Exploring and Improving the Potential Factors of Preschool Teacher Resignation Using the Stratified Bayesian Best-Worst Method

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ARTICLE INFO	ABSTRACT
	The high turnover rate of preschool teachers in the educational sector threatens the ability to retain competent teaching staff. It affects the quality of teaching and the development of early education in many countries. These ramifications are especially poignant given their alignment with the United Nations' sustainable development goals (SDGs) - notably "quality education," "good health and well-being," and "decent work and economic growth." Reducing the turnover rate of educators, especially at the preschool level, has become an urgent issue for the education community. Therefore, this paper develops a multiple criteria decision-making (MCDM) model based on expert knowledge to construct an evaluation model of the main factors for the resignation of preschool teachers. These factors comprise three main dimensions: personal factors, internal organizational culture, and external environment. First, potential resignation factors were identified through a literature survey and interviews with several experts. Then, a stratified Bayesian best-worst method (SB-BWM) was used to evaluate the importance of these potential factors. The method generated and ranked the optimal group weights of the resignation factors. The results of this study reveal that the top five resignation factors are high work stress, work-induced emotional exhaustion/job burnout, poor work atmosphere, high workload, and low collaborative relationships with partners. The results can help preschool education operators and education ministries responsible for decision-making to understand the factors leading to the resignation of preschool teachers so that they can develop strategies to improve retention. Management implications are given to improve operational performance and effectively reduce the teacher turnover rate to promote stability in the learning environment so important to early childhood development, which will lead to quality preschool education development.

1. Introduction

In early education, the ripple effects of teacher turnover are substantial, casting shadows on the operational quality of preschools and emerging as a pervasive issue across numerous countries [1]. Particularly at the preschool level, a soaring turnover rate jeopardizes the sector's operational

stability and early education's foundational growth [2]. The departure of each teacher necessitates the allocation of significant resources and time for the recruitment and training of their replacement. This transition risks derailing the trajectory of the existing educational curriculum and potentially dampens organizational morale, possibly culminating in decreased enrollments [2, 3, 4, 5, 6].

Preschools need to minimize teacher turnover to ensure teaching and organizational development stability. Not only does teacher turnover impact preschool operations, but it also has negative effects on the emotions and learning ability of young students [4, 5, 6]. Kwon *et al.* [7] found that the departure of teachers leads to behavioral deterioration, non-participation in activities, and even depression and feelings of insecurity in some children. It is well-documented that frequent teacher turnover disrupts young children's social, emotional, and cognitive development [3, 8].

In recent years, Taiwan's education-related ministries have actively promoted the development of the preschool education industry. The demand for high-quality preschool educational services has continued to grow, and qualifications for quality teachers have become more stringent. However, the relatively low salaries offered to preschool teachers compared to teachers in other types of schools have made it difficult to retain qualified teachers. This is one of the reasons for the high turnover rate in preschool education [9]. It is well known that every industry needs adequate human resources to support its development. If the demand for preschool teachers is great, retaining current teachers is even more important [1].

Research on teacher resignation in the preschool education industry continues to grow. For example, Kwon *et al.* [7] conducted semi-structured interviews to examine the potential reasons for the resignation and retention of preschool teachers in urban early childhood institutes in the southwestern United States. Their study results revealed that the primary reason for teacher resignation is a lack of job support. The other factors include poor work atmosphere, poor benefits, and lower-than-expected salaries. Schaack et al. [10] also used semi-structured interviews to investigate the risk factors for resignation among 26 U.S. early childhood education teachers. The teachers reported that a lack of resources crippled their ability to do their jobs. In addition, the lack of psychological support and stable partners for dealing with challenging children, curriculum planning, and paperwork sometimes led to frustration. Resignations were also triggered by low pay, weak work incentives, and the fact that female teachers still have primary care responsibilities in the home and are forced to consider leaving the position when there is an imbalance between work and family. Doromal et al. [8] tracked the teacher turnover rates and predicted turnover factors at 575 public childcare centers in Louisiana, USA, that had been in continuous operation from 2015 to 2019. Their results suggested that teacher turnover could be reduced by providing better pre-service and in-service training or increased wages and benefits. Bassok et al. [11] applied a classroom evaluation rating system to examine evidence of teacher turnover among approximately 5,900 teachers in publicly funded centers in Louisiana, USA. They found that over one-third of teachers left after less than one year of service. Reasons given included that teachers did not interact with the children, were poorly paid, and lacked professional support. Nguyen and Springer [12] used meta-analysis criteria to systematically review the literature over the past 40 years to ascertain the factors most commonly associated with teacher resignation, including individual-related, school-related, and external factors. Li and Yao [13] also examined the literature published from 1989 to 2020 to investigate the causes of teacher resignation. They identified job burnout as the most important predictor of teachers' resignation intentions, meaning that job burnout, high workload, and high stress are positively associated with resignation intentions.

In summary, although past studies have found and explored many factors influencing teacher resignation in the preschool education sector, there has been no overall framework to unify these

factors, making evaluating their importance impossible. In addition, little has been done to evaluate and discuss this issue or to look at the problem from a multiple criteria decision-making (MCDM) perspective. Therefore, this study proposes to address the limitations of previous research, using MCDM to identify the most critical factors behind preschool teacher resignations.

Evaluation frameworks typically involve an extensive literature review and discussions with experts to construct initial criteria, followed by applying some screening method (e.g., Delphi method, principal component analysis, or data mining) to determine the most appropriate criteria to form the final framework. In the multi-criteria decision-making process, criterion weighting is a key step that significantly affects the ranking results of the alternatives. One of the methods generally used to determine the criteria weights involves applying analysis to convert the experts' qualitative interview responses into quantitative values. This is called subjective weighting [14]. To achieve the objectives, in this study, we develop a model for evaluating the factors affecting teacher resignations in the preschool education sector. First, a framework is established through a literature review and structured interviews with experts, followed by quantitative analysis using soft computing techniques. The stratified Bayesian best-worst method (SB-BWM) is employed to identify key resignation factors and to determine the optimal group weights across three dimensions and 18 criteria within a structured system analysis. Specifically, the analysis is conducted at two levels: the dimension level, which involves a single Bayesian best-worst method analysis, and the criteria level, which involves three separate Bayesian best-worst method analyses, each corresponding to a different dimension. The SB-BWM was selected for this study because it addresses the limitations of traditional analytical techniques. Unlike methods that rely on the arithmetic mean, this innovative decision analysis technique utilizes a statistical estimation method to integrate expert opinions more effectively [15, 16, 17].

To the best of our knowledge, this study is the first to apply the MCDM concept to the evaluation of teacher resignation factors in the preschool education industry. The proposed study has the following key features and contributions.

i. The factors leading to teacher resignation in the preschool education sector are identified through an extensive literature review and discussions with experts. The literature clearly defines and supports these dimensions and criteria.

ii. The SB-BWM requires fewer pairwise comparisons to identify the weights of the key factors. In addition, this method effectively aggregates the judgments of multiple experts to extract group consensus opinions.

iii. The key factors leading to teacher resignation are identified to support and facilitate the development of improvement strategies and adjustment directions to reduce the teacher turnover rate at the preschool level.

iv. The proposed evaluation framework and methodology are replicable and not limited to any industry. Only minor adjustments for selecting industry-appropriate evaluation criteria are required.

Our research aligns with several objectives outlined in the United Nations' Sustainable Development Goals (SDGs). Our study closely follows Goal 4, which focuses on "Quality Education." This goal aims to ensure inclusive and equitable education and promote lifelong learning opportunities for everyone. Our focus on the preschool educational realm underscores the importance of sustaining quality and consistency during these formative years. Furthermore, we address concerns highlighted in Goal 3, "Good Health and Well-being," as we identify factors like work stress, emotional exhaustion, and job burnout that play significant roles in teacher resignations. These factors intertwine with the well-being and mental health components of the goal. Lastly, by

delving into the working conditions of preschool educators, our research casts a spotlight on the essence of Goal 8, which promotes "Decent Work and Economic Growth," emphasizing the need for a dignified working environment for all.

This paper is organized as follows. Section 2 presents a comprehensive literature review, including an overview of research on teacher resignation intentions and an introduction to the SB-BWM method. Section 3 introduces the proposed framework for evaluating resignation factors. In Section 4, we detail the methodology employed in this study. An empirical study is then presented in Section 5, showcasing the application of the proposed framework. Finally, Section 6 discusses the findings and concludes the paper.

2. Literature review

Studying teacher resignation factors in the preschool education has been a popular research topic. This section reviews past research in the literature and describes the gaps between them. Subsequently, the development and current applications of SB-BWM are introduced.

2.1 Overview of research on teacher resignation intentions

Attracting teachers to stay in early education is a significant challenge, making it difficult to maintain an adequate workforce to meet the challenges of teacher resignation or turnover [1]. Teacher turnover, especially the loss of experienced teachers, is economically, institutionally, and educationally costly [1, 3].

Past research has begun to focus on the factors contributing to teacher resignation in preschool education. For example, Nguyen and Springer [12] found that gender, race, ability, psychology, and family can significantly affect teachers' entry and exit from the preschool education workplace. In addition, teachers might resign due to the lack of access to administrative support and classroom autonomy. According to Kim *et al.* [3], teachers in preschool education may also leave the workforce due to hidden pressures such as burnout or lack of job satisfaction under high work stress. Grant *et al.* [18] showed that teachers who do not feel fulfilled by their work become dissatisfied and try to find better alternatives or leave the workplace. Yang et al. [14] suggested that if administrators cared more about the interests and values of their staff and could provide effective material and emotional support, there would be a significant reduction in teachers' resignation intentions. Mérida-López *et al.* [5] showed that teachers who feel they are working in a supportive and collaborative environment are more likely to stay with their current institute for the long term. Li *et al.* [6] showed that social support and trust in managers/leaders can sustain enthusiasm for teaching and prevent the intention to leave due to job burnout. In addition to the authors above, this study reviewed many works examining the potential reasons for teacher resignation in the last five years; please see the summary in **Table 1**.

Table 1
Summary of the literature on potential reasons for teacher resignation

Study	Brief description of the study
Grant *et al.* [18]	The study shows that poorer working conditions increase the likelihood that preschool teachers will resign when they are unable to promote the children's development due to high stress or emotional exhaustion.
Lambert *et al.* [19]	The study reveals that teachers in preschools that experience high levels of occupational stress will have low career commitment and low willingness to stay in that school.
Zhou *et al.* [4]	The study shows that the tendency to leave the workplace is stronger when family and friends are not supportive of the teachers' work.

Kim *et al.* [3]	The study suggests that teachers who are able to see the positive side of the stress they face are less likely to leave their jobs. In addition, administrative support and good working conditions are important factors in keeping teachers from leaving.
Schaack *et al.* [20]	This study reveals that teachers' intention to quit their jobs stems from emotional exhaustion at work, primarily due to a lack of partnerships, burnout from dealing with challenging child behaviors, and low salaries, all of which increase the teachers' emotional exhaustion. To prevent teachers from resigning, creating a shared vision and allowing more control and autonomy over their work will make their work more fulfilling and reduce their intention to leave.
Mérida-López *et al.* [5]	This study found that when colleagues and directors are less supportive of teachers, teachers' emotional intelligence levels are lower. Because lower emotional intelligence levels reduce teachers' engagement in their work, they are more likely to resign.
Nguyen *et al.* [21]	This study examines three aspects of teacher resignation: first, personal factors, for example, high turnover rates for teachers with higher academic ability, teachers with special education experience, younger teachers, and less experienced teachers. Second, workplace school factors, for example, have high turnover rates for schools with more disciplinary problems and less autonomy in the classroom. External and policy factors, for example, lead to a relatively higher teacher turnover rate when administrative support is weak. Salaries also have a significant impact on teacher turnover decisions. Schools with a special emphasis on teacher performance evaluation systems will also have lower teacher turnover rates.
Kwon *et al.* [7]	This study reveals that teacher resignations occur because of the lack of organizational job support. Teachers are stressed and want to leave. Sometimes teachers resign because of a poor work environment. The paper also mentions that teachers want to leave because of lower-than-expected salaries and benefits.
McMullen *et al.* [22]	It is noted that employees with a positive sense of professional well-being are less likely to leave because they are dissatisfied with their jobs, are more likely to support their colleagues, and are willing to engage in interesting and challenging work.
Li *et al.* [6]	This study shows that preschool teachers' income does not directly predict their intention to leave, but intention can be influenced by organizational commitment and work-family conflict.
Bassok *et al.* [11]	The study reveals that teachers leave because teachers would not provide interactions with children, as well as low pay, lack of professional support, and low educational expectations.
Nguyen and Springer [12]	Factors associated with teacher turnover are personal, school-related, and external. This study found that the turnover rate is usually higher among young teachers than older teachers. Those experiencing low self-satisfaction are more likely to resign throughout their teaching careers. When salaries eventually increase, they are less likely to resign.
Palma-Vasquez *et al.* [1]	This study finds that instability in the teaching force is a serious problem for teacher turnover. Low-quality organizational conditions are also identified as a factor in teacher turnover.
Li and Yao [13]	This study identifies burnout as the most important predictor of teacher turnover intentions.
Hur *et al.* [2]	It is found in this study that teacher turnover is generally higher in centers that do not offer better salaries and benefit policies and some teacher support policies.
Schaack *et al.* [10]	This study finds that the reasons teachers leave or stay include workplace and family factors. Those who leave the workplace often feel that the lack of work resources diminishes their ability to do their jobs. Inconsistencies and imbalances between needs and expectations are also noted. In addition, female teachers still have primary care responsibilities in the home and may consider leaving their jobs when there is an imbalance between work and family.
Heilala *et al.* [9]	This study identifies the main reasons for teachers leaving their jobs, which are low pay, high workload, high job demands, and stress, combined with limited organizational advancement opportunities and lack of job resources.
Yang *et al.* [14]	The results of the study indicate that teachers are more likely to leave their jobs when their socioeconomic status is low. It is also mentioned that if preschools cared enough about the interests and values of their staff, and provided effective material and spiritual support, they could significantly reduce the relative deprivation and intention to leave.
McCormick *et al.* [23]	This study finds that three important factors contribute to teachers' professional well-being: 1. being in a collaborative situation, having their ideas heard and understood, and receiving

	respect and recognition from others; 2. feeling safe and secure; 3. being respected in their professional capacity.
Doromal *et al.* [8]	It is found that teachers experience year after year of resignations due to challenging issues related to "people".

A review of the literature illustrates that there are gaps between this and previous studies. Although previous studies have suggested various reasons for teacher resignation in early education, the importance of these factors and the priorities for improvement have not been identified. Besides, only a few factors have been examined; a comprehensive collection and a larger scope have been lacking. Regarding methodology, most past studies used expert interviews, qualitative surveys, and statistical analysis, with only a few studies using MCDM as a research tool. Therefore, to fill the gaps related to this issue, this study proposes a complete model to evaluate the factors leading to teacher resignation in preschool education. Furthermore, the SB-BWM is used to determine each factor's importance and provide a basis for priorities for improvement. This evaluation process and research methodology can also be used to explore workplace resignation factors in other industries.

2.2 Introduction of the SB-BWM

BWM is a pairwise comparison weighting method proposed by Rezaei [24], which requires only $2n$-3 pairwise comparisons according to the number of criteria instead of the full $n(n$-1$)/2$ pairwise comparisons required by the analytic hierarchy process (AHP). It overcomes the drawbacks of the traditional AHP by reducing the number of pairwise comparisons needed and improving the evaluation consistency to obtain two sets of vectors. The best and worst criteria are identified through pairwise comparison to the other criteria. This structured questionnaire design helps decision-makers to provide more accurate evaluations [25]. However, the main weakness of the BWM approach is that it only includes the evaluation of one decision-maker. Group decision-making must be used to obtain a more comprehensive evaluation, and the simplest method to integrate opinions from multiple experts is the arithmetic mean, but this can lead to distortion of the averaged evaluation information when experts disagree [15, 25, 27, 28].

To address the limitations of the traditional BWM, Mohammadi and Rezaei [15] introduced an enhanced approach known as the Bayesian BWM. This optimized method leverages the concept of probability distributions to integrate group evaluation data, resulting in an optimal set of criterion group weights. In multi-criteria decision-making (MCDM), the weights must sum to 1, and each weight must be non-negative. Considering probability theory, each criterion c_j (j = 1, 2,…, n) can be viewed as a random event, with the weight w_j representing the probability of occurrence of criterion c_j. Hence, constructing a probabilistic model based on the BWM framework is a logical approach [26].

Integrating expert opinions is important in the complex decision-making process as it provides professional knowledge and diverse perspectives, improves decision quality, reduces subjective biases, and facilitates consensus and acceptance. By incorporating expert opinions, the decision-making process can be more comprehensive, objective, and effective, providing valuable guidance and direction for organizations and stakeholders. Undoubtedly, the Bayesian BWM aligns perfectly with this notion. The Bayesian BWM has been widely utilized in decision-making problems in the past five years. For example, Gul and Yucesan [26] proposed an integrated model for evaluating the operational performance of universities in Turkey. They utilized the Bayesian BWM to determine the weights of the evaluation criteria. They applied the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to calculate the overall scores. Ak *et al.* [29] developed the BWM-VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) approach to assess occupational safety

issues in the textile production industry. They considered multiple aspects, such as occupational health, safety, and environmental risks, and assigned appropriate weights using the Bayesian BWM. Yanilmaz *et al.* [30] incorporated the Bayesian BWM into the FEMA-SMUG (Federal Emergency Management Agency and Seriousness Manageability Urgency Growth) model, allowing the user to consider the relative importance of disaster factors, thereby enhancing the effectiveness of such methods for disaster risk management. Chauhan *et al.* [31] applied the Bayesian BWM to identify and classify 37 key success factors for remote healthcare services during the COVID-19 pandemic. Additionally, the Bayesian BWM has been utilized as an analytical method for various decision-making problems, such as airport resilience assessment [25], analysis of mobile commerce service quality [32], and enterprise digital transformation planning [33].

In this study, the term "stratified" refers to the evaluation framework being divided into two levels: dimension and criteria. The Bayesian best-worst method is first applied to analyze the dimension level, followed by its application to the criteria level. Since the criteria level is divided into three dimensions, the Bayesian best-worst method is executed four times—once for the dimension level and three times for the criteria level. This operation way can be referenced in the following articles [30]. Dividing the evaluation framework into distinct levels—dimensions and criteria—allows for a more organized and systematic analysis. This layered structure helps isolate the effects of different dimensions and criteria, leading to more accurate and reliable results. It also enables the method to handle complex decision-making scenarios more effectively by addressing each level separately before integrating them. Additionally, this approach facilitates a more focused analysis at each level, enhancing the clarity and precision of the outcomes.

3. The proposed framework for evaluating resignation factors

The reasons for teacher resignation in early preschool education are of great concern and importance to the education industry, and it is necessary to identify the evaluation criteria that affect teacher resignation. In this study, resignation factors were gleaned from a review of the literature and the initial framework for the evaluation these factors developed. Then, interviews were conducted with 24 experts with backgrounds in preschool education covering a wide variety of position in industry, government, and academia. However, after individually consulting with 24 experts, each was asked to review and filter the initial set of criteria we compiled. If over 80% of the experts (approximately 20 experts) considered a particular criterion to be important, it was included in the final framework. Through this rigorous process, a total of 18 factors were identified as the key potential criteria. The study initially used the same three dimensions to categorize teacher resignation factors as those proposed by Nguyen *et al.* [21], which include personal factors, workplace school factors, and external and policy factors. Consequently, this study ultimately identified Personal factors (D_1), Internal organizational culture (D_2), and External environment (D_3) as the three primary dimensions.

Table 2 presents information about the organizations, years of experience, and number of individuals interviewed with expertise in the fields related to preschool education. In this study, the judgments of all experts are considered equally important. **Table 3** presents the hierarchical structure of teacher resignation factors in preschool education, with descriptions of all the criteria and literature sources referenced.

Table 2
Background and years of experience of the experts

Expert No.	Affiliated Institution	Job Title	Education	Years of Experience

Expert 1	University	Assistant Professor	Master	≥10
Expert 2	University	Associate Professor	PhD	≥10
Expert 3	Preschool	Director	Master	≥5 and <10
Expert 4	Preschool	Director	Master	≥10
Expert 5	Preschool	Director	Master	≥10
Expert 6	Preschool	Director	Bachelor	≥10
Expert 7	Preschool	Director	Bachelor	≥10
Expert 8	Preschool	Executive Director	Master	≥10
Expert 9	University	Assistant Professor	PhD	≥10
Expert 10	Education Department	Officer	Master	≥10
Expert 11	Education Department	Chief	Master	≥10
Expert 12	University	Assistant Professor	PhD	≥10
Expert 13	University	Assistant Professor	Master	≥10
Expert 14	University	Associate Professor	PhD	≥10
Expert 15	Preschool	Director	Master	≥10
Expert 16	Preschool	Director	Master	≥10
Expert 17	University	Assistant Professor	Master	≥10
Expert 18	Preschool	Director	Master	≥10
Expert 19	Education Department	Officer	Bachelor	≥1 and <5
Expert 20	University	Assistant Professor	PhD	≥10
Expert 21	University	Assistant Professor	PhD	≥10
Expert 22	Education Department	Inspector	Master	≥10
Expert 23	Education Department	Chief	Master	≥1 and <5
Expert 24	Education Department	Inspector	Master	≥10

Table 3

Framework of resignation factors of teachers in preschool education proposed in this study

Dimension	Criterion	Description	References
Personal factors (D_1)	Low support from family members/friends (C_{11})	Teachers find they cannot take care of their own families due to working hours and workplace responsibilities, and cannot obtain the support and understanding of family members or friends.	[4, 6, 10]
	Lack of workplace experience and low self-efficacy (C_{12})	Teachers are worried that they are not competent enough to do the job because of their lack of work experience.	[1, 12, 24]
	Low self-engagement in work and low emotional intelligence (C_{13})	Teachers feel less enthusiastic about their job responsibilities and are unable to control their emotions, which makes them vulnerable to emotional ups and downs in their work and interpersonal relationships.	[1, 4, 5, 6, 19]
	Emotional exhaustion through dealing with challenging children (C_{14})	Teachers are unable to facilitate the development of children who present challenges in their work environment (e.g., children from troubled families or children with special needs).	[21, 22, 23]
	Low interaction with children (C_{15})	Teachers are unable to experience trust in their educational interactions with the children resulting in a lack of a sense of accomplishment.	[11, 21, 23]
	Low collaborative relationships with partners (C_{16})	Inability of teachers to work together to solve classroom problems because they do not agree with their partners on how to do this.	[5, 10, 20, 22, 23]
	Low supervisor support (C_{17})	Teachers do not receive support and encouragement from their supervisors in their work. For example, the supervisor has the ability	[1, 2, 3, 5, 14, 21]

		to offer administrative support and create a positive team atmosphere but does not do so.	
Internal organizational culture (D_2)	High work stress (C_{21})	Teachers are stressed by the negative influences of people, events, and things around them in the work environment that prevent them from completing their work successfully.	[3, 7, 9, 13, 21, 22, 23]
	High workload (C_{22})	Teachers are overburdened with job responsibilities and demands.	[1, 9, 13]
	Controlled work decisions (C_{23})	Teachers feel they are not trusted and supported to use independent decision-making and expertise in their work.	[13, 20, 21, 22, 23]
	Poor work atmosphere (C_{24})	Lack of a positive work environment.	[3, 7, 22]
	Work-induced emotional exhaustion/ job burnout (C_{25})	Working in conditions that do not allow teachers to do their jobs successfully. The resulting stress causes emotional exhaustion or job burnout that reduces their ability to perform.	[6, 13, 14, 21, 22, 23]
	Lack of environmental resources (C_{26})	Working in conditions that do not allow teachers to do their jobs successfully, including lack of staffing in addition to the environment and equipment.	[3, 7, 9, 10, 21]
External environment (D_3)	Poor pay and benefits (C_{31})	Teachers are paid less than their peers in the education service industry or receive fewer benefits.	[2, 6, 7, 8, 9, 11, 12, 14, 20, 21]
	Personnel instability (C_{32})	Working in an environment where there is a lot of personnel turnover.	[1, 7, 8, 12]
	Little developmental education or on-the-job training and low professional requirements (C_{33})	Little in-service training and low professional requirements for the job.	[7, 8, 11, 12, 21]
	Differences in organizational commitment and teaching philosophy (C_{34})	Working for an educational organization with teaching philosophies and values that are different from the teachers.	[6, 7, 19, 20]
	No systematic evaluation of teachers' performance (C_{35})	Working in an environment without clearly defined promotion and performance evaluations.	[1, 8, 21]

4. Methodology

This section details the development process and procedural steps of the SB-BWM employed to determine the weights of dimensions and criteria. Additionally, it provides an overview of the adopted methodological framework. The study utilizes the software developed by Mohammadi and Rezaei [15] to execute the SB-BWM computations. The calculation process is briefly described below.

Step 1. Establish the framework for criteria evaluation

Identify n evaluation criteria $c_j = \{c_1, c_2, \ldots, c_n\}$ for teacher resignation factors based on a literature review and expert discussions. The criteria can be grouped into three dimensions, forming a hierarchical evaluation framework.

Step 2. Select the best and worst criteria
The best (c_B) and worst (c_W) criteria are selected from the n criteria.
Step 3. Obtain the BO vectors

Experts assess the relative importance of the criteria compared to the best criterion using a 9-point scale, where 1 indicates equal importance and 9 indicates absolute importance. The higher the value on the scale, the greater the relative importance. The BO vectors are expressed as follows:

$$A_{Bj} = \left(a_{B1}, a_{B2}, \ldots, a_{Bj}, \ldots, a_{Bn} \right), \tag{1}$$

where a_{Bj} denotes the relative importance of the most important criterion B to criterion j.

Step 4. Compare other criteria with the worst criterion to obtain the OW vectors

Similar to Step 3, experts evaluate the relative importance of other criteria in relation to the worst criterion. The OW vectors are expressed as follows:

$$A_{jW} = \left(a_{1W}, a_{2W}, \ldots, a_{jW}, \ldots, a_{nW} \right)^T, \tag{2}$$

where a_{jW} denotes the relative importance of the other criterion j in relation to the worst criterion W.

Step 5. Obtain the optimal group weights of the criteria

From A_{Bj} and A_{jW}, the probability model based on the multinomial distribution can be constructed. The probability function of multinomial distribution of A_{jW} is

$$E\left(A_{jW} \middle| w_j \right) = \frac{\left(\sum_{j=1}^{n} a_{jW} \right)!}{\prod_{j=1}^{n} a_{jW}!} \prod_{j=1}^{n} w_j^{a_{jW}}, \tag{3}$$

where w_j is the weighting probability distribution, and the probability has a positive relationship with a_{jW}, so it can form Eq. 4. The weight probability of the worst criterion w_W is found by Eq. 5. Combine Eqs. 4 and 5 to obtain Eq. 6.

$$w_j \propto \frac{a_{jW}}{\sum_{j=1}^{n} a_{jW}}, \ \forall j = 1, 2, \ldots, n; \tag{4}$$

$$w_W \propto \frac{a_{WW}}{\sum_{j=1}^{n} a_{jW}} = \frac{1}{\sum_{j=1}^{n} a_{jW}}; \tag{5}$$

$$\frac{w_j}{w_W} \propto a_{jW}, \ \forall j = 1, 2, \ldots, n. \tag{6}$$

In addition, the weighting probability of the best criterion w_B is

$$\frac{1}{w_B} \propto \frac{a_{BB}}{\sum_{j=1}^{n} a_{Bj}} = \frac{1}{\sum_{j=1}^{n} a_{Bj}} \Rightarrow \frac{w_B}{w_j} \propto a_{Bj}, \ \forall j = 1, 2, \ldots, n. \tag{7}$$

Then, the Dirichlet probability distribution is used to estimate the optimal weight value w_j with the probability function as follows:

$$Dir\left(w_j \middle| \alpha \right) = \frac{1}{B(\alpha)} \prod_{j=1}^{n} w_j^{\alpha_j - 1}, \tag{8}$$

where α is a vector parameter, usually set to 1; $w_j \geq 0$ and $\sum w_j = 1$ are required to comply with the concept of MCDM.

The SB-BWM is a method for estimating the approximate parameters and to integrate a set of optimal group weights w_j^{agg} obtained by considering the survey data from multiple experts. The operational steps are outlined below.

Step 5.1. Construct the joint probability distribution of the group

The decision group comprises k experts $k=1,2,…, K$. The individual criterion weight supplied by the experts after evaluation is indicated by w_j^k. The group weight of w_j^{agg} can be obtained by integrating all w_j^k. Here, $A_{Bj}^{1:G}$ and $A_{jW}^{1:G}$ denote the BO and OW vectors of the first expert in relation to the Kth expert, and these vectors can construct the joint probability distribution of the group decision as shown in **Eq. 9**.

$$E\left(w_j^{agg}, w_j^{1:G} \middle| A_{Bj}^{1:G}, A_{jW}^{1:G}\right). \tag{9}$$

Step 5.2. Construct the Bayesian hierarchical model

The Bayesian hierarchical model is constructed based on an iterative operation, meaning that the A_{Bj} and A_{jW} vectors of the experts generate w_j^g, and the evaluation data of several experts are added one after another to continuously update the optimal group weight w_j^{agg}. Considering the conditional independence of the variables, the joint probability of the Bayesian model is

$$E\left(w_j^{agg}, w_j^{1:G} \middle| A_{Bj}^{1:G}, A_{jW}^{1:G}\right) \propto E\left(A_{Bj}^{1:G}, A_{jW}^{1:G} \middle| w_j^{agg}, w_j^{1:G}\right) E\left(w_j^{agg}, w_j^{1:G}\right). \tag{10}$$

The result can be further derived from **Eq. 10**, as follows:

$$E\left(A_{Bj}^{1:G}, A_{jW}^{1:G} \middle| w_j^{agg}, w_j^{1:G}\right) E\left(w_j^{agg}, w_j^{1:G}\right) = E\left(w_j^{agg}\right) \prod_{g=1}^{G} E\left(A_{jW}^{g} \middle| w_j^{g}\right) E\left(A_{Bj}^{g} \middle| w_j^{g}\right) E\left(w_j^{g} \middle| w_j^{agg}\right). \tag{11}$$

It can be seen from **Eq. 11** that the statistical distribution of each variable needs to be specified, and the corresponding probability function can be found. The distributions of $A_{Bj}^{g} \middle| w_j^{g}$ and $A_{jW}^{g} \middle| w_j^{g}$ are

$$A_{B}^{g} \middle| w_j^{g} \sim multinomial\left(\frac{1}{w_j^{g}}\right), \forall_g = 1,2,…,G;$$

$$A_{jW}^{g} \middle| w_j^{g} \sim multinomial\left(w_j^{g}\right), \forall_g = 1,2,…,G, \tag{12}$$

and w_j^k under the condition of w_j^{agg} can be constructed as a Dirichlet distribution as follows:

$$w_j^g \middle| w_j^{agg} \sim Dir\left(\gamma \times w_j^{agg}\right), \forall_g = 1,2,…,G, \tag{13}$$

where w_j^{agg} is the average value of the Dirichlet distribution, and γ is a non-negative parameter.

w_j^g must be in the proximity of w_j^{agg} since it is the mean of the distribution, and the closeness is determined by the parameter γ, while the distribution of the parameter γ obeys the gamma distribution, as follows: .

$$\gamma \sim gamma(a,b), \tag{14}$$

where a and b are the shape and rate parameters of the gamma distribution, respectively.

Finally, the group's optimal weight w_j^{agg} obeys the Dirichlet distribution, as shown in **Eq. 15**.

$$w_j^{agg} \sim Dir(\alpha) \tag{15}$$

where the parameter α is set to 1.

Once the probability distribution of all variables has been constructed, the Markov-chain Monte Carlo (MCMC) technique is used to simulate the experiment for p times to obtain the group optimal weight w_j^{agg}.

Step 5.3. Ranking confidence test

After determining the optimal weight of a dimension or criterion through the SB-BWM, a ranking confidence test must be performed. The ranking confidence test confirms that all experts agree on the criteria's importance evaluations. Therefore, credal rankings are used to test the confidence in the dimension or criterion rankings. Suppose there are two criteria c_i and c_j, respectively, the probability that c_i is superior to c_j is

$$E(c_i > c_j) = \int I\left(w_i^{agg} > w_j^{agg}\right) E\left(w^{agg}\right), \qquad (16)$$

where $E(w^{agg})$ is the posterior probability of w^{agg}. Besides, I is a condition parameter. When $w_i^{agg} - w_j^{agg} > 0$ is true, it means $I=1$. Furthermore, when the quantity is Z, the probability that c_i is superior to c_j is

$$E\left(c_i > c_j\right) = \frac{1}{Z} \sum_{z=1}^{Z} I\left(w_i^{agg_z} > w_j^{agg_z}\right),$$

$$E\left(c_j > c_i\right) = \frac{1}{Z} \sum_{z=1}^{Z} I\left(w_j^{agg_z} > w_i^{agg_z}\right). \qquad (17)$$

See [15] for a more detailed mathematical derivation process. In this study, the weight values were calculated using MATLAB software after collecting BO and OW vectors from 24 experts.

5. An empirical study

The work in preschool education is demanding. It requires teachers to both bear childcare responsibilities and curriculum pressure. Many teachers leave the workplace because of insufficient teaching resources, sometimes because of poor classroom partnerships, and sometimes because of lower-than-expected salaries and benefits [2, 7, 8, 9, 21]. If the market demand for teachers to work in the preschool education sector is so severe, then maintaining stability is very important. Making preparations in advance to reduce teacher turnover rates could solve many of the problems in preschool services. Section 2 discussed the framework for teacher resignation factors in preschool education in Taiwan. There are 18 criteria divided into three dimensions: Personal factors (D_1), Internal organizational culture (D_2), and the External environment (D_3) Since the proposed evaluation framework is a hierarchical structure, the BWM questionnaire consists of four parts, including for the dimensions and the criteria under the three dimensions. For example, in the dimensional part, the BO and OW vectors are obtained through the professional feedback of the 24 experts; the results are presented in **Table 4**. As can be seen in **Table 4**, the second expert considered D_1 to be the best dimension, so the BO vector is formed by comparing D_1 with the other dimensions as $A_{Bj},1 = (1, 1, 4)$. Similarly, D_3 was chosen as the worst dimension so the OW vector is $A_{jW},1 = (4, 4, 1)$. The responses from all experts were processed uniformly to obtain the group results. All BWM questionnaires underwent a consistency check, requiring the consistency ratio (CR) of each questionnaire to be below 0.03. The average CR for the 24 experts' questionnaires in this study was 0.0032, indicating a high level of reliability in the results [24].

Table 4

BO and OW vectors selected by the 24 experts: taking dimensions as an example

Expert	BO Vector			OW Vector		
	D_1	D_2	D_3	D_1	D_2	D_3
Expert 1	1	1	1	1	1	1
Expert 2	1	1	4	4	4	1
Expert 3	1	1	1	1	1	1
Expert 4	1	2	3	3	2	1
Expert 5	1	1	2	2	2	1
Expert 6	1	2	3	3	2	1
Expert 7	1	1	2	2	2	1
Expert 8	1	1	3	3	3	1
Expert 9	2	1	2	1	2	1
Expert 10	1	1	1	1	1	1
Expert 11	1	1	3	3	3	1
Expert 12	2	1	3	2	3	1
Expert 13	3	1	2	1	3	2
Expert 14	1	1	2	2	2	1
Expert 15	1	1	1	1	1	1
Expert 16	1	2	3	3	2	1
Expert 17	2	1	2	1	2	1
Expert 18	2	1	1	1	2	2
Expert 19	1	1	3	3	3	1
Expert 20	2	1	1	1	2	2
Expert 21	1	1	1	1	1	1
Expert 22	1	2	2	2	1	1
Expert 23	2	1	1	1	2	2
Expert 24	1	1	3	3	3	1

Unlike the original BWM, the SB-BWM does not necessitate the individual calculation of each of the 24 BWM questionnaire responses from the experts. Instead, it employs a statistical probability model to estimate the optimal criterion weights for the group. In this study, the SB-BWM algorithm was executed using the program provided by Mohammadi and Rezaei [15]. The overall weighting results shown in **Table 5** list the integrated optimal group weights from the 24 experts. In terms of dimensions, Internal organizational culture (D_2) is the most important for the resignation of teachers in early education with a higher weight than the other dimensions of 0.4052. The overall results for the criteria show that the top five ranked factors are High work stress (C_{21}) with a weight of 0.078, Work-induced emotional exhaustion/job burnout (C_{25}) with a weight of 0.075, Poor work atmosphere (C_{24}) with a weight of 0.072, High workload (C_{22}) with a weight of 0.070, and Low collaborative relationships with partners (C_{16}) with a weight of 0.060.

Table 5

Weights of dimensions and criteria

Dimension	Local Weight	Rank	Criterion	Local Weight	Rank	Global Weight	Rank
D_1	0.3632	2	C_{11}	0.135	4	0.049	11
			C_{12}	0.120	7	0.044	16
			C_{13}	0.166	2	0.060	6
			C_{14}	0.130	5	0.047	13
			C_{15}	0.123	6	0.045	15
			C_{16}	0.166	1	0.060	5
			C_{17}	0.160	3	0.058	7
D_2	0.4052	1	C_{21}	0.192	1	0.078	1
			C_{22}	0.174	4	0.070	4
			C_{23}	0.133	6	0.054	10
			C_{24}	0.178	3	0.072	3
			C_{25}	0.185	2	0.075	2
			C_{26}	0.139	5	0.056	9
D_3	0.2316	3	C_{31}	0.244	1	0.056	8
			C_{32}	0.210	2	0.049	12
			C_{33}	0.177	4	0.041	17
			C_{34}	0.196	3	0.045	14
			C_{35}	0.173	5	0.040	18

Additionally, a ranking confidence test was conducted to evaluate the reliability of the obtained optimal group weights and their respective rankings. The results are shown in **Table 6**. For example, the confidence that D_2 is superior to D_3 is 0.995, while the average ranking confidence is 0.913, indicating a high degree of confidence in the ranking of the dimensions. Furthermore, confidence testing was conducted for all criteria within the three dimensions, resulting in an average ranking confidence of 81.62%. This result indicates that the overall weight determined for the evaluation system has a significantly high level of reliability. Furthermore, the SB-BWM provides an optimal individual weight for each expert, with the differences in generated individual weights decreasing as the consensus among the experts' judgments increases. The results shown in **Fig. 1** indicate a high degree of expert consensus in the evaluation system.

Table 5

Confidence in the ranking obtained in this case study: dimensions as an example

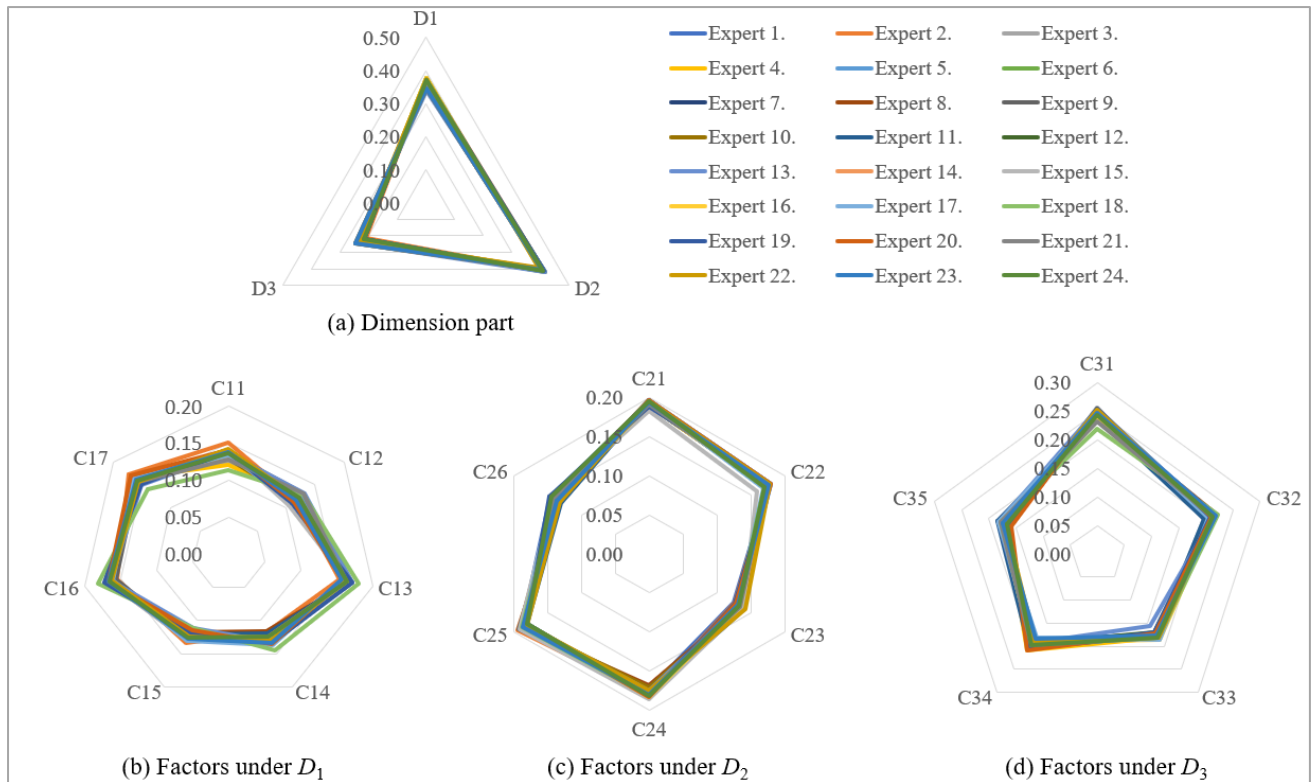|	D_1	D_2	D_3
D_1	-	25.645%	99.595%
D_2	74.355%	-	99.954%
D_3	0.405%	0.046%	-

Fig. 1 Consensus of the 24 experts

6. Discussion and Conclusions

MCDM can structure and analyze complex problems in a systematic way to identify key factors [34, 35, 36]. This study utilizes the concept of MCDM to simultaneously consider multiple constrained factors associated with teacher turnover and develop appropriate management implications, given the current teacher shortage and high turnover rates in preschool education, identifying specific factors leading to teacher resignation. The proposed methodology facilitates a systematic analysis of expert opinions and demonstrates that the SB-BWM is effective for determining criterion weights, particularly in a multi-expert decision-making context. Additionally, the method includes a confidence test for ranking criteria, ensuring the reliability of the generated weights. This comprehensive evaluation framework addresses the issue of teacher resignation in early education. The findings will be compiled into a report for presentation to preschool education operators, aiding them in evaluating and resolving issues to retain existing talent. Based on the analysis, we propose the following management implications.

i. The most critical dimension is the internal organizational culture (D_2), weighing 0.4052. It is recommended measures taken to improve the factors in this dimension that may cause teachers to leave their jobs due to dissatisfaction or suppression includes things such as providing sufficient teaching resources, establishing and maintaining good labor relations, and increasing job satisfaction and happiness, all of which can help improve teachers' work efficiency and significantly reduce job burnout. At the same time, preschools should design a set of performance appraisals and rewards for teachers at all levels [37], understand and take actions to help teachers, improve the teachers' sense of security in the work environment, and attract high-quality personnel to join.

ii. Suggestions for improvement for individual criteria are also provided. First, regarding High work pressure (C_{21}), which has the highest weight among all criteria at 0.078, it is recommended that systematic modular planning of preschool education job responsibilities be made to help teachers understand the actual content of the job, including a written description or a video presentation of the workflow. A series of pre-service training and on-the-job training sessions, with specialized personnel in the group should be planned to assist teachers adapt to the work and the work environment [37]. Secondly, innovative digital transformation techniques can be developed to help teachers keep records and simplify the amount of repetitive paperwork needed. This would help to improve the teachers' work efficiency and reduce resignations due to work pressure caused by a heavy workload. At the same time, teachers' working hours can be adjusted promptly, and the work progress can be appropriately controlled to avoid pressures to work overtime. Finally, multiple communication channels can be arranged to provide timely assistance when faced with difficulties and conflicts in the educational process and to reduce teachers' work stress.

iii. For Work-induced emotional exhaustion/job burnout (C_{25}), the second-highest criterion with a weight of 0.075, it is recommended that preschool programs be arranged that allow teachers to have adequate rest. In addition to restoring energy, psychological assistance can be obtained through family, friends, supervisors, curriculum study, seminars, professional resources, or professional support.

iv. Poor work atmosphere (C24), the third-highest criterion with a weight of 0.072, suggests that preschools adopt various teamwork activities or communication courses. On the one hand, they can promote team morale and discipline. On the other hand, they can maintain a positive and cohesive work environment [35], emphasizing trust, respect, and care for partners, to achieve the goal of building the "best workplace."

v. For High workload (C_{22}), with a weight of 0.070 and ranked fourth, the recommendations are the same as those mentioned in the second point above. Improving teacher work efficiency can help reduce resignations caused by work stress due to a heavy workload.

vi. For Low collaborative relationships with partners (C_{16}), which is ranked fifth with a weight of 0.060, it is suggested that the preschool first obtain an understanding of the partnership through the inclusion of a mutual evaluation mechanism during teacher evaluation; second, supervisors should observe the classroom atmosphere by walking around the school; finally, supervisors should make appointments to talk to those teaching the same class, to ensure that they understand each other's ideas and act in a coordinated way to re-establish the relationship. If this does not work, the supervisor should rearrange their classes at the end of the semester to find more suitable partners.

The MCDM model proposed in this study has not been applied to the issue of teacher resignation before. Overall, the proposed model provides a framework for evaluating teacher resignation factors in early education. The results illustrate the practicability and effectiveness of the proposed model and can provide the educational community, especially the preschool education sector, with the main factors leading to teacher resignation. Ultimately, the teacher turnover rate can be reduced by focusing on and improving these resignation factors. The main findings of this study are summarized below.

i. This study develops a complete framework for evaluating teacher resignation factors. Many of these factors have been detailed in previous studies, but few have proposed an evaluation framework. The results of this study should not only help operators explore

ii.   the factors leading to teacher resignation in depth but also take countermeasures to reduce turnover rates, reduce stress, stabilize the workforce, and enhance team cohesion.

ii.   This is the first time the SB-BWM has been applied to explore the factors leading to the resignation of preschool teachers in the education industry.

iii.   The key factors leading to resignation are identified based on the support of academics, the education community, and preschool educators, leading to the development of appropriate improvement strategies and priorities for finding solutions to reduce teacher resignation rates.

iv.   The evaluation framework proposed in this study is replicable and scalable, and the evaluation indicators and methods proposed are not limited to teacher resignation factors. This model can be applied to evaluate the weighting of factors leading to teacher stress, job burnout, or excess workload. In addition, it can be applied in other countries with indicators added to meet the needs of teachers according to each country's cultural background.

Furthermore, this study's significance transcends the bounds of early education. It has broader implications that directly resonate with the SDGs, by addressing the pivotal issues of teacher resignation and turnover in the education sector. By shedding light on these alignments, our study serves as an academic contribution and a steppingstone in the global journey toward realizing the SDGs.

The proposed model could be utilized in collaboration with software developers to create tools for analyzing factors contributing to teacher resignation, thereby enhancing its accessibility for researchers and industry practitioners. Subsequent studies could incorporate performance metrics of the preschool education sector into the evaluation system. Additionally, future research could expand to explore the interrelationships between the factors influencing teacher resignation. This would provide a deeper understanding of how these factors interact and affect each other. Furthermore, the analytical process outlined in this study can be adapted to other multi-criteria decision-making problems by adjusting the criteria to suit different industries.

Author Contributions
Conceptualization, Y.-H.Y. and H.-W.L.; methodology, Y.-H.Y. and H.-W.L.; software, Y.-H.Y.; validation, H.-W.L.; investigation, Y.-H.Y.; data curation, Y.-H.Y.; writing—original draft preparation, Y.-H.Y. and H.-W.L.; writing—review and editing, H.-W.L. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement
The data supporting this study are confidential and cannot be shared publicly. The data contain sensitive information that is protected to ensure the privacy and confidentiality of the participants and entities involved. For any inquiries regarding the data, please contact the corresponding author directly.

Conflicts of Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Palma-Vasquez, C., Carrasco, D., & Tapia-Ladino, M. (2022). Teacher mobility: What is it, how is it measured and what factors determine it? A scoping review. *International Journal of Environmental Research and Public Health*, *19*(4), 2313. https://doi.org/10.3390/ijerph19042313

[2] Hur, E. H., Ardeleanu, K., Satchell, T. W., & Jeon, L. (2022, April). Why are they leaving? Understanding Associations between early childhood program policies and teacher turnover rates. In *Child & Youth Care Forum* (pp. 1-24). New York: Springer US. https://doi.org/10.1007/s10566-022-09693-x

[3] Kim, J., Shin, Y., Tsukayama, E., & Park, D. (2020). Stress mindset predicts job turnover among preschool teachers. *Journal of School Psychology*, *78*, 13-22. https://doi.org/10.1016/j.jsp.2019.11.002

[4] Zhou, S., Li, X., & Gao, B. (2020). Family/friends support, work-family conflict, organizational commitment, and turnover intention in young preschool teachers in China: A serial mediation model. *Children and youth services review*, *113*, 104997. https://doi.org/10.1016/j.childyouth.2020.104997

[5] Mérida-López, S., Sánchez-Gómez, M., & Extremera, N. (2020). Leaving the teaching profession: Examining the role of social support, engagement and emotional intelligence in teachers' intentions to quit. *Psychosocial Intervention*, *29*(3), 141-151. https://doi.org/10.5093/pi2020a10

[6] Li, X., Guo, Y., & Zhou, S. (2021). Chinese preschool teachers' income, work-family conflict, organizational commitment, and turnover intention: a serial mediation model. *Children and Youth Services Review*, *128*, 106005. https://doi.org/10.1016/j.childyouth.2021.106005

[7] Kwon, K. A., Malek, A., Horm, D., & Castle, S. (2020). Turnover and retention of infant-toddler teachers: Reasons, consequences, and implications for practice and policy. *Children and Youth Services Review*, *115*, 105061. https://doi.org/10.1016/j.childyouth.2020.105061

[8] Doromal, J. B., Bassok, D., Bellows, L., & Markowitz, A. J. (2022). Hard-to-staff centers: Exploring center-level variation in the persistence of child care teacher turnover. *Early Childhood Research Quarterly*, *61*, 170-178. https://doi.org/10.1016/j.ecresq.2022.07.007

[9] Heilala, C., Kalland, M., Lundkvist, M., Forsius, M., Vincze, L., & Santavirta, N. (2022). Work demands and work resources: Testing a model of factors predicting turnover intentions in preschool education. *Preschool education Journal*, 50(3), 399-409. https://doi.org/10.1007/s10643-021-01166-5

[10] Schaack, D. D., Donovan, C. V., Adejumo, T., & Ortega, M. (2022). To Stay or to Leave: Factors Shaping Early Childhood Teachers' Turnover and Retention Decisions. *Journal of Research in Childhood Education*, 36(2), 327-345. https://doi.org/10.1080/02568543.2021.1955779

[11] Bassok, D., Markowitz, A. J., Bellows, L., & Sadowski, K. (2021). New evidence on teacher turnover in early childhood. *Educational Evaluation and Policy Analysis*, 43(1), 172-180. https://doi.org/10.3102/0162373720985340

[12] Nguyen, T. D., & Springer, M. G. (2021). A conceptual framework of teacher turnover: a systematic review of the empirical international literature and insights from the employee turnover literature. *Educational Review*, 1-36. https://doi.org/10.1080/00131911.2021.1940103

[13] Li, R., & Yao, M. (2022). What promotes teachers' turnover intention? Evidence from a meta-analysis. *Educational Research Review*, 100477. https://doi.org/10.1016/j.edurev.2022.100477

[14] Yang, B., Tian, F., & Huang, J. (2022). SES, relative deprivation, perceived preschool support and turnover intention in Chinese teachers during the COVID-19 pandemic: a moderated mediation model. *Early Education and Development*, 1-18. https://doi.org/10.1080/10409289.2022.2033589

[15] Mohammadi, M., & Rezaei, J. (2019). Bayesian best-worst method: A probabilistic group decision-making model. *Omega*, 102075. https://doi.org/10.1016/j.omega.2019.06.001

[16] Li, L., Wang, X., & Rezaei, J. (2020). A Bayesian Best‐Worst Method‐Based Multicriteria Competence Analysis of Crowdsourcing Delivery Personnel. *Complexity*, 2020(1), 4250417. https://doi.org/10.1155/2020/4250417

[17] Mohammadi, M., & Rezaei, J. (2022). Hierarchical evaluation of criteria and alternatives within BWM: A Monte Carlo approach. In Advances in Best-Worst Method: Proceedings of the Second International Workshop on Best-Worst Method (BWM2021) (pp. 16-28). Springer International Publishing. https://doi.org/10.1007/978-3-030-89795-6_2

[18] Grant, A. A., Jeon, L., & Buettner, C. K. (2019). Relating early childhood teachers' working conditions and well-being to their turnover intentions. *Educational Psychology*, 39(3), 294-312. https://doi.org/10.1080/01443410.2018.1543856

[19] Lambert, R., Boyle, L., Fitchett, P., & McCarthy, C. (2019). Risk for occupational stress among US preschool teachers. *Journal of Applied Developmental Psychology*, 61, 13-20. https://doi.org/10.1016/j.appdev.2018.07.003

[20] Schaack, D. D., Le, V. N., & Stedron, J. (2020). When fulfillment is not enough: Early childhood teacher occupational burnout and turnover intentions from a job demands and resources perspective. *Early Education and Development*, 31(7), 1011-1030. https://doi.org/10.1080/10409289.2020.1791648

[21] Nguyen, T. D., Pham, L. D., Crouch, M., & Springer, M. G. (2020). The correlates of teacher turnover: An updated and expanded meta-analysis of the literature. *Educational Research Review*, 31, 100355. https://doi.org/10.1016/j.edurev.2020.100355

[22] McMullen, M. B., Lee, M. S., McCormick, K. I., & Choi, J. (2020). Early childhood professional well-being as a predictor of the risk of turnover in child care: A matter of quality. *Journal of Research in Childhood Education*, 34(3), 331-345. https://doi.org/10.1080/02568543.2019.1705446

[23] McCormick, K. I., McMullen, M. B., & Lee, M. S. (2022). Early Childhood Professional Well-being as a Predictor of the Risk of Turnover in Early Head Start & Head Start Settings. *Early Education and Development*, 33(4), 567-588. https://doi.org/10.1080/10409289.2021.1909915

[24] Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, *53*, 49-57. https://doi.org/10.1016/j.omega.2014.11.009

[25] Huang, C. N., Liou, J. J., Lo, H. W., & Chang, F. J. (2021). Building an assessment model for measuring airport resilience. *Journal of Air Transport Management*, 95, 102101. https://doi.org/10.1016/j.jairtraman.2021.102101

[26] Gul, M., & Yucesan, M. (2022). Performance evaluation of Turkish Universities by an integrated Bayesian BWM-TOPSIS model. *Socio-Economic Planning Sciences*, 80, 101173. https://doi.org/10.1016/j.seps.2021.101173

[27] Haseli, G., Sheikh, R., Ghoushchi, S. J., Hajiaghaei-Keshteli, M., Moslem, S., Deveci, M., & Kadry, S. (2024). An extension of the best–worst method based on the spherical fuzzy sets for multi-criteria decision-making. *Granular Computing*, 9(2), 1-18. https://doi.org/10.1007/s41066-024-00462-w

[28] Moslem, S., Deveci, M., & Pilla, F. (2024). A novel best-worst method and Kendall model integration for optimal selection of digital voting tools to enhance citizen engagement in public decision making. *Decision Analytics Journal*, *10*, 100378. https://doi.org/10.1016/j.dajour.2023.100378

[29] Ak, M. F., Yucesan, M., & Gul, M. (2022). Occupational health, safety and environmental risk assessment in textile production industry through a Bayesian BWM-VIKOR approach. *Stochastic Environmental Research and Risk Assessment*, 1-14. https://doi.org/10.1007/s00477-021-02069-y

[30] Yanilmaz, S., Baskak, D., Yucesan, M., & Gul, M. (2021). Extension of FEMA and SMUG models with Bayesian best-worst method for disaster risk reduction. *International Journal of Disaster Risk Reduction*, *66*, 102631. https://doi.org/10.1016/j.ijdrr.2021.102631

[31] Chauhan, A., Jakhar, S. K., & Jabbour, C. J. C. (2022). Implications for sustainable healthcare operations in embracing telemedicine services during a pandemic. *Technological Forecasting and Social Change*, *176*, 121462. https://doi.org/10.1016/j.techfore.2021.121462

[32] Yao, K. C., Yang, J. J., Lo, H. W., Lin, S. W., & Li, G. H. (2023). Using a BBWM-PROMETHEE model for evaluating mobile commerce service quality: A case study of food delivery platform. *Research in Transportation Business & Management*, *49*, 100988. https://doi.org/10.1016/j.rtbm.2023.100988

[33] Lo, H. W., & Siao, Z. (2023). Exploring the Role of Multiple Criteria Decision-Making in Enterprise Digital Transformation. *International Journal of Business*, *28*(3). https://doi.org/10.55802/IJB.028(3).006

[34] Liu, Z., Deveci, M., Pamučar, D., & Pedrycz, W. (2024). An effective multi-source data fusion approach based on α-divergence in belief functions theory with applications to air target recognition and fault diagnosis. *Information Fusion*, *110*, 102458. https://doi.org/10.1016/j.inffus.2024.102458

[35] Deveci, M., Çiftçi, M. E., Isik, M., Pamucar, D., Wen, X., Chin, T., & Kadry, S. (2024). Aircraft type selection using fuzzy trigonometric based OPA and RAFSI model. *Information Sciences*, *673*, 120688. https://doi.org/10.1016/j.ins.2024.120688

[36] Lo, H. W., Fang, T. Y., & Lin, S. W. (2024). Integrating Technological and Strategic Analysis: Evaluating the Key Determinants of Transportation Sustainability in Taipei Mass Rapid Transit using the Rough-Fermatean DEMATEL Approach. *Socio-Economic Planning Sciences*, 101948. https://doi.org/10.1016/j.seps.2024.101948

[37] Bratton, J., Gold, J., Bratton, A., & Steele, L. (2021). *Human resource management*. Bloomsbury Publishing.