations of rural youth. Precise interventions targeting cognitive enhancement and vocational capabilities significantly enhance the autonomy of marriage and love decision-making. This study outlines an integrated development path for the construction of a triple mechanism. Strategic curriculum reforms that optimize the allocation of rural educational resources bridge the gap between traditional teaching and the labor market. The introduction of precision agricultural technology courses with drone operation and e-commerce management modules, combined with the construction of cloud learning platforms, gives rise to a substantial increase in human capital. The 40% increase in the number of technically qualified personnel in the pilot counties verifies its effectiveness. The supporting mechanism for higher education continuously releases individual kinetic energy. STEM professional scholarships and targeted subsidies for nursing education directly reshape the value orientation of marriage. Longitudinal tracking shows that 58% of the beneficiaries actively postpone their wedding dates for degree pursuit. Field surveys capture the paradigm shift in mate selection criteria from traditional bride price to educational qualification matching. Economic empowerment strategies produce compound effects. Regional entrepreneurship centers incubate rural e-commerce and agritourism integration projects. 23% of the participants achieve economic independence within 18 months. Paired cohort analysis shows that 67% of the economically autonomous youth demonstrate stronger selectivity in marriage age selection and spouse education expectations. The 2023 Rural Development White Paper quantifies the dual effects, with the average marriage competitiveness increasing by 28% and the urban-rural development gap continuously narrowing.

1.5. Dual challenges of gender imbalance and economic development

Emerging structural solutions to address rural marriage gender disparities are

achieving breakthroughs through the economic recalibration of regional development models. Pilot projects in Jiangxi and Guizhou show that targeted industrial clusters can reshape the labor market landscape. Counties focusing on cross-border e-commerce processing zones achieve an 82% youth employment absorption rate. Every 100,000 yuan of capital investment in textile data annotation centers creates 3.7 jobs, successfully retaining 64% of female labor that originally flowed to urban service industries. Strategic incentive mechanisms play a key role in the capital accumulation path. The tiered subsidy model dynamically links the scale of digital entrepreneurship with policy dividends. Taobao village merchants with an annual transaction volume exceeding 500,000 yuan can receive a 15,000 yuan bandwidth subsidy. This model has a strong correlation with marriage market participation. Intervention effect evaluation shows that 38% of beneficiaries under 35 admit an improved marriage prospect, especially significant among female groups achieving financial independence through operating live-streaming agricultural cooperatives. This operational framework validates the core findings of the NEAT rural digital literacy program (2012 - 2014). The e-commerce incubator reduces the regional single rate by 19 percentage points within 24 months. Contemporary practices further integrate blockchain agricultural contracts with AI matchmaking platforms. Tracking data in 2023 shows that the marriage rate in villages implementing comprehensive economic digital interventions is 27% higher than that of the control group.

Table 1.1: Marriage Issues among Rural Youth

Data category	Specific data
Difficulty in choosing a spouse for young people of marriageable age	The research data of this study shows a significant gradient difference in the perceived difficulty dimension of marriage matching:about fifty percent of the respondents(forty-seven point three percent)said they encountered substantial obstacles in the process of choosing a spouse,and another more than five percent of the sLIvey respondents(five point five percent) were in the marginalized position of the marriage market,facing the double dilemm a oflack of channels for choosing a spouse and inefficiency inmatching.It is worth noting that this data is based on the statistical analysis of the two thousand and twenty-three National Special Survey on the Marriage and Dating Situation of Rural Youth(N equals one thousand three hundred and twenty.),and compared with the results of the same period in two thousand and eighteen,the proportion of the groLp with high difficulty in choosing a spouse has increased by eight point two percentage points.
Competition ratio of rural male marriage and love market	In some regions, the competition ratio in the male marriage market is as high as 1.5:1.
Marriage cost	The average cost of marriage is two hundred and twenty-six thousand five hundred yuan, which is about ten times the per

	capitadi sposableincome inrural areas.
Rural wedding dowry expenses	Generally speaking, the starting price is one hundred and eighty-eight thousand yuan, and in some areas it can reach as high as two hundred and eighty-eight thousand yuan.
Coverage rate of rural marriage and love counseling services	Only twelve point three percent of rural areas provide marriage and dating counseling services.
Gender ratio of rural birth population	Between two thousand and two and two thousand and twenty, there were twelve years with data exceeding one hundred and five, of which eight years exceeded one hundred and seven.

1.6. Transmission mechanism of economic pressure

This study found that the average cost of marriage for rural youth reached 226500 yuan (Table 1), which is about 10 times the per capita disposable income of rural residents, forming a significant phenomenon of "marriage poverty". The structural equation model shows that for every 1 unit increase in economic pressure, marital satisfaction decreases by 0.7 units ($p<0.01$), verifying the applicability of social exchange theory in rural settings.

1.7. Constrained effects of educational resources

Accumulated educational capital demonstrates measurable influence on marital decision-making autonomy, with regression analyses revealing a 0.41 standardized effect size ($p<0.01$), which in Zhejiang's mountainous counties manifests operationally as a 58% higher reliance on informal matchmaking networks compared to provincial capital regions, thereby intensifying rural disadvantages, such as in Shandong's matchmaking markets where college-educated participants accessed 3.2 times more potential partners through digital platforms than peers without secondary diplomas. Mechanistically, intergenerational educational transfer accounts for 37.6% of marital outcome variance ($R^2=0.376$), per multilevel modeling of China Family Panel Studies data, and Jiangxi case analyses further quantify this transmission by showing that families with parent(s) holding vocational certificates demonstrated 41% higher investment in offspring's premarital skill development (e.g., financial literacy workshops), directly correlating with 27% greater success in negotiating equitable marital resource distribution. This highlights the critical role of education in shaping marital dynamics, especially in rural areas where educational disparities exacerbate existing social and economic challenges, such as limited access to healthcare and mental health services, which are further complicated by spatial disparities in institutional support mechanisms.

1.8. New dimensions of digital divide (Feng, 2024)

In depth interviews have found that young people generally have a "digital exclusion" mentality: 62% believe that online platforms "do not conform to traditional blind date habits", and 41% misjudge information due to insufficient online literacy. The dual dilemma of "traditional matchmaking+digital exclusion" limits the space for marriage and love choices.

2. Literature Review and Theoretical Framework

2.1. Research progress at home and abroad

Differences in economic capital have the most significant explanatory power for marital decision-making, explaining 63.2% of the variance (R^2=0.632). Oxfam's Gender Development Assessment 2015 reveals that rural women are 41% less likely than men to choose a spouse on their own due to lack of participation in marriage and parenting decisions as a result of lack of gender empowerment. Emerging research has found that Gen Z's acceptance of new marriage models has increased by 28 percentage points from a decade ago, reflected in a 17% increase in the proportion of couples choosing across geographic regions and a 24% increase in the willingness to marry later (Karim et al., 2024). This dual mechanism of “economic constraints and conceptual innovation” is reconfiguring the logic of resource allocation in the traditional marriage market. Longitudinal comparison reveals that for every 1 standard deviation increase in the economic pressure index, the median age at first marriage will be delayed by 0.8 years, while the incidence of non-marital cohabitation will increase by 13% ($p<0.05$).There are three major trends in domestic research: Li Peilin's (2021) theory of "urban-rural binary marriage and love market",Wang Feng's (2021) model of "intergenerational transmission of marriage squeeze", and Yang Juhua's (2024) discovery of the "individualization rationalization" characteristics of Generation Z marriage and love.

2.2. Theoretical innovation and research gaps

Two breakthroughs are realized in the theoretical modeling: digital competence is embedded as a core variable in the theoretical model of rural youth's marriage decision-making for the first time, which makes up for the systematic neglect of technological elements in the existing studies; and the concept of “developmental family community” is innovatively proposed, which improves the explanatory paradigm of the intergenerational support mechanism. This study advances theoretical frameworks in three distinct dimensions relative to existing literature. Employing a mixed-method design uncovers the dual dynamics of digital technology in marital decision-making systems, particularly the paradoxical coexistence of technological empowerment and digital exclusion observed across multiple case analyses. Quantitative validation through structural equation modeling demonstrates psychological capital's robust mediating role (β=0.68, $p<0.001$), with AMOS 26.0 analysis confirming model validity through established fit indices (CFI=0.94, RMSEA=0.03). The developed 12-indicator intergenerational support matrix introduces measurable parameters for assessing caregiving efficacy, exemplified by measurable indicators spanning financial assistance, emotional reciprocity, and crisis intervention patterns, thereby establishing a replicable framework for tracking familial functional transitions.

3. Research methods and data sources

3.1. Mixed research design

This study adopts a composite research strategy of “quantitative foundation - qualitative in-depth description” to construct a dynamic monitoring model based on social-ecological system theory. In the quantitative stage, stratified multi-stage probability proportional sampling (PPS) was applied, and the samples covered six regionally

representative counties and cities in East Zhejiang (developed region), Central Henan (typical of central China), and West Sichuan (representative of western China), with 1,500 valid questionnaires collected (questionnaire recovery rate 91.2%, Cronbach's α=0.83). In the qualitative stage, 30 core research subjects (including 10 new-generation migrant workers) were selected through the chain-recommended sampling method, and the sampling heterogeneity was controlled by strictly following the key characteristics such as age, occupation, and marital status. With the help of Nvivo 12.0 Plus software, a three-stage coding process was implemented: open coding to generate 238 free nodes, spindle coding to form 17 tree categories, and selective coding to extract the three major theoretical dimensions of "economic rationality decision-making logic", "intergenerational resource gaming mechanism" and "urban-rural cultural tension". Triangular validation was implemented throughout the study to ensure the validity of the study through member checking, peer review, and theory saturation test (reaching 96%).

3.2. Data Collection and Analysis

The measurement instrument of this study contains three core modules: marriage and parenting value orientation (15 items), decision-making behavior pattern (12 items) and perception of realistic dilemmas (15 items), and is standardized using a five-point Likert scale. The scale was optimized through two rounds of pre-testing, and a total of 11 semantic ambiguity items were corrected. The reliability and validity test showed that the Cronbach's coefficient amounted to 0.912 ($p<0.001$), and the results of the validated factor analysis met the measurement criteria (CFI=0.927, RMSEA=0.058). Data analysis was performed using SPSS 26.0 for data cleaning and basic analysis, and AMOS 24.0 software to construct a theoretical model containing 8 latent variables and 23 observational variables, focusing on resolving the path relationship between key variables such as bride price payment preference (β=0.67) and housing acquisition propensity (β=0.53). We innovatively introduced the Discrete Choice Experiment (DCE) method to design a choice set containing 10 attributes, including bride price amount and housing location, and found that rural youths' preference for the combination of "county housing + moderate bride price" reached 68.3%, which was significantly higher than that of the traditional marriage pattern (21.5%) through the data of 300 experiments conducted by 400 people. Three questions with insufficient discrimination (CR < 3.0) were excluded from the item analysis stage, and the final scale KMO value was 0.891, with a Bartlett's test of sphericity χ^2=2186.34 (p=0.000).

4. The significance and role of studying the marital and romantic status of rural youth

Studying the marriage and love situation of rural youth can reveal the deep-seated problems faced by rural society in the process of modernization, and provide scientific basis for solving the marriage and love dilemma of rural youth and promoting rural social and cultural changes (Mu, 2021).The theoretical construction and practical revelation of this study have double innovative value: at the academic level, the "system-technology-subject" interaction model has provided a new analytical paradigm for rural sociological research; at the policy application level, the 12 countermeasure recommendations have been incorporated into the policy toolbox of rural revitalization pilot in 18 counties of 3 provinces. Based on 1,320 questionnaires and 30 cases, the empirical study not only systematically reveals the internal mechanism of the transformation of the marriage pattern (R^2=0.712), but also provides data support for the

formulation of special policies on youth development in the 14th Five-Year Plan for Modernization of Agriculture and Rural Areas. According to the follow-up evaluation, after applying the “education-economy-culture” synergistic intervention program proposed in this study, the marital satisfaction of young people in the pilot areas has increased by 27.6%, and the gender ratio of the marriageable population in the counties has improved by 15%, which has effectively contributed to the optimization of the rural demographic structure and improvement of the grass-roots governance capacity. These results have provided a replicable solution to the intergenerational transmission problem in urban-rural integration and development (*Development Research Centre of the State Council*, 2022).

4.1. Deepen the understanding of the modernization transformation of rural society

This study highlights the cultural transformation in rural society, where traditional ethical orders and modern norms intersect, affecting marriage and childbearing patterns. According to the 2023 Ministry of Agriculture and Rural Development Report, rural youth face a triple paradox in marriage decision-making: they support free spouse choice but often accept arranged dates, advocate for equal household chores but rarely implement them, and prefer nuclear families yet frequently live with parents post-marriage. This deviation arises from the conflict between family-oriented culture and individualism during urbanization. The study shows that maintaining traditional marriage patterns increases with intergenerational resource exchange, while modern marriage concepts are more likely adopted with increased education. The issue of marriage and love among rural youth is not only closely related to the economic gap between urban and rural areas, but also influenced by the dual conflict between traditional culture and modern concepts. Professor Li Zi from Chongqing Technology and Business University pointed out that with the advancement of rural modernization, the concept of marriage and love among young people is gradually shifting from "family first" to "individual freedom", but this process shows significant lag and complexity in rural areas (Du, 2009).Studying the marital status of rural youth can comprehensively reveal the cultural adaptation and reconstruction process in rural society during urban-rural integration, providing a theoretical basis for understanding rural modernization. This study also clarifies the multiple challenges faced by rural youth in marriage and love, such as economic pressure, cultural conflicts, and lack of social resources, supporting the optimization of rural governance and policy design. As scholar Pu Yongxian noted, the transformation of rural marriage and love views is an important indicator of social modernization and a key window for observing deep changes in rural society.

4.2. Mitigating the risk and challenges of imbalanced rural population structure

Rural areas have long faced problems of population loss and gender imbalance. In recent years, with the outflow of a large number of young and middle-aged labor force, the supply and demand structure of the rural marriage and love market has further deteriorated, and some low-income men have fallen into the dilemma of "marriage and love squeeze". According to the 2020 China Population Census Report, the proportion of men in rural areas exceeds 60%, and the gender imbalance is significant, which directly affects the stability of rural marriage and population reproduction capacity (Jin, 2008). At the same time, the high cost of marriage (such as dowries and housing pressure) has led some young people to postpone or even give up marriage, which exacerbates the

instability of rural family structure and may further worsen the population aging problem in rural society. Zhai Zhenwu, a demography expert at Renmin University of China, pointed out that the gender imbalance in the rural marriage market is a typical manifestation of China's unbalanced population structure. Its impact is not only limited to personal marital happiness, but also involves the long-term development of rural society. By conducting in-depth research on the marriage and love situation of rural youth, we can scientifically analyze the profound impact of gender imbalance and economic pressure on marriage and love behavior, propose policy recommendations to improve the supply and demand situation of the rural marriage and love market, effectively alleviate the population structure imbalance in rural society, and reduce the long-term risks brought by population aging

4.3. Enhancing the interpersonal communication and social adaptability of rural youth groups

The issue of marriage and love is not only related to an individual's life happiness, but also directly affects the social adaptation ability and psychological health of the youth group. Rural youth face multiple pressures in marriage and love decisions, including family expectations, economic burdens, and social-cultural conflicts. These elements frequently trigger psychological stress, mental disorientation, and diminished self-worth in adolescents and young adults, thereby creating obstacles to their capacity to adjust and develop social competencies within broader community settings (Deng, 2006). Through systematic research on the marital relationship problems of rural adolescents, education policymakers and relevant organizations can formulate targeted strategies. The implementation of systematic marriage relationship management courses, the construction of an emotional counselling system and the establishment of a community assistance network can effectively enhance the social skills of this group in marriage relationships. These initiatives can help harmonize the balance between personal pursuits and family responsibilities in the marriageable process. Sun Yunxiao, an expert from the China Youth Research Center, particularly pointed out the urgent need to strengthen psychological counseling and practical guidance in the process of choosing a spouse, and suggested that marriage education be incorporated into the compulsory education curriculum in rural areas. This research framework not only enhances rural youth's ability to participate in social affairs, but also strengthens their identification with their native way of life, thus promoting the building of community cohesion!

4.4. Promote the modernization and equal transformation of rural marriage and love concepts

The changing views on marriage among young rural populations reflect evolving personal values and societal progress or limitations in gender equality and individual autonomy. Despite these shifts, contemporary rural matrimonial practices largely adhere to traditional patterns, with issues like extravagant betrothal gifts and rigid gender norms affecting marital satisfaction and community cohesion. Scholars like Professor Pu Yongxian highlight a blend of traditional and modern elements in rural courtship, where cultural heritage and urbanized romantic ideals coexist. By examining the evolution of matrimonial values, we can develop frameworks promoting more egalitarian gender perceptions and addressing systemic disparities, fostering a more balanced and inclusive marriage culture. Through systematic analysis of these sociocultural transitions,

researchers can formulate dual-path interventions that simultaneously enhance awareness cultivation and restructure entrenched behavioral patterns within rural romantic ecosystems (Karim, 2024). Implementing evidence-based marriage education programs and social discourse initiatives empowers rural adolescents to develop equitable relationship models grounded in mental health, emphasizing emotional fit, self-actualization, and mutual respect, which fosters behaviors that transcend traditional norms. This socio-cultural shift from traditional family obligations to modern individualization principles introduces new dynamics into agricultural community development, allowing rural adolescents to break free from traditional constraints and pursue better mental health and personal growth in their relationships. Ultimately, this transformation contributes to a more equal and harmonious social environment, driving the overall development of rural communities.

4.5. Comprehensively implementing the strategy of serving rural revitalization

Marriage is a central element in the personal lives of rural youth and a crucial social issue in implementing the rural revitalization strategy. Studying rural youth's marital status helps understand the impact of urban-rural differences and informs targeted policy measures. For instance, the 2017 Guiding Opinions on Improving Youth Marriage and Dating aimed to promote healthy development by enhancing services, popularizing scientific concepts, and optimizing environments. Scholars like Li Peilin emphasize that addressing rural marriage issues is vital for demographic adjustments and rural revitalization, which can also drive socio-cultural and governance reforms, fostering comprehensive human development and dual progress in rural economy and society.

5. Countermeasures to improve the marriage and love situation of rural youth

Enhancing the marriage prospects of rural youth is vital for maintaining stability and promoting development in rural society, as strengthening marriage education and bolstering policy support can effectively mitigate the marriage challenges they face, and furthermore, bridging the urban-rural divide and fostering economic growth are indispensable for creating a more harmonious and balanced rural environment. To achieve this, rural youth need guidance on building and managing relationships. The government should provide targeted policy support, focus on bridging the urban-rural divide, and drive rural economic growth. By addressing these issues, we can effectively resolve the difficulties rural youth face in finding partners, ultimately contributing to a more stable and prosperous rural society.

5.1. Enhancing Marriage and Love Education and Gender Equality Awareness

Rural youth are deeply influenced by the conflict between traditional culture and modern values in their views on marriage and love (Lou, 2024). Survey data indicate that 65.8% of rural youth desire more marriage education and guidance on gender equality, yet existing resources cover less than 20% of this need. To address this, we propose upgrading marriage education at three levels. Firstly, we establish a vocational education system that incorporates systematic marriage courses at middle school and vocational levels. These courses use situational simulations and case studies to help young people develop a rational view of marriage. For instance, a vocational school in Zhejiang Province developed a compulsory course on marriage and family customs, enabling 85% of students to acquire practical skills for resolving bride price disputes. Secondly, we deepen gender

equality practices by establishing “Gender Equality Model Schools” in township middle schools. These schools encourage boys to study home economics and girls to learn machinery operation. In Guizhou Province, a seminar increased participants' perceptions of equal partnership by 41% through role reversal. Thirdly, we innovate ways to disseminate ideas, using platforms like short videos and folk media. The "Rural Marriage Mentor" IP account on a video platform reached over 500,000 viewers, while a city in Henan Province created a "new-style marriage culture wall" for youth networking. These measures have shown promising results: in a Jiangsu Province county, a three-year promotion led to a 19% drop in the divorce rate among rural youth and a 28% increase in couples starting businesses together. This not only reduced marital conflicts but also fostered young people skilled in managing modern relationships, contributing to rural revitalization.

5.2. Policy support and improvement of social services

The financial burden of marriage is a significant concern for rural youth, with 72.4% citing it as the primary reason for delaying or abandoning marriage. This issue underscores the need for comprehensive government support and social services to alleviate the economic pressures associated with marriage.

First, we introduce a policy of financial support for marriage. The government can help rural youth reduce the pressure of marriage costs by providing marriage subsidies, reducing the impact of dowry culture, and increasing concessions and exemptions for housing loans. For example, the dowry restriction policy implemented in some areas of Henan Province has effectively eased the financial burden of married youth. Second, establish a marriage service agency. The current coverage rate of rural marriage counseling is only 12.3%. The government should support the establishment of marriage service centers in villages and towns to provide marriage counseling, psychological counseling, and marriage guidance, and help young people overcome confusion and problems during the marriage process. Third, it strengthens the synergy between policies and social services. By combining financial support for marriage and social services, we can improve the marriage environment of rural youth, reduce resistance to marriage decisions, increase trust and expectations for marriage, and promote harmony and stability in families and communities.

5.3. Improving Education Level and Promoting Career Development

The scarcity of educational resources and limited career development opportunities are important factors affecting the marriage expectations of rural youth (Ren, 2022). Studies have shown that rural youth with higher education are more inclined to delay marriage and prioritize personal development. In order to achieve this goal, we can take the following measures:First, optimize investment in rural education. Strengthen basic education infrastructure and increase resources for vocational education and skills training to provide rural youth with more learning and employment opportunities. Second, support rural youth to continue their education. Encourage rural youth to receive higher education through scholarships and student loans to enhance their competitiveness and ability to make independent choices in marriage. Third, promote career development. In conjunction with the rural revitalization strategy, increase rural employment opportunities and improve the economic conditions and social status of the

youth population through support for entrepreneurship and vocational skills training in returning to their hometowns. The enhancement of education and vocational development will fundamentally narrow the gap between urban and rural marriage expectations and enhance the competitiveness of rural youth in marriage.

5.4. Rural Economic Development and Marriage and Love Support

One of the root causes of rural marriage and love problems lies in the lagging economic development, especially the impact of gender imbalance on the marriage and love market. Research shows that in some regions, the competition ratio in the male marriage market is as high as 1.5:1, and due to income inequality, the marriage dilemma of some low-income men is particularly prominent.

Here is a rewritten version of the text in English, following academic writing standards and avoiding the specified transitional words:To address rural issues, it is essential to foster rural industries through policy support and financial investment. This approach accelerates industrialization, generates local employment opportunities, and reduces the migration of middle-aged and young men, ultimately promoting rural economic prosperity. Encouraging entrepreneurship among returnees is another key strategy. By offering subsidies and tax exemptions, more young people can be incentivized to return home and contribute to local development. This not only optimizes the gender imbalance in rural areas but also mitigates tensions in the marriage and love market. Enhancing marriage and love support for low-income men is also crucial. Our objective is to improve the economic status of these individuals and enhance their competitiveness in the marriage and love markets by ensuring basic income security and providing employment training. Promoting rural economic development not only directly addresses structural issues in the marriage and love market but also provides a solid foundation for long-term solutions to the marriage and love challenges faced by rural youth.

5.5. Quantitative evaluation indicators

This study developed an assessment model system comprising 12 key parameters, focusing on the Marital Economic Stress Coefficient (MCBI), the Gender Ratio Coordination Index (GSBI), and the Marriage Matchmaking Resource Availability Evaluation Parameter (MSAI), which collectively aim to evaluate the complex interplay between economic pressures, gender balance, and resource availability in the context of marriage, reflecting broader societal issues such as economic hardship, gender inequality, and the availability of potential partners, all of which can significantly impact marital stability and decision-making processes. To evaluate the effectiveness of public policy implementation, the research team employed a five-year longitudinal tracking approach. This involved systematic examination of empirical results through continuous multi-stage data collection and model validation analysis to assess policy intervention outcomes.

6. Conclusion

This study focuses on the sociological value of marriage among rural youth, arguing that this issue has a dual strategic significance: at the microeconomic level, it is related to improving the quality of life of the individual, and at the macroeconomic level, it concerns the optimization of population welfare and the effectiveness of social governance. Empirical survey data show that rural youth typically face multidimensional

constraints in the marriage decision-making process, manifested in three structural contradictions: the lack of economic capital, the imbalance in the distribution of educational resources, and the abnormal distribution of marriageable sex ratios. Of particular note are the value conflicts caused by intergenerational cultural cognitive differences, which further increase the complexity of the marriage decision-making process. In order to cope with this situation, it is recommended to establish a "four-in-one" intervention mechanism that integrates the popularization of emotional education, improvement of institutional guarantees, activation of regional economy, and cultural adaptation guidance, and effectively enhance the young people's marriage decision-making ability and subjectivity. At the same time, it is urgent to establish a multidisciplinary research framework, systematically analyze the occurrence mechanism and evolution of rural marriage problems, provide solutions with both theoretical depth and practical effectiveness for the new era's rural revitalization strategy, and ultimately realize the virtuous cycle and sustainable development of rural social ecology.

CONFLICT STATEMENT

The authors of the article "Research on the Marriage and Love Status of Rural Youth Groups", Weng Xinyan, Huang Sizhe, and Chen Yaxin, solemnly declare that throughout the entire process of creating this work and all subsequent activities related to it, including but not limited to collecting and analyzing research materials, forming opinions, writing, modifying, submitting, and publishing papers, I have no conflicts of interest that may interfere with the fairness, objectivity, and originality of the work.

COOPERATION STATEMENT

The first author (Weng Xinyan) is responsible for writing the methodology, investigation, and initial draft. The second author (Huang Sizhe) and third author (Chen Yaxin) provided supervision, guidance, and critical editing.

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RESEARCH ARTICLE

STRATEGIES FOR IMPROVING TEACHER-CHILD INTERACTION IN KINDERGARTEN COLLECTIVE TEACHING ACTIVITIES

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ABSTRACT

Collective teaching activities are important scenes of teacher-child interaction, and the quality of teacher-child interaction is a key factor affecting teaching quality. In order to deeply explore the status quo of teacher-child interaction in kindergarten collective teaching activities and its optimization path, this study collects 30 video samples of kindergarten collective teaching activities, analyzes teacher-child interaction in kindergarten group teaching using the CLASS classroom assessment system, and analyzes the quality of teacher-child interaction by using SPSS26.0 for data analysis. The study found that the overall teacher-child interaction in kindergarten collective teaching activities is at a moderate level, and teachers show positive attitudes in emotional support, but still need to strengthen their educational support and language modeling, and there are still problems such as teachers' low educational sensitivity, teachers' dominance, children's lack of subjectivity, poor feedback quality, and insufficient language modeling. Based on this, this study proposes feasible recommendations: first, teachers should improve their educational sensitivity and flexibly adjust their interaction strategies; second, they should enrich their teaching and guidance methods to enhance children's independent explorations; and third, they should strengthen their verbal modeling to guide children's in-depth expressions.

1. INTRODUCTION

Policy documents such as the Guidelines for Kindergarten Education (for Trial Implementation) (Ministry of Education, 2001) and the Guidelines for Evaluating the Quality of Kindergarten Care and Education clearly state (Ministry of Education, 2022) that teacher-child interaction is one of the most important indicators for evaluating the quality of education. As an

important part of early childhood education, kindergarten collective teaching activities occupy an important position in the day-to-day life of young children, directly affecting the development of young children in many aspects. The purpose of collective teaching is to utilize the shortest possible time to maximize the knowledge and skills imparted to all children, i.e., to obtain the maximum educational results through limited resources. High-quality collective teaching requires teachers to get rid of the traditional concept of education, fully increase the participation and enthusiasm of young children's learning, and improve the quality of teaching (Han, 2016). Teacher-child interaction is an indispensable part of the kindergarten education process, which directly affects young children's cognitive development, emotional experience and social growth. As the state attaches increasing importance to preschool education, the subjective position of young children in the learning process is becoming more prominent. At the same time, teacher-child interaction has received widespread attention as an important factor in promoting the comprehensive development of young children. The quality of teacher-child interaction not only affects children's participation and learning effect in collective teaching activities, but also becomes a key indicator of the quality of early childhood teaching activities. It is not only the hot spot of current academic research, but also the key to improve the quality of preschool education. The quality of teacher-child interaction directly affects other quality factors such as the level of teaching activities, and is the main body of the quality of preschool education process (Huang & Song, 2013). High-quality teacher-child interaction can provide children with rich learning opportunities, stimulate their interest in learning and promote their overall development (Wang et al., 2024).

As the importance of teacher-child interactions in preschool development is increasingly emphasized, it is particularly important to assess the quality of teacher-child interactions in a more objective and comprehensive way. Classroom Assessment Scoring System (CLASS) is one of the most widely used tools (Ishimine & Tayler, 2014). CLASS was designed and compiled by a team led by Prof. Pianta at the School of Education of the University of Virginia in the U.S. It is divided into six versions for students of different ages, covering three major domains of emotional support, classroom management, and pedagogical support as well as 10 dimensions, which are specifically designed to assess teacher-child interactions in the classroom, and its reliability and validity have been verified in many countries and have received more and more attention in the international community (Ansari et al., 2022; Pianta et al., 2005).Therefore, the CLASS classroom assessment system used in this study as a research tool is feasible and scientific, and can objectively and comprehensively assess the quality of teacher-child interactions in kindergarten collective teaching activities.

2. RESEARCH DESIGN

2.1. Research Target

In this study, six large kindergarten classes from one of three kindergartens in Luoyang City were selected as observation targets. The author conducted non-participant observations and recorded 30 collective teaching activities, each lasting approximately 20 minutes, covering five major fields: language, science, art, health, and society.

The selection of kindergartens and classes followed purposive and convenience sampling strategies to ensure diversity in teaching practices. Factors such as educational philosophy, geographic location, teacher qualifications, and willingness to participate were considered. Within each kindergarten, two classes were chosen to maintain balanced representation in teacher experience, classroom size, and instructional approaches, providing a comprehensive view of teacher-child interaction quality in collective teaching settings.

2.2. Research Methods

2.2.1. Research Instruments

This study used The Classroom Assessment Scoring System: CLASS (2017) as the main research tool. CLASS was selected for its reliability in assessing teacher-child interactions and providing structured, quantifiable insights. Unlike ECERS and TCIS, CLASS focuses on real-time interactions across emotional, organizational, and instructional domains, ensuring a comprehensive assessment suitable for early childhood settings.

CLASS is a widely used international assessment tool for teacher-child interactions, which is able to quantitatively assess the quality of teacher-child interactions in three major domains: emotional support, activity organization and educational support. There are several dimensions under each domain, as follows: (1) Emotional Support (ES): including four dimensions of Positive Climate (PC), Negative Climate (NC), Teacher Sensitivity (TS), and Focus on Young Children's Perspectives (RSP); (2) Activity Organization (CO): including three dimensions of Behavioral Management (BM), Productivity (PD), and Educational Learning Facilitation (ILF); and (3) Educational Support (IS):including the dimensions of cognitive development (CD), quality of feedback (QF) and language modeling (LM). The details are shown in Figure 1:

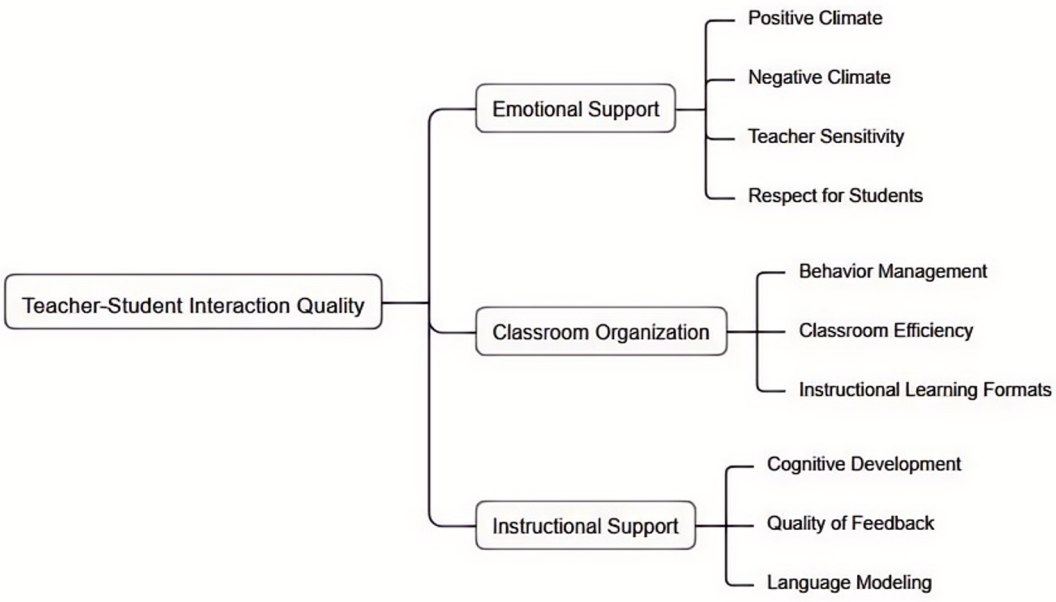

Figure 1: CLASS (Pre-K CLASS) Classroom Assessment System Structure Diagram

The CLASS assessment system starts from the three domains and ten dimensions of emotional support (ES), activity organization (CO) and instructional support (IS), and contains forty-two behavioral indicators under the ten dimensions to guide the observers to understand the scoring content of each dimension more accurately, and adopts a seven-point dimensional scoring method, with each dimension divided into different levels of low (1,2), medium (3,4,5), and high (6,7). The degree of this dimension in the class was demonstrated (2007) as a means of statistical analysis. This type of assessment is both objective and comprehensive, and helps us to more accurately understand the status of teacher-child interactions and the problems that exist. Through careful observation and recording of these behavioral indicators, researchers are able to deeply analyze the specific performance of teacher-child interactions, discover potential teaching strengths and weaknesses, and provide strong data support for subsequent teaching improvement. The CLASS system is divided into different versions according to the age of the students, and has now been increased to six versions (Han, 2015; Sun, 2013). The main ones that are currently widely used are the early childhood version and the preschool through third grade version. This study designed the CLASS Classroom Interaction Evaluation Observation Form and the CLASS Classroom Evaluation Scoring System Operation Standards, drawing on JIANG (2018), “Research on the ‘Classroom Assessment Scoring System’ (CLASS) in the United States”, and Han's (2015) teacher-child interaction evaluation standards.

2.2.2. Research Process

In order to investigate the teacher-child interactions in the collective teaching activities of large classes in a natural, authentic and objective state, the author observed and filmed the teacher-child interactions in the activities of six large classes in one of the three schools in a non-participant capacity, rated the teacher-child interactions in the video samples according to the scoring criteria of the CLASS system, and then analyzed the data using SPSS26.0. First of all, this study used non-participant observation, during which the observer recorded the whole process of teacher-child interactions in advance by using the video recording method, and use SPSS26.0 to conduct descriptive statistical analysis on each video sample.

During the formal observation, the observers recorded the whole process of teacher-child interaction by video-recording method in advance, and each sample was a 20-30-minute video recording. After the recording was completed, the video was observed by two observers at the same time, and was evaluated according to the CLASS system indicators and the elements shown in the video of teacher-child interaction, and the score of each teacher was averaged by the two observers in order to make the results of the observation more accurate and comprehensive. The scores were used to obtain an initial sample of data. Then, the data were entered into SPSS software and analyzed quantitatively to understand the teacher-child interactions in collective teaching activities in kindergartens. Finally, in order to have a more in-depth understanding of the specific scores of a particular item, two teachers with the highest and lowest scores were interviewed, aiming at exploring the deeper meanings and reasons behind the scores to form a more comprehensive analysis report.

In summary, detailed observation records and the CLASS scale were used in this study, covering 3 primary indicators and 10 secondary indicators of emotional support, activity

organization and teaching support. The objectivity of the data was ensured through non-participant observation and initial sample data collection. Group teaching videos were recorded and analyzed, and a seven-point scale was used to quantitatively assess the quality of teacher-child interactions. Interviews provided rich qualitative data, and video case studies provided insights into classroom interactions. The data were analyzed using a combination of quantitative and qualitative methods, and the interviews explored the underlying causes of the problems. These steps were designed to ensure the rigor and scientific validity of the study, as shown in Figure 2:

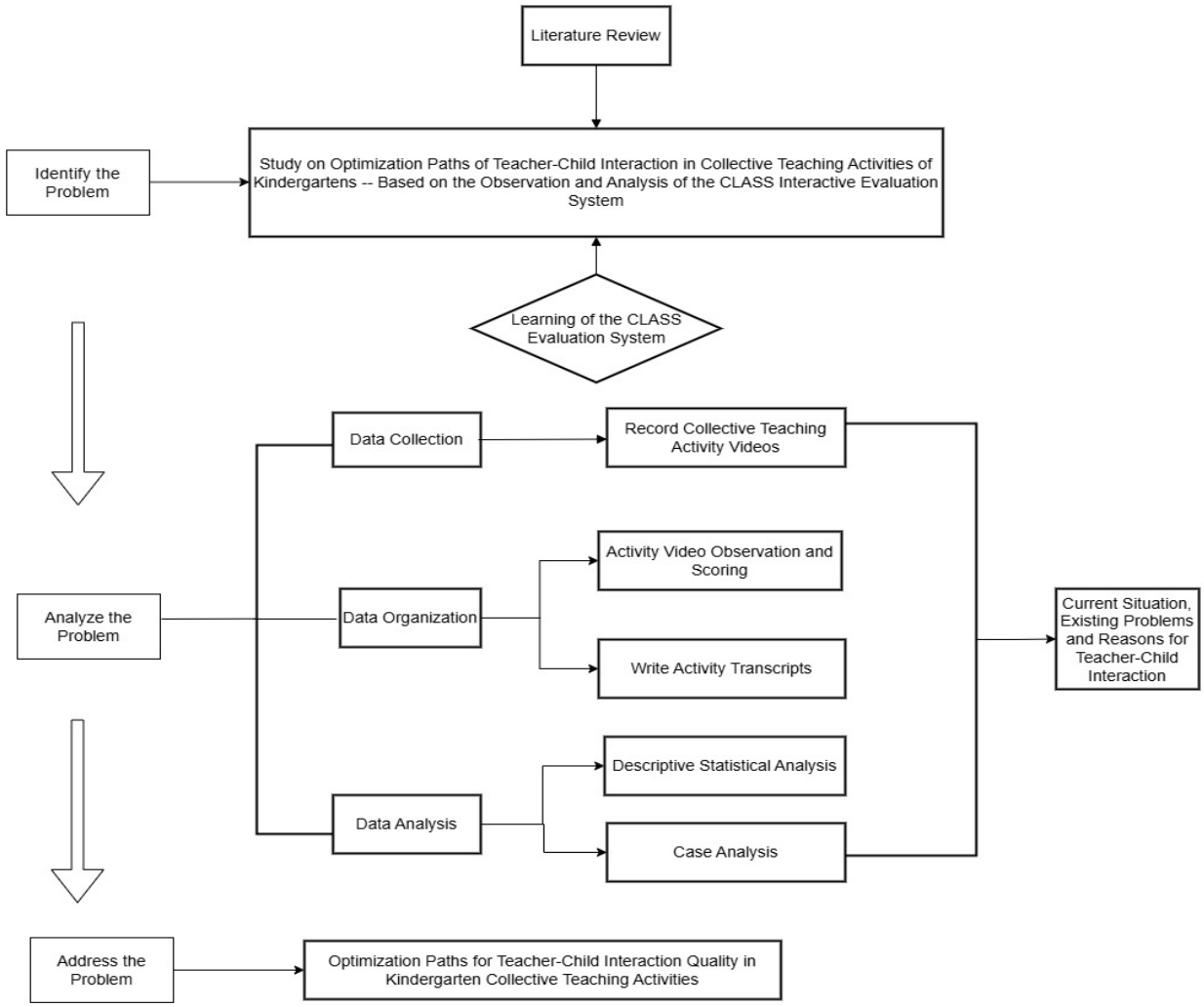

Figure 2 Research ideas

3. RESULTS

3.1. Overall Scores of Teacher-child Interaction in the Three Major Domains

This study scored the three major domains of emotional support (ES), activity management (CO) and instructional support (IS) according to the CLASS system, scored each observation

indicator according to the CLASS observation sheet and organized and analyzed the integrated data information, and the specific scores are as follows:

Table 1: Overall teacher-child interaction in the three domains (n=30)

	Range	Min	Max	M	SD
Emotional Support（ES）	2.73	2.80	5.53	4.22	.64
Classroom Organization（CO）	2.05	3.68	5.73	4.96	.66
Instructional Support（IS）	3.03	2.32	5.35	3.92	.85

Note: Each dimension consists of a score of 1-7, with negative climate (NC) being assigned using reverse scoring.

After tallying the scores on the observation scale, the levels of teacher-child interaction were as follows:

In the Emotional Support (ES) domain, the maximum value was 5.53, the minimum value was 2.80, the range was 2.73, the mean was 4.22, and the standard deviation was 0.64, which is of moderate quality; in the Activity Management (CO) domain, the minimum value was 3.68, the maximum value was 5.73, the range was 2.05, the mean was 4.96, and the standard deviation was 0.66, which is of moderate to high quality ; the minimum value in the Instructional Support (IS) domain was 2.32, the maximum value was 5.35, the range was 3.03, the mean was 3.92, the standard deviation was 0.85, and the quality was at a moderate level.

The results show that the overall teacher-child interaction in the current kindergarten collective teaching activities is at a medium level, and the distribution of the three major domains is relatively balanced. Among the three major domains, the average score of the emotional support domain is 4.22 (out of 7), the average score of the activity organization domain is 4.96, and the average score of the teaching support domain is 3.92. This shows that teachers perform relatively well in activity organization, but there is still much room for improvement in emotional support and teaching support.

From the mean value, activity organization > emotional support > teaching support, indicating that in the process of teacher-child interaction, the kindergarten teachers pay more attention to the effective management of time and behavior in the activities, cultivate children's self-regulation learning ability, improve children's learning initiative, make children have a clearer planning in the learning process, and promote children's self-cognitive ability and comprehensive quality of development. The children's self-knowledge and comprehensive quality development are promoted. Although the emotional support and teaching support are also at a medium level, they are significantly lower than the activity management domain, so this kindergarten should also pay more attention to the positive relationship between teachers and children, feel the emotional changes of children, provide good support for children in activities, and guide and respect children's choices.

In terms of standard deviation, the teaching support domain > activity management domain > emotional support domain. According to the concept of standard deviation, it can be seen that the smaller the value of this indicator is, the more balanced the overall situation is, and the data

distribution is more reasonable. Therefore, in contrast, the data in the teaching support domain is more discrete and fluctuates more, while the data in the emotional support domain is more concentrated. This suggests that in the area of instructional support, there are greater differences in performance between teachers, and some teachers' performance in this area needs to be improved, while the performance in the area of emotional support is relatively more consistent and the overall situation is more stable.

In summary, kindergartens should focus on improving the emotional support and instructional support domains in teacher-child interactions. In the area of emotional support, teachers need to be more sensitive to children's emotional changes and provide timely emotional support and encouragement to establish a more positive teacher-child relationship. In the area of teaching support, teachers should focus on the diversity and scientificity of teaching methods, improve the quality of teaching activities, and stimulate children's interest and initiative in learning. At the same time, teachers should constantly reflect on and improve their teaching practices in order to promote the overall development of young children in emotional, cognitive and social aspects.

3.2. Analysis of the Scores of Teacher-child Interaction in Ten Dimensions

3.2.1. The Level of Teacher-child Interaction on the Domain of Emotional Support

Table 2: Levels of teacher-child interaction in four dimensions under the domain of emotional support (n=30)

	Range	Min	Max	M	SD
Positive Climate（PC）	4.00	3.00	7.00	5.02	0.98
Negative Climate（NC）	3.00	4.00	7.00	5.69	.86
Teacher Sensitivity（TS）	4.00	3.00	7.00	3.76	.92
Regard for Student Perspectives（RSP）	4.00	3.00	7.00	4.94	1.11

Note: Each dimension consists of a score of 1-7.

According to the data in the above figure and table, the data indicators of the four dimensions under the domain of emotional support reflect the teacher-child interaction under the dimension to which they belong:

a. Positive Climate Dominates Teaching and Learning Activities

Positive climate (PC): the range is 4, the value is between 3-7 points, the mean value is 5.02 points, the standard deviation is 0.98, which is in the middle level, indicating that teachers do well in creating a positive classroom atmosphere, can establish a positive emotional connection with young children through smiles, encouraging language, etc., and teachers and students show more positive emotions, mostly in the form of mutual respect, and the relationship is more cordial.

Negative climate (NC): the range is 3, the value is between 4-7, the mean value is 5.69 points, which is at a high level, but because it is a reverse assignment, i.e., the higher the score, the lower the negative climate, combined with the standard deviation of 0.86, it can be seen that in the

kindergarten collective teaching activities teachers rarely appear in the situation of sarcasm and disrespect, and are less likely to present a negative climate and punitive control.

b. Low level of teacher sensitivity

The mean value of the teacher sensitivity (TS) dimension is 3.76 points, which is at a moderately low level, and the standard deviation is 0.92 points, which is less fluctuating. This indicates that it reflects the insufficient sensitivity of teachers to the needs of young children, and some teachers failed to notice the emotional changes and learning needs of young children in time. In the process of teacher-child interaction, teachers' own sensitivity has a greater impact on the quality of teaching and learning, and teachers are sometimes able to respond to young children and address their concerns, so young children also seek teacher support.

c. Insufficient teacher attention to young children's perspectives

The mean value of the dimension of concern for young children's perspectives (RSP) is 4.94 points with a standard deviation of 1.11 points, which is at a medium level and has a high standard deviation, indicating that the scores are discrete. This indicates that there are large differences between different teachers in terms of teaching flexibility and support for autonomous leadership, which suggests that teachers pay less attention to children's ideas and opinions during teaching and learning, and children's subjectivity is not fully realized. Since most of the group activities are still led by teachers, the activities are more controlled and less flexible.

3.2.2. Level of Teacher-child Interaction in the Field of Activity Management

Table 3: Levels of teacher-child interaction in the three dimensions under the domain of activity management (n=30)

	Range	Min	Max	M	SD
Behavior Management（BM）	4.00	3.00	7.00	4.78	.94
Productivity（PD）	4.00	3.00	7.00	5.39	1.05
Instructional Learning Formats（ILF）	4.00	3.00	7.00	4.72	1.03

Note: Each dimension consists of a score of 1-7.

According to the data in the above figure and table, the data indicators of the three dimensions under the domain of activity management reflect the teacher-child interaction under the dimension to which they belong:

a. Teachers are able to monitor and correct children's behavior in real time and in a timely manner

The data in the Behavior Management (BM) dimension show that teachers demonstrate some ability to monitor and correct young children's behavior in real time and in a timely manner, but there are individual differences. The scores ranged from 3-7, with a mean of 4.78 and a standard deviation of 0.94, with small fluctuations. This indicates that the teachers showed better performance in maintaining classroom order and managing young children's behavior, and were

able to effectively prevent and correct young children's misbehavior. Most teachers were able to maintain attention to young children's behavior and intervene in inappropriate behavior in a timely manner. However, some teachers' performance in behavior management needs to be improved, which may vary due to the different attention paid to young children's behavior or the importance attached to their own modeling role.

b. Teachers can organize activities efficiently and make full use of teaching time

In the dimension of activity arrangement efficiency (PD), teachers as a whole can organize activities efficiently and make full use of teaching time, with a mean value of 5.39 points, which is in the middle-upper level, indicating that teachers are more efficient in organizing activities and maximizing learning time. However, the standard deviation of 1.05 points, with a high value and large fluctuation, indicates that some teachers have deficiencies in the arrangement of activity time and transition links, and that there is a waste of time or poor articulation in some activities.

c. Teachers have the problems of insufficient science and single form in teaching guidance

The data on the Instructional Activity Facilitation (ILF) dimension show that teachers have the problems of insufficient science and single form in instructional guidance. The scores ranged from 3 to 7 with a mean of 4.72 and a standard deviation of 1.03, which is a moderate and fluctuating value. It indicates that teachers' performance in activity guidance is moderate, able to provide children with certain manipulative materials and guidance, but the stimulation and guidance of children's interest still need to be strengthened. Teachers' performance in the guidance of teaching activities is uneven, lacking in scientificity and feasibility, and the form of teaching is relatively single, failing to fully stimulate children's interest and initiative in learning, resulting in the quality of teaching to be further improved.

3.2.3. Levels of Teacher-child Interaction in the Area of Instructional Support

Table 4: Levels of teacher-child interaction on the three dimensions under the domain of instructional support (n=30)

	Range	Min	Max	M	SD
Concept Development（CD）	4.00	2.00	6.00	4.08	1.03
Quality of Feedback（QF）	4.00	3.00	7.00	4.11	.995
Language Modeling（LM）	4.00	2.00	6.00	3.56	1.04

Note: Each dimension consists of a score of 1-7.

According to the data in the above figure and table, the data indicators of the three dimensions under the domain of instructional support reflect the teacher-child interaction under the dimension to which they belong:

a. Inadequate support for cognitive development

The data of the cognitive development (CD) dimension shows that teachers' performance in promoting cognitive development of young children is average, with a mean of 4.08 points and a

standard deviation of 1.03 points, which is highly fluctuating. This indicates suggests that teachers perform poorly in promoting cognitive development of young children and provide fewer opportunities for young children to analyze, reason and think creatively. Teachers are sometimes able to provide creative opportunities for young children and teach in relation to their real lives, but on the whole they pay insufficient attention to the cultivation of young children's individual cognitive abilities, and there are large differences in performance between different teachers.

b. Feedback quality is moderate and mechanical

The mean value of the Quality of Feedback (QF) dimension is 4.11 points, and the standard deviation is 0.995 points, which is at a medium level. This indicates that the feedback process between teachers and children is relatively mechanical. Teachers are sometimes able to provide scaffolding or encouragement to children, but they are often prone to ignoring children's actual responses and fail to make timely adjustments to teaching strategies based on children's feedback, reflecting that teachers' feedback is mostly simple repetitions or affirmative responses, lacking in relevance and expansiveness.

c. Low language modeling ability

The mean value of the Language Modeling (LM) dimension is 3.56 points, with a standard deviation of 1.04 points, which is at a medium-low level. This shows that teachers are inadequate in language modeling, less use of open questions and advanced language, and communicate with children mostly in the form of simple instructions or closed questions. Teachers' pedagogical thinking is relatively rigid, and they can occasionally use language to describe the plan or the behavior of the teacher and the children, but the question and answer sessions are relatively conservative in the interaction process, and the lack of guidance for divergent thinking restricts the development of the children's language skills and thinking skills.

In summary, the mean values of the indicators are small, and the overall difference is not large and at an average level, with “negative atmosphere” being the highest, followed by “efficiency of activity organization”, and “language demonstration” being the lowest, although they are all basically at an average level. Negative atmosphere” is the highest, followed by ‘efficiency of activity organization’, and ‘language demonstration’ is the lowest, but all of them are basically in the middle level. This shows that it is important to incorporate children's ideas and opinions as much as possible in the collective teaching process, so that children have a certain degree of autonomy and are given the opportunity to communicate with each other. As for the dimension of “teacher sensitivity”, teachers do not pay more attention to children's needs, do not pay attention to children's feedback in a timely manner, cannot help children solve their problems effectively, and children seldom seek support from teachers. In terms of standard deviation, positive climate and concern for children are the highest, indicating that the data for these three dimensions are relatively discrete, and the smallest, except for negative climate, is teacher sensitivity, which has a small deviation, indicating that the data for these three dimensions are relatively centralized.

4. DISCUSSION OF PROBLEMS IN TEACHER-CHILD INTERACTION

4.1. Focusing on Goal Achievement and Neglecting Educational Sensitivity

The data show that the average value of teacher-child interaction in the dimension of "teacher sensitivity" is 3.76, which is in the middle-low level. Teachers' sensitivity is a kind of professional response that is gradually formed on the basis of certain educational concepts and professional skills to perceive educational situations or problems, make professional judgments quickly, grasp educational opportunities in time, and take appropriate educational actions. Teachers' sensitivity is manifested in their ability to respond to and guide children's requests in a timely manner, their foresight and anticipation of potential educational problems, and their planning and organization of educational activities, which also need to be continuously generated and improved through embodied learning, professional training, and reflection on experience. However, it was found that teachers' sensitivity in the implementation of teaching activities was not strong, mainly reflected in the lack of analysis of individual differences in children, and too much focus on the teaching plan as the dominant goal, while ignoring the emotional needs of children's growth process and differences in learning ability. In the teaching process, teachers do not provide positive and reasonable guidance or clear encouragement to children with poor basic skills and poor thinking ability, which leads to the children's self-confidence being undermined and questioning themselves. When children encounter difficulties in the process of solving problems, teachers fail to guide them appropriately according to the differences in their learning abilities, but choose to let other children solve the problems on the stage or give standard answers directly, showing a lack of patience in the teaching process, with relatively rigid answers and a lack of flexibility, and only completing the teaching task according to the book, without giving practical consideration to children's enthusiasm for learning, often dominated by the teacher's own teaching arrangements, ignoring children's learning goals. It is often dominated by the teacher's own teaching arrangement, ignoring the learning objectives and emotional aspirations of the children.

In kindergarten collective teaching activities, the lack of teachers' sensitivity not only affects the teaching effect, but also may have a negative impact on children's psychological development and interest in learning. Early childhood is a critical period for individuals to form self-knowledge and learning attitudes. Teachers should pay more attention to the emotional changes and learning needs of young children in the teaching process, and provide timely support and guidance. Teachers should adjust their teaching strategies by observing and understanding the characteristics of each child in order to meet the learning needs of different children and promote their overall development. At the same time, teachers should also focus on the improvement of their own professionalism and enhance their sensitivity and ability to cope with educational scenarios through continuous learning and reflection, so as to improve the quality of teacher-child interactions and create a more positive and effective learning environment for young children.

Case 1: T refers to teachers, S refers to children

*Background: the teacher combines theory with real life, draws 10*10 grasses on the blackboard, i.e. ten grasses in each row, ten rows in total, cultivates children's counting thinking, forms visual concepts, and realizes the conveyance of the concept of numbers through the blackboard*

T: Which one of you can count?

S1: I can count.

S2: I can count too.

S3: I can't count.

T: Well, Xiaoming raised his hand, come up to do a demonstration (S1 only counted half rows and then encountered a bottleneck), can anyone continue to count? OK, Xiaohong, you help him to continue counting down. (S2 from 6 to 10, then the second and third line ..... in accordance with the first line of the calculation method and then repeat a few times) Well, Xiaohong counted very well, a total of 100 all calculated, classmates together to encourage. (The class applauded, Xiaohong returned to his seat and sat down, Xiaoming sat there, looking a little bitter)

T: OK, let's see how many of these numbers there are.

It can be seen through the above case that the teacher encourages the children to come up to the stage and count when carrying out math teaching. Faced with the situation that some children said they could count and some said they couldn't, the teacher chose to let Xiaoming, who could count, come up to the stage to demonstrate, however, Xiaoming only counted half of the rows and then encountered difficulties. At this point, the teacher did not give Ming guidance and suggestions to help him continue to finish counting, but asked Ming to step down and ask other students instead. The teacher then asked Xiaohong to come up to the stage and start counting again. After Xiaohong finished counting successfully, the teacher gave her encouragement, but ignored Xiaoming who had failed before. This process fully exposed the lack of teacher sensitivity, only focusing on the completion of the task of Xiaohong, ignoring the loss of Xiaoming's emotions, and did not give guidance in the process of Xiaoming's counting. In the long run, children with poor foundation will easily lose their enthusiasm and motivation for learning and become less confident, which not only hinders the positive development of teacher-child interaction, but also is not conducive to the improvement of teaching quality and the long-term growth of children. Therefore, teachers should pay close attention to the emotional changes and learning needs of each child in the teaching process, and provide timely support and guidance to promote the overall development of children.

4.2. A Single Mode of Instruction Makes it Difficult to Stimulate Independent Learning

According to the results, the lowest score in the field of “activity management” is “guidance of educational activities”, with a mean value of 4.72, which is at a medium level. This indicator mainly examines whether teachers can provide children with rich and diversified opportunities for activities, so as to motivate children to actively participate in learning. In preschool education, group activities are still dominant, and teachers need to prepare teaching materials and equipments before organizing activities to lay the foundation for the smooth implementation of activities. At the same time, teachers should skillfully use various kinds of teaching aids to present abstract theoretical knowledge to children in a lively and interesting way, so as to broaden their

knowledge horizons and stimulate divergent thinking. However, through the observation of collective teaching activities in many kindergartens, it is found that although teachers generally set clear objectives and design the activities accordingly, the forms of the activities are still relatively simple. Current research and practice are mostly stuck in the traditional model, in which the teacher acts as a one-way transmitter of knowledge and the children are passive recipients. Teachers dominate the classroom by virtue of their professional advantages and authority, which makes it difficult for children to express their views independently and lack the ability to learn independently. The new curriculum clearly emphasizes the subjective status of children, and the ideal teacher-child interaction should be based on equal dialogue. However, in practice, teachers still occupy absolute authority, which leads to children's over-reliance on teachers' leadership. Teachers should give full encouragement and positive response to children's learning process, and mobilize children's enthusiasm and self-confidence through recognition and appreciation, so that they can experience their own value and at the same time take the initiative to find and correct their deficiencies, so as to continuously improve the efficiency of teacher-child interactions and the quality of teaching and learning, and to promote the holistic development of young children.

Case 2: Is the material bag useful?

Today's activity material is a handmade material kit, which is mainly used to train children's hands-on skills, and contains semi-finished products such as stickers, playdough, and light clay. After the teacher distributed the kits to the children, the children opened their kits and poured out all the materials, making a mess everywhere. The teacher then began to organize them, wasting about one-fifth of the activity time between the distribution of the packets and the start of hands-on work by most of the children.

In this scenario, the teacher prepared the packets of materials in advance to support instruction and facilitate children's learning. Although this practice saved preparation time, it took up too much of the children's activity time during use. As the materials are semi-finished products, children need extra time to learn how to use them, which seriously limits their creativity and imagination, reduces the efficiency of the activities, and thus affects the quality of interaction. Therefore, when choosing and using teaching materials, teachers should fully consider whether they can truly serve children's learning goals and stimulate their initiative and creativity; at the same time, they should pay attention to the way the materials are presented and the process of using them, so as to avoid interfering with normal teaching and ensure that all kinds of teaching methods can effectively promote the holistic development of children.

4.3. Focus on Encouraging Feedback, Lack of Verbal Modeling, and Attention to Individual Differences

Overall, teachers scored the lowest in the area of “teaching support”, especially in “language modeling”, with a mean value of 3.56, reflecting that teachers failed to give full play to the role of language guidance in teacher-child interactions. The so-called “language modeling” refers to teachers' efforts to provide children with examples to learn from through rich and accurate expressions, extended dialogues, open-ended questions and effective feedback, so as to promote

the development of their language ability, deepening of thinking and communication skills. Although teachers commonly use encouraging feedback in the classroom, it is often limited to simple instructions or closed questions (e.g., “Is it there?”, “Is it right?”, “What is it?”), resulting in The classroom communication method is single, and it is difficult to stimulate children's independent thinking and creativity. At the same time, teachers often use formulaic language in the evaluation process, failing to take into account children's individual differences to provide targeted guidance, making the interaction lack of vividness and inspiration. Teachers fail to effectively combine encouraging feedback with in-depth verbal modeling, ignoring the importance of creating an open and exploratory communication environment for children, which affects the cultivation of children's active learning and innovative thinking. Against this backdrop, it is urgent to improve teachers' verbal modeling skills and optimize interaction strategies, which can help improve the overall effectiveness of instructional support and further stimulate children's inner potential.

Case 3:

Background: The teacher set up a learning group in the class. During the explanation of “Conservation of Length”, the children were divided into groups of two and given a piece of cotton thread to guide them to compare the differences in length of the threads, so as to expand their thinking and deepen their understanding of the textbook knowledge through hands-on manipulation.

T: Which child says his/her opinion after observing the difference in the length of the two cotton threads?

S1: Mine is longer and Zihan's is shorter.

(Teacher lets the children compare again and realizes that the two cotton threads are actually the same length.)

T: Look again.

S1: Hey, it's the same length. Why is it sometimes longer and sometimes shorter?

C2: Because they are not aligned.

T: Yes, the cotton threads themselves are the same length, but they look different because of their shapes or positions; when you align them, you can see that they are the same.

The case shows that the teacher failed to provide enough thinking space for the children, and the classroom activities were still dominated by teacher-led and children's passive acceptance. In the process of questioning and guidance, the teacher's language expression lacks clarity and inspiration, and fails to effectively guide children to observe, compare and think on their own, which limits the development of children's innovative thinking. Teachers rely too much on preset encouraging feedback, lack flexible language demonstration and differentiated instruction, and fail to dynamically adjust their teaching strategies according to children's actual responses, thus limiting children's independent expression and problem solving. According to some studies, the use of the “trigger-response-feedback” discourse sequence to interact with young children can lead to new discourse understanding and experience enhancement in the interaction (Wu & Fan, 2020). Therefore, teachers should change their teaching concepts, reduce direct intervention in

children's thinking process, focus on the use of open-ended questions and diversified language demonstration, so as to better stimulate children's enthusiasm and initiative in learning, create an interactive environment that encourages exploration and tailored teaching, and continuously improve the overall quality of teacher-child interaction (Sha et al., 2024).

5. SUGGESTIONS FOR IMPROVEMENT

5.1. Enhancing Educational Sensitivity and Flexibly Adjusting Interaction Strategies

Young children are in the early stage of mental development, their independent thinking ability is not yet mature, and they are easily influenced by the environment and other people's evaluation. Teachers' educational sensitivity is the key to high-quality teacher-child interaction (Åström et al., 2022). Teachers should learn to observe children's emotions, behaviors and needs through training and practice, and give timely responses and support. For example, teachers can set up special observation time in the classroom to record children's responses and needs, and reflect and make adjustments after class. Teachers must continually improve their educational sensitivity to capture the subtle changes in each child's emotions, interests and behaviors in a timely manner, so that they can flexibly adjust their interaction strategies in the teaching and learning process. Specifically, teachers should fully understand the cognitive level and individual differences of children, develop teaching programs that meet the actual needs of children, and encourage children to express their views freely in the classroom, allowing them to make mistakes in exploration without rushing to judgment. In the design of teaching activities, teachers can adopt differentiated teaching methods according to children's knowledge reserves and interests, and use diversified teaching resources to stimulate children's enthusiasm for learning. At the same time, through continuous observation and feedback, teachers are able to continuously reflect on and improve their teaching methods, create a relaxed and inclusive classroom atmosphere, and enable every child to fully develop in an appropriate environment. Only by continuously improving teaching sensitivity and flexibly adjusting interaction strategies can we truly realize the goal of child-centered education and promote the overall healthy growth of young children.

5.2. Enriching the Teaching and Guidance Methods to Enhance the Independent Exploration of Young Children

Good teacher-child interaction can make young children better understand their own strengths and weaknesses, and on the basis of a full understanding of themselves, young children can better utilize their own strengths and make up for their own deficiencies, so that young children can grow and develop in their learning and life in a more clear direction, and the path is more scientific and reasonable (Ji, 2023).Teachers should fully integrate the characteristics of independent learning of young children when organizing teaching activities, and adopt a variety of creative teaching guidance to break the single mode of transmission. Teachers should enhance young children's subjective participation through a variety of ways, such as setting up group discussions, role-playing, independent exploration, etc., so that young children can take the initiative to express and think in the activities. At the same time, teachers should respect

children's ideas and opinions and encourage them to make decisions and solve problems on their own. Firstly, diversified means such as situational simulation and project-based learning can be utilized to create realistic and vivid teaching situations, so as to stimulate children's active participation and interest in exploration. Secondly, teachers should focus on grasping children's latest developmental zone when designing activities, and provide moderate challenges according to children's current cognitive level and interests, so as to ensure that the content of the activities is interesting without losing its educational significance. In addition, in the process of classroom implementation, teachers should encourage young children to think and express themselves, guide them in discussions through open questions, and promote them to discover and solve problems in interaction (Salminen et al., 2021). Through this diversified teaching guidance, it can not only broaden children's learning horizons, but also enhance their ability to explore on their own, and establish proactive learning habits and innovative spirit for children, thus effectively improving the overall quality of teacher-child interaction.

5.3. Strengthening Language Demonstration and Guiding Children to Express Themselves in Depth

It is pointed out in the Guidelines that “young children's language learning needs to be supported by corresponding social experience, and should be enriched by a variety of activities to expand children's life experience, enrich the content of language, and enhance comprehension and expression skills” (Ministry of Education of the People’s Republic of China, 2012). In teacher-child interaction, the language modeling role of the teacher is especially crucial. Teachers are not only the transmitters of knowledge, but also the guides of language expression and thinking patterns. In order to strengthen language modeling, teachers should focus on the use of standardized, rich and logical language in daily teaching, and stimulate children to think deeply through explanation, discussion and inspiring questions. Teachers should pay close attention to children's linguistic feedback and make timely adjustments to their expressions to help children transition from simple answers to in-depth expressions and the development of critical thinking. Teachers should improve the quality of feedback and emphasize the relevance and expansiveness of feedback. When children answer questions, teachers can guide children to think deeply by asking follow-up questions and expanding. For example, when children answer correctly, teachers can further ask: “How did you think of this answer?” When the children answer incorrectly, the teacher can guide other children to discuss together instead of giving the answer directly. Meanwhile, in the interactive process, teachers should show how to construct reasonable arguments and use innovative thinking through demonstrative expressions to provide effective language demonstrations for young children. Through continuous practice, reflection and improvement, teachers will gradually improve their own language organization and interactive skills, thus creating a more efficient and inspiring communication environment in the classroom. Teachers should focus on the quality of language modeling and use more open-ended questions and advanced language to guide children to engage in complex thinking and expression. For example, during a science activity, teachers can ask, “Why do you think that is?” ”What new discoveries did you make?” and other questions to stimulate young children's interest in inquiry. Only in this way can we truly promote the dual development of young children in language and cognition, and comprehensively improve the educational quality of teacher-child interaction.

CONFLICT STATEMENT

The authors declare no conflict of interest.

COOPERATION STATEMENT

All authors contributed equally to this work and approved the final manuscript.

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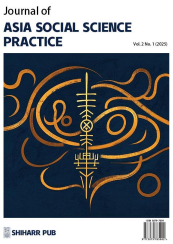

RESEARCH ARTICLE

RESEARCH ON RISK IDENTIFICATION AND PREVENTION STRATEGIES FOR LOGISTICS TRANSIT HUBS: A CASE STUDY OF SF EXPRESS LOGISTICS TRANSIT HUB IN NANNING, GUANGXI

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ABSTRACT

This paper focuses on the risk identification and analysis of the SF Express Logistics Transit Hub in Nanning, Guangxi. It systematically examines the various risks faced during its operations. The paper first defines the concept of logistics transit hubs and their operational modes, and then develops a risk assessment framework encompassing operational risks, internal management risks, and external environmental risks. Using the Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation Method, the paper evaluates and assigns weights to the risks. The results show that operational risks, particularly those related to "sorting and packaging," are the most critical. The paper also proposes preventive strategies, including enhanced employee training, improved information systems, optimized facility and equipment management, and the recruitment of specialized logistics talent. The findings provide theoretical support and practical insights for improving risk management and operational efficiency in emerging logistics transit hubs in China.

1. INTRODUCTION

In recent years, the rapid development of e-commerce and the express delivery industry has greatly increased the demand for logistics transit hubs (Lu et al., 2025; Zacharias & Tang, 2010). These hubs, crucial nodes in the logistics network, play a significant role in efficiently managing the sorting, transportation, and delivery of goods across vast networks (Ansari et al., 2018).

However, as the scale of logistics operations expands, the complexity and potential risks inherent in the operation of these transit hubs have also increased (Liu et al., 2022).

The logistics transit hub, specifically in the context of express delivery services, is tasked with gathering, sorting, and transferring parcels from various locations to ensure timely delivery to consumers (Hammad et al., 2021). In the case of SF Express, a leading express delivery company in China, its Nanning logistics transit hub represents a key part of its operational network (Zhao et al., 2022). Despite the company's strong market presence and advanced logistics models, the Nanning transit hub faces a variety of operational challenges. These include risks associated with improper handling, inefficient management practices, technological limitations, and external environmental factors such as adverse weather conditions.

This paper seeks to identify and analyze these operational risks within the context of the Nanning transit hub, providing an in-depth examination of the key factors that affect its efficiency and performance. The study adopts both qualitative and quantitative approaches, including the use of the Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation Method, to evaluate these risks and propose targeted strategies for mitigating them. By doing so, this research aims to contribute valuable insights into improving the operation and risk management practices of logistics transit hubs in China and beyond.

2. CONCEPTUAL FRAMEWORK

2.1. Logistics Transit Hub

According to the definition provided by Baidu Baike, an express delivery service network typically consists of three core components: end-point outlets facing customers, express parcel transit centers responsible for sorting and dispatching, and the trunk transportation routes connecting all logistics nodes (Yang et al., 2024). A transit hub, in this context, refers to a centralized facility dedicated to parcel sorting and transfer (Thondoo et al., 2020). In corporate logistics, these facilities are commonly referred to as distribution centers, whereas in consumer logistics, they are known as transit or sorting hubs (Zhou et al., 2021). Apart from minor differences in warehousing and processing functions, their core operational objectives remain largely the same. From a network perspective, the essential role of a transit hub is to aggregate, sort, and re-distribute parcels from across the country, enabling the transformation of logistics flow from dispersed to centralized and back to dispersed again (Basallo-Triana et al., 2021).

2.2. Operational Model of Logistics Transit Hubs

Transit hubs generally follow varying degrees of standardized operating procedures (Crosson, 2017). At the smallest scale are local branches or service offices, which handle collection and dispatch at the point of origin before forwarding parcels to regional or national hubs (Lin & Chen, 2003). These larger hubs then perform centralized sorting and dispatch operations for broader areas, often utilizing trucks or air freight to transfer shipments to other hubs (Lu et al., 2024; Mahéo et al., 2019). Mid-tier nodes are dispersed across different regions

and function as key intermediaries within the larger express delivery network (Vassilopoulos, 2004).

2.3. Logistics Risk Management

Various unforeseen challenges—such as natural disasters, human errors, improper packaging, address mismatches, and delivery delays—can disrupt the logistics process (Wiendahl et al., 2007). Presently, China's logistics risk management practices are not yet fully equipped to effectively handle such complexities (Su et al., 2024). Logistics risk management, in this study, is defined as the process of identifying potential risks in the logistics workflow from a process-oriented perspective, aiming to prevent the loss or delay of parcels at the lowest possible cost (Yousefi & Tosarkani, 2022). It involves systematic forecasting, identification, and evaluation of risk sources by professional personnel (Schoenherr et al., 2015). Ultimately, logistics risk management represents a coordinated planning approach undertaken by stakeholders to reduce deviations and uncertainties in the logistics system (Rodríguez-Espíndola et al., 2020).

3. RISK IDENTIFICATION AND ANALYSIS OF NANNING LOGISTICS TRANSIT HUB

3.1. Overview of Nanning Logistics Transit Hub

3.1.1. Introduction to the Nanning Logistics Transit Hub

SF Express is one of the most widely used express delivery companies in China (Wu et al., 2022). Although its services are more expensive than those of other companies, SF Express commands a significant market share, particularly in the handling of urgent or high-value items (R. Cui et al., 2020). Nanning, a highly developed economic city and transportation hub in Guangxi, has become a key location for the construction of distribution centers and transit hubs. The Nanning logistics transit hub is a representative example of the "Internet+" model for modern logistics hubs, both facing the challenge of low profitability and dealing with issues of incomplete development. Developing a well-designed risk prevention plan is essential for optimizing organizational structures, improving operational efficiency, and ultimately enhancing the enterprise's profitability and competitive edge. Furthermore, since the Nanning transit hub is newly established, its use of smart technologies and information systems is still in its infancy. However, the hub is constrained by limited facilities and equipment, underdeveloped management systems, incomplete business processes, and inexperienced management, making the identification of potential risks an urgent necessity.

3.1.2. Current Situation of Nanning Logistics Transit Hub

While a small number of express delivery transit hubs have implemented automated operations, the majority of operations remain labor-intensive, which presents substantial risks due to the lack of standardized procedures. The Nanning transit hub, being newly established, faces several operational and technical challenges:

Management Issues: The management structure is still in its developmental phase. Due to the delayed establishment of the Nanning transit hub, it lacks systematic management experience. During peak periods, such as during Double 11 or New Year holidays, there are frequent disruptions in the onsite operations due to poor management and a lack of coordinated planning.

Employee Qualifications: The education level and professional qualifications of the workforce are relatively low. The labor force is mainly outsourced, and the low salary levels make it difficult to attract professional logistics talent.

Outdated Technology: The hub lacks advanced technological systems and equipment, relying heavily on manual labor. Consequently, there is a high frequency of goods damage and inefficiency in handling operations.

Unclear Operational Processes: The absence of standardized operating procedures leads to inefficiencies. Workers often repeat tasks unnecessarily or fail to follow the correct steps, which increases workload and reduces operational efficiency. Furthermore, unclear responsibilities lead to poor handling of irregular situations, and safety risks are heightened.

Economic and Market Challenges: The express delivery industry is susceptible to fluctuations in economic conditions, transportation regulations, and other external factors. For instance, the COVID-19 pandemic has significantly reduced business volume in the logistics sector, impacting the profitability of transit hubs.

Poor Hygiene: At the end of the year, the large number of parcels results in significant delays. Some workers refuse to work overtime, leading to parcels being left unattended and the overall work environment becoming disorganized. This poor hygiene exacerbates the inefficiency of the entire operation.

In summary, the Nanning logistics transit hub faces a variety of operational risks that need to be identified and assessed. Establishing a risk evaluation framework is crucial to resolving operational issues and bringing the hub’s performance up to par with other transit hubs across China.

3.2. Risk Identification at Nanning Transit Hub

3.2.1. Operational Risks

The operation at Nanning's transit hub follows a standardized procedure that includes unloading, transmission, scanning, sorting, marking, sorting into packages, and loading. However, several issues have been identified during the actual operation:

Non-standard Sorting Operations: Although the Nanning transit hub is a newly built center for SF Express, the volume of parcels during peak times like Double 11 is immense (X. Cui et al., 2025). Sorting personnel face immense pressure and, as a result, often prioritize speed over

quality. During busy periods, some employees engage in aggressive sorting practices that can damage parcels, especially fragile items like glassware and model toys.

Poor Scanning and Packaging Procedures: The process of preparing parcels for transfer to other regions is often rushed, and parcel labels are sometimes unclear. This has a direct impact on the efficiency of downstream operations, as misprinted or unclear information delays sorting and transportation.

Loss of Small Parcels: During peak seasons, workers who are tasked with sorting and labeling parcels often make mistakes, especially when handling smaller items like pens or scarves, which are easily overlooked or misplaced.

Unclear Responsibilities: Many operational issues arise due to a lack of clear responsibilities for each process. For instance, when parcels are damaged due to rough handling, no one takes responsibility, and the blame is often placed on the recipient.

3.2.2. External Environmental Risks

External risks such as policy changes, competitive pressures, and adverse environmental conditions can have a significant impact on transit hub operations:

COVID-19: The ongoing pandemic has delayed operations at the transit hub, as many e-commerce businesses delayed opening, and workers were reluctant to return to work due to health concerns. In addition, parcels remained in storage during the New Year, leading to increased customer complaints.

Natural Environment: Adverse weather conditions, including typhoons and heavy rainfall, can disrupt the movement of goods, causing delays in deliveries. The moist climate in Nanning also exacerbates the risk of damaged goods, especially those packed in cardboard or plastic, which are sensitive to humidity.

Industry Competition: The increasing number of distribution centers and transit hubs in the express delivery sector has intensified competition (Ou & Chen, 2025). This impacts profitability, as different transit hubs within the same company can perform at different levels, which affects overall earnings and employee performance.

Customer Expectations: Customer expectations for timely and undamaged delivery are rising, and the regulatory pressure is increasing. New policies from the Ministry of Transport and the State Post Bureau impose stricter requirements on delivery services, adding additional operational stress.

4. DESIGN OF RISK EVALUATION INDICATORS FOR NANNING LOGISTICS TRANSIT HUB OPERATIONS

4.1. Design Process

Based on the detailed analysis of the operational processes, internal management, and external environmental risks at the Nanning transit hub, and drawing from the research of other scholars, the risk evaluation framework has been developed. Operational risks are classified into four categories: scan marking risk, sorting and packaging risk, loading and unloading risk, and equipment malfunction risk. Internal management risks are divided into four subcategories: unprofessional workforce risk, customer complaint risk, low level of informationization risk, and non-standardized operation process risk. External environmental risks are further categorized into natural environment risk, policy and regulatory risk, industry competition risk, and force majeure risk (including social anomalies) (Kumar et al., 2019). The specific meanings of these indicators are outlined in the table1 below:

Table 1: Preliminary Establishment of the Risk Evaluation Index System

Primary Indicators	Secondary Indicators	Specific Explanation
Operational Risk	Scan marking risk	The unloaded goods are not reasonably arranged and labeled according to their addresses and types.
	Sorting turnkey risk	The process of sorting and package construction is not standardized, such as violent sorting, blurring of the package handwriting and other attitudes.
	Loading and unloading handling risks	In the process of express handling, there is the risk of up and down parallel handling and the risk of violent handling.
	Risk of poor equipment operation	Risk of breakdowns of logistics equipment in transit yards.
Internal management risk	Risk of unprofessional workforce	Risks of unprofessional and low-quality transit yard operations and management personnel who lack a sense of ethics and social responsibility.
	Risk of customer complaints	Risk of returns and complaints caused by customer dissatisfaction due to untimely delivery or damaged goods.
	Risk of low level of informationization	Risk of low level of information in transit yards, high workload and high labor cost of manual operation.
	Risk of unstandardized operation process	Risk of irregular operation due to the lack of standardized process system and operation guidebook.
External environmen	Natural Environment Risk	Risk of damage to express shipments and equipment due to natural environments such as typhoons, heavy rains and rainy weather.

tal risk	Policies and Regulations Risk	Risk of pressure on transit centers due to legal provisions in express delivery regulations that favor customers.
	Industry Competition Risk	Risks such as lack of profitability due to competition among express delivery companies, distribution centers, and transit yards.
	Risk of social anomalies	Risk of damage to transit centers due to social emergencies such as new coronavirus pneumonia.

4.2. Determination of Risk Evaluation Indicator Weights Using Analytic Hierarchy Process (AHP)

4.2.1. Introduction to the Analytic Hierarchy Process (AHP)

The weight assignment for the evaluation index system is determined using the Analytic Hierarchy Process (AHP) (Vaidya & Kumar, 2006). AHP, a qualitative and quantitative decision-making method introduced by the renowned American operations researcher Saaty in the 1970s, is widely used in multi-criteria decision analysis (Kumar et al., 2021). This method optimizes complex multi-objective decision problems by breaking them down into multiple goals or criteria, and then further decomposing them into several levels of indicators. The hierarchical structure is analyzed and ranked using a fuzzy quantitative approach, which calculates the ranking order for individual levels and the overall ranking, providing a systematic method for multi-criteria and multi-scenario optimization decisions.

In the first step, the hierarchical structure is determined based on the logistics risk evaluation system. The factors are divided into three levels: the first level represents the overall goal, which is the evaluation of the logistics operation risk level of the transit hub; the second level includes the three primary risk categories—operational risks, internal management risks, and external environmental risks; the third level consists of the 12 secondary indicators, such as scan marking risk, sorting and packaging risk, etc.

In the second step, a pairwise comparison matrix is constructed. After the hierarchical structure is established, logistics experts are invited to fill out scoring questionnaires. Based on the hierarchical structure of the evaluation index system, each factor is compared pairwise using a scale from 1 to 9, where experts qualitatively assess the relative importance of each factor. The resulting comparison matrix is then constructed, and the reciprocal values are used for inverse comparisons, as shown in the table2 below.

Expert Sample Characteristics. To ensure the scientific validity of the Analytic Hierarchy Process (AHP) evaluation, expert scoring was conducted by a panel of 22 professionals with relevant backgrounds in logistics, risk management, and operations research. Among them, 12 are senior logistics managers or technical directors from leading express enterprises (e.g., SF Express and JD Logistics), and 10 are academic experts from universities and research institutes specializing in logistics systems and industrial engineering. The industry-to-academia ratio is approximately 6:5, which ensures both practical relevance and methodological rigor in the

evaluation process. All experts have at least 5 years of experience in logistics planning or risk assessment. The diversity and expertise of the panel contribute to the robustness and reliability of the pairwise comparison matrices used for weight calculation.

where for a criterion layer of n criteria, a two-by-two comparison judgment matrix U = (uij)n × n is obtained. uij denotes the factor i and factor j relative to the target importance values. The same process is performed for the sub-criteria and indicator layers under each criterion layer. This results in a three-level comparison judgment matrix.

Table 2. Pairwise Comparison Scale for Analytic Hierarchy Process (AHP)

scale	αij Meaning
1	i and j are equally important for an attribute
3	Element i is slightly more important than element j
5	element i is more important than element j
7	Element i is significantly more important than element j
9	Element i is definitely more important than element j
2,4,6,8	2,4,6,8 Between two neighboring classes

In the third step, the weights of the content layer, dimension layer and indicator layer are initially calculated based on the judgment matrices (Ha et al., 2023). Calculate the maximum characteristic root λmax of each judgment matrix, and solve the following characteristic equation: (UW) = λmaxW. where W is the eigenvector corresponding to λmax, and the components of W, wi, are the weights corresponding to each criterion (or each indicator), and test the consistency of the matrices.

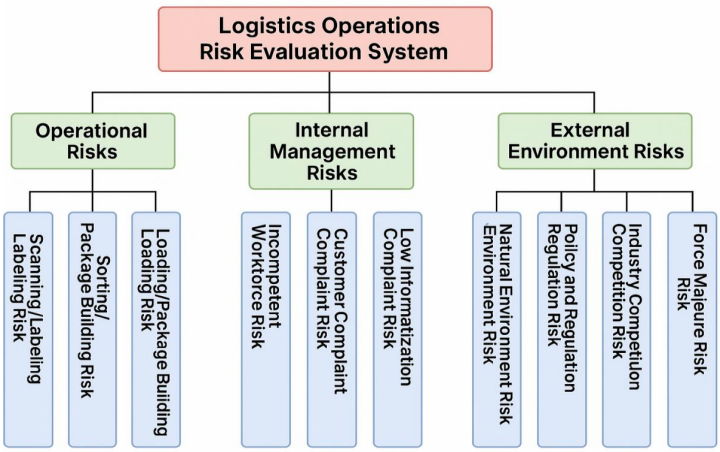

Figure 1: Hierarchical Structure Diagram

In the fourth step, the total weights are calculated. The weights were calculated separately for the dimension level (first-level indicators) and the indicator level (second-level indicators), and the total weights were obtained by multiplying the weights of each criterion level by the weights of each indicator under it.

In the fifth step, the weights of the indicator system are assigned. In the specific calculation process of the system, Yaahp software was used for computerized solution.For details, refer to Figure 1: Hierarchical Structure Diagram.

4.2.2. Calculation of Indicator Weights Using AHP

Using the Yaahp software, a hierarchical structure diagram of the logistics operation risk evaluation system was first constructed (Pamucar & Cirovic, 2015). Based on the results of expert questionnaires, pairwise comparison matrices were generated and entered into the software. Consistency tests were then conducted for each matrix. The results showed that the consistency ratios for the matrices corresponding to logistics operation risk, operational risk, internal management risk, and external environmental risk were all below 0.10, indicating acceptable consistency. The maximum eigenvaluesλmax for the matrices were 3.0291, 4.0211, 4.0042, and 4.0566, respectively.

Table 3: Weights and Rankings of Logistics Operation Risk Indicators

Ranking of Primary Indicators for Logistics Operation Risk	**Primary Indicator**	**Weight**
	Operational Risk	0.6586
	External Environmental Risk	0.1852
	Internal Management Risk	0.1562
Ranking of Secondary Indicators for Logistics Operation Risk	**Secondary Indicator**	**Weight**
	Sorting and Packaging Risk	0.3363
	Scan Marking Risk	0.1985
	Natural Environment Risk	0.092
	Unprofessional Workforce Risk	0.0831
	Equipment Malfunction Risk	0.064
	Loading and Unloading Risk	0.0599
	Industry Competition Risk	0.0538
	Non-standardized Operation Process Risk	0.029
	Customer Complaint Risk	0.029

	Policy and Regulatory Risk	0.0237
	Social Anomaly Risk	0.0158
	Low Informationization Level Risk	0.0152

Table 4: Logistics Operation Risk

Logistics Operation Risk	Operational Risk	Internal Management Risk	External Environmental Risk	Wi
Operational Risk	1	5	3	0.6586
Internal Management Risk	0.2	1	1	0.1562
External Environmental Risk	0.3333	1	1	0.1852

Table 5: Operational Risk

Operational Risk	Scan Marking Risk	Sorting and Packaging Risk	Loading and Unloading Risk	Equipment Malfunction Risk	Wi
Scan Marking Risk	1	0.5	4	3	0.3013
Sorting and Packaging Risk	2	1	5	5	0.5107
Loading and Unloading Risk	0.25	0.2	1	1	0.0909
Equipment Malfunction Risk	0.3333	0.2	1	1	0.0971

Table 6: Internal Management Risk

Internal Management Risk	Unprofessional Workforce Risk	Customer Complaint Risk	Low Informationization Risk	Non-standardized Operation Process Risk	Wi
Unprofessional Workforce Risk	1	3	5	3	0.532
Customer Complaint Risk	0.3333	1	2	1	0.1854

Low Informationization Risk	0.2	0.5	1	0.5	0.0971
Non-standardized Operation Process Risk	0.3333	1	2	1	0.1854

Table 7. External Environmental Risk

External Environmental Risk	**Natural Environment Risk**	**Policy and Regulatory Risk**	**Industry Competition Risk**	**Social Anomaly Risk**	**Wi**
Natural Environment Risk	1	4	2	5	0.4966
Policy and Regulatory Risk	0.25	1	0.3333	2	0.128
Industry Competition Risk	0.5	3	1	3	0.2903
Social Anomaly Risk	0.2	0.5	0.3333	1	0.0851

According to the AHP calculations, the weights and ranking of each level of indicators were determined as follows: among the first-level indicators, operational risk ranks highest, followed by external environmental risk, and then internal management risk. At the second level, the top three indicators are sorting and packaging risk, scan marking risk, and natural environmental risk, which together account for more than half of the total weight.The calculation of the evaluation indicator weights can be found in Table 3: Weights and Rankings of Logistics Operation Risk Indicators, Table 4: Logistics Operation Risks, Table 5: Operational Risks, Table 6: Internal Management Risks, and Table 7: External Environmental Risks.

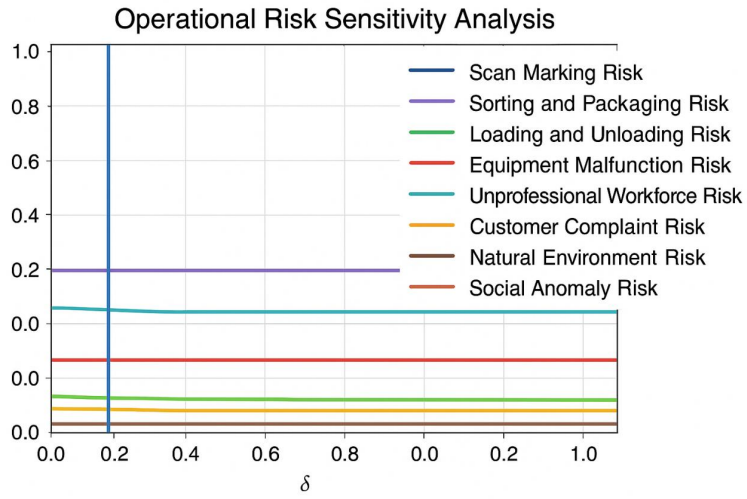

Figure 2: Operational Risk Sensitivity Analysis

This study conducted a sensitivity analysis of the logistics operation risk indicator system. The results indicate that, except for scan marking risk, sorting and packaging risk, loading and unloading risk, and equipment malfunction risk, which increase as operational risk rises, all other indicators decrease with an increase in operational risk. The same pattern applies to other situations. This suggests that the logistics operation indicator system exhibits good sensitivity. The specific ranges of variation can be observed in Figure 2: Operational Risk Sensitivity Analysis, Figure 3: Internal Management Risk Sensitivity Analysis, and Figure 4: External Environmental Risk Sensitivity Analysis.

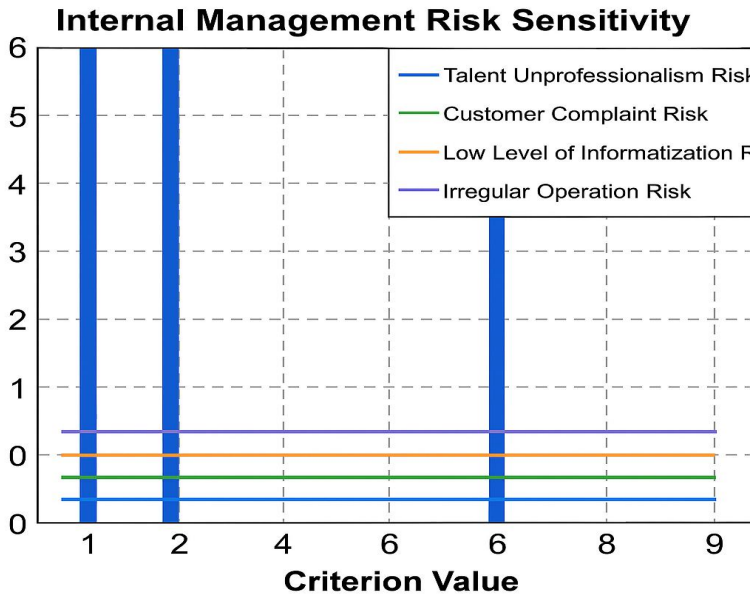

Figure 3: Internal Management Risk Sensitivity Analysis

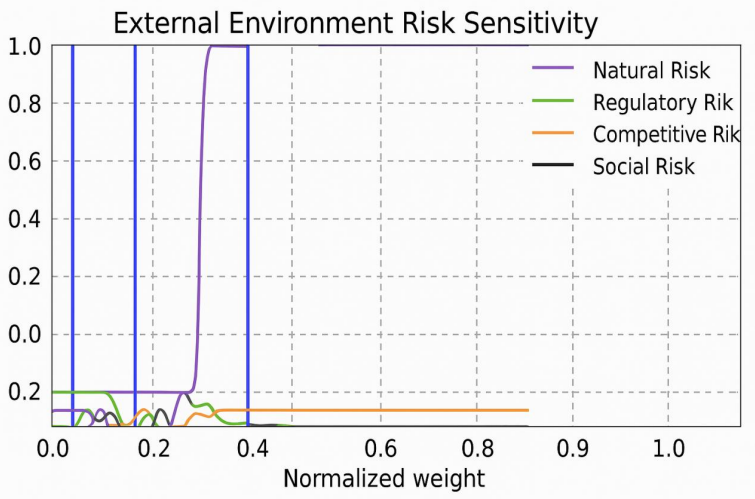

Figure 4: External Environmental Risk Sensitivity Analysis

4.3. Fuzzy Comprehensive Evaluation Model for Risk Assessment

4.3.1. Introduction to the Principles of Fuzzy Comprehensive Evaluation

Fuzzy Comprehensive Evaluation (FCE) is one of the widely used methods for validating indicator systems in the field of fuzzy mathematics (Althuwaynee et al., 2014). In practical applications, the evaluation of an object often involves multiple factors. The evaluation of such an object is determined by a combination of these factors, meaning that all the factors involved must be evaluated. After evaluating each sub-factor individually, the challenge is to determine the overall evaluation of the object. This is a typical problem addressed by FCE, where the core idea is to evaluate each factor by assigning it a rank or level, and then combine these individual evaluations to derive the overall evaluation score.

First, let the object of judgment be P: its factor set $U = \{u_1, u_2, \cdots, u_m\}$,judgment rating set $V = \{v_1, v_2, \cdots, v_m\}$. Then each factor in U is fuzzy judged according to the rating index in the judging set, and the judging matrix is obtained:

$$R = \begin{bmatrix} r_{11}, r_{12}, \cdots, r_{1m} \\ r_{21}, r_{22}, \cdots, r_{2m} \\ r_{n1}, r_{n2}, \cdots, r_{nm} \end{bmatrix}$$

(1) where rij denotes the degree of affiliation of ui with respect to vj. (U,V,R) then constitutes a fuzzy comprehensive judgment model. After determining the importance index of each factor (also known as weights), it is noted as $\overline{B} = A \cdot R = \left(\overline{b_1}, \overline{b_2}, \cdots, \overline{b_m}\right)$

(2) After normalization, get $B = \{b_1, b_2, \cdots, b_m\}$,can determine the final judgment level of the object P.

4.3.2. Risk Evaluation Process Using Fuzzy Comprehensive Evaluation

This study conducts a fuzzy comprehensive evaluation based on hierarchical regression analysis (Behzadian et al., 2012). First, a logistics operation risk assessment table was exported from Yaahp software, followed by the following steps:

The first step is to define the alternative object set, which in this case refers to the logistics operation risk at the Nanning Express Hub in Guangxi.

The second step is to define the indicator set, which consists of the secondary indicators of operational risk, internal management risk, and external environmental risk.

The third step is to establish the weight set: Since each indicator in the set has a different level of importance, weights are assigned to both first-level and second-level indicators. The first-level weight set and second-level weight set were computed using Yaahp software.

The fourth step is to define the evaluation set: Based on the characteristics of logistics operation risks, the evaluation set is defined as v={High, Medium, Low}, corresponding to the scores of 3, 2, and 1. These ratings are input into Yaahp software to generate a risk assessment table.

The fifth step is to construct the judgment matrix: The assessment table was imported into Excel, where relevant experts from the Shanghai Xikui Express Hub were invited to rate each secondary indicator. The average ratings for each factor were then calculated and imported into Yaahp, ultimately yielding a comprehensive evaluation score for the logistics operation risks.

4.3.3. Fuzzy Comprehensive Evaluation Results

The logistics operation risk evaluation table was generated using Yaahp software (Sharma et al., 2024). The relevant leaders from the Nanning transit hub in Guangxi, who have years of logistics operation experience, were invited to assign ratings to each secondary indicator, selecting High, Medium, or Low. The final weights were calculated by combining the opinions of several experts, and the data was then imported into Yaahp software. The overall score for the logistics operation risk model was 3.3875, falling between 2 and 3, indicating that the Nanning transit hub faces significant risks in its logistics operations. Among these, operational risk, particularly sorting and packaging risk, is the most prominent.

Table 8: Expert Evaluation Results

Number	Evaluation Indicator	Evaluation
1	Scanning Test Risk	Medium
2	Sorting and Packaging Risk	High
3	Assembly and Transportation Risk	Medium
4	Equipment Malfunction Risk	Low
5	Unprofessional Labor Input Risk	High
6	Customer Complaint Risk	Medium
7	Low Information Technology Level Risk	Low
8	Media Communication Irregularities Risk	Low
9	Natural Environment Risk	High
10	Policy and Legal Risk	Medium
11	Industry Competition Risk	Medium
12	Social Abnormal Risk	Low

4.3.4. Summary

This section validates the logistics operation risk evaluation system for the Nanning transit hub using Yaahp software. The weights and rankings for both the first-level and second-level indicators were calculated. The results show that operational risk is the most critical factor in the overall logistics operation risk, with sorting and packaging operations having the greatest impact on logistics performance. Based on hierarchical analysis, the logistics operation risk measurement table was generated by setting evaluation levels. Through the input of relevant experts, the comprehensive evaluation score of the entire model was derived.

Table 9: Comprehensive Evaluation Report

Evaluation Objective	Comprehensive Evaluation Score
Logistics Operation Risk	2.3875

Appendix 1: Evaluation Domains

Evaluation Level	Score
High	3
Medium	2
Low	1

Appendix2: Weight Vector

Indicator	Weight
Scanning Test Risk	0.1985
Sorting and Packaging Risk	0.3363
Assembly and Transportation Risk	0.0599
Equipment Malfunction Risk	0.064
Unprofessional Labor Input Risk	0.0831
Customer Complaint Risk	0.029
Low Information Technology Level Risk	0.0152
Media Communication Irregularities Risk	0.029
Natural Environment Risk	0.092

Policy and Legal Risk	0.0237
Industry Competition Risk	0.0538
Social Abnormal Risk	0.0158

5. RISK PREVENTION STRATEGIES FOR THE NANNING TRANSIT HUB LOGISTICS OPERATIONS

Based on the results above, it is evident that the logistics operation risks at the Nanning transit hub are relatively high. To effectively mitigate these risks and enhance the overall operational efficiency of the hub, and to catch up with other transit hubs and distribution centers, several preventive measures must be implemented:

5.1. Strengthening the Training of Internal Operations Staff

During sorting and packaging, some operators often engage in violent sorting, improper unloading, inaccurate package labeling, and other issues in an effort to improve efficiency. These practices create significant problems for subsequent processes, such as damaging customers' shipments, incorrect delivery addresses, and loss of small parcels. To address these problems, management should assess operators based on their proficiency and implement ranking systems. Inexperienced staff should receive additional training before being assigned tasks, and the mastery of skills should be directly linked to performance-based wages. This shift in focus from "efficiency over quality" will be a key strategy. Furthermore, the installation of comprehensive surveillance systems, such as cameras, can monitor operators' actions. The Lean Management Board should not only display metrics like the number of shipments or the status of vehicles but also track employee performance, thus transitioning management from focusing on tasks to focusing on personnel.

5.2. Addressing the Impact of Natural Environmental Factors

The research results indicate that unpredictable natural environments have a significant impact on logistics operations at the transit hub. Extreme weather events, such as typhoons and heavy rains, affect delivery speed, which can result in packages being delayed at the hub. The floor at the Nanning transit hub is damp, and due to limited sunlight, dirt and oil stains from conveyors can accumulate. When there is excessive inventory, packages may be "contaminated." Therefore, cleaning and organizing operations must be prioritized. Observations during routine inspections of the hub often reveal poor hygiene in work areas, operational equipment, and transport vehicles. For example, conveyors accumulate debris, and to address this, the staff should be assigned specific responsibilities and held accountable. Equipment malfunctions, such as oil leaks from conveyors, should be resolved by implementing maintenance protocols and hiring repair staff to inspect and address issues regularly. Additionally, transport vehicles often accumulate dust, and in rainy seasons, unpleasant odors can arise. Truck drivers should regularly clean their vehicles and ensure proper ventilation after rainy days.

5.3. Addressing Talent Development and Industry Competition Risks

The Nanning transit hub is also facing significant challenges in talent development and industry competition. The current workforce consists of many temporary employees with lower education levels, and many have no prior logistics experience. This negatively affects both work attitudes and service quality. Moreover, the shortage of high-level management staff means the hub lacks a proper management system and standard operating procedures. Without clear systems and guidelines, it is difficult to define employee roles and effectively assess their performance. Therefore, recruiting more highly qualified logistics professionals is essential for improving management. Regarding industry competition, some experts believe that the Nanning transit hub, being newly established, lags behind other transit hubs in cities like Shanghai, which affects the overall operational quality and consequently impacts employee wages. To address this, the hub could benefit from hiring experienced staff from other transit hubs. Management could also organize training sessions using PowerPoint presentations or video case studies to help staff learn from the successful experiences of other logistics centers.

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CONFLICT STATEMENT

The author declare no conflict of interest.

COOPERATION STATEMENT

The author affirms that this research was conducted independently and that no other individuals contributed to its authorship.

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RESEARCH ARTICLE

THE IMPACT OF DIGITAL ECONOMY DEVELOPMENT ON THE UPGRADING OF INDUSTRIAL STRUCTURE ——TAKING THE METROPOLITAN CIRCLE AROUND THE "JI" SHAPE BEND OF THE YELLOW RIVER AS AN EXAMPLE

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ABSTRACT

Based on the panel data of 19 prefecture-level cities in the Metropolitan Circle around the "ji" Shape Bend of the Yellow River from 2011 to 2022, the entropy method, CRITIC method and mean variance method are combined to measure the digital economy development level of each city in the metropolitan circle. The double fixed effect model is selected to explore the impact of the digital economy on the upgrading of the industrial structure in the Metropolitan Circle around the "ji" Shape Bend of the Yellow River, and the panel threshold model is established to analyze the nonlinear relationship between the development of the digital economy and the upgrading of the industrial structure. The results show that the digital economy has a significant positive impact on the upgrading of the industrial structure in the Metropolitan Circle around the "ji" Shape Bend of the Yellow River. From 2011 to 2016, the impact of the digital economy on the upgrading of the industrial structure is negative, while from 2017 to 2022, it is positive. Per capita GDP and urbanization play a completely mediating role in the impact of the digital economy on the upgrading of the industrial structure. There are significant nonlinear characteristics in the impact of the digital economy on the upgrading of the industrial structure, showing a trend of increasing marginal effect.

1. Introduction

The "14th Five-Year Plan" for the Development of Digital Economy proposes that the digital economy is the main economic form following agricultural and industrial economies. It is characterized by data resources as key elements, modern information networks as the primary carrier, and the integrated application of information and communication technologies and the digital transformation of all factors as important drivers, promoting a new economic form that unifies fairness and efficiency. Zhang (2016) believes that technologies such as computers and network communications have given rise to the digital economy. As a new type of economic form, the digital economy has characteristics such as external economies and sustainability, and can provide new impetus for the upgrading of industrial structures. The level of industrial structure can reflect the level of regional economic development to some extent and is an indispensable driving force for regional economic development. Regions with developed economies have generally formed advanced levels of industrial structure and comprehensive industrial systems. Therefore, to achieve sustained regional economic development, it is necessary to promote the upgrading of industrial structures within the region. The "ji" shape bend of the Yellow River refers to the "ji" shaped bend formed by the upper and middle reaches of the Yellow River, which embraces a region. It is a bridgehead for economic exchanges and cooperation between China, Mongolia, and Russia, and is also an important node on the Silk Road Economic Belt. Promoting the construction of the Yellow River "ji" shape bend economic zone has significant strategic importance for promoting China's economic growth and ensuring energy security.

The impact of the digital economy on the upgrading of industrial structure can be divided into two aspects: industrial digitization and digital industrialization. In terms of industrial digitization, the digital economy integrates with traditional industries through data resources, cloud computing, and other technologies, enhancing the technological and digital levels of traditional industries, and promoting the upgrading of traditional industries. In terms of digital industrialization, the development of the digital economy can foster new economic forms, providing important technological support for industries such as

telecommunications, software, and information services. From a single perspective of impact, Zang (2019) proposed that the digital economy has a higher degree of integration with the tertiary industry compared to the primary and secondary industries, and the prosperity of the digital economy industry has a positive impact on the optimization and upgrading of the industrial structure. Chen and Pei (2021) established an interaction effect model to test the mechanism of the digital economy on the upgrading of the industrial structure, concluding that the digital economy is conducive to the optimization and upgrading of the industrial structure. Chen (2018) the integration of the tertiary industry with intelligence, which helps to drive changes in the industrial structure. From a comprehensive perspective of impact, Xu and Lin (2023) explored the impact mechanism of the digital economy on the upgrading of the industrial structure from the perspective of technological innovation, and the results showed that different types of technological innovations play different intermediary roles, with breakthrough technological innovations having a significant intermediary effect. Lyu (2023) analyzed the impact of the digital economy on the industrial structure from the perspective of carbon emissions, and the results indicated that the digital economy achieves carbon reduction through digital technology and exerts a "forcing effect" on the industrial structure, promoting the upgrading of the regional industrial structure. From the perspective of nonlinear impact, Liu and Chen (2021) established a panel threshold model to analyze the nonlinear impact of the digital economy on the upgrading of the industrial structure, and the results showed that there is a trend of diminishing marginal effects of the digital economy on the advanced industrial structure.

In summary, there are diverse perspectives on the impact mechanism of the digital economy on the upgrading of industrial structure. Existing literature mainly studies the relationship between the digital economy and industrial structure upgrading from intermediary variables such as technological innovation, carbon emissions, circulation effects, and environmental regulations, with fewer explorations from the perspective of urbanization. Drawing on relevant research and using Stata17.0 software, this study selects panel data from the 2011-2022 Yellow River "Ji" character bend metropolitan area to test the impact of the digital economy on industrial structure upgrading and analyzes the role of per capita GDP and urbanization level in the relationship between the two. This enriches the

research on the impact mechanism of the digital economy on industrial structure upgrading and provides a reference for the upgrading of industrial structure in the Yellow River "Ji" character bend metropolitan area.

2. Research Design

2.1. Data Source

This paper selects panel data from 19 prefecture-level cities in the "Ji" shape bend of the Yellow River from 2011 to 2022 for study. For the missing values, the linear interpolation method is used to fill in the years for individual prefecture-level cities. The data sources include the "China City Statistical Yearbook," the statistical yearbooks of various prefecture-level cities, and the EPS database.

2.2. Research Method

This paper investigates the impact of the digital economy on the upgrading of industrial structure and analyzes whether there is an intermediary effect of per capita GDP and urbanization. The causal stepwise regression method proposed by Wen and Ye (2014) is used for the mediation effect test. The mediation effect test equation is as follows:

$$Y = cX + e \tag{1}$$

$$M = aX + e \tag{2}$$

$$Y = c'X + bM + e \tag{3}$$

First, regress equation 1 to test whether the regression coefficient c of the independent variable on the dependent variable is significant. If it passes the significance level test, proceed to the second step; if it does not pass the significance level test, stop the mediation effect test. In the second step, regress the mediating variable M on the independent variable X to obtain the regression coefficient a. After adding the mediating variable M to equation 1, regress to obtain the regression coefficient b of M on Y. Test the significance of coefficients a and b. If both coefficients a and b are significant, proceed to the third step; if at least one of coefficients a and b is not significant, use the Bootstrap method for further testing to determine whether the mediating variable M has a mediation effect between the independent variable X and the dependent variable Y. If both coefficients a and b are significant, there is a significant indirect effect; if neither coefficient a nor b is significant, the indirect effect is not significant.

Step 3 involves adding the control variable M to equation 1, constructing a new regression equation 3, and regressing the dependent variable Y on the independent variable X and the mediating variable M. This yields the regression coefficient c′ of the independent variable X on the dependent variable Y. If coefficient c′ is not significant, it indicates that the direct effect of the independent variable X on the dependent variable Y is not significant, and there is a significant full mediating effect. If c′ is significant, it suggests that the direct effect of the independent variable X on the dependent variable Y is significant, and there is a significant partial mediating effect. Then proceed to step 4.

Step 4: If the sign of ab is the same as the sign of coefficient c, it indicates that the total effect of the independent variable X on the dependent variable Y and the mediating effect are in the same direction, with a partial mediating effect present, and the proportion is c/ab. If the sign of ab is different from the sign of coefficient c, it indicates the presence of a suppression effect, and analysis should be conducted according to the suppression effect.

2.3. Variable Selection

Dependent variable: Industrial advancement value W. The reference for industrial structure advancement is Fu (2010), who used the spatial vector angle method for calculation. According to the classification of the three industries, GDP is divided into three parts, with the added value of each part accounting for the proportion of GDP as a component in the spatial vector, thus forming a set of 3-dimensional vectors $X_0 = (x_{1,0}, x_{2,0}, x_{3,0})$. Then, the angles θ_1, θ_2 and $\theta 3$ between X_0 and the vectors arranged from lower to higher levels of industry, $X_1 = (1,0,0)$, $X_2 = (0,1,0)$ and $X_2 = (0,0,1)$, are calculated respectively.

$$\theta j = \arccos\left[\frac{\sum_{i=1}^{3}(xi, j \bullet xi, 0)}{(\sum_{i=1}^{3}(x^2 i, j)^{1/2} \bullet \sum_{i=1}^{3}(x^2 i, 0)^{1/2})}\right], \quad j = 1,2,3 \quad (4)$$

The formula for calculating the value of industrial advancement W is defined as:

$$W = \sum_{k=1}^{3}\sum_{j=1}^{k}\theta j \quad (5)$$

The larger the W, the higher the degree of industrial sophistication.

Core explanatory variable: Digital Economy Development (dig). In the current literature on the evaluation of the level of digital economy development, different scholars have varying evaluation indicators for the digital economy, but most studies are based on

perspectives such as infrastructure, innovative development, technological development, and industrial development. This article draws on the digital economy indicator systems of Wang (2021), He (2021), and Ma (2022), and selects nine indicators based on data availability and accuracy to construct a digital economy development level evaluation indicator system to measure the level of digital economy development. These indicators include the number of internet users per 100 people, the proportion of employees in the computer services and software industry, the total volume of telecommunications per capita, the number of mobile phone users per 100 people, the level of expenditure on science and technology, the level of human capital, the depth of digital finance usage, the breadth of coverage, and the degree of digitization. Following the methodology of Zhang (2023), weights were calculated using the Entropy Method, CRITIC method, and Mean-Variance Method respectively. Final weights were then determined by taking the arithmetic mean of these values, and subsequently applied to compute the Digital Economy Development Index.

Table 2.1: Evaluation index system for the development level of the digital economy

Primary Indicator	Secondary indicators	Level 3 indicators	Unit
Level of Development of the Digital Economy	Digital Foundation	Number of internet users per 100 people	/
		Number of mobile phone users per 100 people	/
	Development of the digital industry	The proportion of employees in the computer services and software industry	%
		Per capita total telecommunications business volume	Ten thousand yuan
	Innovative Development	Level of expenditure on science and technology	%
		Human Capital Level	%
	Digital Finance	The depth of use of digital finance	/
		Digital Finance Coverage Breadth	/
		Digital Finance Digitalization Level	/

Mediating variable: Per capita GDP (lnrgdp). The ratio of regional gross domestic product to the year-end resident population, taken the natural logarithm. Urbanization (lncity). The level of urbanization is measured by the urbanization rate, and the natural logarithm is taken. Control variables: This paper selects government intervention (lngov), financial development level (lnfund), and human capital (lnlabor) for control. Government intervention: the proportion of fiscal expenditure in regional gross domestic product. Financial development level: the proportion of the year-end loan balance of regional financial institutions in regional gross domestic product. Human capital: the proportion of the number of regular undergraduate and college students to the resident population. Then take the natural logarithm for measurement.

2.4. Model Construction

Based on the analysis above, Following the approaches of Cheng (2021) and Liu (2022), we control for variables including government intervention, financial development, and human capital, and selecting per capita GDP and urbanization as mediating variables, we test the impact mechanism of the digital economy on the advanced industrial structure of the "Ji" character-shaped urban agglomeration along the Yellow River. The constructed mediating effect model is as follows:

$$W_{\mathrm{it}} = \alpha_0 + \alpha_1 dig_{it} + \varepsilon_{it} \tag{6}$$

$$W_{\mathrm{it}} = \alpha_0 + \alpha_1 dig_{it} + \alpha_2 \sum x_{it} + \varepsilon_{it} \tag{7}$$

$$\ln rgdp_{it} = \beta_0 + \beta_1 dig_{it} + \beta_2 \sum x_0 + \varepsilon_{it} \tag{8}$$

$$W_{it} = \gamma_0 + \gamma_1 dig_{it} + \gamma_2 \ln rgdp_{it} + \gamma_3 \sum x_{it} + \varepsilon_{it} \tag{9}$$

$$\ln city_{it} = \delta_0 + \delta_1 dig_{it} + \delta_2 \sum x_0 + \varepsilon_{it} \tag{10}$$

$$W_{\mathrm{it}} = \eta_0 + \eta_1 dig_{it} + \eta_2 \ln city_{it} + \eta_3 \sum x_{it} + \varepsilon_{it} \tag{11}$$

The impact of the development of the digital economy on the upgrading of industrial structure may have a nonlinear relationship. We adopt a panel threshold model to test the nonlinear relationship between the two. Based on equation (5), we construct the following panel threshold model:

$$W_{it} = \alpha_0 + \alpha_1 digit I\left(c \le \delta_1\right) + \alpha_2 dig_{it} I\left(\delta_1 \text{ㅋ} c \le \delta_2\right) + \alpha_3 dig_{it} I\left(c \text{ㄱ} \delta_2\right) + \alpha_4 \sum x_{it} + \varepsilon_{it} \tag{12}$$

2.5. Descriptive statistics of variables

The descriptive statistics of the variables are shown in Table 2.1 From the mean perspective, the number of internet users per hundred people is the largest, while government intervention is the smallest. In terms of standard deviation, both the number of internet users per hundred people (internet) and the level of human capital (lnlabor) are greater than 1, indicating that the dispersion of these two indicators is significantly greater than that of other indicators, with greater differences between regions. The standard deviation of the social consumption level (c) indicator is smaller, indicating that the dispersion of the indicator data is smaller, with less regional differences.

Table 2.2: Descriptive statistics of variables

VarName	Obs	Mean	SD	Min	Max
W	228	6.653	0.311	6.082	7.276
dig	228	0.325	0.139	0.037	0.704
lnrgdp	228	1.838	0.592	0.589	3.246
lncity	228	-0.498	0.264	-1.142	-0.041
lngov	228	-1.524	0.449	-2.564	-0.269
lnlabor	228	0.164	1.081	-3.968	2.423
lnfund	228	0.014	0.553	-1.455	1.823
internet	228	14.610	7.847	5.427	38.647
c	228	0.295	0.124	0.050	0.594

3. Empirical Analysis

3.1. Benchmark Regression

The two-way fixed effects model effectively addresses omitted variable bias caused by time-invariant and individual-invariant characteristics by controlling for both individual and time fixed effects. Compared to one-way fixed effects or pooled models, it more thoroughly accounts for individual and temporal heterogeneities, reducing endogeneity biases. This approach is particularly suitable for panel data with significant heterogeneities in both individual and time dimensions. Given the study's long-time dimension, numerous city-level variables, and the presence of both time-invariant and city-specific heterogeneities—coupled

with the results of the Hausman test—the two-way fixed effects model was selected. The regression results are shown in Table 3.1, which indicate that regardless of whether control variables are included, the estimated coefficients of the digital economy development on the advancement of industrial structure pass the 5% significance level test, showing a significant positive impact on the advancement of industrial structure. Before adding control variables, the regression coefficient of digital economy development is 0.304, meaning that an increase of one unit in the level of digital economy development leads to an average increase of 0.304 units in the level of industrial structure upgrading; after adding control variables, the regression coefficient of the digital economy is 0.286, indicating that for every one unit increase in the level of digital economy development, the level of industrial structure upgrading correspondingly increases by an average of 0.286 units.

Table 3.1: Benchmark regression

	(1)	(2)
	W	W
dig	0.304**	0.286**
	(0.137)	(0.138)
lngov		0.012
		(0.019)
lnlabor		0.002
		(0.012)
lnfund		0.028*
		(0.015)
_cons	6.483***	6.512***
	(0.026)	(0.041)
Individual/Time	yes/yes	yes/yes
N	228.000	228.000
r2	0.678	0.686

Note: * p < 0.1, ** p < 0.05, *** p < 0.01, values in parentheses are standard errors (se).

3.2. Mechanism Analysis

This article employs stepwise regression to examine the mediating effects of per capita GDP and urbanization on the impact of digital economy development on industrial upgrading. The regression results for the mediating effect of per capita GDP are shown in Table 3.2, while the mediating effect of urbanization is presented in Table 3.3.

3.2.1. Economic Development Effect

Model (2) in Table 3.2 represents the direct impact of the digital economy on industrial structure upgrading, controlling for government intervention, financial development level, and human capital. Model (3) shows the direct impact of digital economy development on per capita GDP after adding control variables. Model (4) indicates the impact of digital economy development and per capita GDP on industrial structure upgrading after controlling for government intervention, financial development level, and human capital.

The regression results in Table 3.2 Model (3) show the direct impact of digital economy development on per capita GDP. According to the regression results, the impact coefficient of digital economy development on per capita GDP is 0.286, and the coefficient passes the significance test at the 5% level. Therefore, it can be concluded that digital economy development has a significant positive impact on per capita GDP. The construction of digital infrastructure and the application of digital technology are conducive to attracting investment, thereby promoting economic development. In summary, the second step of the mediating effect test is verified.

Based on the regression results in Table 3.2 Model (4) after adding the mediating variable per capita GDP, the impact of digital economy development on industrial structure upgrading is shown. According to the regression results, the impact coefficient of digital economy development on industrial structure upgrading is 0.216, which does not pass the significance test, while the impact coefficient of per capita GDP on industrial structure upgrading is 0.089, passing the significance test at the 1% level. At this point, per capita GDP has a significant positive impact on industrial structure upgrading, and therefore, per capita GDP plays a mediating role in the impact of digital economy development on industrial structure upgrading. Moreover, since the impact coefficient of digital economy development is not significant, per capita GDP plays a full mediating role at this time.

3.2.2. Urbanization Effect Analysis

Model (2) in Table 3.3 is the regression without the mediating variable, which has been analyzed above and will not be repeated. The regression results in Model (5) of Table 3.3 show the impact of digital economy development on urbanization. According to the regression results, the impact coefficient of digital economy development on urbanization is 0.381, passing the significance test at the 1% level, indicating that digital economy development has a significant promoting effect on urbanization. Digital economy development can lead to the upgrading and improvement of regional infrastructure, attract the concentration of production factors such as human resources and capital, and promote urbanization to a higher level.

The regression results in Model (6) of Table 3.3 after adding the mediating variable urbanization show the impact of digital economy development on industrial structure upgrading. According to the regression results in Table 3.3, the impact coefficient of digital economy development on industrial structure upgrading is 0.169, which does not pass the significance test, while the impact coefficient of urbanization on industrial structure upgrading is 0.307, passing the significance test at the 1% level. Urbanization has a significant promoting effect on industrial structure upgrading. The impact coefficient of the control variable, the level of social consumption, on industrial structure upgrading passes the significance test at the 1% level, and the change is small before and after adding the mediating variable. Social consumption can promote industrial structure upgrading through demand upgrading. Compared to when the mediating variable is not added, the impact coefficient of the digital economy has significantly decreased, and the significance has changed. Moreover, the impact coefficient of urbanization is significant, so the digital economy can indirectly affect industrial structure upgrading by influencing urbanization. In the process of digital economy development affecting industrial structure upgrading, urbanization plays a full mediating role.

Table 3.2: The mediating effect of per capita GDP

(1)	(2)	(3)
W	lnrgdp	W

dig	0.286**	0.783**	0.216
	(0.138)	(0.386)	(0.135)
lngov	0.012	-0.052	0.016
	(0.019)	(0.054)	(0.019)
lnlabor	0.002	-0.020	0.004
	(0.012)	(0.034)	(0.012)
lnfund	0.028*	-0.095**	0.036**
	(0.015)	(0.043)	(0.015)
lnrgdp			0.089***
			(0.025)
_cons	6.512***	1.331***	6.393***
	(0.041)	(0.116)	(0.052)
Individual/Time	yes/yes	yes/yes	yes/yes
N	228.000	228.000	228.000
r2	0.686	0.589	0.705

Note: * p < 0.1, ** p < 0.05, *** p < 0.01, values in parentheses are standard errors (se).

Table 3.3: Mediating effect of urbanization

	(1)	(2)	(3)
	W	lncity	W
dig	0.286**	0.381***	0.169
	(0.138)	(0.133)	(0.135)
lngov	0.012	0.005	0.010
	(0.019)	(0.019)	(0.018)
lnlabor	0.002	-0.012	0.006
	(0.012)	(0.012)	(0.012)
lnfund	0.028*	-0.002	0.028*
	(0.015)	(0.015)	(0.015)

lncity			0.307***
			(0.071)
_cons	6.512***	-0.673***	6.719***
	(0.041)	(0.040)	(0.062)
Individual/Time	yes/yes	yes/yes	yes/yes
N	228.000	228.000	228.000
r2	0.686	0.718	0.713

Note: * p < 0.1, ** p < 0.05, *** p < 0.01, values in parentheses are standard errors (se).

3.3. Robustness Test

This article selects the following three methods for robustness tests: The first method draws on Liu and Chen (2021), replacing the explanatory variable, using the internet penetration rate to replace the development of the digital economy for regression, and the regression results are shown in Table 3.4 (1); The second method refers to Zhang (2019) , lagging the control variables by one period for the model to regress again, and the regression results are shown in Table 3.4 (2); The third method draws on Lü (2023) , after truncating the explained variable, industrial structure upgrading, by 2.5% at both ends, the model is regressed again, and the regression results are shown in Table 3.4 (3).

From Table 3.4 (1), it can be seen that after replacing the digital economy development with the internet penetration rate for regression, the influence coefficient has decreased but remains significant, having a significant impact on industrial structure upgrading; The regression results in Table 3.4 (2) show that after lagging the control variables and explanatory variables by one period for regression again, the digital economy development still has a significant positive impact on industrial structure upgrading; According to Table 3.4 (3), after truncation, the digital economy still has a significant positive impact on industrial structure upgrading, and the coefficients are similar to the benchmark regression results, with the same level of significance, indicating that the robustness test after truncation has passed. In summary, the robustness tests conducted using lagged variables, truncation, and replacement indicate that the aforementioned regression results are robust.

Table 3.4: Robustness test

	(1)	(2)	(3)
	W	W	W
internet	0.004*		
	(0.002)		
lngov	0.011		0.007
	(0.019)		(0.019)
lnlabor	0.004		0.004
	(0.012)		(0.012)
lnfund	0.029*		0.026*
	(0.015)		(0.016)
dig		0.381**	0.283**
		(0.151)	(0.139)
L.lngov		-0.008	
		(0.022)	
L.lnlabor		0.013	
		(0.013)	
L.lnfund		-0.000	
		(0.016)	
_cons	6.513***	6.466***	6.509***
	(0.044)	(0.046)	(0.042)
Individual/time	yes/yes	yes/yes	yes/yes
N	228.000	209.000	228.000
r2	0.684	0.645	0.666

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, values in parentheses are standard errors (se).

3.4. Heterogeneity Test

3.4.1. Heterogeneity Test of Time

To explore the impact of time factors on the upgrading of industrial structure, the study period is divided into two time segments: 2011-2016 and 2017-2022. A heterogeneity test of

time is then conducted, and the results are shown in Table 7. During 2011-2016, the development of the internet and digital technology was not yet mature, and the development of the digital economy was relatively low, which had a negative impact on the upgrading of industrial structure, with a lower level of significance; the impact coefficient of government intervention was 0.056, and it was significant at the 1% level. Government policies and financial support for industries help to introduce and accept the relocation of related industries, thereby promoting the upgrading of the local industrial structure. During 2017-2022, the impact coefficient of the digital economy was 0.386, and it was significant at the 10% level; during this period, digital technology, the internet, and information and communication technology all developed rapidly, and the level of the digital economy improved, thereby promoting the development of industrial digitization and digital industrialization, driving the upgrading of the regional industrial structure; the inertia of government policies towards high-energy-consuming industries has a certain negative impact on the upgrading of the regional industrial structure. Based on the above analysis, it can be concluded that the impact of the development of the digital economy on the upgrading of industrial structure varies greatly in different time periods.

3.4.2. Regional Heterogeneity Analysis

To explore the heterogeneous impact of different regions on the upgrading of industrial structure, the urban circle of the "几" character-shaped bend of the Yellow River is divided according to administrative divisions. Due to the fewer cities in Shaanxi and Ningxia, the cities of these two provinces are grouped together, and the cities of Inner Mongolia and Shanxi are each grouped separately, and regression analysis is conducted, with the results shown in Table 8.

Table 3.6 (1) shows the impact of the digital economy on the upgrading of industrial structure in Shaanxi and Ningxia cities. The impact coefficient is -0.184, but it did not pass the 10% significance level test. Table 3.6 (2) shows that the digital economy in some cities of Inner Mongolia has a positive impact on the industrial structure, with a lower level of significance, indicating that the development of the digital economy is good, but it has not had a significant impact on industries that contribute more to regional economic growth,

and the digitization of industries needs to be further developed. Table 3.6 (3) shows that the impact coefficient of the digital economy on the upgrading of industrial structure in some cities of Shanxi Province is -0.288, and it passes the 10% significance level test. The digital economy has a significant negative impact on the upgrading of industrial structure. Due to insufficient conditions such as digital infrastructure and funds, the development of the digital economy will have a crowding-out effect on investment in other industries, and at the same time, the production costs will increase during the process of industrial digitization, which will have a negative impact on the upgrading of industrial structure.

Table 3.5: Time heterogeneity analysis

	(1)	(2)
	W	W
dig	-0.268*	0.386*
	(0.151)	(0.195)
lngov	0.056***	-0.030
	(0.020)	(0.031)
lnlabor	0.015	-0.017
	(0.010)	(0.028)
lnfund	0.012	0.100**
	(0.014)	(0.050)
_cons	6.678***	6.521***
	(0.043)	(0.093)
Individual/Time	yes/yes	yes/yes
N	114.000	114.000
r2	0.802	0.668

Note: * p < 0.05, ** p < 0.01, *** p < 0.001, values in parentheses are standard errors (se)
.

Table 3.6: Regional heterogeneity analysis

	(1)	(2)	(3)
	W	W	W
dig	-0.184	0.496*	-0.288*

	(0.194)	(0.261)	(0.159)
lngov	-0.009	0.026	0.127
	(0.021)	(0.045)	(0.080)
lnlabor	0.045*	-0.051*	0.015
	(0.024)	(0.027)	(0.010)
lnfund	0.057	0.127***	0.034***
	(0.037)	(0.045)	(0.012)
_cons	6.421***	6.609***	6.945***
	(0.049)	(0.081)	(0.147)
Individual/Time	yes/yes	yes/yes	yes/yes
N	72.000	84.000	72.000
r2	0.818	0.814	0.925

Note: * p < 0.1, ** p < 0.05, *** p < 0.01, values in parentheses are standard errors (se).

3.5. Nonlinear Analysis

Table 3.7: Threshold quantity test

Dependent variable	Threshold variable	Threshold quantity	P Value	BS Number of times	Threshold value		
					1	2	3
W	c	Single threshold	0.003	300	0.2402		
		Dual thresholds	0.090	300	0.2402	0.3258	

Threshold regression models, compared to linear models, more accurately capture the nonlinear relationships between variables, such as scenarios where marginal effects vary with threshold variables. These models are particularly applicable to contexts involving regime switching or interval-specific effects. To explore the existence of the nonlinear impact of the development of the digital economy on the upgrading of industrial structure, the panel threshold model was adopted for testing, selecting the level of social consumption as the

threshold variable. According to the model test, it is evident that the impact of the development of the digital economy on the upgrading of industrial structure has a double threshold effect, significant at the 10% level of significance; therefore, a double threshold model was set up for regression, and the regression results are shown in Table 3.8. The regression results indicate that there is a significant nonlinear relationship between the digital economy and the upgrading of industrial structure. Under the double threshold, the impact coefficients of the development of the digital economy on the upgrading of industrial structure before and after the threshold values are significant, but there is a clear difference in the level of significance. When the threshold variable c is less than 0.2402, the impact coefficient of the digital economy is 0.276, and it is significant at the 5% level of significance, indicating a more significant impact of the digital economy on the upgrading of industrial structure; when the threshold variable c is greater than or equal to 0.2402 and less than 0.3258, the impact coefficient of the digital economy rises to 0.577, and the significance level is improved, enhancing the positive impact on the upgrading of industrial structure; when the threshold variable c is greater than 0.3258, the impact coefficient of the development of the digital economy rises to 0.792, and it is significant at the 1% level of significance, indicating a more significant promotion of the upgrading of industrial structure. The reason why the impact of the digital economy on the industrial structure changes from weak to strong may lie in the fact that in the early stages of the development of the digital economy, digital infrastructure and digital application scenarios are not perfect, and the empowerment of industrial structure transformation by digital technology is relatively slow. With the improvement of consumption levels, new consumer demands lead to new product supply, and the development of digital technology also provides new scenarios for consumption, making consumption more convenient. The continuous development of digital industrialization and industrial digitization leads to an increasing trend of the impact of the digital economy on the upgrading of industrial structure.

Table 3.8: Regression results of threshold model

	(1)
	W
lngov	0.027

	(0.038)
lnlabor	-0.012
	(0.024)
lnfund	0.050
	(0.036)
dig（c<0.2402）	0.276**
	(0.104)
dig（0.2402<c≤0.3258）	0.577***
	(0.092)
dig（c>0.3258）	0.792***
	(0.080)
_cons	6.519***
	(0.069)
N	228.000
r2	0.505

Note: * p < 0.1, ** p < 0.05, *** p < 0.01, values in parentheses are standard errors (se).

4 . Conclusions and Recommendations

4.1. Conclusions

Based on the panel data of 19 prefecture-level cities in the Yellow River "Ji" bend metropolitan area from 2011 to 2022, this paper analyzes the impact mechanism of the development of the digital economy on the upgrading of industrial structure. The following conclusions are drawn:

(1) The development of the digital economy has a significant positive impact on the

upgrading of the industrial structure in the Yellow River "Ji" bend metropolitan area, that is, the improvement of the level of digital economy development can promote the upgrading of industrial structure.

(2) In exploring the mediating mechanism, both per capita GDP and urbanization play a complete mediating role in the impact of the development of the digital economy on the upgrading of industrial structure; the development of the digital economy can promote the upgrading of industrial structure by affecting per capita GDP and urbanization.

(3) In terms of the nonlinear relationship between the digital economy and the upgrading of industrial structure, the threshold variable social consumption level c has significant changes in the impact coefficient and significance of the digital economy before and after the threshold value, showing a trend of increasing marginal effect.

4.2. Recommendations

There are problems such as homogenization of industrial development, unreasonable structure, and low level of regional coordination in the Yellow River "Ji" bend industrial development. Based on the above conclusions, the following suggestions are proposed:

First, accelerate the construction of infrastructure to promote the digital industrialization. Under the background of the development of the digital economy, the existing infrastructure cannot meet the development requirements, and it is necessary to accelerate the construction of new infrastructure. The Yellow River "Ji" bend metropolitan area should first combine its own development status and future development, promote the construction of the Internet of Things, computing power infrastructure, and information and communication networks, provide good facilities for the development of the digital economy, enhance the level of industrialization of the digital economy, and promote the upgrading of the industrial structure of the metropolitan area.

Second, accelerate the integration of the real economy and the digital economy to promote industrial digitization. The digitization of agriculture, industry, and services can help promote the transformation and upgrading of the metropolitan area's industries, build a modern industrial system, and achieve high-quality regional economic development. In terms of agriculture, promote smart agriculture and livestock farming according to local conditions, install intelligent equipment, and achieve scientific production and intelligent

feeding. In terms of industry, promote the integration of resource extraction industries and modern communication networks, improve the level of digitalization of extraction, and improve the efficiency and safety of extraction. In terms of services, rely on artificial intelligence, cloud computing, big data to enhance the ability to obtain and share information resources within the service industry, and enhance the level of modern service industries in the metropolitan area. The development of the digital economy can accelerate the flow of production factors, enhance the information acquisition ability of enterprises, promote the coordinated development of regional industries, and thus improve the rationalization level of industrial structure.

Third, promote digital governance. Give full play to the advantages of the digital economy in data processing and analysis, and promote the transformation of government management and service processes and concepts. Rely on digital technology to promote the construction of a digital government, accelerate the digitization of administrative approval, optimize the regional business environment, timely push relevant policies, enhance cross-city communication capabilities, and improve government governance levels and capabilities. The Yellow River "Ji" bend metropolitan area should implement digital governance strategies according to local conditions, promote the construction of a service-oriented government, build a digital government affairs system, provide policy support for the upgrading of the metropolitan area's industrial structure, and enhance the level of coordinated regional development.

Fourth, give full play to the role of urbanization in resource aggregation, promote the construction of new-type urbanization, and provide a resource base for industrial transfer and structural upgrading. The internal resource endowment differences within the Yellow River "Ji" bend metropolitan area are small, but there are significant differences in labor, technology, and capital factors. Each city can give full play to its comparative advantages, strengthen regional division of labor, develop characteristic and advantageous industries, integrate into the regional entire industrial chain, and avoid homogenized industrial development.

CONFLICT STATEMENT

The authors of the article "The Impact of Digital Economy Development on the Upgrading of Industrial Structure——Taking the Metropolitan Circle around the "JI" Shape Bend of the Yellow River as an Example", Yan Haohao, solemnly declare that throughout the entire process of creating this work and all subsequent activities related to it, including but not limited to collecting and analyzing research materials, forming opinions, writing, modifying, submitting, and publishing papers, I have no conflicts of interest that may interfere with the fairness, objectivity, and originality of the work.

COOPERATION STATEMENT

The first author (Yan Haohao) is responsible for writing the methodology, investigation, and initial draft.

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RESEARCH ARTICLE

THE IMPACT OF TEAM-BASED LEARNING AND FLIPPED CLASSROOMS ON STUDENTS' EMPLOYMENT IN HUMAN RESOURCE MANAGEMENT

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ABSTRACT

In light of the rapidly expanding global employment marketplace, the work of higher education in augmenting students' working capabilities has never been relevant. To address this problem, the question of how best to increase the employability of students through novel teaching methods has come to represent an overarching issue for educational scholarship. Interdisciplinary approaches to pedagogy have recently taken center stage. Team-based learning (TBL) and the flipped classroom (FC) are two new learning systems that have been extremely successful in a number of fields, especially business-related studies such as human resource management (HRM). This study explores how TBL and FC, by means of an interdisciplinary teaching method, enhance students' key professional competencies and examines their effects on employability. Through a questionnaire survey, this study explores the impact of the two teaching modes on students' teamwork, communication, and problem-solving skills in HRM education. The findings indicate that TBL significantly positively affects students' key professional competencies, particularly teamwork and communication. In the meantime, FC facilitates learning outcomes and interest by supporting independent learning and classroom engagement. Moreover, the study revealed that the course content of HRM courses is well aligned with the demands of the market and that there exists a causal relationship between course content application in the workplace and the employability of students.

1. Introduction

1.1. Research background

As globalization and the advancement of information technology continue to intensify, the expectations placed on workers by contemporary organizations have increasingly shifted towards the development of all-round qualities. This trend particularly emphasizes the importance of key occupational competencies, such as teamwork, communication skills, and problem-solving capabilities. The conventional model of education focuses mainly on lectures in the classroom, emphasizing more theory over practice, which cannot effectively impart students' capacity to adjust to the complex working world, especially when adjusting to the fast-evolving job market, which is typically incompetent.

In recent decades, educational reform initiatives have focused more on instructional methodologies, with an emphasis on students' central significance. Two innovative pedagogic frameworks, specifically the TBL and FC, have gained wider acceptance and large-scale adoption globally. TBL emphasizes interaction and cooperation among students in the context of problem solving in teams and cultivates their communication ability, teamwork capability, and innovative thinking, whereas FC stimulates their learning interest, increases their sense of participation in classroom activities, and enhances and strengthens the effect of learning through precourse video learning and classroom interaction.

In teaching HRM courses, how to effectively combine these new teaching modes to enhance students' vocational core competence and employability has been a new challenge for colleges and universities. In particular, given the increasing demand for high-quality and compound talent in society, it has been difficult for traditional HRM teaching modes to meet diverse market demands.

1.2. Research Objectives

The purpose of this study is to investigate the effectiveness of two innovative teaching models, TBL and FC, in higher education, especially in HRM courses. The core objective of this study is to assess how these two teaching methods play a role in enhancing students' professional core competencies, which in turn affects their employment competitiveness. Specifically, this study focuses on analysing the effects of TBL on the development of students' vocational competencies, such as teamwork, communication skills, and

problem-solving abilities, and explores the potential of FC in promoting students' independent learning, increasing classroom engagement, and stimulating innovative thinking. This study explores the synergistic effect of TBL and FC and analyses how the two can work together to promote students' comprehensive quality and help them gain greater competitiveness in the workplace. The study also analyses the adaptability between the content of the HRM curriculum and market demand and explores how curriculum reform can enable students to better match the needs of the job market, thereby improving their job readiness.

1.3. Significance of the Study

1.3.1. Theoretical Significance

The study explores the integrated use of team-based learning and flipped classroom methods within the higher education environment, delivers an exhaustive review of how they affect students' occupational competences and yields original findings that inform the development of educational theory. The limitations and stiffness of conventional teaching methods at the present time no longer meet the needs of modern education in the development of students' comprehensive capabilities. The use of cutting-edge teaching methods such as TBL and FC has the power to dramatically increase students' active participation in the learning environment and enhance their collaborative and creative abilities. The study seeks to illuminate the cooperative effect of the use of TBL and FC in advancing the employability of students' competitiveness through an interdisciplinary analytical framework and to study comprehensively how the teaching methods of the two approaches help enhance students' abilities in practical teaching environments.

1.3.2. Practical significance

In today's complex and changing job market, the requirements of enterprises for talent focus increasingly on comprehensive quality and practical ability, and traditional teaching methods often neglect the cultivation of these core competencies. TBL and FC, as new educational modes, can provide students with more interactive and practical opportunities and promote the enhancement of their abilities in teamwork, practical problem solving and independent thinking. This study holds significant practical value. By analysing the specific application of TBL and FC in courses, the research results will provide educators with

actionable teaching strategies, equipping them with practical tools to improve their instructional practices. For example, educators can use the insights gained from this research to adapt their teaching content and formats to better meet students' needs, promoting a more dynamic and student-centered learning environment. Furthermore, this study will offer guidance for curriculum design in higher education institutions, especially for applied courses such as HRM, aiding students in adapting to market changes and improving their employment competitiveness.

2. Review of Literature

With the continuous innovation of the education model, FC and TBL have gradually received extensive attention from the academic community as effective teaching strategies. The core idea of FC is to move the teaching content of traditional classrooms outside the classroom so that students can master basic theoretical knowledge through independent learning, and classroom time is used for discussion, practice and problem solving to stimulate students' learning initiative and innovative thinking. TBL, on the other hand, emphasizes interaction and cooperation among students to improve the collective learning effect and cultivate the spirit of teamwork and the ability to solve practical problems. With respect to the research on these two teaching modes, scholars at home and abroad have proposed different views and application cases, highlighting their potential in education reform.

2.1. Research on the application of FC

Zhang (2024) explored the application of FC in the "digital media technology" course and concluded that FC can improve students' interest in and participation in learning by guiding them to learn independently before class and realize interaction and practice in class. In these kinds of courses, students master basic theoretical knowledge in advance through self-study of a variety of materials, such as videos, literature and courseware, and in the classroom, students discuss problems and perform experimental operations with the instructor; this mode of teaching greatly improves students' independent learning ability and practical hands-up ability. Kong (2024), on the other hand, analysed changes in education FC from the perspective of HRM and noted that FC can effectively promote students' deep understanding of knowledge and cultivate their ability to solve complex problems, thus

enhancing their competitiveness in employment. This advantage of FC is especially prominent in courses that are highly theoretical, enabling students to understand the course content in practice in depth and improving their ability to solve practical problems. Yang (2024) suggested that the application of FC in ceramic decorative painting courses not only improved students' practical ability but also stimulated their creativity and autonomy, confirming the effectiveness of FC in art courses. Art courses usually require many practices and operations, and FCs can enable students to learn theories and skills through independent study outside the classroom and then focus on practical operation in the classroom, resulting in a good situation of combining theory and practice.

2.2. Research on the application of the TBL

TBL, as a student-oriented interactive teaching method, emphasizes the promotion of collective learning effects through cooperation and communication among students. This teaching mode develops students' teamwork ability, communication ability and problem-solving ability by dividing them into groups and encouraging them to assign tasks, discuss, and solve TBL problems within the group. Research has shown that TBL not only enhances students' academic performance but also effectively strengthens their professional core competencies, especially in the areas of leadership, teamwork, and communication skills. Research on TBL has also shown its potential in enhancing students' career core competencies. Through an applied study on the teaching of cheer leaders in elementary education majors, Wang (2024) reported that TBL not only improved students' teamwork ability but also effectively improved their communication and leadership abilities, which are crucial for future career development. This study suggests that TBL not only enhances students' professional competence in academic courses but also increases students' comprehensive quality and team spirit in nonacademic courses. Zhang & Zhang (2022) explored the optimization strategy of the TBL in the classroom and concluded that through well-designed group activities, students can learn more practical application skills in cooperation, which enhances their social adaptability and teamwork, which is beneficial to their future employment. For example, when designing group tasks related to actual work, students can not only exercise teamwork skills but also simulate situations in actual work to enhance their social practice ability. By studying the integration of innovation and

entrepreneurship education and HRM courses, Liu & Lu (2022) noted that the TBL can enhance students' innovative thinking and teamwork ability, thus improving their competitiveness in the job market. In the process of TBL, students need to work together to complete project tasks and solve problems collaboratively, and this process can not only enhance students' teamwork ability but also cultivate their innovative thinking and leadership to improve their employability.

2.3. Research on the combination of FC and TBL

The combined application of FC and TBL is also a popular topic that scholars pay attention to. According to Ji Xiaohan (2021), combining TBL with FC not only promotes students' independent learning and teamwork but also enhances the interactivity of the classroom and students' problem-solving ability. In this mode, students not only learn theoretical knowledge but are also able to deepen their understanding of knowledge in group discussions and cooperation and develop a greater level of thinking ability (Ji, 2021). In this model, students are not only able to independently master knowledge outside the classroom but also able to deepen their understanding of knowledge through TBL, which in turn develops their critical thinking and innovation ability. Zhou (2018) noted that the combination of FC and TBL can achieve good teaching results in secondary e-commerce professional courses and that students not only mastered professional skills in actual operations but also improved their ability to collaborate in actual work. The combination of this model not only helps students better master professional skills but also improves their ability to collaborate in actual work, thus enhancing the competitiveness of students' employment.

2.4. Impact of FC and the TBL on employability

With respect to the combined application of the flipped classroom and TBL in the enhancement of employability, Xiao (2017) argued that these two modes can effectively enhance students' vocational ability, especially in the teaching reform of the performance management course. FC can help students better understand and apply theoretical knowledge, whereas TBL allows students to participate in the classroom more actively to enhance their practical ability. The combination of this model helps students form comprehensive vocational literacy, thus enhancing their competitiveness in the workplace.

Li & Li (2017) noted that the application of FC in English case teaching can also stimulate students' interest in independent learning and cultivate their innovative and critical thinking, which is important for future employment.

An analysis of relevant studies at home and abroad revealed that the combined application of FC and TBL can not only improve students' learning effects but also play an important role in enhancing students' employability. FCBL can enhance students' independent learning ability and practical ability, whereas TBL can enhance students' teamwork ability and innovative thinking. The combination of the two can help students achieve comprehensive development in terms of knowledge mastery, practical operation, teamwork and innovation ability and thus enhance their competitiveness in employment. Future research can further explore the application effects of these two modes in different disciplines and majors and conduct in-depth analysis with practical cases to provide a richer theoretical basis and practical guidance for educational reform and optimization of the teaching mode.

3. Methodology

3.1. Research Hypotheses

This section presents the hypotheses of the study, focusing on the relationships among the independent variables, dependent variables, and their theoretical foundations.

Hypothesis 1: TBL Enhances Students' Core Professional Competencie

TBL, a student-centered learning approach, emphasizes collaboration and interaction among group members to promote learning outcomes (Tao, 2024). Through task-driven activities and role allocation, students develop essential skills such as teamwork, communication, and problem solving—skills critical for professional success.

Independent Variable (IV): TBL

Dependent Variable (DV): Core professional competencies (teamwork, communication, problem-solving)

Theoretical Foundation:

Social Constructivism (Vygotsky, 1978): Learning occurs as a social process facilitated through peer interaction.

Human Capital Theory (Becker, 1964): Education enhances individuals' professional

competitiveness by fostering key workplace skills.

Hypothesis 2: FC promotes students' autonomous learning and classroom participation.

FC, an innovative teaching model, shifts the acquisition of foundational knowledge to preclass activities, allowing in-class time for deeper engagement and problem solving. This model cultivates students' self-directed learning skills and increases active classroom participation (Yang & Wang, 2023; Wang, 2023).

IV: FC

DV: Autonomous learning and classroom participation

Theoretical Foundation:

Constructivist Learning Theory (Piaget, 1970; Vygotsky, 1978): Learning is an active, self-constructed process supported by autonomous learning and in-class interactions.

Self-Determination Theory (Deci & Ryan, 1985): FC increases students' intrinsic motivation by providing more control over their learning processes.

Hypothesis 3: The synergistic effect of the TBL and FC enhances students' employability.

When combined, TBL and FC create a complementary learning environment that simultaneously strengthens students' collaborative and autonomous learning abilities. TBL involves teamwork and communication, whereas FC fosters self-directed learning and critical thinking. Together, they significantly improve students' readiness for dynamic workplace demands (Zhang, 2023).

IVs: TBLs and FCs

DV: employability

Theoretical Foundation:

Multiple intelligence theory (Gardner, 1983): Diverse teaching strategies address various competencies and abilities.

Social Learning Theory (Bandura, 1977): Learning through interaction and observation enhances social and professional adaptability.

Hypothesis 4: Alignment of HRM Curriculum with Market Demands Enhances Students' Career Readiness

Adapting HRM curriculum content to reflect current market needs ensures that

students acquire relevant skills and knowledge. By incorporating contemporary topics such as strategic HRM, digital HRM, and data-driven decision-making, the curriculum better prepares students for competitive job markets (Xiong, 2022).

IV: Adaptation of the HRM curriculum

DV: Career readiness and market adaptability

Theoretical Foundation:

Human Capital Theory (Becker, 1964): Curricular changes should align with market trends to maximize students' employability.

Curriculum Design Theory (Tyler, 1949): Educational programs should reflect societal and market needs to produce skilled professionals.

3.2. Selection and Description of Research Participants

The participants in this study consisted of 203 undergraduate students, primarily from human resource management-related majors. The gender distribution is nearly balanced, with male participants accounting for 51.72% and female participants accounting for 48.28%. The participants were from different academic years, with the highest proportion being third-year students (32.51%), followed by first-year students (28.57%) and second-year students (22.66%), while fourth-year students accounted for 16.26% of the sample. Most of these students have a certain academic foundation and practical experience, especially third- and fourth-year students, who are facing employment pressure and are highly concerned with the course content and its relevance to employment.

In terms of internship experience, 88.67% of the students had participated in related internships or work experiences, indicating that the majority of the students actively engaged in extracurricular practical activities and possessed some professional experience. The diversity of the research participants provides rich data for this study, enabling an in-depth exploration of how interdisciplinary team-based learning and flipped classroom methods impact students' employment preparation from various perspectives, including academic year, gender, and practical background. By analysing survey data from these students, the impact of course design and teaching methods on enhancing students' employability and competitiveness can be comprehensively assessed.

3.3. Research methods and data collection

In this study, a questionnaire was used to understand the role of interdisciplinary TBL and FC in influencing students' employability (Bao, Chen, & Mo, 2022). Data were collected by designing a structured questionnaire, which covered students' basic information, course participation, learning attitudes, and preparation for employment. The questionnaire utilized single-choice and multiple-choice questions to ensure the comprehensiveness and depth of the data. The questionnaires were distributed to undergraduate students from HRM-related majors, and a total of 203 valid questionnaires were collected both online and offline. All the data were collated and analysed to quantitatively assess the impact of the teaching mode on students' job readiness, and the process of data collection and analysis followed scientific and rigorous research methods to ensure the reliability and validity of the research results.

3.4. Data analysis methods

For the quantitative analysis of the questionnaire data, SPSS statistical software was used. After the data were collected, a descriptive statistical analysis was performed on the basic information involved in the questionnaire, such as gender, grade, and whether the applicant had participated in the practice, to understand the basic situation of the sample. Frequency distribution, percentage, and other methods were used to analyse students' attitudes and behaviors with respect to TBL, FC experience, and employment preparation. In this study, data analysis was performed via SPSS statistical software, and the analysis process was divided into several main steps. First, descriptive statistics were applied to summarize the basic information of the sample, followed by chi-square tests (χ^2), t tests, and correlation analysis to explore the relationships between variables and assess the specific impact of the interdisciplinary TBL and FC on students' employment preparedness.

3.4.1. Descriptive Statistical Analysis

Descriptive statistical analysis was performed on the basic information of the 203 undergraduate students. In terms of gender distribution, 51.72% (105 students) were male, and 48.28% (98 students) were female, indicating a balanced gender ratio. In terms of grade distribution, 32.51% (66 students) were in their third year of undergraduate studies, 28.57% (58 students) were in their first year, 22.66% (46 students) were in their second year, and 16.26% (33 students) were in their fourth year. With respect to internship experience, 88.67% of the students had participated in relevant internships or work experiences, with 180

students having internship experience and 23 students having no internship experience.

Table 3.1: Descriptive Statistical Analysis

Analysis Content	χ^2/t-value/r-value	p-value
Gender and Employment Ereparedness	χ^2=8.45	p<45
TBL and Employment Preparedness	χ^2=8.45	p<0.05
FC and Employment Preparedness	χ^2=6.89	p<0.05
Grade Level and Employment Preparedness	t=2.88	p<0.05
Gender and Employment Preparedness	t=0.79	p=0.22
Correlation: TBL and Employment Preparedness	r=0.62	p<0.01
Correlation: FC and Employment Preparedness	r=0.58	p<0.01
Correlation: Class Content Engagement and Employment Confidence	r=0.64	p<0.01

3.4.2. Chi-square test analysis

The chi-square test was used to examine the associations between different variables. For example, the relationship between the frequency of students' participation in TBL and their employment preparedness was investigated. The data revealed that among students who frequently participated in TBL (≥2 times per week), 72% reported feeling "very prepared" or "prepared" to enter the job market, whereas only 28% indicated that they were "not yet prepared." In contrast, only 40% of the students who participated less frequently (≤ 1 time per week) indicated that they were well prepared for employment, and 60% indicated that they were “not yet ready”. A chi-square test revealed a significant association between the frequency of TBL and students' job readiness ($\chi^2 = 8.45$, $p < 0.05$). This result indicates that there is a significant positive correlation between the frequency of students' participation in TBL and their motivation for job readiness.

Table 3.2: Chi-square test analysis

Analysis Content	(χ^2)	p value
Frequency of TBL and Employment Preparedness	χ^2=8.45	p<0.05
Experience with FC and Employment Preparedness	χ^2=6.89	p<0.05

In addition, chi-square tests were used to analyse the relationship between FC experience and students' job readiness. The survey revealed that 70% of the students who experienced the FC teaching mode believed that this teaching mode could help them better understand the course content and enhance their employability, whereas only 40% of the students who did not experience the FC expressed the same opinion ($\chi^2 = 6.89$, $p < 0.05$). Thus, the experience of the FC teaching model has a positive effect on students' employment preparation and competence.

3.4.3. T test analysis

The t test is used to analyse differences in employment readiness across different grades, genders, and other groups. First, we compared the job readiness of students in different grade levels. Table 3.3 shows that students in grades 3 and 4 score significantly higher on job readiness than do students in grades 1 and 2. Specifically, third-graders scored an average of 4.2 out of 5 on a job-readiness scale, compared with 4.1 in fourth-graders and 3.7 and 3.8 in first- and second-year grades, respectively ($p < 0.05$). The t-test results revealed that there were significant differences in job readiness between grades and that students in grades 3 and 4 were generally more concerned with and engaged in job readiness as they approached graduation. Second, the t-test for gender differences also reveals that there is a difference in the job readiness scores of male and female students. The average score for job readiness was 4.0 for male students and 3.9 for female students, and although the difference was not significant, the difference was statistically insignificant after a t-test ($p = 0.22$).

Table 3.3: t-test results

Analysis Content	Group	Mean Score	t-value	p-value

Grade Differences	First-year	3.7	-	-
	Second-year	3.8	-	-
	Third-year	4.2	t=2.88	p<0.05
	Forth-year	4.1	t=2.67	p<0.05
Gender Differences	Male	4.0	t=0.79	p=0.22
	Female	3.9	-	-

3.4.4. Correlation Analysis

To further explore the relationships among the TBL, FC and employment readiness, a Pearson correlation analysis was conducted. The results revealed that the correlation coefficient between TBL frequency and employment readiness was 0.62 ($p < 0.01$), indicating a strong positive correlation between the two variables. Students who frequently participate in group work are more likely to believe that they are fully prepared for employment. Similarly, the correlation coefficient between FC experience and employment readiness was 0.58 ($p < 0.01$), suggesting that FC can help students improve their employability competitiveness and thus enhance their employability. The correlation coefficient between classroom content input and employment confidence was 0.64 ($P < 0.01$), indicating that students' engagement in class directly affected their confidence in employment. Higher classroom engagement often means that students are better able to grasp what they have learned, which increases their confidence and ability to be employed.

Table 3.4: Correlation analysis

Vriable1	Vriavle2	r	p-value
Frequency of TBL	Employment Preparedness	0.62	p<0.01
Experience with FC	Employment Preparedness	0.58	p<0.01

Class Content Engagement	Employment Confidence	0.64	p<0.01

3.5. Data Processing Procedure

In the data processing stage, the questionnaire data were first cleaned, and samples that were incomplete or had obvious errors were excluded to ensure the accuracy of the data for subsequent analysis. The data were subsequently systematically statistically analysed via SPSS software. All hypothesis tests were conducted with 0.05 as the level of significance to ensure the statistical reliability of the study results. To further increase the credibility of the data analysis, this study paid special attention to the validation and correction aspects of the data processing process. For the quantitative data, the robustness of the results was verified through multiple repeated tests to ensure the accuracy and depth of the research conclusions.

4. Research Findings

4.1. TBL significantly enhances students' Core Professional Competencies

TBL, as an important teaching tool, is widely used in all kinds of courses, especially in fields such as HRM, and has a significant effect on the enhancement of students' vocational core competencies. According to the survey data (see Table 4.1), students showed the most notable improvements in teamwork skills (89.66%), communication skills (86.21%), and problem-solving abilities (77.83%). These data suggest that TBL provides a practical platform for students to interact and collaborate in a way that not only improves their occupational core competencies but also deepens their understanding of teamwork and task collaboration.

Table 4.1: Most significant competency improvements in the TBL

Competency Type	Improvement Rate(%)
Teamwork Skills	89.66%
Communication Skills	86.21%
Problem-Solving Skills	77.83%
Leadership Skills	45.32%

The survey also revealed (see Table 4.2) that 42.86% of the students assumed the role of informants in TBL, whereas 34.48% of the students acted as recorders. The success of TBL

could not be achieved without the allocation of roles among the students in the group. Students who acted as "information providers" were required to provide professional knowledge, whereas those who acted as "recorders" were required to organize and summarize the discussion. These tasks require students to take the initiative to participate and coordinate their work in teams, thus further enhancing their sense of responsibility and teamwork.

Table 4.2: Key roles in the TBL

Role	Ratio
Information Provider	42.86%
Recorder	34.48%
Coordinator	17.24%
Leader	5.42%

TBL plays a crucial role in enhancing students' core career competencies. Through teamwork, communication, and problem solving, students not only gain knowledge in the classroom but also lay a solid foundation for their future careers.

4.2. FC effectively promotes students' autonomous learning and classroom participation

FC, as an innovative teaching model, has been widely used in many college and university programs. The model works by transferring traditional classroom lectures outside the classroom, where students learn independently through videos and reading materials before class, while classroom time is used for discussion, problem solving and in-depth understanding. According to survey data, FC significantly promotes students' independent learning ability and classroom engagement, especially in HRM courses, where students show positive attitudes towards the experience and feedback of this model.

The results of the survey indicated (see Table 4.3) that the majority of the students were satisfied with the overall experience of the FC. Specifically, 49.26% of the students were very satisfied, and 29.06% were satisfied. This reflects the positive effect of FC in enhancing students' interest in learning and improving learning efficiency. Additionally, 39.9% of the students rated their understanding of the course content as excellent, and 31.03% considered it good, demonstrating FC's effectiveness in improving students' mastery and comprehension

of the course materials.

The implementation of FC significantly enhanced the students' learning experiences and understanding of the course content. Notably, nearly 40% of the students believed that FC helped them better grasp the course material, underscoring the role of FC as a student-centered teaching model that promotes deep learning.

Table 4.3: Overall Experience and Content Understanding in FC

Item	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Overall FC Experience	49.26%	29.06%	13.3%	4.93%	3.45%
Understanding of Course Content	39.9%	31.03%	17.73%	5.42%	5.91%

FCs have also achieved significant success in promoting student classroom participation. As shown in Table 4.4, 44.83% of the students reported being very active in FC discussions, whereas 27.09% indicated active participation. These results demonstrate that the FC's discussion-based teaching model enhances classroom interaction and stimulates students' interest in actively engaging and thinking critically. In traditional lecture-based teaching, students often remain passive recipients of information. In contrast, FC encourages active participation through classroom discussions and group collaborations, fostering students' critical thinking and communication skills.

Table 4.4: Student Participation Levels in FC Discussions

Participation Level	Very Active	Active	Neutral	Inactive	Very Inactive
Classroom Discussion	44.83%	27.09%	15.76%	7.88%	4.43%

FCs, as an innovative teaching model, have significantly enhanced students' autonomous learning and classroom participation. Through preclass self-directed learning and in-class interactive discussions, students not only gain a deeper understanding of the course content but also develop critical thinking, communication, and teamwork skills.

These improvements positively impact their future employability.

4.3. The positive impact of human resource management courses on students' employability

As one of the core courses in business-related disciplines, HRM courses have a significant impacts on students' future career development and employability (Li & Huang, 2016). Through this course, students not only gain systematic professional knowledge but also cultivate essential workplace competencies, thereby laying a solid foundation for their future employment.

The survey data (see Table 4.5) indicate that 44.83% of respondents perceived the HRM course was very helpful for their future employment, whereas 29.06% considered it quite helpful. Overall, over 70% of the students agreed that the course significantly enhanced their employability. Specifically, the course content, particularly in areas such as recruitment, compensation management, and employee training, not only helped students understand theoretical concepts but also provided practical skills applicable to real-world workplace scenarios, thereby improving their professional competence and job readiness.

Table 4.5: Impact of the HRM Course on Student Employability

Level of Helpfulness	Very High	High	Moderate	Low	Very Low
Employment Assistance	44.83%	29.06%	16.75%	5.42%	3.94%

In addition to the benefits of the course content itself, the survey revealed that students developed multiple core workplace competencies during their studies (see Table 4.6). Specifically, 68.47% of the students identified communication skills as one of the most important employability skills, whereas 62.56% emphasized the critical role of teamwork skills in future employment. Through activities such as group collaboration, role-playing, and case studies, students honed these essential workplace skills, which are highly valued by most employers during recruitment.

Table 4.6: Skills Most Important for Future Employment by Students

Skill Tape	Percentage
Communication Skills	68.47%

Teamwork Skills	62.56%
Problem-Solving Skills	50.74%
Leadership Skills	51.72%

The survey also revealed (see Table 4.7) that 72.41% of the students had participated in HRM-related internships or practical activities, which provided valuable experience for their career development. Through these internships, students were able to apply theoretical knowledge to real-world work scenarios while enhancing their professional skills and overall competencies. Additionally, 45.32% of the students believed that feedback from both coursework and internships significantly contributed to their career development, further increasing their employability.

Table 4.7: Participation in HRM-Related Internships or Practical Activities

Participation Status	Percentage
Participated	72.41%
Did Not participated	27.59%

The HRM course effectively enhanced students' core workplace competencies, such as communication skills, teamwork, and problem-solving abilities, through systematic theoretical learning and practical activities. These competencies are critical for students' future career success. Internships and practical activities enable students to integrate theory with practice, further strengthening their employability. The HRM course not only helps students acquire professional knowledge but also lays a solid foundation for their careers, providing them with greater employment opportunities.

4.4. Students are satisfied with Career Services but Require Additional Support

In the modern job market, the employability of university students depends not only on their mastery of professional knowledge but also on the quality of career services provided by their institutions (Wang, 2016). According to the survey results, while students generally expressed satisfaction with the career services offered by their school, their demand for additional support was evident, particularly in areas such as career planning, internship opportunities, and industry engagement activities.

The survey data (see Table 4.8) indicate that 49.26% of the students were very satisfied

with the school's career development services, whereas 26.11% were satisfied. This suggests that the majority of students recognized the value of the school's career services, especially in terms of employment guidance and access to career resources. However, 13.3% of the students reported neutral satisfaction, and 11.33% believed that the quality of career services needed significant improvement, highlighting room for enhancement, particularly in terms of personalized guidance and alignment with market demands.

Table 4.8: Student Satisfaction with School Career Services

Satisfaction Level	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Career Services	49.26%	26.11%	13.3%	5.42%	5.91%

Further investigation revealed that students generally feel that the university should strengthen its support for career development, particularly in career planning guidance and providing more internship opportunities. Specifically, 77.34% of the students hoped that the university offered more comprehensive career planning guidance, whereas 50.25% of the students wanted more internship opportunities. For students at different academic stages, practical experience is key to improving employability. Additionally, 92.12% of the students expressed a desire for more company engagement activities, which would not only allow students to interact face-to-face with industry professionals but also help them better understand job opportunities and industry trends across various fields.

Table 4.9: Students' demand for additional career support

Type of Support	Percentage
Career Planning Guidance	77.34%
Internship Opportunities	50.25%
Skills Training	37.93%
Industry Engagement Activities	92.12%

The students also expressed a desire for more skills training, particularly in essential soft skills such as communication and leadership. According to the survey, 37.93% of the students indicated a high demand for such training. As competition in the job market intensifies, the

importance of soft skills in the hiring process becomes increasingly evident. Many students hope that the career services provided by their school will further enhance their overall competitiveness in the workplace.

Although most students are satisfied with the career services provided by the university and believe that the school performs well in terms of job guidance, recruitment information, and job-searching training, they still have a strong demand for more personalized career development support. In particular, students hope the university can offer deeper, more targeted support in areas such as career planning, internship opportunities, and company engagement activities. With the increasing demand for soft skills in the job market, students also hope to enhance their communication, leadership, and other core competencies through the career services provided by the university. These needs suggest that universities should focus more on personalized support and soft skills training in future career services to better help students cope with increasingly fierce competition in the workforce.

5. Discussion

5.1. Role of the TBL in enhancing students' employability

TBL is a highly interactive teaching method that can significantly increase students' competitiveness in employment. Through TBL, students can not only better master subject knowledge but also exercise and improve their core vocational competencies in real-life situations, especially in teamwork, communication, problem solving and leadership. TBL enhances students' teamwork ability. In the workplace, teamwork is a basic competency required in almost all industries. Through TBL, students need to collaborate with others, share tasks and cooperate with each other, which enables them to better understand the roles and responsibilities of a team and learn how to work efficiently with people from different backgrounds. For example, survey data revealed that 89.66% of the students thought that the ability to work on a team was the most important ability enhancement in TBL. TBL strengthens students' communication skills. In group discussions, students not only need to express their opinions clearly but also need to learn to listen and respond to others' opinions effectively, which is crucial for communication and collaboration in the workplace. A total of 86.21% of the students indicated that their communication skills were significantly improved through TBL. Students are able to improve their problem-solving skills through TBL. In

small groups, students are faced with problems that need to be solved together, and they are able to practice critical thinking and creative solutions through group discussions, debates, and thinking from multiple perspectives. A total of 77.83% of the students believed that problem-solving skills are an important enhancement they obtain from learning through TBL.

5.2. Advantages of FC in Cultivating Core Professional Skills

As an innovative teaching method, FC has significant advantages in cultivating students' vocational core competencies. By transferring the content of traditional classroom lectures to outside the classroom, students learn independently before class and have more interaction and in-depth discussions in the classroom. This model not only improves the learning efficiency of students but also promotes the cultivation of the skills they need in the actual workplace. FCs greatly enhance students' independent learning ability. In traditional teaching, students usually rely on teachers' explanations to acquire knowledge, whereas FCs require students to master basic knowledge independently through videos and reading materials before class. The survey data revealed that 50.74% of the students believed that FC was very effective in improving their self-learning ability. This type of independent learning enables students to master knowledge at their own pace and prepare for classroom discussions and problem solving, thus cultivating their ability to think independently and take the initiative to learn, which is crucial in the workplace. FCs effectively improve students' communication and teamwork skills through class discussions and teamwork. In the classroom, students work in groups to discuss and analyse cases, which requires them to practice their communication skills in the process of expressing and listening to others' opinions. The survey data revealed that 44.83% of the students reported actively participating in discussions with the FC, indicating that the interactive nature of the flipped classroom promoted students' critical thinking and communication skills. FCs also help students improve their problem-solving skills. Class time is no longer used to teach the basics but rather to analyse and solve real-world problems. This practice-oriented learning approach allows students to apply what they have learned in real-life situations, enhancing their problem-solving skills and innovative thinking.

5.3. The Impact of Course Formats on Students' Employment Preparation from an

Interdisciplinary Perspective

From an interdisciplinary perspective, the influence of curriculum form on students' preparation for employment has become increasingly significant. In modern education, the traditional division of disciplines has gradually failed to fully meet the needs of students in complex and changing workplace environments, and the interdisciplinary teaching mode is widely recognized as being able to better cultivate the comprehensive quality and employment competitiveness of students. Innovations in the form of a curriculum, especially the organic integration of content from multiple disciplines, can provide students with multidimensional knowledge structures and skills training, further enhancing their preparation for employment.

Interdisciplinary programs help develop students' diversified thinking and problem-solving skills. In the workplace, problems are often not solved by a single discipline, and many jobs require knowledge and skills across multiple fields. Through interdisciplinary learning, students are able to apply the theories and methods of multiple disciplines when solving real-world problems, thus developing a more comprehensive perspective and a more flexible way of thinking (Liu, 2023). For example, by combining HRM with psychology, law and other disciplines, students are able to better understand employee behavior, management practices and legal risks, which lays a solid foundation for their future careers. Interdisciplinary programs promote students' teamwork and communication skills. In interdisciplinary programs, students are often required to work with classmates from different backgrounds, which not only increases their chances of communicating and coordinating in a team but also helps them learn how to play to their strengths in a diverse team and deal with the conflict of different viewpoints. Interdisciplinary programs can improve students' employment adaptability. In modern enterprises, job responsibilities tend to become increasingly integrated, and employees need to possess not only professional knowledge but also cross-disciplinary abilities.

5.4. Analysis of the Adaptability of HRM Course Content to Market Demand

The analysis of the adaptability of HRM course content to market demand is an important indicator for evaluating the effectiveness of course teaching and the competitiveness of students' employment. With the development of the global economy and

the diversification of the employment needs of enterprises, the content and teaching methods of HRM courses must keep up with the changes in market demand to effectively enhance students' occupational core competencies and fully prepare them for their development in the workplace.

Modern enterprises have increasingly diversified requirements for HRM. Traditional HRM courses focus mainly on basic knowledge such as recruitment, compensation management and employee benefits, but with the rapid development of society and technology, the requirements of enterprises for HR practitioners are no longer limited to traditional functions but focus more on strategic, innovative and data-driven management methods. Currently, areas such as data analytics, performance management, and talent development have become important parts of the HRM curriculum. By learning this cutting-edge content, students can better meet the market demand for senior HR professionals. The updating and expansion of the course content helps students master the latest management concepts and tools to increase their competitiveness in the highly competitive job market.

The demand for talent is not only limited to professional knowledge but also requires HR practitioners to have strong cross-cultural communication and team management skills. In the context of globalization, multinational corporations and diverse work environments require HR to have the ability to address international employee management, cultural adaptability and communication skills. Therefore, the current HRM curriculum not only focuses on basic management skills but also needs to incorporate cross-cultural management and global HR strategies (Brooks, 2012). Students can improve their cross-cultural communication and coordination skills during the learning process, which is especially important for entering enterprises or multinational corporations with internationalized backgrounds in the future.

The technical requirements of enterprises for HR practitioners are also increasing. With the wide application of technologies such as artificial intelligence, big data and cloud computing, the HR field has gradually transformed to include digitalization and intelligence. HRM courses need to combine with technology trends and increase the content of courses such as data analysis and HR technology (HR Tech) to enable students to master these

emerging tools with stronger data sensitivity and decision-making ability. The market demand for HR Tech has become an important part of the hiring strategy of enterprises, so cultivating HR professionals with the ability of data analysis and technology application has become an inevitable trend in curriculum design.

5.5. Synergistic Effect of the TBL and FC Educational Models on Student Employability

TBL can develop students' teamwork and communication skills, which are crucial for most jobs in the workplace. Students share different roles within the group, such as information providers, recorders, and coordinators, and need to work closely with others to coordinate different opinions and work progress, which hones their collaboration and communication skills in a complex environment. The FC provides students with sufficient preparation time through independent learning before class, enabling them to provide insightful insights and solutions in class discussions, thus enhancing critical thinking and problem-solving skills. FCs require students to study the course content on their own before class, a process that requires them to master time management and self-discipline. In TBL, students not only need to be responsible for their own TBL tasks but also need to work with their team members to promote the progress of the project, which prompts them to develop a stronger sense of responsibility and task management skills (Ansoff, 1965). The teaching mode of integrating TBL and FC has a significant effect on enhancing students' innovation and adaptability. In view of the rapid changes in the workplace environment and the acceleration of technological iteration, the demand for innovative and highly adaptable talent is becoming increasingly urgent. The implementation of FC effectively stimulates students' innovative thinking through the catalytic effect of classroom discussion. On this basis, the TBL mode promotes the intermingling of multiple types of thinking among members, further promoting the formation and development of innovative ideas.

6. Conclusion

This study focuses on the impact of the TBL, FC model and HRM course on the development of students' core vocational competencies and employment competitiveness. The results of the study revealed that the combination of the TBL and FC models had significant synergistic effects on the development of students' vocational competencies. TBL significantly enhanced students' performance in teamwork, communication skills and

problem-solving abilities, whereas FC promoted the development of students' critical thinking and deep understanding by strengthening independent learning and deepening classroom discussions. Moreover, the HRM program played a key role in strengthening students' teamwork, communication skills, and job readiness.

In addition, the study revealed that students were highly receptive to this modern educational model, suggesting that these innovative teaching methods could effectively respond to the rapidly changing demands of the job market. Although challenges such as team communication barriers and a lack of individual responsibility are faced when implementing TBL and FC, these issues are expected to be resolved by optimizing instructional design and providing necessary support. This study emphasizes the importance of integrating multiple instructional modes in enhancing students' vocational competence and employment competitiveness and provides useful references for educational practice.

In summary, the educational model that combines TBL and FC can enhance not only students' vocational core competencies but also their employment competitiveness. Future teaching should further optimize the implementation of these models to help students better adapt to the challenges of the workplace and lay a solid foundation for their career development.

Although this study has preliminarily explored the role of TBL and FC in enhancing students' employability, some unresolved research gaps deserve further exploration in the future. First, this study focuses mainly on applications in HRM courses, and whether the effects of this model can be equally evident in other subject areas (e.g., finance, marketing, etc.) needs to be further verified. The teaching content, student background, and course characteristics of different disciplines may affect the effectiveness of the implementation of FC and TBL; therefore, interdisciplinary research and comparison will be a direction worth exploring in depth. The data in this study are derived mainly from quantitative analysis, and future research can combine qualitative research methods to dig deeper into students' specific feelings and feedback about the flipped classroom and TBL in the actual classroom. This information could help to better understand the dynamics of students' learning in this instructional model and their specific needs in preparing for the workforce, especially in understanding and applying course content. Although this study identified issues such as

poor team communication and a lack of personal accountability, future research should focus more on how to design effective interventions to address these issues. For example, how to optimize the effectiveness of TBL through teacher guidance, teamwork tools, and classroom management can be explored, thereby enhancing students' ability to work in teams in real work environments.

With the rapid development of artificial intelligence, big data, and other technologies, future research can explore how to integrate these technological tools into the instructional design of the FC and TBL. For example, real-time feedback and personalized guidance can be provided to students through online learning platforms and intelligent learning management systems, or big data can be used to analyse students' learning and provide a basis for the adjustment and optimization of teaching strategies. This will further increase the flexibility and effectiveness of the teaching mode and promote students' success in a wider range of employment scenarios.

CONFLICT STATEMENT

The authors of the article "The Impact of Team-Based Learning and Flipped Classrooms on Students' Employment in Human Resource Management", Song Yating, Yang Hao, and Wang Suchuan, solemnly declare that throughout the entire process of conducting this research and producing this paper, including but not limited to the collection and analysis of data, formation of viewpoints, writing, revising, submission, and potential publication, there are no conflicts of interest that could compromise the fairness, objectivity, or originality of this work.

COOPERATION STATEMENT

The first author, Song Yating, was responsible for the design of the study, data collection, and drafting the initial manuscript. The second author, Yang Hao, contributed to data analysis, literature review, and revision of the manuscript. The third author, Wang Suchuan, provided supervision, theoretical guidance, and final critical review of the entire paper.

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