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From automation to employee loyalty: understanding the balance between robots and workforce stability

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Abstract

Purpose – Grounded in the conservation of resources (COR) theory, this study aims to investigate how robot usage influences employees' job insecurity, perceived organizational support, job satisfaction and turnover intention, while also considering the moderating effects of training and development opportunities.

Design/methodology/approach – Leveraging survey data from 343 employees across 20 robot-integrated hotels in Guangdong, China. This study pioneers a dual-method approach (partial least squares structural equation modeling [PLS-SEM] + fuzzy set qualitative comparative analysis [fsQCA]) to model turnover intention as both linear and configurational outcomes, revealing that robot usage alone explains only 32.8% of job insecurity, while combined factors (e.g. low perceived organizational support) drive 79.9% of turnover cases.

Findings – The findings reveal that the implementation of robots significantly heightens job insecurity, subsequently driving up turnover intentions. Conversely, job satisfaction and perceived organizational support effectively mitigate turnover intention and mediate the relationship between job insecurity and turnover intention. Notably, enhanced training and development opportunities alleviate the negative impacts of job insecurity on employee outcomes. In addition, fsQCA identifies six distinct configurations leading to high turnover intentions, offering actionable strategies for hotels to foster employee engagement and retention in the face of technological advancements.

Originality/value – This study combines PLS-SEM and fsQCA to address a key paradox in COR theory, how training can both reduce job insecurity and increase turnover. This dual-method approach highlights previously unexplored resource tradeoffs in automation literature. High robot usage leads to 32.8% job insecurity (PLS-SEM), but with low organizational support, it influences 79.9% of turnover instances (fsQCA).

Keywords Robots' usage, Job insecurity, Turnover intention, Human resource management, PLS-fsQCA

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从自动化到员工忠诚：理解机器人与劳动力稳定性的平衡

摘要

研究目的 – 基于资源保存理论（COR），本研究探讨机器人使用如何影响员工的工作不安全感、感知到的组织支持、工作满意度和离职意向, 并考察培训与发展机会的调节作用。

研究方法 – 本研究基于对中国广东20家引入机器人的酒店中343名员工的调查数据, 创新性地采用偏最小二乘结构方程模型（PLS-SEM）与模糊集定性比较分析（fsQCA）的双方法, 分别将离职意向建模为线性与组态性结果。结果显示，单纯机器人使用仅能解释32.8%的工作不安全感，而结合其他因素（如低组织支持）时可解释79.9%的离职案例。

研究发现 – 结果表明, 机器人应用显著提高了员工的工作不安全感, 进而增强离职意向; 相反, 工作满意度与感知到的组织支持能有效缓解离职意向，并在工作不安全感与离职意向之间发挥中介作用。值得注意的是，完善的培训与发展机会可减轻工作不安全感对员工结果的负面影响。此外，fsQCA分析识别出导致高离职意向的六种不同配置，为酒店在技术进步背景下提升员工投入与留任提供了可操作的策略。

研究创新 – 本研究结合PLS-SEM与fsQCA，回应了资源保存理论中的核心悖论——培训既能降低工作不安全感，又可能提升离职率。该双方法揭示了自动化文献中尚未探索的资源权衡：高水平的机器人使用带来32.8%的工作不安全感（PLS-SEM），但在组织支持不足时，可导致79.9%的离职案例(fsQCA)。

关键词 机器人使用, 工作不安全感, 离职意向, 人力资源管理, PLS-fsQCA

文章类型 研究型论文

Introduction

The hospitality industry is facing unprecedented challenges. China's hospitality sector is experiencing considerable workforce instability, with post-COVID turnover at 58% (Xu *et al.*, 2023). This issue is further complicated by the swift integration of automation and inconsistent labor policies. Amid this turmoil, advancements in artificial intelligence are driving the integration of robots into service delivery, promising operational efficiency and innovative guest experiences (Park *et al.*, 2023). By 2023, service robots are expected to comprise nearly 25% of the global hospitality workforce, and AI and automation are anticipated to replace one-third of jobs by 2025 (Xu *et al.*, 2023, 2024). Managers operationalize robot usage as the extent to which hotels deploy automated systems (e.g. AI-powered concierge robots, automated room-cleaning devices) to replace or augment human tasks. For instance, Japan's Henn-na Hotel uses robots for 40% of its front-desk operations, whereas US hotels lag behind at 15% due to labor union resistance (Reis *et al.*, 2020; Willcocks, 2020). These differences may suggest that labor market conditions, technology adoption and technological infrastructure influence automation trends in different regions/countries.

Robots are increasingly deployed in customer reception, room cleaning and food and beverage service to optimize processes and reduce costs (Koo *et al.*, 2023). However, the ability of robots to perform tasks independently may threaten people's sense of job security, but the extent of this impact will vary depending on an individual's job role. Haldorai *et al.* (2024) suggested that frontline employees experience higher levels of job insecurity due to direct exposure to automation. Conversely, back-office employees tend to perceive robots as effective in improving their productivity.

Effective robot implementation typically involves collaboration with human workers, requiring a nuanced understanding of employee perceptions and emotions (Li *et al.*, 2024). Hotel managers must address these insecurities proactively to prevent increased turnover. Ideally, the introduction of robots should create a symbiotic cycle where organizations invest in employee skill development, thereby enhancing workforce efficiency, expertise and job satisfaction.

Some studies suggest that robot integration can increase employee turnover due to job displacement (Fulmore *et al.*, 2023; Zhang *et al.*, 2023; Brougham and Haar, 2020), while others indicate that this impact can be mitigated through organizational support (Başer *et al.*, 2025). Conservation of resources (COR) theory suggests that employees evaluate the loss of job security against the support they receive. However, little research has examined this in high-automation settings, such as China. While some findings suggest that robots may increase turnover intentions due to concerns about job security (Zhang *et al.*, 2023), others indicate that perceived organizational support and employee development can foster positive attitudes toward human–robot collaboration (Başer *et al.*, 2025). Ekuma (2024) confirmed that enhanced training and development opportunities can mitigate the negative effects of automation integration, and that training programs that focus on human–machine collaboration significantly increase employee job security. Stacho *et al.* (2024) implemented a human–robot collaboration curriculum (e.g. troubleshooting robot errors, optimizing task allocation between staff and robots), which reduced turnover by 20%. This highlights the importance of role-specific training, rather than generic upskilling. Therefore, understanding the reciprocal relationship between robot usage and employee outcomes is crucial for balancing technological benefits with workforce sustainability.

This study examines the reciprocal relationship using the COR theory, investigating how the introduction of robots affects job insecurity, perceived organizational support, job satisfaction and turnover intention in the hospitality sector. COR theory suggests that individuals strive to retain and build resources, such as job security and support, to manage work demands. The cycle of reciprocity between automation integration and the employee depends not only on the employee's own ability to adapt, but also on management strategies that optimize human–robot collaboration (Khoa *et al.*, 2023; Leocádio *et al.*, 2024). Hotel managers play a crucial role in maintaining this balance by assigning tasks effectively, redesigning roles, providing structured training and making ongoing operational adjustments. For example, robots perform repetitive tasks, while employees focus on providing personalized and emotionally valuable interactions to guests (Khoa *et al.*, 2023), aiming to improve service quality and work engagement. In addition, the effectiveness of structured training for various roles, including retraining programs, cross-training and technology adaptation workshops, can be beneficial in reducing employee turnover (Pinnington *et al.*, 2024).

This study aims to fill the research gap on the interplay of robot use on employees' job outcomes and turnover intentions by exploring the impact of robot use on job insecurity, examining the link between job insecurity and turnover intentions, assessing the mediating role of job satisfaction and perceived organizational support and examining the moderating role of skill development opportunities. This research used partial least squares structural equation modeling (PLS-SEM) and fuzzy set qualitative comparative analysis (fsQCA) to comprehensively address these objectives. PLS-SEM examines complex theoretical models, while fsQCA analyzes multiple causal pathways, providing nuanced insights into factors influencing turnover intention. By integrating these methods, the study provides a robust understanding of how robot use affects employee retention, offering hotel management practical guidance to enhance workforce sustainability amid rapid technological advancements.

Conceptual framework and hypothesis development

Theoretical foundation

COR theory posits that individuals strive to acquire and protect resources essential to their well-being, experiencing stress when these resources are threatened or lost (Hobfoll and Freedy, 2017). Widely applied to workplace stress and employee resilience, COR emphasizes that resources such as job security and organizational support are crucial for

maintaining employee well-being and optimal performance. When employees perceive an inability to safeguard these resources, turnover intentions may increase (Anasori *et al.*, 2021; Raper *et al.*, 2024; Xiaoxin *et al.*, 2025).

In this study, hotel robots are found to play a dual role. For some employees, the improvements in work efficiency; for others, they raise concerns about job security and signal a potential loss of valued resources (Gonzalez-Jimenez and Costa Pinto, 2024; Tojib *et al.*, 2022). The relationship between employee outcomes and robot use is dynamic. The initial use of automation raises concerns about barriers to work, prompting firms to invoke labor development programs. As employees master human–robot collaboration fits, firms may adjust their automation strategies (Li *et al.*, 2024; Tan *et al.*, 2025). This iteration underscores the developmental nature of integrating labor and technology, thereby promoting a cycle of resource replenishment that aligns with COR's conservation-restoration principles (Guo *et al.*, 2023; Koo *et al.*, 2023). This study advances COR theory by introducing resource trade-off cycles. In this cycle, automation can decrease job security for workers because machines take over certain tasks. At the same time, automation increases efficiency, streamlining processes and boosting productivity. This update to COR's conservation principle shows how employees weigh gains against losses. When their resources change, such as when job stability falls but efficiency rises, employees have to rethink what matters most in their work environment. Unlike prior work (Zhang *et al.*, 2023), researchers model this duality through moderated mediation, revealing how training transforms depletion into resilience. technological context (see Figure 1).

Hypothesis development

The usage of robots, job insecurity and turnover intention. The integration of artificial intelligence and robots in hospitality fundamentally transforms service operations, impacting hotels, employees and guests. Existing research highlights both the benefits and challenges of robotics in hospitality (Rampersad, 2020; Shao *et al.*, 2022), with job insecurity emerging as a key concern for employees. The perceived threat of robot replacement heightens job insecurity, leading to stress, reduced motivation and impacts on cognitive and emotional well-being (De Cuyper *et al.*, 2020; Langerak *et al.*, 2022). This insecurity can result in dissatisfaction, anxiety and increased turnover intentions (Nemteanu *et al.*, 2021). Initially, employees may be curious about working alongside robots, but this can shift to insecurity if

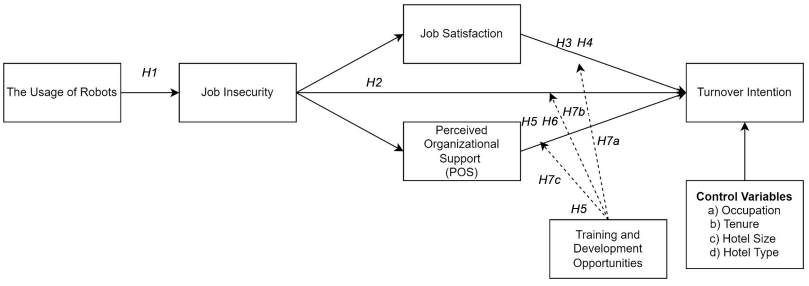

Figure 1. Conceptual model

Note(s): The usage of robots (UOR); job insecurity (JI); job satisfaction (JS); turnover intention (TI); perceived organizational support (POS); training and development opportunities (TDO); UOR → JI (*H1*); JI → TI (*H2*); JS → TI (*H3*); JI → JS → TI (*H4*); POS → TI (*H5*); JI → PO → TI (*H6*); TDO x JS → TI (*H7a*); TDO x JI → TI (*H7b*); TDO x POS → TI (*H7c*)

Source: Authors' own creation

they feel their roles are at risk (Na *et al.*, 2023). Adekiya (2024) noted that job insecurity primarily arises from fears of involuntary unemployment, which a lack of organizational support can exacerbate (Wang *et al.*, 2020a, 2020b, 2020c). However, organizational support and skill development opportunities can mitigate these negative effects by providing employees with resources and security, thereby reducing job insecurity and further highlighting the importance of a supportive work environment for job stability. According to COR theory, Yam *et al.* (2023) found that fears of automation increase employee stress and anxiety, prompting them to seek additional training and internal transfers to protect their resources. Based on these insights, researchers propose the following hypothesis:

H1. Using robots is positively correlated with employee job insecurity.

Turnover intention, influenced by factors such as job stress, satisfaction and perceived organizational support, refers to an employee's intent to leave an organization or role in the near future (Yan *et al.*, 2021a, 2021b; Yu *et al.*, 2021). It is a significant predictor of actual turnover, strongly impacting employees' decisions to exit (Wong and Cheng, 2020). Job insecurity, particularly during technological transitions like robot integration, is a key predictor of turnover intention (Brougham and Haar, 2020). When employees perceive a threat to their employment, their intentions to turnover increase. According to COR theory, perceived resource loss due to job insecurity motivates employees to seek new opportunities or disengage from their current roles. Since this turnover often results from perceived instability, researchers propose the following hypothesis:

H2. Employee's job insecurity is positively correlated with their turnover intention.

Job satisfaction as a mediating variable. The integration of robots in hotels has significantly enhanced service efficiency in tasks such as room service and customer interactions (Garcia-Haro *et al.*, 2020; Zeng *et al.*, 2020; Gupta *et al.*, 2022; Lin and Mattila, 2021). However, as robots take on more responsibilities, employees may experience increased job insecurity, leading to anxiety and reduced job satisfaction. Job satisfaction, defined as employees' positive perception of their roles and work environment (Khatun *et al.*, 2022; Taj *et al.*, 2020), is crucial in reducing turnover intentions. Research shows that job satisfaction is influenced by both organizational and personal factors (Díaz-Carrión *et al.*, 2020). Employees who perceive strong training opportunities and a supportive environment tend to report lower job insecurity and turnover intentions (Díaz-Carrión *et al.*, 2020; Viseu *et al.*, 2020). From the COR theory perspective, perceived resource losses, such as increased workloads or insufficient support, heighten stress and diminish job satisfaction, thereby driving turnover intention. Thus, we propose that job satisfaction acts as a vital mediator between job insecurity and turnover intention. Accordingly, researchers propose the following hypotheses:

H3. Employee's job satisfaction is negatively correlated with their turnover intention.

H4. Employee job satisfaction mediates the relationship between job insecurity and turnover intention.

Perceived organizational support as a mediating variable. Perceived organizational support refers to the beliefs and subjective feelings of employees that the organization values their well-being and recognizes their contributions (Aldabbas *et al.*, 2023; Wang *et al.*, 2020a, 2020b, 2020c). It typically involves holistic organizational care, such as job resources and psychological support, which affects employees' sense of belonging and loyalty (Chen *et al.*, 2023;

Li *et al.*, 2020; Takaya and Ramli, 2020). When employees feel supported, they are more likely to perceive their importance within the organization, leading to increased effort and loyalty (Asghar *et al.*, 2021; Eisenberger *et al.*, 2020). Research shows a positive correlation between high levels of perceived organizational support (POS) and reduced turnover intentions, fostering a sense of belonging (Asghar *et al.*, 2021). In addition, POS can alleviate negative emotions and stress during challenging work conditions, enhancing psychological well-being and further reducing turnover intentions (Akgunduz *et al.*, 2023; Tetteh *et al.*, 2020). From a COR theory perspective, POS serves as a vital resource by providing emotional, psychological and material support, motivating employees to mitigate job insecurity and lower turnover intentions (Bardoel and Drago, 2021; Eisenberger *et al.*, 2020). Lu *et al.* (2024) found that providing appropriate training and psychological support in automated environments effectively reduces employee stress and enhances loyalty. Thus, researchers propose the following hypotheses:

H5. Employee's perceived organizational support is negatively correlated with their turnover intention.

H6. Employee's perceived organizational support mediates the relationship between their job insecurity and turnover intention.

Training and development opportunities as a moderating variable. Training and development opportunities are crucial for enhancing employee skills and competencies, as well as fostering organizational identification (Piwowar-Sulej, 2021; Rampa and Agogué, 2021). It focuses on enhancing employees' skills and promoting continuous professional growth, typically through training programs, on-the-job learning or promotional opportunities (Tan *et al.*, 2023). Practical training ensures employees maintain the knowledge and skills needed for high service quality and a positive organizational image (Nguyen and Malik, 2022). Research highlights the importance of equipping frontline staff with job-specific and behavioral skills to enhance service delivery and foster long-term career growth (Kamna and Ilkhanizadeh, 2022; Lan *et al.*, 2021). Organizations investing in career development often see reduced turnover intentions (Fulmore *et al.*, 2023).

Training can buffer the adverse effects of job insecurity on turnover intentions (Lin and Huang, 2021). Employees who perceive ample training are more likely to demonstrate loyalty and commitment, thereby reducing the likelihood of turnover (Sun *et al.*, 2025; Memon *et al.*, 2021). However, some argue that increased training may boost employees' confidence in pursuing external opportunities, potentially increasing turnover intentions (Salleh *et al.*, 2020; Vizano *et al.*, 2021). In addition, high-potential employees may seek better prospects after gaining new skills and dissatisfaction with misaligned training can expedite turnover decisions (Deller, 2023). According to COR theory, training and development enable employees to build knowledge and skills, thereby reducing stress; however, they may also lead to negative outcomes. Consequently, researchers propose the following hypotheses:

H7a. Training and development opportunities moderates the relationship between job satisfaction and turnover intention; that is, job satisfaction's effect on turnover intention increases when training and development opportunities are increased.

H7b. Training and development opportunities moderates the relationship between job insecurity and turnover intention, i.e. the effect of job insecurity on turnover intention diminishes when training and development opportunities increase.

H7c. Training and development opportunities moderates the relationship between perceived organizational support and turnover intention, i.e. the negative impact of perceived organizational support on turnover intention increased when training and development opportunities increased.

Methodology

Sample and data collection

Guangdong, as one of the first provinces in China to adopt automation in the hospitality industry, provides a unique and representative context for exploring the impact of robot integration. Its high level of internationalization offers valuable insights for countries/regions with similar economic and cultural backgrounds. Therefore, this study was conducted in Guangdong Province, China, focusing on frontline employees at 20 hotels who have integrated robots into their hotel operations. Eligible participants were at least 18 years old and had experience using robots in their work tasks. Data collection was facilitated by the HR managers of each hotel, who distributed questionnaires via a link to an electronic survey hosted on Wenjuanxing (www.wjx.cn/) through internal WeChat employee group chats. This approach ensured that employees could complete the survey privately and anonymously. Data collection took place in August 2024.

Measures and pilot testing

The questionnaire measured six constructs: usage of robots (Zhang *et al.*, 2023), job insecurity, perceived organizational support (Akgunduz and Sanli, 2017), job satisfaction (Wang *et al.*, 2020a, 2020b, 2020c), training and development opportunities and turnover intention (Yavas *et al.*, 2003). In addition, it included demographic information and a screening question. All items were rated on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

Prior to the formal study, a pilot test was conducted with 20 hotel employees who interacted with robots, leading to revisions for improved clarity and comprehension. Scale validation involved calculating correlations and Cronbach's alpha coefficients. The questionnaire was also reviewed by two hospitality researchers and two HR managers to ensure relevance and content validity. A direct-translation method was used to maintain consistency and accuracy for Chinese respondents (Wang and Wang, 2022).

From the initial responses, 36 incomplete surveys were excluded, resulting in 343 valid responses. G*Power analysis confirmed that this sample size exceeded the minimum requirement of 146 (effect size $f^2 = 0.15$, $\alpha = 0.05$, power = 0.95), ensuring adequacy for analysis. The demographic breakdown of respondents was 56.3% female and 43.2% aged 18–24 years. Educational backgrounds were primarily high school or below (37.6%) and associate degrees (38.5%). Most participants held service positions (49.3%), with 28% having a tenure of 6 months to 1 year, 30.6% working in hotels with fewer than 50 rooms and 19.5% employed in boutique hotels (see Table 1).

Control variable

Li and Zhang (2023) indicated that demographic characteristics (such as gender, age or job occupation) can lead to differences in employee behavior intentions. Related studies have pointed out that employee turnover intentions are significantly associated with tenure, hotel size and hotel type (Ampofo and Karatepe, 2022; Başer *et al.*, 2025; Li *et al.*, 2021). Therefore, in this analysis, this study controls for four variables: demographic characteristics (such as job occupation), tenure, hotel size and hotel type.

Table 1. Demographics of participants ($N = 343$)

Characteristic	Categories	Frequency	%
Gender	Male	150	43.7
	Female	193	56.3
Age	18–24	148	43.2
	25–34	76	22.2
	35–44	33	9.6
	45–54	56	16.3
	55–64	20	5.8
	Above 65	10	2.9
Education	High school and below	129	37.6
	Associate degree	132	38.5
	Bachelor's degree	55	16.0
	Master's degree/PhD	27	7.9
Occupation	Service position	169	49.3
	Sales position	113	32.9
	Technical position	61	17.8
Tenure	6 months– one year	96	28.0
	1 year–3yearsyears	95	27.7
	3 years–5 years	70	20.4
	Above 5 years	82	23.9
Hotel size	Less than 50 rooms	105	30.6
	51–150 rooms	94	27.4
	151–300 rooms	61	17.8
	Above 300 rooms	83	24.2
Hotel type	Chain hotel	62	18.1
	Budget hotel	61	17.8
	Boutique hotel	67	19.5
	Resort hotel	46	13.4
	Business hotel	53	15.5
	Luxury hotel	54	15.7

Source(s): Authors' own creation

Common method bias

Before hypothesis testing, a Harman one-way test was conducted to assess common method bias (CMB). The cumulative variance explained was 28.5%, below the 50% threshold, indicating that CMB is not a concern in this study. PLS-SEM identifies multiple pathways by examining linear causality between variables (Hair *et al.*, 2023), whereas fsQCA emphasizes causal complexity (Lazzari *et al.*, 2022) and can identify multiple pathways by revealing the common effects of different combinations of variables on outcomes. The combination of the two analytical approaches tests hypotheses and explores potential alternative pathways, thereby enhancing the robustness, theoretical depth and timeliness of the study's conclusions. Therefore, data analysis in this study was performed using SmartPLS 4.0 PLS-SEM and fsQCA 3.0 software.

Results

Results of assessment of model using PLS-SEM

Measurement model evaluation. The measurement model's reliability, convergent validity and discriminant validity were rigorously assessed. Convergent validity was evaluated using Cronbach's alpha, factor loadings, composite reliability (CR) and average variance extracted

(AVE). Both Cronbach's alpha and CR exceeded the recommended threshold of 0.7 and AVE values surpassed 0.5, indicating satisfactory construct reliability. Factor loadings ranged from 0.790 to 0.916, all of which exceeded the 0.7 threshold (see Table 2), confirming convergent validity (Hair *et al.*, 2024).

To ensure that no multicollinearity existed before testing hypotheses, Variance Inflation Factor (VIF) values were examined for the variables of robot usage, job insecurity, perceived organizational support, job satisfaction, training and development opportunities and turnover intention. VIF values ranged from 1.718 to 3.808, well below the 5 thresholds, indicating no multicollinearity issues (Hair *et al.*, 2023). In addition, the Heterotrait-Monotrait ratio (HTMT) was calculated to assess discriminant validity, with all values below 0.85, confirming adequate discriminant validity. Detailed HTMT results are presented in Table 3.

Structural model evaluation. The structural model evaluation results are summarized in Table 4. The analysis revealed that robot usage has a positive effect on job insecurity (β = 0.328, $p < 0.001$), supporting *H1*. Job insecurity, in turn, has a positive impact on turnover intention (β = 0.315, $p < 0.001$), confirming *H2*. In addition, job satisfaction negatively influences turnover intention ($\beta = -0.277$, $p < 0.001$), supporting *H3*. Job satisfaction also significantly mediates the relationship between job insecurity and turnover intention (β = 0.095, $p < 0.001$), supporting *H4*. Perceived organizational support negatively correlates with turnover intention ($\beta = -0.312$, $p < 0.001$), confirming *H5*. In addition, it significantly mediates the relationship between job insecurity and turnover intention (β = 0.101, $p < 0.001$), supporting *H6*.

Training and development opportunities significantly moderated the relationship between job insecurity and turnover intention ($\beta = -0.153$, $p < 0.05$) and between perceived organizational support and turnover intention ($\beta = -0.101$, $p < 0.05$), supporting *H7b* and *H7c*. However, training and development opportunities did not significantly moderate the relationship between job satisfaction and turnover intention ($\beta = -0.082$, n.s.), thereby rejecting *H7a*.

The model explained 41.8% of the variance in turnover intention ($R^2 = 0.418$), surpassing the 0.30 threshold and demonstrating good explanatory power. Model fit was confirmed with a standardized root mean square residual (SRMR) of 0.067, below the acceptable cutoff of 0.08. Furthermore, the positive Q^2 value for turnover intention ($Q^2 = 0.036$) validated the model's predictive capability.

Results of fsQCA

After model estimation, fsQCA was used to further analyze the data and identify factors associated with high turnover intention. The previous PLS-SEM findings clarified the relationships among variables and provided empirical evidence on how robot usage affects employee turnover intention. Recognizing that multiple factors influence turnover intention, with no single element dictating it entirely (Lazzari *et al.*, 2022; Yan *et al.*, 2021a, 2021b), researchers leveraged the PLS-SEM results to apply the fsQCA approach. This allowed us to explore effective strategies for mitigating turnover intention from a configurational perspective and identify optimal solutions (see Figure 2).

Data calibration. Data calibration is essential for conducting fsQCA (Fainshmidt *et al.*, 2020). This process converts raw data into fuzzy sets with affiliation scores ranging from 0.00 to 1.00, accurate to two decimal places (Ragin, 2007). Scores of 0.00 and 1.00 denote complete non-membership and full membership, respectively, while 0.50 indicates maximum ambiguity and was adjusted to 0.499 based on prior studies (Drăgan *et al.*, 2023). Calibration was performed using fsQCA 3.0 software, setting the 95th percentile, mean and 5th percentile for each construct as full membership, crossover point and full

Table 2. Measurement model evaluation results

Construct	Factor loading	Cronbach's α	CR	AVE	VIF
The usage of robots (UOR)		0.850	0.863	0.768	
UOR1. I used robots to carry out most of my job functions	0.840				1.928
UOR2. I spent most of the time working with robots	0.890				2.079
UOR3. I worked with robots in making major work decisions	0.898				2.312
Job insecurity (JI)		0.884	0.886	0.684	
JI1. My job is insecure	0.831				2.084
JI2. My job is likely to change in the future	0.841				2.205
JI3. My job is not permanent	0.813				1.973
JI4. I am worried about the possibility of being fired	0.834				2.183
JI5. The thought of getting fired really scares me	0.816				2.066
Perceived organizational support (POS)		0.933	0.935	0.682	
POS1. The organization really cares about my well-being	0.811				2.294
POS2. Help is available from the organization when I have a problem	0.851				2.773
POS3. The organization strongly considers my goals and values	0.836				2.699
POS4. The organization is willing to help me when I need a special favor	0.841				2.624
POS5. If given the opportunity, the organization would take advantage of me	0.814				2.319
POS6. The organization tries to make my job as interesting as possible	0.817				2.364
POS7. The organization takes pride in my accomplishments at work	0.826				2.541
POS8. The organization values my contribution to its well-being	0.810				2.422
Job satisfaction (JS)		0.826	0.838	0.655	
JS1. In my job, I feel that I am doing something worthwhile	0.790				1.718
JS2. I feel that my job is interesting	0.794				1.772
JS3. I feel that my job is satisfying	0.813				1.719
JS4. If I had to do it all over again, I would choose another job	0.840				1.770

(*continued*)

Table 2. Continued

Construct	Factor loading	Cronbach's α	CR	AVE	VIF
Training and development opportunities (TDO)		0.953	1.054	0.762	
TDO1. This hotel will have a variety of trainings to enhance the staff's guest service skills	0.912				3.695
TDO2. Employees receive continued training to provide good service	0.916				3.244
TDO3. Working at this hotel, I receive a large number of guests on a daily basis	0.862				3.480
TDO4. Service training before we come into contact with customers	0.870				3.808
TDO5. We receive training on how to serve customers better in this hotel	0.821				3.444
TDO6. We are trained to deal with customer complaints in this hotel	0.863				3.433
TDO7. We receive training on dealing with customer problems in this hotel	0.862				3.200
Turnover intention (TI)		0.913	0.914	0.793	
TI1. I basically have no desire to leave this current hotel	0.899				3.001
TI2. I plan to have a long-term career in this hotel	0.879				2.698
TI3. I often feel bored with my current job and want to change to a new hotel	0.888				2.696
TI4. In the next six months, I will most likely leave this current hotel	0.895				2.945

Source(s): Authors' own creation

Table 3. Heterotrait-monotrait ratio (HTMT)

Constructs	JI	JS	POS	TDO	TI	UOR
JI	–					
JS	0.397	–				
POS	0.353	0.046	–			
TDO	0.324	0.209	0.196	–		
TI	0.528	0.419	0.460	0.052	–	
UOR	0.375	0.332	0.247	0.198	0.278	–

Source(s): Authors' own creation

Table 4. Structural model results

Paths specified	Standardized coefficient	Finding
UOR → JI	0.328***	*H1* supported
JI → TI	0.350***	*H2* supported
JS → TI	−0.277***	*H3* supported
JI → JS → TI	0.095***	*H4* supported
POS → TI	−0.312***	*H5* supported
JI → POS → TI	0.101***	*H6* supported
TDO × JS → TI	−0.082	*H7a* unsupported
TDO × JI → TI	−0.153*	*H7b* supported
TDO × POS → TI	−0.101*	*H7c* supported
Control variable		
Occupation → TI	−0.026	
Tenure → TI	−0.026	
Hotel size → TI	0.034	
Hotel type → TI	−0.011	
SRMR composite model = 0.041		
R^2TI = 0.418	Q^2TI = 0.036	

Note(s): *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source(s): Authors' own creation

non-membership, respectively, following the direct calibration method recommended in the literature (Kang and Shao, 2023). This range of thresholds is widely used in fsQCA studies to ensure the effective inclusion of high-intensity cases and to maintain the scientific validity and comparability of the analysis.

Necessary conditions analysis. After calibrating the data into fuzzy sets, researchers conducted a necessity analysis focusing on the dependent variable, turnover intention (TI), to determine if any of the five antecedent conditions, usage of robots (UOR), job insecurity (JI), POS, job satisfaction (JS) and training and development opportunities (TDO), were necessary predictors of TI. The adherence of cases to these conditions was measured by "consistency" scores, ranging from 0 to 1 (Liang *et al.*, 2020). A condition was deemed necessary if its consistency score exceeded 0.90 (Sukhov *et al.*, 2023). As shown in Table 5, the consistency scores for the five antecedents ranged from 0.425 to 0.764, all of which were below the 0.90 threshold, indicating that none were necessary for TI. Therefore, these five antecedent conditions can be combined for further analysis of their effects on TI.

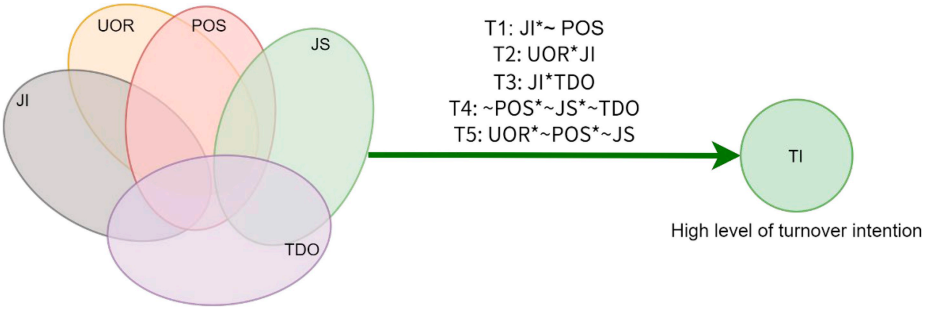

Figure 2. Configurational model
Note(s): TI = turnover intention; JI = job insecurity; UOR = the usage of robots; POS = perceived organizational support; JS = job satisfaction; TDO = training and development opportunities; "~" indicates negation
Source: Authors' own creation

Table 5. Analysis of necessary conditions for predicting turnover intention (TI)

Conditions	High TI Consistency	Coverage	Low TI Consistency	Coverage
UOR	0.671	0.660	0.511	0.537
~UOR	0.529	0.503	0.677	0.687
JI	0.764	0.697	0.489	0.476
~JI	0.425	0.438	0.689	0.757
POS	0.524	0.517	0.700	0.736
~POS	0.732	0.696	0.540	0.548
JS	0.546	0.534	0.699	0.730
~JS	0.724	0.692	0.554	0.566
TDO	0.612	0.621	0.533	0.577
~TDO	0.583	0.539	0.651	0.642

Note(s): "~" means logical operator NOT
Source(s): Authors' own creation

Sufficient conditions analysis. Following the necessity analysis, researchers conducted a sufficiency analysis to identify combinations of conditions that predict turnover intention. According to Pappas and Woodside (2021), researchers first generated a truth table of all logical condition combinations, calculated as 2^k (where k is the number of conditions). This study sets the consistency threshold at 0.60, a value referenced from existing empirical research in the field of organizational management (Hossain *et al.*, 2024; Liang *et al.*, 2020; Wang *et al.*, 2023). In management and organizational contexts, causal relationships often exhibit complexity and heterogeneity. A consistency standard of 0.6 helps identify causal paths that hold under specific combinations of conditions but are difficult to detect in the overall sample. This approach not only ensures the logical relevance of the analysis but also allows us to reveal the diverse and authentic configuration patterns in organizational practices more comprehensively. The fsQCA results produced three solutions: complex, economical and intermediate. Researchers choose the intermediate solution because the causal conditions of the complex solution may have redundant factors that affect the interpretability of the results. The parsimonious solution retains only the core conditions, potentially overlooking

some peripheral conditions that are critical in a particular context. Therefore, the intermediate solution strikes a balance between the two, eliminating unnecessary conditions while retaining theoretically plausible causal pathways, thereby making the conclusion more explanatory (Kang and Shao, 2023). As shown in Table 6, six configurations were identified that lead to high turnover intention, with an overall solution coverage of 0.799 and consistency of 0.780, indicating strong explanatory power and consistency.

The first configuration (T1) revealed that high job insecurity, combined with low perceived organizational support, leads to elevated turnover intention (consistency = 0.804, raw coverage = 0.593). The second configuration (T2) indicated that the absence of perceived organizational support, job satisfaction and training and development opportunities contributes to turnover intention (consistency = 0.891, raw coverage = 0.352). The third configuration (T3) revealed that high robot usage alongside low perceived organizational support and low job satisfaction is associated with increased turnover intention (consistency = 0.836, raw coverage = 0.439). The fourth configuration (T4) demonstrated that high job satisfaction, when combined with high robot usage and job insecurity, results in high turnover intention (consistency = 0.802, raw coverage = 0.448). The fifth configuration (T5) revealed that high job satisfaction, in the presence of high job insecurity and high training and development opportunities, is associated with high turnover intention (consistency = 0.804, raw coverage = 0.442). Finally, the sixth configuration (T6) indicated that high robot usage, high job insecurity and high training and development opportunities contribute to increased turnover intention (consistency = 0.791, raw coverage = 0.406).

Discussion and conclusion

This study, grounded in COR theory, explores the complex relationship between robot usage and employee turnover intentions, highlighting the mediating roles of job insecurity, job satisfaction and perceived organizational support, as well as the moderating effects of training and development opportunities. By using both PLS-SEM and fsQCA methodologies, researchers examined the multifaceted interplay of these variables.

Our PLS-SEM analysis reveals that robot usage significantly increases job insecurity (*H1*), aligning with existing literature (Koo *et al.*, 2023) and suggesting that automation heightens concerns about job stability, especially in roles susceptible to automation. This

Table 6. Main configurations for high TI

	Solutions					
Configuration	T1	T2	T3	T4	T5	T6
UOR	–	–	●	●	–	●
JI	●	–	–	●	●	●
POS	⊗	⊗	⊗	–	–	–
JS	–	⊗	⊗	⊗	⊗	–
TDO	–	⊗	–	–	●	●
Raw coverage	0.593	0.352	0.439	0.448	0.442	0.406
Unique coverage	0.070	0.033	0.028	0.034	0.022	0.022
Consistency	0.804	0.891	0.836	0.802	0.804	0.791
Solution coverage	0.799					
Solution consistency	0.780					

Note(s): ● indicate the core condition exist, ⊗ indicate the core condition does not exist and ⊗ indicate the peripheral condition does not exist. The presence or absence of a condition is indicated by "–"
Source(s): Authors' own creation

heightened anxiety likely drives employees to seek more stable employment alternatives, indicating that organizations must address job insecurity to effectively mitigate turnover intentions (Adekiya, 2024; Na *et al.*, 2023; Nemteanu *et al.*, 2021). Furthermore, job insecurity emerges as a critical predictor of turnover intentions (*H2*), where psychological stress prompts employees to explore other opportunities (Yu *et al.*, 2021). Organizations can reduce turnover rates by implementing strategies that alleviate job insecurity while leveraging productivity gains (Lu *et al.*, 2024; Wong and Cheng, 2020).

In addition, our analysis reveals significant negative relationships between job satisfaction and perceived organizational support, as well as between these factors and turnover intention (*H3*, *H5*). While previous studies have emphasized job autonomy, our findings highlight the importance of job satisfaction and perceived organizational support in meeting employees' psychological needs. Organizations prioritizing these factors can enhance talent retention and satisfaction (Khatun *et al.*, 2022; Yu *et al.*, 2021). Moreover, both job satisfaction and perceived organizational support mediate the impact of job insecurity on turnover intention (*H4*, *H6*). High levels of satisfaction and perceived support can mitigate the effects of job insecurity on turnover intentions, consistent with findings from Addai *et al.* (2022).

Our findings also confirm the moderating role of training and development opportunities (*H7b*, *H7c*), indicating that such opportunities can lessen the negative effects of job insecurity on turnover intentions and enhance perceived organizational support (Brougham and Haar, 2020; Chen *et al.*, 2023; Yao *et al.*, 2024). This investment not only develops professional competencies but also fosters a sense of belonging among employees (Fulmore *et al.*, 2023; Tan *et al.*, 2023). However, training and development opportunities do not significantly moderate the relationship between job satisfaction and turnover intention (*H7a*). The rejection of *H7a* aligns with emerging evidence on technology-driven skill markets (Ekuma, 2024). This may reflect a dual role of training: while it enhances loyalty by signaling organizational investment (Fulmore *et al.*, 2023), it also equips employees with skills that increase their external marketability. For example, a front-desk employee trained in robot maintenance may leverage this skill to seek higher-paying tech roles, thereby offsetting the need for additional satisfaction (Salleh *et al.*, 2020). COR theory explains this paradox by examining how people assess their resources. Training provides employees with new skills, enabling them to assess the resources they already have. When employees perceive that their organization's support for initiatives such as career growth is lacking, they may seek better opportunities elsewhere (Hobfoll and Freedy, 2017).

In addition, this study controlled for variables such as job occupation, tenure, hotel size and hotel type. Although the control variables did not show statistical significance, they still have the potential to explain the differences between robot exposure and employee responses. For example, employees in frontline service departments (such as housekeeping and food and beverage) are more likely to interact directly with robots. At the same time, back-office positions or mid-to-senior-level roles have relatively lower interaction frequencies. Such interaction differences may influence employees' perceptions of technological replacement, training needs and career development, thereby indirectly affecting their turnover intentions and work attitudes.

The fsQCA results identify six configurations leading to high turnover intention, notably highlighting that low perceived organizational support exacerbates turnover intentions among employees facing job insecurity (Solution 1). Other configurations demonstrate that the interplay between job satisfaction, job insecurity and training opportunities significantly influences turnover intention, thereby validating our hypotheses (*H1*, *H5*, *H7c*). While PLS-SEM identified linear relationships (e.g. robot usage → job insecurity), fsQCA revealed non-

linear pathways. For instance, high robot usage alone (PLS-SEM: β = 0.328) does not guarantee turnover unless combined with low POS (T3: consistency = 0.836). This aligns with COR theory's emphasis on resource bundles rather than isolated factors. This comprehensive analysis enhances our understanding of the factors driving turnover intentions.

Notably, the fsQCA results (T5–T6) indicate that high training opportunities and high turnover intentions can coexist, a phenomenon that contradicts the conventional wisdom in traditional human resource management, which holds that "training helps retain employees." However, from the perspective of COR theory, on the one hand, training provides employees with important resources to enhance their professional capabilities and strengthen their personal competitiveness; on the other hand, training may also enhance employees' awareness of their own market value, prompting them to reassess the resource environment provided by their current job. When employees perceive that there is limited space for growth within the organization or that there are more attractive resource returns in the external environment, they may choose to leave the organization to further accumulate and optimize their resources. It can thus be seen that training is not only a resource investment by the enterprise in its employees, but may also become a trigger for employees' intention to leave the organization. This dual mechanism is highly consistent with the logic of proactive behavior emphasized by COR theory, whereby individuals take proactive actions to obtain, maintain and enhance resources.

Overall, our research indicates that robot integration increases job insecurity, supporting COR theory, which posits that employees view job security as a valuable resource and respond to its threat by seeking to preserve it. Job satisfaction acts as a mediator for turnover intentions, helping employees manage feelings of insecurity (Díaz-Carrión *et al.*, 2020; Khatun *et al.*, 2022), while perceived organizational support enhances commitment and mitigates job-related insecurities (Eisenberger *et al.*, 2020; Aldabbas *et al.*, 2023). Training opportunities have a mixed effect; they improve skills and boost organizational commitment but may also provide employees with resources to pursue external opportunities if more appealing prospects arise (Fulmore *et al.*, 2023; Memon *et al.*, 2021).

Theoretical implications

This study advances the literature on robot usage and employee turnover intention through three key contributions. First, it extends the COR theory by exploring the circular reciprocity between organizations and employees, demonstrating how robot usage increases job insecurity, which in turn affects turnover intentions through job satisfaction and perceived organizational support (Zhang *et al.*, 2023).

Second, it develops COR literature by showing that job satisfaction, perceived organizational support and training opportunities mitigate turnover intentions, enhancing employee motivation and organizational commitment. We extended the COR theory by identifying cycles in resources that result from automation. Specifically, technological resources, such as robots, can create dynamic shifts between loss and gain. When companies invest in employee training for using these technologies, it might unintentionally lead to higher turnover rates. This occurs when employees assess their job resources and opportunities based on external environments, favoring what they could find elsewhere rather than what is available within their current organization. These findings not only highlight the value of training as an investment by organizations to enhance employee skills and productivity but also challenge the traditional human resource management view of training as a one-way tool for talent retention. They reveal that while training improves employee capabilities, it may also trigger a reassessment of resources and lead to increased turnover intentions. This study deepens researchers' understanding of the cognitive and

behavioral mechanisms of employee resources and further expands the applicability and explanatory power of COR theory in organizational contexts.

Finally, the study identifies multiple configurations leading to high turnover intention by integrating PLS-SEM and fsQCA. In addition, fsQCA emphasizes causal complexity and equifinality, suggesting that the effect of robot usage on employee turnover intention is not linear, but depends on the interaction of job insecurity, support, satisfaction and training. This finding enriches COR theory, which is based on the principle of reciprocal symbiosis between organizations and employees. It also suggests that the success of technological change is not only dependent on the technology itself (Yan *et al.*, 2024; Yan *et al.*, 2025), but is also influenced by a combination of the accumulation of resources and the work environment to which employees are adapted, providing a nuanced understanding of the factors that influence turnover.

Practical implications

In today's rapidly evolving hospitality landscape, the increasing prevalence of robotics and artificial intelligence presents hotel managers with critical opportunities and challenges. This study highlights that effective robot integration not only enhances operational efficiency but also influences employee perceptions and turnover intentions. By leveraging these insights, managers can create environments that reduce turnover and improve organizational health.

To integrate robots successfully, managers must address the psychological impacts of automation, recognizing that employees may perceive robots as a threat. Path 1 (T1) of fsQCA reveals high levels of job insecurity, accompanied by low levels of perceived organizational support. Managers can prioritize weekly one-on-one meetings to address employee concerns and allocate budgets for mental health programs. Investing in comprehensive training programs can mitigate these concerns, fostering trust and helping staff perceive robots as partners rather than competitors. Transparent communication is essential; informing employees about how robotics will affect their roles and the workplace, coupled with regular feedback sessions and open forums, empowers staff and fosters an inclusive culture. The use of robotics may lead to employees' dependence on automation, weakening their autonomous decision-making abilities and career paths.

Moreover, tailored training and development initiatives are crucial. Specialized programs that prepare employees for effective human–robot interaction and practical automation applications enhance confidence and skills, strengthening emotional attachment and promoting engagement and productivity. Path 3 of fsQCA (T3) shows that in situations where high robot usage coexists with low job satisfaction, employees are more likely to develop a tendency to leave, suggesting that high automation may lead to issues such as job monotony and a lack of professional fulfillment. In response, managers can try introducing job rotation mechanisms (such as rotating between robot supervision and customer service positions) to reduce job monotony and enhance employee engagement and work commitment. Meanwhile, although the moderating effect of training, development and opportunities on job satisfaction and turnover intention, as hypothesized in *H7a*, was not significantly supported, this does not mean that organizations should abandon efforts to improve satisfaction. This study recommends implementing resource-conserving strategies for job satisfaction training. This includes combining technical training with retention incentives, such as tuition reimbursement tied to a two-year commitment. It is important to align skill development with opportunities for internal career advancement. In addition, incorporating "future-proofing" workshops can help alleviate anxiety around technological changes. On the contrary, the results suggest that relying solely on emotional motivation or traditional training methods may be insufficient when addressing the adaptive challenges

posed by technological change. Therefore, when formulating training strategies, companies should place greater emphasis on achieving resource-oriented goals, such as enhancing employees' technical adaptability, career development awareness and sense of resource control, so that employees are not only satisfied with their current work situation but also have the confidence to cope with future changes. For small and medium-sized budget hotels with limited resources, low-cost methods such as online courses, internal knowledge sharing and collaborative learning can be used to enhance the coverage and effectiveness of training, ensuring that every employee receives the necessary support and growth opportunities. Only by effectively linking the practical needs of employee development with organizational change goals can training and management strategies truly play a role in stabilizing human resources and reducing turnover risks in the context of technological transformation.

Ultimately, promoting technological integration in the hotel industry requires striking a balance between innovation and empathy. Managers should promote technological progress while fostering an organizational culture that prioritizes employee well-being, ensuring that employees feel safe, valued and engaged, thereby transforming potential challenges into opportunities for organizational growth and development. However, it is worth noting that this study is grounded in a specific cultural and institutional context, particularly concerning Chinese organizational culture and human resource practices. Therefore, although the study provides a series of management recommendations for human resource managers, their applicability should be carefully considered in light of the specific circumstances of different countries and regions.

Limitations and future research

While this study offers valuable insights, it has several limitations. First, data were collected only from Guangdong, China, which may not represent employee responses to robots and job insecurity in different cultural contexts. Future research should include diverse global settings to compare how cultural factors influence job satisfaction, organizational support, training opportunities and turnover intentions. Second, the rapid advancement of robotics may affect the long-term relevance of the findings. Longitudinal studies that track employee perceptions over time would better capture how job insecurity and turnover intentions evolve in response to technological integration. Third, while fsQCA identifies configurations, it does not capture dynamic interactions over time. Future studies should use longitudinal fsQCA to track how turnover pathways evolve with prolonged robot exposure. Forth, the applicability of these recommendations may be influenced by the type, size and cultural context of the hotel. Future studies should apply this dual-method approach to compare the impact of automation in collectivist (e.g. Japan) versus individualist (e.g. the USA) cultures. For example, fsQCA could identify whether high POS universally offsets job insecurity or is culturally contingent, advancing COR theory's cross-cultural applicability. Future research could further expand the sample to include the perspectives of more experienced or managerial employees, thereby providing a more comprehensive understanding of the impact of robot use on job insecurity and turnover intentions among employees at different levels. Furthermore, this study did not thoroughly investigate the interaction mechanisms of various control variables. Given the potential systemic differences between job types and the degree of contact with robots, future research may consider using multi-group analysis to systematically compare the psychological responses and behavioral tendencies of different groups in the context of technology application, thereby further revealing the heterogeneous effects of robotics technology on outcome variables such as employee turnover intentions. Finally, some scholars have pointed out that the sensitivity of Harman's single-factor test for assessing CMB is limited (Bozionelos and Simmering, 2022; Howard *et al.*, 2024;

Zhang *et al.*, 2022). However, in the design of this study, methodological bias was mitigated through control strategies, including anonymous completion and item randomization. Therefore, the results of this test can still provide a basic reference for assessing CMB. Of course, future research could further integrate more advanced technical approaches (such as marker variable methods or latent variable factor analysis) to enhance the ability to identify potential biases and strengthen the robustness of empirical conclusions.

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