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# Post-pandemic job market: an analysis of factors influencing university students' willingness for flexible employment based on SEM-ANN-fsQCA

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The COVID-19 pandemic has reshaped global work patterns, making flexible employment a critical issue. This study investigates how self-determination efficacy influences university students' willingness to pursue flexible jobs in China. Using data from 1270 survey responses, we applied Partial Least Squares Structural Equation Modeling (PLS-SEM), Artificial Neural Networks (ANN), and Fuzzy-Set Qualitative Comparative Analysis (fsQCA). The results show that self-determination efficacy positively affects students' willingness to pursue flexible employment directly and indirectly through mediating factors like work-life balance, job satisfaction, and perceived self-development. The ANN model reveals complex nonlinear relationships, indicating that the impact of self-determination efficacy on employment intention is not linear. Furthermore, fsQCA identifies multiple pathways under different conditions, highlighting the importance of self-determination efficacy in specific contexts. This research provides valuable insights for policymakers and higher education institutions on promoting flexible employment among students.

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## Introduction

The COVID-19 pandemic not only disrupted global public health systems but also profoundly impacted the global economy and labor markets. As traditional work models faced significant challenges, businesses struggled with shrinking market demand, supply chain disruptions, and operational uncertainties (Benchrif et al., 2024). Additionally, rising unemployment and economic downturns forced both individuals and organizations to adapt to rapidly changing conditions (Dheer et al., 2022).

In this context, flexible employment—including remote work, part-time jobs, and freelance entrepreneurship—emerged as a critical form of employment. Research indicates that flexible employment offers notable advantages, such as enhancing work autonomy and improving work-life balance, which are especially important in supporting the recovery of the post-pandemic job market (Nwoko et al., 2022; Rahman et al., 2021). However, there remains a lack of systematic research exploring university graduates' willingness to engage in flexible employment, particularly regarding its underlying mechanisms and the factors influencing their decisions. Since university graduates represent a crucial part of the future labor market, understanding their employment preferences and decision-making processes is essential for shaping long-term socioeconomic development. Examining these aspects will not only fill a significant theoretical gap but also offer practical guidance for governments and businesses in formulating targeted employment policies (Mamilla et al., 2023).

While existing studies have focused on organizational adaptability and business performance during crises (Pereira et al., 2021) and on entrepreneurial activities among younger generations (Widyanti et al., 2021), relatively little attention has been paid to university graduates' willingness to pursue flexible employment in the post-pandemic era. Considering the significant role of flexible employment in fostering economic resilience, it is critical to identify the factors influencing graduates' employment choices, such as personal attitudes, career expectations, financial conditions, and policy support (Szostak et al., 2021). This research aims to contribute both theoretically and practically by exploring the mechanisms underlying these choices.

This study establishes a comprehensive analytical framework grounded in Self-Determination Theory (SDT) and the Theory of Planned Behavior (TPB). These theories are particularly valuable in understanding the intrinsic and external factors that drive university graduates' employment choices, especially in the context of flexible employment.

SDT, introduced by Deci and Ryan (Deci et al., 1985), posits that individuals are more likely to engage in activities that fulfill their intrinsic needs for autonomy, competence, and relatedness. In the context of flexible employment, SDT suggests that university graduates may seek autonomy through flexible work options, as such jobs often provide greater control over work hours, location, and responsibilities. Particularly post-pandemic, many graduates are seeking ways to balance their professional lives with personal development, family obligations, or other life goals. When graduates perceive that flexible employment aligns with their intrinsic desires, such as autonomy or personal growth, they are more likely to choose it over traditional forms of employment. This intrinsic motivation is crucial for understanding their willingness to pursue flexible employment.

The TPB, developed by Ajzen (Ajzen, 1985), complements SDT by explaining how external factors—such as attitudes, subjective norms, and perceived behavioral control—affect behavioral intentions. In the case of university graduates, TPB helps elucidate how positive attitudes toward flexible work (e.g., benefits like

work-life balance and job satisfaction), social influences (e.g., encouragement from family or peers), and perceived control (e.g., the belief in one's ability to secure flexible work) shape their decisions. The integration of both SDT and TPB provides a more comprehensive framework for understanding the factors influencing graduates' employment decisions, addressing both internal motivations (IM) and external pressures (EM).

Combining these two theories, this study provides a more holistic understanding of the factors affecting university graduates' willingness to engage in flexible employment. This integrated framework allows us to explore not only the intrinsic motivations (e.g., autonomy, work satisfaction) but also the external factors (e.g., economic environment, policy support, subjective norms) that shape employment choices. Such an approach is critical to addressing the research gap on post-pandemic flexible employment, ensuring a well-rounded exploration of the underlying mechanisms driving graduates' decisions.

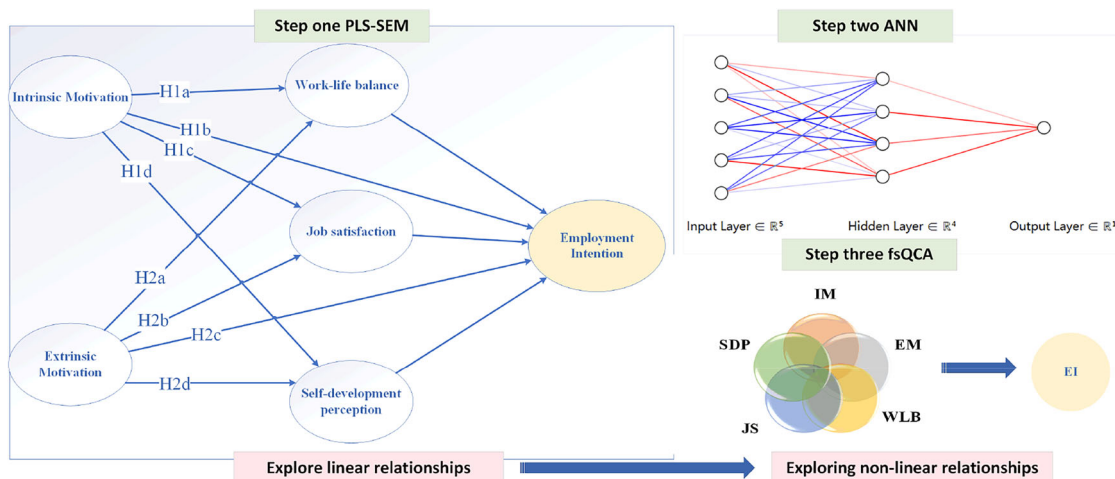
This study systematically investigates how intrinsic motivations (e.g., autonomy, work satisfaction) and external factors (e.g., economic conditions, policy support) influence university graduates' willingness to pursue flexible employment. By integrating theories like SDT and TPB, the study aims to explore the complex interplay between personal factors (attitudes, motivations) and external influences (economic environment, policies). In addition, this research will examine the mediating roles of work satisfaction and personal growth perception, as well as the moderating effects of demographic factors such as gender, household registration, and work experience.

To achieve this, the study will apply a multi-method integration of Partial Least Squares Structural Equation Modeling (PLS-SEM), Artificial Neural Network (ANN) analysis, and Fuzzy-Set Qualitative Comparative Analysis (fsQCA), enhancing predictive accuracy and offering new theoretical and empirical insights.

Specifically, the research will focus on the following key areas:

1. **Intrinsic Mechanisms:** Drawing on SDT, the study will examine how the inherent motivations, such as the desire for autonomy and personal growth, influence graduates' willingness to pursue flexible employment.
2. **External Factors:** Using TPB, the study will analyze how attitudes toward flexible work, perceived behavioral control, and social influences affect graduates' employment choices.
3. **Policy and Economic Environment:** The research will explore how external environmental factors, such as government policies and broader economic conditions, influence graduates' decisions to enter the flexible employment market.

The insights gained from this study will inform targeted policy recommendations to promote flexible employment, ensuring that universities, businesses, and governments can better support graduates' transitions into the evolving labor market. As shown in Fig. 1, the paper is divided into six sections. Section 1 introduces the study. Section 2 reviews relevant literature, highlighting the theoretical foundation and research gap. Section 3 proposes the theoretical model and research hypotheses. Section 4 explains the data sources and research methods. Section 5 analyzes the empirical results. Section 6 discusses the findings, summarizes the key conclusions, and offers policy recommendations and future research directions. By integrating existing theories with innovative methodologies, this study addresses the research gap in post-pandemic flexible employment among university graduates, providing significant contributions to theoretical development and practical applications.



**Fig. 1 Research framework and analysis methods.** Step one (PLS-SEM) models the linear relationships among exogenous variables ([IM], [EM], [WLB], [JS], and [SDP]) and the endogenous variable ([EI]). Step two (ANN) explores nonlinear relationships using a neural network structure with 5 input nodes (representing the exogenous variables), 4 hidden layer nodes (optimized through tuning), and 1 output node (predicting EI). The different structures reflect the complementary methodologies: PLS-SEM focuses on path coefficients to validate linear effects, while ANN identifies variable importance in non-linear contexts.

## Literature review

**Theoretical background.** The COVID-19 pandemic triggered severe economic recessions and widespread unemployment, presenting unprecedented challenges to the labor market (Lu et al., 2023). Many businesses were forced to downsize, reduce operations, or shut down during the pandemic, resulting in a significant loss of jobs and a sharp decline in income (Liu et al., 2022). In recent years, academic research on the post-pandemic labor market has increased, focusing mainly on the impacts of digital transformation and labor market inequality. The pandemic accelerated digital transformation, profoundly affecting the structure and functioning of the labor market. Scholars have widely discussed applying digital technologies, such as artificial intelligence, big data, and cloud computing, in remote work and flexible employment, analyzing how these technologies redefine the nature and environment of work (Alhaimer & Management, 2024).

Against the backdrop of digital transformation driving industry change, management theories increasingly emphasize Agility in Human Resources Management (AHRM). In the post-pandemic era, the concept of an agile workforce has become crucial, with organizations expected to quickly adapt to new technologies, market shifts, and changing employee needs (Skordoulis et al., 2024). AHRM advocates for flexible employment models, such as remote work and the gig economy, as key paths to fostering an agile workforce. These models provide flexible work structures that help organizations operate more efficiently amidst uncertainty while enhancing employee satisfaction. The COVID-19 crisis further accelerated this shift, and HR agility is increasingly recognized as a competitive advantage in the digital economy.

In addition, recent research in Leadership and Motivation (Baccaro Nonato et al., 2024) highlights the intersection of autonomous motivation and organizational support, exploring how these factors contribute to the success of flexible work environments. In this context, SDT emphasizes autonomy as the core of motivation (Deci & Ryan, 2012), and recent studies have expanded the application of this theory, particularly in explaining university students' willingness to engage in flexible employment. The application of SDT in the context of university students' career choices underscores how factors such as autonomy, competence, and relatedness influence their attraction to flexible employment (He et al., 2019). As the labor market evolves,

employees increasingly seek greater control over their work and career development, making flexible employment more attractive.

*Integrating SDT and TPB: a unique theoretical contribution.* While SDT and TPB are widely applied in employment intention (EI) studies, their integration in this research offers a new theoretical perspective, breaking the limitations of traditional labor market studies. The novelty of combining SDT and TPB lies in their complementarity: SDT focuses on intrinsic motivation, while TPB emphasizes external influences. The interaction between these two dimensions helps to better understand employment intentions, especially in the post-pandemic labor market.

SDT views intrinsic motivation as the core driver of behavior, with autonomy being a central factor. In the context of flexible employment, SDT suggests that employees, particularly university students, are more likely to pursue flexible work when it satisfies their intrinsic needs for autonomy, competence, and relatedness (Deci & Ryan, 2012). However, this intrinsic motivation often requires external support, such as organizational policies that align with these intrinsic needs, to manifest fully in employment intentions.

On the other hand, TPB provides a framework to explain how external factors—such as attitudes toward flexible work, perceived behavioral control, and subjective norms—shape individuals' employment intentions (Ajzen & Driver, 1991). TPB effectively explains how external motivations, such as job stability, social expectations, and policy incentives, influence decision-making contexts. By integrating SDT and TPB, this study explores how intrinsic and external motivations independently affect employment intentions and how they interact to shape complex employment decisions.

Thus, integrating SDT and TPB provides a more comprehensive understanding of flexible employment intentions. It highlights that autonomy and control (from SDT) are influenced not only by intrinsic motivation but also by external conditions (as suggested by TPB) to drive decision-making fully. This theoretical synergy offers a more nuanced framework, going beyond the traditional scope of each theory. It helps us better understand the shift toward flexible employment in the post-pandemic era—driven by intrinsic desires for autonomy and external pressures such as market changes, social norms, and organizational structures.

**Emerging factors in the post-pandemic labor market.** While traditional factors such as work-life balance (WLB) and job satisfaction (JS) remain important, new emerging factors have emerged in the post-pandemic labor market, reshaping employment choices. Among these, digital adaptability and mental health are gaining significant attention as key drivers of job intentions, particularly in remote work and flexible employment.

**Digital adaptability:** The pandemic accelerated the adoption of digital technologies, requiring employees to develop digital adaptability—the ability to effectively engage with new technologies and work processes. This factor is particularly important for university students, who, having grown up in a highly connected digital environment, are expected to demonstrate high levels of digital literacy and the ability to work remotely (Ataide et al., 2023). Recent studies indicate that digital skills are increasingly linked to employment success, and digital adaptability has become a key determinant of labor market participation (He et al., 2019). Digitally adaptable university graduates are more likely to engage in flexible employment as they possess the skills to thrive in remote work settings (Niebuhr et al., 2022).

**Mental health:** The mental health implications of the pandemic have also become a critical factor influencing employment decisions. The transition to remote work and the uncertainty surrounding the labor market have increased stress, anxiety, and burnout, affecting students' willingness to pursue flexible employment. Mental health considerations are particularly significant for university graduates navigating the early stages of their careers during an uncertain economic period. Studies suggest that psychological well-being directly impacts career choices, and students with better mental health are more likely to seek flexible employment options that give them greater control over their schedules and work environments (Boland et al., 2020).

**Global remote work trends:** The pandemic accelerated the trend of global remote work, fundamentally changing how employees interact with organizations. Once seen as a niche option, remote work has now become a mainstream employment model. This shift has significant implications for university students, as remote work offers greater flexibility and opens global career opportunities. Working remotely enables students to seek employment beyond national borders, expanding their career options and providing opportunities for international collaboration (Chung, Van der Lippe, (2020)). This trend is reshaping the concept of job satisfaction as students increasingly prioritize work-life integration and autonomy over traditional job benefits.

Moreover, recent research has examined the growing demand for digital skills, analyzing the impacts of digital transformation on employment opportunities and job structures across various professions (Ataide et al., 2023). Changes in the demand for high-skilled and low-skilled jobs have become a central focus as scholars seek to understand how digital transformation reshapes the labor market and propose corresponding policy recommendations (He et al., 2019). Furthermore, the reshaped labor market has exacerbated inequalities, particularly affecting low-income groups, women, and minority communities. Hassan et al. (Hassan et al., 2021) emphasized that gender plays a critical moderating role in corporate performance and labor market outcomes, illustrating how disparities affect career advancement. Through empirical analyses, researchers have explored the opportunities and barriers faced by various groups, highlighting the importance of policy interventions to promote employment equity and social inclusion. These studies propose targeted support measures, such as vocational training, educational opportunities, and improvements to social security systems (Barbieri, 2009).

**Research gaps.** Despite the extensive and systematic research conducted on flexible employment for university students (as shown in Fig. 2), there remains a lack of studies examining the driving factors behind the flexible employment intentions of Chinese university graduates in the post-pandemic era. Existing research predominantly focuses on single theoretical frameworks, such as motivation theory or behavioral intention theory, failing to comprehensively reveal the mechanisms of how intrinsic and extrinsic motivations jointly influence flexible employment intentions. Addressing this research gap, the current study integrates SDT and the TPB for the first time to propose an innovative theoretical framework. This framework systematically explores the intersection of these theories in forming university students' flexible employment intentions, highlighting the theoretical contribution and novelty of the research.

SDT emphasizes fulfilling basic psychological needs for autonomy, competence, and relatedness as drivers of intrinsic motivation for behavioral choices (Deci & Ryan, 2012). In contrast, TPB focuses on the external pathways influencing behavioral intentions, including attitudes, subjective norms, and perceived behavioral control (Ajzen & Processes, 1991). This study argues that the complementary characteristics of these two theoretical frameworks can more comprehensively explain the formation of university students' flexible employment intentions. Specifically:

SDT offers a micro-level perspective on intrinsic motivation, uncovering the psychological drivers behind university students' autonomous choices for flexible employment, such as the pursuit of personal growth, self-efficacy, and work-life balance. TPB provides an analytical framework for external pathways, explaining how attitudes, social norms, and perceived behavioral control influence flexible employment intentions through external mechanisms.

**Innovative contributions.** This study is the first to explore the intersection of SDT and TPB in the context of flexible employment intentions. It reveals the interaction between intrinsic and extrinsic motivations and constructs a comprehensive analytical framework combining both. This innovation overcomes the limitations of single-theory approaches, extends the application boundaries of these two theories, and offers new theoretical perspectives for understanding the formation of flexible employment intentions.

Additionally, this study employs innovative methodologies. To validate the effectiveness and robustness of the theoretical framework, it combines Partial Least Squares Structural Equation Modeling (PLS-SEM) and Artificial Neural Network (ANN):

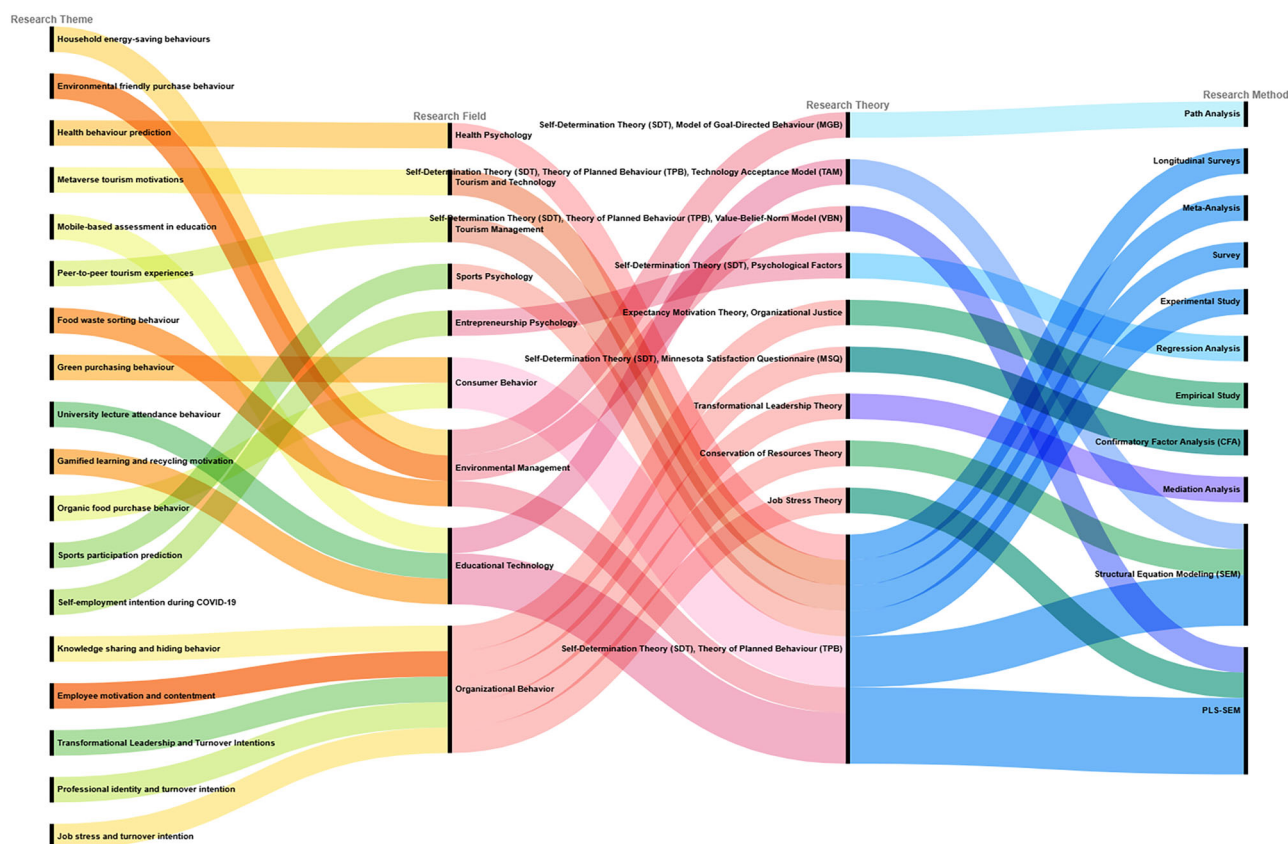
PLS-SEM is well-suited for handling complex causal path models, identifying key driving factors and their pathways, and validating the rationality of the theoretical framework.

ANN simulates brain neural network functions, further enhancing model predictive accuracy and robustness, revealing the mechanisms of influence under nonlinear relationships.

By integrating these two methods, the study provides an in-depth analysis of the formation mechanisms behind university students' flexible employment intentions. It improves the model's predictive validity, offering more precise empirical evidence for policy-making.

Furthermore, existing studies rarely examine the moderating effects of work-life balance, job satisfaction, and perceived personal growth in the process of intrinsic and extrinsic motivations influencing employment intentions. Through empirical analysis, this study reveals for the first time the moderating mechanisms of these variables, enriching the existing theoretical framework. Findings demonstrate that job satisfaction and perceived personal growth significantly enhance the influence of





**Fig. 2** The Intersection of Self-Determination Theory and Theory of Planned Behavior.

intrinsic and extrinsic motivations on university students' flexible employment intentions, underscoring the importance of policy interventions in improving the quality of employment and career satisfaction.

Finally, based on data from 1270 survey responses from Chinese universities, this study provides new empirical evidence for the mechanisms behind forming flexible employment intentions among Chinese university students in the post-pandemic context. Results indicate that indirect effects via moderating variables are more significant than direct effects in influencing flexible employment intentions, further validating the scientific and practical applicability of the integrated SDT and TPB framework.

**Theoretical contributions.** In summary, the primary theoretical contributions of this study are as follows:

1. For the first time, the intersection of SDT and TPB is explored, proposing a complementary framework of intrinsic and extrinsic motivations and extending the application boundaries of these two theories.
2. Methodological Innovation: Combining PLS-SEM and ANN enables multi-level analysis of the formation mechanisms behind flexible employment intentions, enhancing the model's explanatory and predictive accuracy.
3. Breakthroughs in Moderating Mechanisms: Unveiling the moderating roles of variables such as job satisfaction and perceived personal growth in the process of intrinsic and extrinsic motivations influencing flexible employment intentions, further refining the systematicity and empirical applicability of the theoretical framework.

This study achieves innovation and breakthroughs at the theoretical, methodological, and empirical levels. It provides a

novel theoretical perspective for understanding the intrinsic mechanisms behind university students' flexible employment intentions and offers scientific evidence and practical guidance for policy-making and employment counseling.

**Definition and theoretical basis of mediating and moderating variables.** This section systematically examines their theoretical foundations to address the insufficient clarity regarding mediating and moderating variables in the literature review. It comprehensively explains their classification and relevance in studying flexible employment intentions.

**Mediating variables.** Mediating variables explain the mechanisms through which independent variables influence dependent variables, providing insight into causal pathways. In the context of this study, work-life balance, job satisfaction, and perceived personal growth are categorized as mediating variables based on the following theoretical foundations:

**Work-life balance:** Rooted in boundary and work-family conflict theory (Clark, 2000), work-life balance mediates employment studies by linking motivational drivers to employment choices. For example, flexible work arrangements enhance autonomy and reduce conflict between professional and personal responsibilities, ultimately increasing flexible employment intentions (Greenhaus & Powell, 2006).

**Job satisfaction:** Drawing from Herzberg's two-factor theory (Herzberg, 1966), job satisfaction is an outcome of intrinsic motivators like self-efficacy and competence, as well as extrinsic factors such as organizational support. Higher job satisfaction

fosters positive attitudes toward employment forms that align with individual values, such as flexible work (Judge et al., 2020).

**Perceived Personal Growth:** This variable is informed by SDT (Deci & Ryan, 2012), underscoring the importance of fulfilling competence and autonomy needs. Flexible employment formats often provide continuous learning and skill development opportunities, strengthening perceptions of personal growth and influencing employment intentions (Alhaimer, 2024).

**Moderating variables.** Moderating variables affect the strength or direction of relationships between independent and dependent variables. Variables such as gender, regional economic conditions, and cultural norms are categorized as moderators in this study based on the following considerations:

**Gender:** Gender plays a critical role in employment outcomes, supported by social role theory (Eagly, et al., (1991)). Research highlights gender differences in preferences for work-life balance and flexibility, which, in turn, shape flexible employment intentions differently for men and women (Hassan & Technology, 2021).

**Regional economic conditions:** Drawing from institutional theory (North, 1990), variations in economic environments influence the accessibility and attractiveness of flexible employment. For instance, developing economies often view flexible employment as a practical necessity, whereas in developed economies, it is seen as a lifestyle choice (Adams-Prassl et al., 2020).

**Cultural norms:** Hofstede's cultural dimensions theory (Hofstede, 1984) provides the basis for understanding how collectivist versus individualist values influence attitudes toward flexibility. In collectivist cultures, traditional stable employment may be more valued, moderating the relationship between flexibility preferences and employment intentions (Alhaimer & Management, 2024).

Empirical studies substantiate the classification of these variables. For instance, work-life balance and job satisfaction have consistently been identified as mediators linking motivational drivers to career decisions (Chung, Van der Lippe, (2020); Niebuhr et al., 2022). Gender and cultural norms, in contrast, have been shown to moderate the impact of motivational drivers on employment preferences, highlighting contextual nuances (Adams-Prassl et al., 2020).

This systematic review and classification provide a robust theoretical basis for understanding the interplay of mediating and moderating variables in forming university students' flexible employment intentions.

## Research hypotheses and theoretical mechanisms

### Intrinsic motivation and willingness for flexible employment.

Intrinsic motivation is among the most critical factors influencing university students' willingness to pursue flexible employment. Intrinsic motivation refers to the psychological state driven by an individual's inherent interest, enjoyment, and satisfaction from engaging in an activity (Fasone & Pedrini, 2023). Unlike extrinsic motivation, which relies on external rewards or punishments, intrinsic motivation originates from the internal pleasure, sense of challenge, and achievement associated with the activity. It is closely related to high levels of autonomy, self-determination, and personal interest, which are crucial drivers for autonomous behavior and sustained engagement (Evans et al., 2024).

In flexible employment, intrinsic motivation encompasses autonomy, competence, and relatedness. These factors directly impact students' employment choices and indirectly influence their employment intentions through various pathways.

Autonomy aligns with the flexible nature of employment models, allowing students to balance work and life better (Van den Broeck et al., (2010)). Flexible employment offers options for adjustable work hours and locations, catering to students' needs for self-managed work and life arrangements (Xu et al., 2022). Research indicates that work-life balance can significantly enhance job satisfaction and overall well-being, increasing the willingness for flexible employment (Weideman & Hofmeyr, 2020). Thus, work-life balance driven by intrinsic motivation becomes a significant consideration for students when choosing flexible employment (Hassan et al., 2021).

Autonomy directly influences students' employment intentions. Students with high autonomy prefer work arrangements that offer greater freedom and decision-making authority, such as freelancing, remote work, or part-time jobs (Marx et al., 2021). Enhancing competence boosts students' confidence, encouraging them to embrace challenges and explore new employment forms. The satisfaction of relatedness through social support and a sense of belonging strengthens their trust and acceptance of flexible employment (Karimi et al., 2022).

Intrinsic motivation directly affects employment intentions and indirectly influences students' choices through improved job satisfaction. Studies have found that fulfilling autonomy, competence, and relatedness significantly enhances job satisfaction (Simon, 2021). A high level of job satisfaction makes students more inclined to choose flexible employment forms that provide this satisfaction. Therefore, by enhancing job satisfaction, intrinsic motivation further increases students' willingness for flexible employment (Caringal-Go et al., 2022).

Furthermore, intrinsic motivation affects employment intentions through self-development perception (SDP). Flexible employment forms, such as project-based work and short-term contracts, offer students diverse career experiences and skill-building opportunities, enhancing their self-development perception (Alkhaldi et al., 2024). An improved self-development perception leads students to recognize the positive impact of flexible employment on their career growth and development, thus increasing their willingness for flexible employment.

H1a: Intrinsic motivation influences employment intentions through work-life balance.

H1b: Intrinsic motivation directly affects employment intentions.

H1c: Intrinsic motivation influences employment intentions through job satisfaction.

H1d: Intrinsic motivation affects employment intentions through self-development perception.

### External motivation and willingness for flexible employment.

External motivation is the state of motivation where individuals engage in activities or behaviors due to external factors such as rewards, pressures, or environmental expectations (Elshaer, 2024). The core driver of this motivation comes from the external results or returns rather than the intrinsic satisfaction and pleasure derived from the activity itself. External motivation includes external regulation, introjected regulation, identified regulation, and integrated regulation, which vary based on the degree to which individuals internalize external demands (Demirgüç-Kunt et al., 2024). External motivation also influences university students' employment intentions through their self-development perception (Blomqvist et al., 2022). Flexible employment forms, such as project-based work and short-term contracts, offer university students diverse career experiences and skill training opportunities, enhancing their self-development perception. As their self-development perception improves, students increasingly recognize the positive impact of flexible employment on their career

growth and development, thereby increasing their willingness towards flexible employment (Biesenbeek & Volkerink, 2023).

Under the influence of external motivation driven by economic rewards and career development opportunities, university students are prompted to choose flexible employment forms that offer a better work-life balance (Barnes, 2023). Flexible employment can provide higher income potential and career development space while allowing students to arrange their work and personal time autonomously, thus achieving a better work-life balance (Barbieri, 2009). Achieving work-life balance leads students to prefer flexible employment when weighing economic rewards and quality of life (Van den Broeck et al., (2010)). External motivation indirectly influences students' employment intentions by enhancing job satisfaction. Achieving economic rewards and career development opportunities significantly boosts job satisfaction, making students more appreciative of the advantages of flexible employment and willing to choose this form of employment (Nadeem & Hendry, 2003). Therefore, by enhancing job satisfaction, external motivation further strengthens students' willingness for flexible employment. External motivation directly affects students' employment intentions. High income and good career prospects lead students to prefer flexible employment forms that offer these external incentives. For instance, the diversity and flexibility of flexible employment forms allow students to achieve economic goals and career development through various means, further increasing their interest and willingness towards flexible employment.

External motivation also influences students' employment intentions through self-development perception (Cai et al., 2025). Realizing career development opportunities and social recognition in flexible employment allows students to gain more self-development opportunities and career growth experiences. Improving self-development perception leads students to recognize better the positive role of flexible employment in their career growth and development, thereby increasing their willingness towards flexible employment.

H2a: External motivation influences employment intentions through work-life balance.

H2b: External motivation influences employment intentions through job satisfaction.

H2c: External motivation directly influences employment intentions.

H2d: External motivation influences employment intentions through self-development perception.

In summary, the research framework of this paper is illustrated in Fig. 3.

## Methodology and data

**Data collection process.** The data collection process in this study aimed to gain a comprehensive understanding of the employment market conditions and trends for Chinese university graduates in 2023 and 2024 post-pandemic. Given the significant impact of the post-pandemic job market on graduates, particularly the shift towards online remote learning and its effect on their acceptance of flexible employment, an online survey was deemed the most appropriate method. Online surveys offer broad coverage, allow for autonomous completion, and help minimize social desirability bias (Larson, 2019).

The questionnaire was designed based on a thorough literature review and relevant theories, supplemented with input from psychology, education, and labor economics experts to ensure its scientific validity. This process identified the study's core dimensions and key variables, including intrinsic motivation, extrinsic motivation, employment intentions,

work-life balance, job satisfaction, and self-development perception. Several experts then reviewed the questionnaire to ensure its relevance and comprehensiveness. A pilot test was conducted with a small group of participants before the formal survey to gather feedback and improve clarity and response quality.

This study targeted Chinese university graduates from the 2023 and 2024 cohorts. To ensure diversity and representativeness, the sample selection process specifically aimed to include graduates from various regions of China, including comprehensive universities, engineering schools, and teacher training colleges. The study covered significant urban areas and less-developed regions to capture a balanced representation of students' diverse backgrounds.

Data collection was conducted in two phases: the first from May to July 2023 and the second from May to July 2024. The survey was distributed through online platforms such as Wenjuanxing, a popular tool for administering surveys in China, which enabled efficient and large-scale data collection. The platform also provided statistical analysis tools that facilitated the subsequent data processing and ensured robust data integrity.

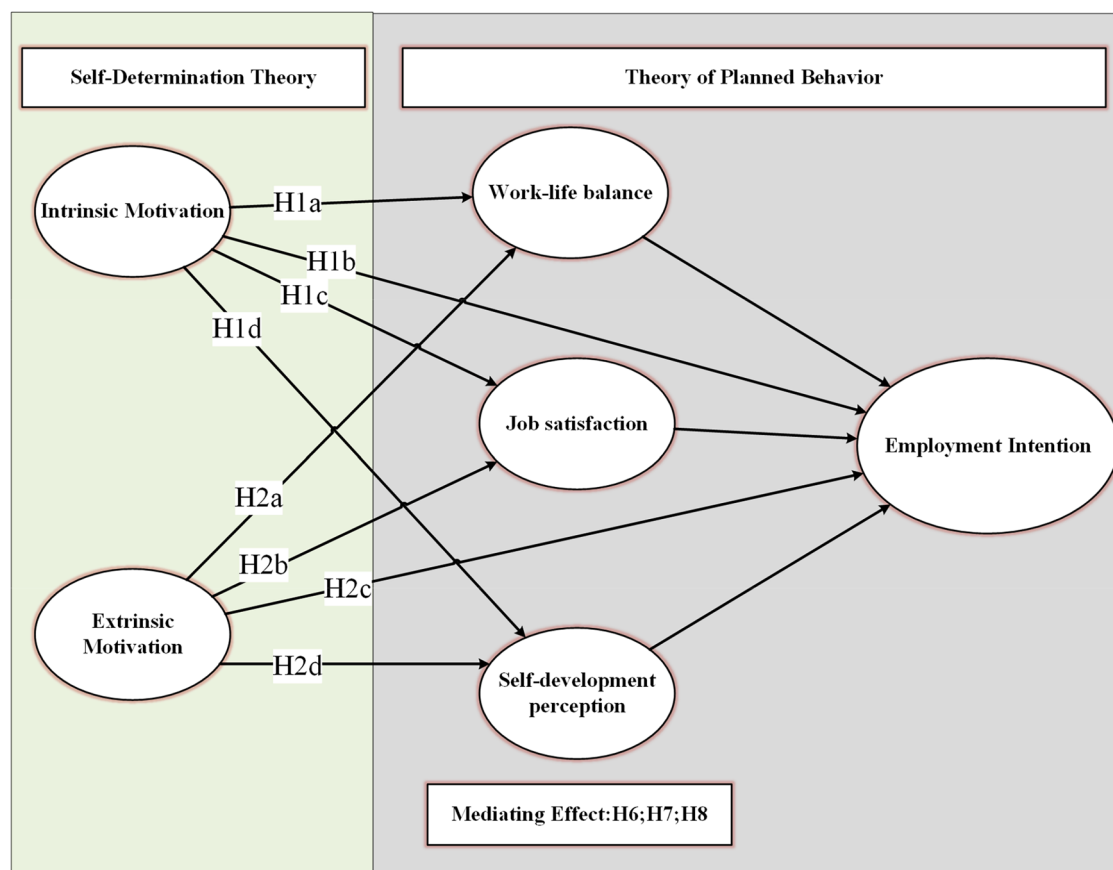
### Data collection procedure.

1. **Sample diversity and regional coverage:** To ensure the sample's diversity, we strategically selected graduates from various regions across China, including Eastern, Central, and Western regions, as well as from urban and rural areas. Special attention was given to including different institutions, such as prestigious comprehensive universities, engineering-focused schools, and vocational or teacher-training colleges. This diversity was crucial to ensure the sample's representativeness in reflecting the varied experiences and employment expectations of university graduates across China.
2. **Recruitment strategy:** Participants were invited to participate in the survey through multiple channels, including email invitations, social media platforms (e.g., WeChat, QQ), and university alum networks. This broad approach ensured that we reached many students from diverse academic backgrounds and geographical locations.
3. **Incentives and confidentiality:** A small incentive mechanism (e.g., a lottery for a prize) was introduced to enhance participation rates. Additionally, all participants were assured that their responses would be anonymous, helping to increase trust and the reliability of the data.

**Questionnaires and data cleaning.** The questionnaire covered several sections: demographic information (e.g., age, gender, educational background), intrinsic and extrinsic motivations (using Likert scales), work-life balance (evaluating the respondents' perceptions), job satisfaction (assessing their contentment with their job or expectations), self-development perception, and employment intentions (with specific focus on the willingness to engage in flexible employment).

Once data collection was completed, the responses underwent a thorough cleaning process, where invalid responses (e.g., extremely short completion times or incomplete answers) were removed to ensure the dataset's validity. Responses to multiple-choice questions were coded for statistical analysis, and open-ended responses were categorized for further qualitative insights. Descriptive and inferential statistical analyses were performed using SPSS software, allowing for a robust exploration of the relationships between intrinsic, extrinsic, and employment intentions.





**Fig. 3 Model framework.** Note: Work-life balance, Job satisfaction, and Self-development perception are mediators in this model.

#### Statistical analysis.

1. Descriptive statistics: Initially, descriptive statistics were calculated to understand the demographic characteristics of the sample and the distribution of key variables such as gender, age, academic major, and household registration type.
2. Correlation and regression analysis: Pearson correlation coefficients were computed to explore relationships between intrinsic motivation, extrinsic motivation, and employment intentions. Multiple regression analysis was conducted to test motivation factors' direct and indirect effects on employment intentions.
3. Structural equation modeling (PLS-SEM): PLS-SEM was used to analyze the mediating roles of work-life balance, job satisfaction, and self-development perception in the relationship between intrinsic motivation and employment intentions.
4. Cross-validation: Cross-validation and subgroup analyses were conducted to verify the robustness and reliability of the findings across different demographic groups (e.g., male vs. female, local vs. non-local students).

**Ensuring data representativeness.** The study's sample was deliberately selected to ensure it was representative of the broader population of Chinese university graduates. To this end, we compared our sample characteristics with the national distribution of graduates by region, central, and institution type. For example, in the final sample, 40% of participants were from Eastern China, 30% from Central China, and 30% from Western China, closely mirroring the regional graduate population in China. Furthermore, the breakdown of the sample by university

type included 50% from top-tier universities (e.g., 211 and 985 universities), ensuring a balanced representation of prestigious and non-prestigious institutions.

**Variable selection and questionnaire designs.** The design of the questionnaire in this study is based on an in-depth literature review combined with the SDT and the TPB (Hagger & Chatzisarantis, 2007). The questionnaire design drew on the theoretical frameworks, research focus, independent variables, dependent variables, moderating variables, and questionnaire design choices of relevant studies to construct the variables and questionnaire for this research. To ensure the rigor and scientific validity of the questionnaire, a substantial amount of literature and existing scale tools were consulted during the design process. Appendix A details the referenced constructs and the questionnaire's development.

During the development of the questionnaire, some parts were adapted from previously validated questionnaires, especially those that had been tested for reliability in similar studies. In addition, other parts of the questionnaire were developed based on original concepts combined with this research's specific objectives and requirements. To ensure the quality of the questionnaire tool, a pilot study was conducted before the formal distribution of the questionnaire. The reliability and validity of the pilot data were analyzed to confirm that the questionnaire accurately measured the variables being studied. The pilot study results showed that respondents highly understood the questionnaire content and the questions were well-designed in logic and coherence. This feedback provided a solid foundation for the quality of the formal survey data and for reducing bias.

Regarding the sample size, this study considered the requirements of the target population and statistical power, ensuring that



the sample size was large enough to improve the research results' reliability and validity and represent the target population, namely, university students. To further ensure the sample's representativeness, a diversified sampling method was adopted, covering university students from different backgrounds in discipline, grade, and gender, thus ensuring that the sample sufficiently represented the overall target population.

Data collection was conducted using online and offline methods to maximize sample diversity and the generalizability of the results. Specifically, the online questionnaire was distributed via the Wenjuanxing platform, accounting for 76.2% of the sample. In contrast, the offline questionnaire was distributed with the assistance of class advisors for graduating cohorts, accounting for 23.8%. The two modes of distribution were carried out simultaneously, increasing the survey's coverage and ensuring the inclusion of diverse participant groups. Before data collection, all participants were required to sign an informed consent form to ensure they understood the purpose of the study and voluntarily participated.

**Methodological analysis.** This study employs a mixed-method approach combining Partial Least Squares Structural Equation Modeling (PLS-SEM), Artificial Neural Networks (ANN), and Fuzzy-Set Qualitative Comparative Analysis (fsQCA) to investigate the factors driving university students toward flexible employment. Each method offers unique strengths and complements the others.

Firstly, PLS-SEM is suitable for exploring complex model structures, particularly theoretical constructs involving latent variables. It effectively handles incomplete or non-normally distributed data and analyzes multiple relationships among latent variables. However, PLS-SEM has limitations, such as a tendency to overfit and relatively weaker causal inference and model fit assessment than CB-SEM.

This study incorporates ANN, a nonlinear modeling method with strong generalization capabilities, to address these limitations. ANN can handle complex nonlinear relationships, large datasets, and diverse data distributions without sample size constraints (Di, Chen, Shi, Cai, Liu, et al., 2024). While PLS-SEM establishes the basic framework and results by exploring relationships among factors, ANN validates and complements these findings, enhancing the robustness and reliability of the results.

Finally, fsQCA analyses combinations of conditions driving flexible employment decisions (Q. Cai et al., 2024). FsQCA reveals multiple pathways and causal relationships, emphasizing the interaction and combined effects of variables (Q. L. Cai et al., 2024). This is particularly useful for understanding complex social phenomena, such as decision-making processes in employment.

By integrating PLS-SEM, ANN, and fsQCA, this study explores and validates key driving factors while uncovering complex pathways of influence. This multi-method approach provides a comprehensive understanding of flexible employment mechanisms among university students, offering solid theoretical and empirical support for policymaking and practice.

## Analysis and results

**Common method bias.** Standard method bias refers to the spurious variance arising from the measurement method rather than the measured constructs. This bias can significantly affect the validity of research results, mainly when using self-reported questionnaires. To effectively address this issue, both procedural and methodological improvements were made in this study.

Procedurally, this study adopted the method proposed by Kock (Kock et al., 2021). We collected data from multiple sources, gathering information from different cities and schools to avoid

over-reliance on homogeneous respondents and to reduce the potential for common method bias. To ensure the quality of the questionnaire design, we focused on clear and concise wording, avoiding leading questions or ambiguous terms to minimize response bias. Additionally, by providing confidentiality and anonymity assurances, we ensured participants' privacy, reducing the influence of social desirability or response tendencies and encouraging them to provide truthful and objective answers.

Methodologically, we conducted Harman's single-factor test on the constructs involved in the theoretical model (Aguirre-Urreta & Hu, 2019). We used principal component analysis with varimax rotation, and the results showed that a single factor explained 24.3% of the total variance. Since the variance explained by a single factor was less than 50%, it can be preliminarily concluded that common method bias is not a significant concern in our data. This indicates that the multidimensionality of the measurements was reasonably ensured, and the differences between the constructs in the data were reflected to some extent.

To further verify this, we also conducted confirmatory factor analysis (CFA), comparing the goodness-of-fit between the single and multi-factor models. The fit indices for the single-factor model ( $CFI = 0.65$ ,  $TLI = 0.62$ ,  $RMSEA = 0.12$ ,  $SRMR = 0.08$ ) indicated poor fit, whereas the multi-factor model showed significant improvement ( $CFI = 0.91$ ,  $TLI = 0.89$ ,  $RMSEA = 0.05$ ,  $SRMR = 0.04$ ). This further supports that common method bias had a minimal impact in this study. Additionally, we employed the marker variable technique, selecting a theoretically unrelated variable as the marker variable. The results showed that the correlations between the marker variable and the primary variables were low (all  $r$  values below 0.20), indicating that common method bias was insignificant.

In conclusion, through multiple tests and validations, we can confirm that common method bias had a minimal impact on this study's data, ensuring the research results' validity and reliability.

**Assessing the outer measurement model.** In structural equation modeling (SEM) analysis, evaluating the external measurement model is a critical step in ensuring the model's validity. The external measurement model primarily assesses the relationship between latent variables (constructs) and their corresponding observed variables (indicators) (Hair et al., 2019). This study first evaluated the reliability of the external measurement model through reliability analysis. Specifically, Cronbach's Alpha coefficient was used to assess the internal consistency of each dimension of the questionnaire. The results showed that the Cronbach's Alpha values for all latent variables were above 0.7, indicating good internal consistency of the questionnaire. Additionally, the Composite Reliability (CR) for all latent variables in the study was more significant than 0.7, further indicating the high reliability of the measurement model (as shown in Table 1).

Validity analysis is another crucial aspect of evaluating the external measurement model. This study assessed validity through convergent validity and discriminant validity. Convergent validity was evaluated using the Average Variance Extracted (AVE), and the results showed that the AVE values for all latent variables were above 0.5, indicating good convergent validity. Discriminant validity was assessed using the Fornell-Larcker criterion and the cross-loadings method. According to the Fornell-Larcker criterion, the square root of the AVE for a latent variable should be greater than its correlations with other latent variables. The results showed that the square roots of the AVEs for all latent variables were more significant than their correlations with other variables, and the cross-loading test results indicated that each measurement indicator had the highest

**Table 1 Loadings, Construct Reliability and Validity.**

Constructs	Items	Loadings ( $p$ -levels)	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
EI	EI1	0.761 ( $p < 0.001$ )	0.772	0.788	0.851	0.588
	EI2	0.75 ( $p < 0.001$ )				
	EI3	0.78 ( $p < 0.001$ )				
	EI4	0.775 ( $p < 0.001$ )				
EM	EM1	0.768 ( $p < 0.001$ )	0.759	0.766	0.848	0.583
	EM2	0.826 ( $p < 0.001$ )				
	EM3	0.787 ( $p < 0.001$ )				
	EM4	0.663 ( $p < 0.001$ )				
IM	IM1	0.745 ( $p < 0.001$ )	0.711	0.714	0.823	0.538
	IM2	0.792 ( $p < 0.001$ )				
	IM3	0.648 ( $p < 0.001$ )				
	IM4	0.741 ( $p < 0.001$ )				
JS	JS1	0.789 ( $p < 0.001$ )	0.809	0.820	0.867	0.567
	JS2	0.805 ( $p < 0.001$ )				
	JS3	0.703 ( $p < 0.001$ )				
	JS4	0.748 ( $p < 0.001$ )				
	JS5	0.716 ( $p < 0.001$ )				
SDP	SDP1	0.746 ( $p < 0.001$ )	0.716	0.723	0.823	0.537
	SDP2	0.687 ( $p < 0.001$ )				
	SDP3	0.765 ( $p < 0.001$ )				
	SDP4	0.731 ( $p < 0.001$ )				
WLB	WLB1	0.821 ( $p < 0.001$ )	0.788	0.819	0.861	0.611
	WLB2	0.879 ( $p < 0.001$ )				
	WLB3	0.693 ( $p < 0.001$ )				
	WLB4	0.718 ( $p < 0.001$ )				

**Table 2 Fornell-Larcker criterion.**

	EI	EM	IM	JS	SDP	WLB
EI	<i>0.767</i>					
EM	0.367	<i>0.764</i>				
IM	0.27	0.543	<i>0.733</i>			
JS	0.588	0.441	0.336	<i>0.753</i>		
SDP	0.307	0.526	0.526	0.401	<i>0.733</i>	
WLB	0.433	0.455	0.332	0.52	0.415	<i>0.781</i>

Diagonal elements (in italic) are the square root of the average variance extracted.

loading on its corresponding latent variable, confirming good discriminant validity (as shown in Table 2).

Finally, this study evaluated the model fit of the external measurement model. Using the Standardized Factor Loadings method, the standardized factor loadings of each observed variable on its corresponding latent variable were all above 0.6, indicating strong explanatory power of the observed variables for the latent variables. These evaluation results indicate that the reliability and validity of the measurement model are well assured, laying a solid foundation for subsequent structural model analysis. The measurement model in this study reliably and validly captures the critical drivers of university students' flexible employment, providing robust data support.

**Inspecting the inner structural model.** In structural equation modeling (SEM) analysis, evaluating the internal structural model is essential for validating the relationships between latent variables. This study comprehensively assessed the internal structural model to ensure its validity and reliability. The significance and directionality of path coefficients are critical indicators for evaluating the internal structural model. The path coefficients and their significance levels obtained through PLS-SEM path analysis indicate that hypotheses H1a ( $IM \rightarrow WLB \rightarrow EI$ ) and H1c

( $IM \rightarrow JS \rightarrow EI$ ) are significant, suggesting that intrinsic motivation significantly influences employment intentions through work-life balance and job satisfaction, with  $p$ -values of 0.01 and 0.000 and  $t$ -values of 2.569 and 3.874, respectively, at the 99% confidence level. Hypothesis H1d ( $IM \rightarrow SDP$ ) is also significant, with a  $t$ -value of 10.754 and a  $p$ -value of 0.000. However, hypothesis H1b ( $IM \rightarrow EI$ ) failed to pass the significance test, with a  $p$ -value of 0.592, indicating that intrinsic motivation does not significantly affect employment intentions. Among the hypotheses related to extrinsic motivation, H2a ( $EM \rightarrow WLB \rightarrow EI$ ) and H2b ( $EM \rightarrow JS \rightarrow EI$ ) are significant, with  $t$ -values of 3.833 and 8.742 and  $p$ -values of 0.000 for both. Additionally, hypotheses H2c ( $EM \rightarrow EI$ ) and H2d ( $EM \rightarrow SDP$ ) also passed the significance test, with  $t$ -values of 2.24 and 11.08 and  $p$ -values of 0.025 and 0.000, respectively, suggesting that extrinsic motivation significantly influences employment intentions through work-life balance, job satisfaction, and self-development perception. The direction of the path coefficients aligns with theoretical expectations, except for H1b, confirming the validity of the research model (as shown in Table 3).

This study systematically assessed mediation effects using PLS-SEM path analysis to explore further the mechanisms underlying the relationships between latent variables. The mediation analysis involved several steps. First, a direct effect model, which excludes

Table 3 Outcome of the structural model examination.									
Hypothesis	PLS Path	Establish	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (tO/STDEV)	P Values	Bias Corrected Confidence Interval (2.50%-97.50%)	Remarks
H1a	IM → WLB → EI	YES	0.017	0.017	0.007	2.569	0.01	0.007	*
H1b	IM → EI	NO	0.017	0.017	0.032	0.536	0.592	-0.046	n.s.
H1c	IM → JS → EI	YES	0.064	0.065	0.017	3.874	0	0.032	***
H1d	IM → SDP	YES	0.34	0.341	0.032	10.754	0	0.276	***
H2a	EM → WLB → EI	YES	0.056	0.056	0.015	3.833	0	0.029	***
H2b	EM → JS → EI	YES	0.172	0.173	0.02	8.742	0	0.136	***
H2c	EM → EI	YES	0.082	0.081	0.037	2.24	0.025	0.011	*
H2d	EM → SDP	YES	0.341	0.342	0.031	11.08	0	0.276	***
* Significant at $p < 0.05$ level. ** Significant at $p < 0.01$ level. *** Significant at $p < 0.001$ level. n.s. not supported.									

mediating variables, was constructed to evaluate the direct path coefficients and their significance between independent and dependent variables. Subsequently, mediating variables were introduced to create a full mediation model. The mediating effects were identified and analyzed by comparing the path coefficients of the direct effect model and the full mediation model. This study applied the bootstrapping technique further to verify the significance of the effects of mediation. This non-parametric resampling method involves multiple (e.g., 5000) random resamplings of the data to generate the distribution of path coefficients. The bootstrapping process calculated the indirect effect values, standard errors, and confidence intervals for mediating paths (e.g., IM → WLB → EI). If the confidence interval for the indirect effect does not include zero, the mediation effect is considered significant. Additionally, the significance and strength of the mediation effects were evaluated through the p-values of the indirect effects, the standardized path coefficients ( $\beta$  values), and the Variance Accounted For (VAF) value. The VAF value, which represents the proportion of the total effect explained by the mediation effect, was used to determine whether the mediation was complete ( $VAF > 80\%$ ), partial ( $20\% \leq VAF \leq 80\%$ ), or absent ( $VAF < 20\%$ ). The results show that intrinsic motivation significantly mediates employment intentions through work-life balance and job satisfaction. In contrast, extrinsic motivation significantly mediates employment intentions through work-life balance, job satisfaction, and self-development perception.

Additionally, Table 4 reports the model's explanatory power ( $R^2$  values), which reflect the proportion of variance in endogenous variables explained by exogenous variables and are a critical indicator of the model's explanatory capacity. The results indicate that the  $R^2$  value for employment intentions is 0.375, meaning that the model explains 37.5% of the variance in employment intentions. The adjusted  $R^2$  value is 0.372, with only a slight difference from the  $R^2$  value, indicating a good model fit and high explanatory power. The  $R^2$  value for self-development perception is 0.358, with an adjusted  $R^2$  value of 0.357, demonstrating a good model fit and strong explanatory power. The  $R^2$  values for job satisfaction and work-life balance are 0.208 and 0.218, respectively, with adjusted  $R^2$  values of 0.207 and 0.216, indicating moderate explanatory power for these variables.

Furthermore, the model's predictive relevance was assessed using the Stone-Geisser  $Q^2$  value (Table 5), calculated through the blindfolding procedure. A  $Q^2$  value greater than 0 indicates good predictive relevance. The results show that the  $Q^2$  value for employment intentions is 0.203, and the  $Q^2$  value for self-development perception is 0.187, demonstrating high predictive relevance.

Finally, the robustness of the model was evaluated through model fit indices, as reported in Table 6. The Standardized Root Mean Square Residual (SRMR) was used to measure model fit, with a value of 0.091 below the recommended threshold of 0.10, indicating good model fit. Other model fit indices, including the Chi-square value and Normed Fit Index (NFI), confirm that the model's fit is within acceptable ranges. Overall, based on the comprehensive evaluation of path coefficient significance,

Table 4 R-squared and Adjusted.		
	R-square	R-square adjusted
EI	0.375	0.372
JS	0.208	0.207
SDP	0.358	0.357
WLB	0.218	0.216

	SSO	SSE	Q <sup>2</sup> (=1-SSE/SSO)
EI	5080	4049.440	0.203
EM	5080	5080	0
IM	5080	5080	0
JS	6350	5612.200	0.116
SDP	5080	4130.560	0.187
WLB	5080	4419.170	0.130

	Saturated model	Estimated model
SRMR	0.074	0.091
d_uls	1.774	2.692
d_g	0.373	0.412
Chi-square	2881.280	3051.413
NFI	0.754	0.740

**Multi-group comparison.** Table 7 presents the results of a Multi-Group Analysis (MGA) conducted to examine the moderating effects of different demographic characteristics, including gender, household registration type, work experience, volunteer experience, and career planning, on the hypothesized paths within the structural model. The MGA method allows for comparing path coefficients across different subgroups, thereby enabling the identification of significant differences in the relationships between variables based on moderating factors. This approach is beneficial in assessing whether demographic characteristics influence the strength or direction of the relationships in the model. This study used Henseler's MGA approach to evaluate the significance of the differences in path coefficients between groups.

*Moderating effect of household registration type (Hukou).* Household registration type (local vs. non-local students) demonstrated significant moderating effects on the paths from intrinsic motivation (IM) to employment intention (EI) (path coefficient difference = 0.388,  $p=0.009$ ) and from IM to EI through job satisfaction (IS) (path coefficient difference = 0.164,

### Table 7 Multi-group comparison.

Hypothesis	PLS Path	Gender(Male-Female)			Type of Household Registration (Local - Other)			Type of Work Experience (YES - NO)			Type of Volunteer Experience (YES - NO)			Type of Career Planning (YES - NO)		
		Path Coeff.	p-Value	Henseler's MGA	Path Coeff.	p-Value	Henseler's MGA	Path Coeff.	p-Value	Henseler's MGA	Path Coeff.	p-Value	Henseler's MGA	Path Coeff.	p-Value	Henseler's MGA
H1a	IM → WLB → EI	0.039	0.231		0.000	0.443		-0.003	0.541		0.021	0.175		0.014	0.243	
H1b	IM → EI	0.014	0.495		0.388	0.009		0.082	0.300		0.221	0.108		-0.075	0.688	
H1c	IM → JS → EI	-0.128	0.85		0.128	0.033		0.029	0.384		-0.099	0.770		0.412	0.084	
H1d	IM → SDP	0.074	0.344		-0.057	0.648		-0.057	0.657		0.141	0.190		-0.154	0.859	
H2a	EM → WLB → EI	0.138	0.04		-0.036	0.702		-0.007	0.557		-0.019	0.591		-0.048	0.771	
H2b	EM → JS → EI	0.168	0.16		-0.195	0.971		0.019	0.438		-0.099	0.770		0.142	0.084	
H2c	EM → EI	0.015	0.457		0.388	0.983		-0.268	0.943		-0.321	0.934		0.154	0.178	
H2d	EM → SDP	-0.078	0.661		0.136	0.173		0.051	0.356		-0.164	0.851		0.194	0.080	

Results for Henseler's approach eligible for a p-value onetailed test:

2. This table examines the influence of various moderating variables on the hypothesized paths within the model. Moderating variables include: Gender (Male vs. Female); Type of Household Registration (Local vs. Other); Type of Work Experience (Yes vs. No); Type of Career Planning Experience (Yes vs. No); Type of Career Planning (Yes vs. No). The moderating variables are tested across paths (e.g., IM → WLB → EI, IM → WLB → EI, IM → EI) using Henseler's approach for significance. *P*-values and path coefficient differences highlight the moderation effects, with a one-tailed *p*-value test applied where appropriate.



**Table 8 RMSE value of 10-fold ANN models.**

Network	N (Training)	N (Testing)	RMSE (Training)	RMSE (Testing)	Accuracy for training	Accuracy for testing
1	911	102	0.2718	0.2784	76.08%	74.41%
2	858	85	0.2702	0.2820	62.01%	68.90%
3	803	125	0.2742	0.2652	73.92%	80.31%
4	797	204	0.2731	0.2684	77.46%	77.56%
5	874	109	0.2702	0.2808	79.82%	73.62%
6	971	106	0.2733	0.2649	75.20%	79.13%
7	712	165	0.2683	0.2736	72.64%	73.62%
8	936	104	0.2721	0.2719	75.69%	79.92%
9	1001	156	0.2744	0.2673	75.79%	80.71%
10	855	132	0.2685	0.2805	74.51%	73.62%
Mean	871.80	128.80	0.2716	0.2733	74.31%	76.18%
SD	87.26	36.35	0.0022	0.0067	4.74%	3.92%

$p = 0.033$ ). These findings highlight that local students benefit more from the influence of intrinsic motivation (IM) and job satisfaction (JS) on employment intentions than non-local students. This difference may stem from socioeconomic disparities and variations in access to social capital support, as local students may receive more substantial support from their social environment, which enhances their ability to pursue flexible employment intentions. The results also reflect the role of subjective norms from the TPB, as differing social expectations based on household registration backgrounds can significantly influence employment-related behaviors.

*Insignificant moderating effects of work experience, volunteer experience, and career planning.* The results indicate that work experience, volunteer experience, and career planning have no significant moderating effects on any hypothesized paths. For instance, the paths from intrinsic motivation (IM) to employment intention (EI) and from external motivation (EM) to employment intention (EI) through work-life balance (WLB) did not show significant differences based on these variables. This suggests that these factors influence university students' flexible employment intentions. However, it is worth noting that these variables may have more pronounced effects over extended periods, highlighting the potential need for longitudinal research to capture their long-term impact.

*Overview of multi-group analysis results.* Table 7 provides detailed results of the MGA, including path coefficient differences and  $p$ -values for each moderating variable across all hypothesized paths. Henseler's approach was used to test the significance of these differences with a one-tailed  $p$ -value test. The findings suggest that while gender and household registration type significantly moderate specific paths, work experience, volunteer experience, and career planning are weaker moderating variables in this model.

In summary, the MGA results provide valuable insights into how demographic characteristics influence the relationships between motivational factors, mediating variables, and employment intentions. By identifying significant differences between subgroups, this analysis highlights the importance of considering demographic diversity in understanding employment-related behaviors among university students.

**Artificial neural network analysis.** This study employed the Artificial Neural Network (ANN) method to assess the normalized importance of antecedents of endogenous variables (Di, Chen, Shi, Cai, & Zhang, 2024). The ANN analysis utilized the significant exogenous variables identified from the PLS-SEM analysis as inputs for the neural network model. Specifically, constructs such as intrinsic motivation (IM), extrinsic motivation

(EM), work-life balance (WLB), job satisfaction (JS), and sustainable development practices (SDP) were used as input variables. These constructs, identified as significant in PLS-SEM, were fed into the ANN model using a sensitivity analysis approach to explore their importance (Cai et al., 2024).

The ANN analysis used a feedforward-backpropagation algorithm with the sigmoid function as the activation function (Alnoor et al., 2024). A 10-fold cross-validation method was applied to address potential overfitting, as suggested by Aguirre-Urreta and Hu (Aguirre-Urreta & Hu, 2019). Each network was trained on 90% of the data and tested on the remaining 10%, and this process was repeated across 10 different folds. The model architecture included one hidden layer with an optimized number of neurons determined through experimental tuning, ensuring a balance between computational efficiency and model performance. The output layer consisted of a single node, representing the endogenous variable (EI).

Performance metrics, such as the Root Mean Square Error (RMSE), were calculated for the training and testing phases to evaluate the model's accuracy and consistency. As shown in Table 8, the average RMSE for the training and testing phases was 0.2716 and 0.2733, respectively, indicating stable predictive performance. The low standard deviations of RMSE values across folds (0.0022 for training and 0.0067 for testing) further reflect the model's robustness and the absence of significant overfitting or underfitting issues. The average testing accuracy of 76.18% demonstrates that the ANN model can make reliable predictions in practical applications.

*Comparison of PLS-SEM and ANN models.* While PLS-SEM and ANN models were utilized in this study to examine the relationships between exogenous and endogenous variables, their methodological differences and complementary strengths should be noted. PLS-SEM is a statistical method that estimates path coefficients, quantifying the direct effects of exogenous variables (e.g., JS, WLB, IM) on the endogenous variable (EI). In contrast, the ANN model is a machine learning approach that uses non-linear relationships and determines the relative importance of input variables through sensitivity analysis.

Table 10 highlights the consistency between the two methods. For instance, job satisfaction (JS) is identified as the most important variable in both models, with the highest path coefficient in PLS-SEM (0.469) and a normalized importance of 100% in ANN. Similarly, work-life balance (WLB) ranks second in both analyses, further validating its critical role in predicting students' flexible employment intentions. Although variables such as intrinsic motivation (IM), extrinsic motivation (EM), and sustainable development practices (SDP) have relatively lower impacts, their importance rankings remain consistent across both

models. The agreement between PLS-SEM and ANN results demonstrates the robustness of the findings and the reliability of the multi-method approach used in this study.

The sensitivity analysis conducted through ANN provides additional insights into the relative importance of variables, which complements the path coefficient analysis in PLS-SEM. This integration of methods enhances the depth of analysis and strengthens the validity of the conclusions drawn from the study.

Table 8 presents the RMSE values and accuracy across the 10-fold cross-validation for the ANN model. The consistent performance metrics indicate the model's reliability and precision. Table 9 provides a detailed sensitivity analysis of the ANN model, showing that job satisfaction (JS) and work-life balance (WLB) are the most critical variables in predicting flexible employment intentions. Lastly, Table 10 compares the results of the PLS-SEM and ANN models, highlighting the consistency in the rankings of variable importance across both approaches.

By integrating the results of PLS-SEM and ANN models, this study validates job satisfaction and work-life balance as the primary factors influencing students' intentions toward flexible employment. These findings underscore the importance of improving job satisfaction and promoting work-life balance to stimulate students' engagement in flexible employment opportunities.

Fuzzy-set qualitative comparative analysis (fsQCA)

**Calibration.** Before conducting a fuzzy-set qualitative comparative analysis (fsQCA), it is essential to calibrate the variable data. In this study, the scores from the 7-point Likert scale were calibrated into fuzzy-set scores ranging from 0 to 1. According to Ragin (Ragin, 2008), a fuzzy score of 1 indicates full membership in a fuzzy set, while a score of 0 indicates non-membership. For the 7-point Likert scale, researchers have set different calibration thresholds. Fiss (Fiss, 2011) set “6.75” as full membership, “4” as the crossover point (indicating moderate membership), and “1.25” as non-membership. Similarly, Pappas and Woodside (Pappas, Woodside, (2021)) suggested using “6,” “4,” and “2” as the thresholds for full, moderate, and non-membership, respectively.

However, in this study, we adopted the method proposed by Ong and Johnson (Pappas, Woodside, (2021)), which uses each variable's mean and combined standard deviation for data calibration. Specifically, scores more than one standard deviation above the mean of each variable were considered full member-

ship, mean scores were considered moderate membership, and scores more than one standard deviation below the mean were considered non-membership. Greckhamer (Greckhamer et al., 2018) explained that the practical determination of fsQCA calibration thresholds should be “half-conceptual, half-empirical” because the thresholds should reflect “both kind and degree differences among cases”. Therefore, we used Ong and Johnson's method to reduce the potential bias caused by the non-normal distribution of data, which can be an issue when using fixed calibration thresholds such as “6,” “4,” and “2.”

**Analyzing necessity and sufficiency.** Necessity analysis tests whether a particular variable is a necessary condition for an endogenous variable (Ragin, 2008). In this study, EI (Employment Intention) was set as the outcome variable for necessity analysis. At the same time, IM (Intrinsic Motivation), EM (Extrinsic Motivation), WLB (Work-Life Balance), JS (Job Satisfaction), and SDP (Sustainable Development Practices) were considered possible antecedent conditions determining university students' flexible employment intention. Ragin (Ragin, 2008) suggests that a consistency value exceeding the threshold of 0.8 is acceptable, with a value greater than 0.8 indicating that the variable is necessary for the outcome variable. Meanwhile, coverage represents the percentage of the dataset that a particular variable explains for EI. Table 11 presents the results of the necessity and sufficiency analysis. According to the data in the table, the consistency values for IM, EM, WLB, JS, and SDP all exceed 0.6, indicating that they are effective antecedent conditions for determining EI.

**Analyzing fsQCA results.** This study constructed a truth table that lists all possible configurations leading to university students' flexible employment intention (EI). Following Fiss(Fiss, 2007), we adopted a consistency threshold 0.8 for the configurations and a PRI consistency threshold 0.5. Given that the study collected 1,270 valid responses, the minimum case frequency was set at 3 to exclude combinations that only reflect specific cases (Ragin, 2008). The truth table enabled us to summarize the final configuration paths that explain the outcome variable. Three types of solutions were returned using the Quine-McCluskey algorithm:

Table 9 Sensitivity analysis for the ANN models.			
Feature	Mean importance	Normalized importance	Ranking
IM	0.050	9.92%	3
EM	0.020	4.05%	5
WLB	0.098	19.36%	2
JS	0.504	100.00%	1
SDP	0.042	8.26%	4

Table 11 Analysis of necessary conditions.		
Analysis of Necessary Conditions	Consistency	Coverage
IM	0.6372	0.6505
-IM	0.4749	0.4788
EM	0.6497	0.6889
-EM	0.4606	0.4480
WLB	0.6393	0.7331
-WLB	0.4495	0.4089
JS	0.7354	0.7569
-JS	0.3684	0.3686
SDP	0.6341	0.6723
-SDP	0.4616	0.4489

Table 10 Comparison of PLS-SEM and ANN results.					
PLS- SEM Path	Original sample (O)/ Path Coefficient	ANN results: Normalized relative importance	Ranking (PLS-SEM) [based on Path Coefficient]	Ranking (ANN) [based on Normalized relative importance]	Remark
IM → EI	0.017	9.920%	3	3	March
EM → EI	0.082	4.050%	5	5	March
WLB → EI	0.143	19.360%	2	2	March
JS → EI	0.469	100.000%	1	1	March
SDP → EI	0.007	8.260%	4	4	March

**Table 12 Configurations for achieving high level of EI.**

Configuration	1	2	3	4	5
IM		☺	⊗		⊗
EM				☺	☺
WLB		☺	☺	☺	☺
JS	☺				
SDP		⊗	☺	⊗	
Consistency	0.756854	0.838058	0.830048	0.825523	0.821753
Raw coverage	0.735425	0.162906	0.183007	0.161059	0.185056
Unique coverage	0.470972	0.005992	0.005324	0.000838	0.000279
Overall solution consistency	0.779788				
Overall solution coverage	0.738781				

Black smiley face (☺) indicate the presence of a condition, and circles with "x" (⊗) indicate its absence. Large circles indicate core conditions; small ones, peripheral conditions. Blank spaces indicate "don't care".

parsimonious, intermediate, and complex. However, in this study, we followed the recommendations of Chuah (Chuah et al., 2021) and only interpreted the intermediate solution to simplify the research hypotheses and achieve better interpretability. Table 12 presents the final fsQCA results, identifying each configuration's core and peripheral conditions. In the final fsQCA results table, a black smiley face (☺) indicates a causal condition; a crossed circle (⊗) indicates the absence or negation of a condition, while a blank space indicates that the population studied has no preference regarding the presence of the condition.

Additionally, a large black smiley face represents a core condition, and a small black smiley face represents a peripheral condition (Pappas, Woodside, (2021)). According to the table, the fsQCA generated five solutions with a total consistency of 0.7798 and a total coverage of 0.7387. Thus, these five solutions explain a significant portion of EI. Pappas, Woodside, (2021) suggest that testing the predictive validity of the solutions can enhance the value of fsQCA, as it assesses the model's ability to predict the outcome variable in different samples. We randomly divided the data sample into subsample and holdout sample to test predictive validity. The first step was to use the subsample to generate results (solutions) with the fsQCA algorithm. The second step involved modeling the combinations derived from the subsample as a variable and comparing it with the outcome variable using the holdout data. Configuration 1 involved only Job Satisfaction (JS); Configurations 2 and 3 both included Work-Life Balance (WLB) but differed in other factors; Configurations 4 and 5 emphasized Extrinsic Motivation (EM) and Work-Life Balance (WLB). By exploring different combinations of conditions to explain complex causal relationships, this study highlighted the importance of combinations of factors rather than the independent effect of a single factor. This approach provides valuable insights into understanding the complex dynamics of university students' flexible employment intentions.

## Discussion

This study investigates the roles of various variables and their combinations in shaping university students' intentions to pursue flexible employment in the post-pandemic labor market. The results of the PLS-SEM analysis show that intrinsic motivation significantly influences job intention through three mediators: work-life balance, job satisfaction, and self-development perception. Specifically, hypotheses H1a, H1c, and H1d were supported, suggesting that the effect of intrinsic motivation on job intention is largely mediated by these factors. Moreover, extrinsic motivation also exerts a significant impact, with hypotheses H2a, H2b, H2c, and H2d being confirmed. This finding indicates that extrinsic motivation directly influences job intention, and also has an indirect effect via work-life balance, job satisfaction, and self-

development perception. However, hypothesis H1b was not supported, suggesting that intrinsic motivation does not directly affect job intention. This implies that the influence of intrinsic motivation on job intention is more reliant on its indirect effects through mediators rather than a direct pathway.

Our findings are consistent with the theoretical frameworks introduced in the introduction, especially SDT and the TPB. The significant effect of intrinsic motivation through mediators such as work-life balance and self-development perception supports SDT, which underscores the role of fulfilling psychological needs—autonomy, competence, and relatedness—in driving intrinsic motivation (Deci & Ryan, 2012). These psychological needs are primarily met through flexible employment options, which indirectly shape students' decisions. The lack of a direct effect of intrinsic motivation on job intention further supports SDT's proposition that autonomy and self-regulation are essential, but may require external factors, such as work-life balance and job satisfaction, to fully manifest in employment intentions.

Furthermore, the role of extrinsic motivation in shaping job intention aligns with TPB, which asserts that external factors like attitudes, subjective norms, and perceived behavioral control directly influence behavioral intentions (Ajzen & Driver, 1991). Our findings indicate that extrinsic motivation, influenced by work-life balance and job satisfaction, plays a crucial role in determining job intention. This corresponds with TPB, showing how external factors significantly shape individuals' behavior in decision-making contexts.

Additionally, we examined the moderating effects of demographic variables such as gender, household registration type, work experience, volunteer experience, and career planning through multi-group analysis. The results show significant differences in specific paths, particularly where extrinsic motivation impacts job intention through work-life balance and satisfaction. These differences are primarily observed between male and female students and between those with local versus non-local household registrations. While work experience, volunteer experience, and career planning did show some moderating effects, these were not statistically significant. This suggests that when designing motivational strategies, managers should pay special attention to gender and household registration differences in order to better motivate students from diverse backgrounds, enhancing overall organizational job intention.

This result underscores the relevance of Leadership and Motivation Theory, which highlights the importance of understanding intrinsic and extrinsic motivations across different demographic groups. Recent leadership theories emphasize that personalized motivational strategies are critical for optimizing engagement and enhancing organizational outcomes. The moderating effects of gender and household registration type support

these theories by stressing the importance of tailored approaches to leadership and motivation.

This study also integrates PLS-SEM with Artificial Neural Network (ANN) models to analyze the key factors driving university students' flexible employment intentions. The results indicate that both models highlight job satisfaction and work-life balance as significant factors, with job satisfaction being ranked with 100% relative importance in the ANN model. Moreover, the consistency of variable rankings across both models confirms the decisive role of these factors in influencing students' flexible employment intentions. Consequently, promoting job satisfaction and supporting work-life balance are critical strategies for enhancing students' innovative potential and providing practical guidance for enterprise management practices.

The importance of job satisfaction and work-life balance in shaping flexible employment choices is directly related to Human Resource Agility Theory (AHRM). In the post-pandemic landscape, organizations need to remain agile, and employees' ability to balance work and life while maintaining satisfaction is key to both retention and productivity. Our study emphasizes the necessity for organizations to adopt flexible work arrangements that prioritize these factors, fostering an environment where employees are motivated to contribute their innovative potential, as outlined in AHRM.

Finally, the fsQCA results offer valuable insights into the driving factors behind university students' flexible employment intentions (EI). The analysis identified five configurations leading to high levels of EI, with work-life balance (WLB) and extrinsic motivation (EM) acting as core or peripheral conditions in these configurations. Notably, Configuration 1 stands out due to its consistency and unique coverage, highlighting its significant contribution to explaining EI. These results underscore the importance of multidimensional combinations of conditions in influencing job intention, particularly the roles of WLB and EM.

These findings contribute new insights to Social Exchange Theory (SET), which emphasizes the role of reciprocal benefits in decision-making. In the context of flexible employment, students are motivated by the balance between personal needs (e.g., work-life balance) and the benefits offered by employers (e.g., extrinsic motivation). The significance of multidimensional conditions in driving job intention aligns with SET's premise that employment decisions are shaped by the mutual exchange of benefits, particularly in flexible work environments.

**Theoretical and methodological contribution.** This study makes several important contributions to the understanding of employment market choice behavior in the post-pandemic era, both in terms of theory and methodology. First, it challenges the traditional perspective that relies on classical employment intention models and provides a more comprehensive explanation of college students' flexible employment choices. Classical models, such as SDT (Deci & Ryan, 2012) and the TPB, have been widely used to assess students' employment intentions. However, their widespread application has raised concerns about their originality, as they primarily focus on rational decision-making factors and overlook the multidimensional motivational factors that influence college students' flexible employment choices, such as economic pressure, mental health, and work-life balance. This study introduces SET and emphasizes emotional motivation (EM) and work-life balance (WLB), providing a fresh perspective on flexible employment intentions and offering new empirical support for the applicability of SDT and TPB.

Second, this study proposes a novel methodology that combines Partial Least Squares Structural Equation Modeling (PLS-SEM) with Artificial Neural Network (ANN) analysis to

investigate the complex employment choice behavior. While PLS-SEM has been extensively used in employment intention research to test linear relationships between variables (e.g., Hair et al., 2019), it has limitations in capturing nonlinear relationships and interaction effects. This study combines ANN to address these complexities, revealing the significance of WLB, EM, and job satisfaction (JS) in flexible employment choices. The comparative analysis between PLS-SEM and ANN shows differences in path coefficients and relative importance rankings, suggesting that researchers should consider the nonlinear dynamics of influencing factors and combine multiple methods to analyze employment choice behavior for a more comprehensive understanding.

Finally, the application of Fuzzy-Set Qualitative Comparative Analysis (fsQCA) further enriches this study's contributions. While existing research on the post-pandemic employment market typically focuses on the influence of individual factors on employment choices, the fsQCA method reveals how different combinations of conditions collectively influence students' flexible employment choices. fsQCA analysis shows that combinations of factors, such as job satisfaction and work-life balance, can explain different pathways leading to students' employment intentions. This provides new insights into the complexity of employment decision-making and lays the groundwork for future research on employment choice behavior in different contexts.

Through these theoretical and methodological innovations, this study not only deepens our understanding of college students' flexible employment choices but also provides new paradigms and tools for future research in the ever-evolving employment market.

**Research limitations and suggestions.** Although this study has made significant contributions to the theoretical and empirical research on flexible employment choices, several limitations remain that should be addressed in future research.

First, the sample in this study primarily focuses on graduates in China. This homogeneity in the sample may limit the generalizability of the findings. The unique socio-economic background, cultural environment, and educational system in China may have specific influences on students' employment choices, thus restricting the applicability of the results to other countries or cultural contexts. Additionally, the exclusion of non-graduate groups could lead to a biased understanding of college students' flexible employment tendencies. Future research should expand the sample to include participants from different countries or cultural backgrounds and cover students at different stages of their academic journey, such as non-graduates and postgraduates. This would provide a more comprehensive reflection of the universality and diversity of flexible employment choices. In particular, cross-cultural or cross-regional comparative studies could further validate the applicability of the findings and explore how different cultural, economic, and policy factors influence flexible employment choices.

Second, this study uses a cross-sectional research design, which captures the current situation but does not reflect the dynamic nature of flexible employment choices. Over time, changes in external factors such as economic fluctuations, technological advancements, and policy adjustments could significantly affect individuals' employment choices. Future research should consider adopting a longitudinal design to track flexible employment behavior over time, revealing long-term trends and pathways.

Third, this study primarily relies on self-report data. Although this method is standard in social science research, it may introduce social desirability bias and self-report bias, which could affect the accuracy of the results. Future research could use more diverse data collection methods to enhance the reliability of the



data, such as combining quantitative and qualitative data or employing experimental designs to validate causal relationships between key variables. Additionally, data from employers or third-party sources, such as job postings or actual employment statistics, could complement the limitations of subjective reports.

Finally, the variables selected in this study focus mainly on relatively subjective influencing factors, such as work-life balance and job satisfaction, while overlooking other potentially important factors, such as social support, career development opportunities, market demand, and digital skills requirements. Future research should broaden the scope of variables to explore how these factors influence flexible employment choices and the interaction mechanisms between these factors. In particular, examining the role of social support and career opportunities in different cultural contexts may provide a more comprehensive theoretical perspective on flexible employment choices.

In conclusion, while this study offers new insights into college students' flexible employment choices, several limitations remain. Future research should address these issues by expanding the sample range (e.g., including non-graduates and students from different regions), adopting longitudinal designs, optimizing data collection methods, and expanding the scope of variables. Special attention should be given to cross-cultural and cross-regional comparative studies to deepen and broaden our understanding of this complex social phenomenon.

### Data availability

The data underpinning the findings of this study were obtained with permission from the relevant institutional statistics offices in the research region and are not publicly available. The data were collected solely for academic research purposes and do not contain any sensitive or private information about the students. Interested researchers may contact the corresponding author to request access to the data. All requests will be reviewed to ensure compliance with institutional policies and ethical guidelines. The data provided will be fully anonymized to protect the privacy of the participants.

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## Author contributions

QC: Formal analysis; Resources; Software; Supervision; Validation; Visualization; Writing—original draft; Writing—review and editing; Translation. WC: Funding acquisition; Project administration. MW: Data curation; Investigation. KD: Conceptualization; Methodology.

## Competing interests

The authors declare no competing interests.

## Ethical approval

This study does not require ethical approval as the data were obtained with permission from the relevant statistical office of the local educational bureau's employment office in the research region. The data were collected solely for academic research purposes and do not contain any sensitive or private information about the students. Furthermore, the institution does not have an ethics review committee. According to Article 32 of the "Notice on Issuing the Ethical Review Measures for Life Science and Medical Research Involving Human Subjects" (State Council Document), the data used in this study are exempt from ethical review. The data were obtained through proper authorization and explicit permission from the relevant institution. This study did not involve any personal information or biological samples, and all data were fully anonymized. As stipulated by the regulations, the use of anonymized data for research purposes does not pose any harm to human subjects and does not involve sensitive personal data or commercial interests. This exemption helps reduce unnecessary burdens on researchers and facilitates the advancement of life science research. The study adheres to the "Helsinki Declaration" and relevant ethical research guidelines. Exemption approval was granted by the Local Educational Bureau Employment Office (Exemption Number: Guo Wei Ke Jiao Fa [2023] No. 4) on February 18, 2023. The exemption was granted due to the fact that the data were fully anonymized and do not involve any sensitive personal information or biological samples, which are exempt from ethical review. For further details, please refer to the URL: [https://www.gov.cn/zhengce/zhengceku/2023-02/28/content\\_5743658.htm](https://www.gov.cn/zhengce/zhengceku/2023-02/28/content_5743658.htm).

## Informed consent

Informed consent was obtained from all participants prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without providing a reason. Consent was obtained in written form, and participants were assured that their responses would remain anonymous and confidential. The study did not disclose any personal or sensitive information about the respondents.

## Additional information

**Supplementary information** The online version contains supplementary material available at <https://doi.org/10.1057/s41599-025-05117-y>.

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