

Evaluating job stress factors among secondary school teachers using fuzzy decision-making trial and evaluation laboratory (DEMATEL)

Siti Shakirah Shapri¹, Nur Solihah Khadhiah Abdullah^{1*}, Norhamimah Rani², Ruhana Jaafar¹, Nurmuslimah Kamilah Abdullah³

¹Center of Mathematical Sciences, Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Cawangan Terengganu, Kampus Kuala Terengganu, 21080 Kuala Terengganu, Malaysia.

²Academy of Language Study, Universiti Teknologi MARA Cawangan Terengganu, Kampus Dungun, 23000 Dungun, Malaysia.

³Faculty of Business Management, Universiti Teknologi MARA Cawangan Terengganu, Kampus Dungun, 23000 Dungun, Malaysia.

ABSTRACT - Stress is defined as an individual's struggle to manage challenges from their surroundings, leading to unhappiness and discomfort. Job stress is a mental and physical state that influences one's productivity, effectiveness, and well-being in the workplace. Individuals experiencing job stress may face negative emotional states and teachers are not exempt from encountering stress in their professional environment. Despite growing concerns, existing research lacks a structured, data-driven approach to analyze key stress factors. Thus, this study aims to identify and evaluate the primary causes and effects of job stress among secondary school teachers using a systematic decision-making approach. The fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) method with Simplified Centroid Defuzzification (SCD) was applied to assess nine stress-related criteria which are job satisfaction, mental health, burnout, workload, environment discomfort, student's behavior, role conflict, unrelated tasks, and personal problems. Data were collected through expert evaluations from three secondary schools. The findings indicate that mental health, role conflict, and personal problems were the primary causes of teacher stress, while the remaining factors were effects. Based on the distribution map result, mental health influenced all the effect criteria while job satisfaction, burnout, workload and student's behavior have mutual relationship. Personal problem was categorized as isolated criteria since it was neither influenced by nor influencing other criteria. These findings provide valuable insights for educators, school administrators, and policymakers to implement targeted interventions. Addressing the right key factors that cause stress can improve teacher well-being, enhance job satisfaction, and contribute to a more effective education system.

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1. INTRODUCTION

Stress occurs when a person struggles to cope with environmental challenges, resulting in feelings of discomfort and unease. It is also associated with the body's efforts to maintain balance and confront the demands of life. Job stress, in particular, is a mental and physical state that influences one's productivity, effectiveness and well-being at work. Every job comes with different struggles, challenges and stress because of the excessive pressure and demand from the company or higher ups. Teaching is no exception since teachers often face high expectations from everyone, including parents, students and school management [1]. Although high expectation and pressure can sometimes motivate better performance, prolonged stress can also lead to harmful consequences [2].

Work-related stress is a significant global issue, affecting employees' well-being and productivity across various professions, including educators. According to the Health and Safety Executive, 595,000 workers in the UK experience work-related stress, leading to the loss of 15.4 million working days annually. Among every 100,000 educators, 2,100 are affected by stress [3]. In Malaysia, a study by the Human Research Ethics Committee examined the prevalence of psychological distress which includes depression, anxiety, and stress among secondary school teachers in Klang. From 14 secondary schools, six were randomly selected, with 365 teachers participating in the study. Using the Depression Anxiety Stress Scale (DASS), the findings revealed that female teachers, particularly Indian teachers, exhibited higher levels of stress. Similarly, in Kota Bahru, Kelantan, a study involving 580 secondary school teachers found that 34% of them experienced significant stress levels [4].

Despite the increased awareness of mental health issues, teachers' stress remains as an overlooked concern, with long-term implications for both educators and the education system. Chronic stress can lead to burnout, reduced job performance, and a decline in teaching quality, ultimately impacting student learning experiences. However, existing research lacks a structured approach to systematically identify and evaluate the key stress factors affecting teachers. Therefore, this study aims to bridge this gap by employing a data-driven approach to analyse the causes and effects of

*CORRESPONDING AUTHOR | Nur Solihah Khadhiah Abdullah | ✉ nsolihah@uitm.edu.my

teacher stress, providing insights to improve their well-being, sustain teaching quality, and enhance overall educational outcomes.

This study implements a multi-criteria decision making (MCDM) technique which is Decision Making Trial and Evaluation Laboratory (DEMATEL) specialized in Simplified Centroid Defuzzification (SCD) method to identify the cause and effect of work stress among secondary school teachers. To deal with the existence of vagueness in decision making process, a fuzzy concept was integrated. [5] agreed that DEMATEL is a method used in decision making problems based on the relationship between the criteria and their correlations dependencies. This method utilized mathematical techniques to analyze and quantify the strength and direction of relationship among different criteria, and to help experts to understand the interdependence of the Fuzzy DEMATEL system. By employing fuzzy logic into the method, it has the ability to handle complicated real-world decision problems under uncertainty environments [6].

Fuzzy DEMATEL has been widely applied in various fields to analyze complex decision-making problems by identifying cause and effect relationship among multiple criteria. A study by Abd. Nasir et al. [7] which applied SCD method in fuzzy DEMATEL to solve a supplier selection problem in fertigation systems, was explored and implemented in this project. The research aimed to identify the best supplier for maximizing crop yield. The findings revealed that technical aspects and procurement policy were classified as causes, while price, quality, delivery, and managerial aspects were categorized as effects.

Several studies have applied fuzzy DEMATEL to analyze job stress factors and their interdependence. Zhong et al. [8] who had utilized fuzzy DEMATEL to model cause-and-effect relationships among workplace stress factors, classified role conflict, work complexity, job knowledge, job security, job satisfaction, and shift work as the causes of stress, while mental health, fatigue, mental workload, sleep disorders, environmental discomfort, and work pressure were identified as effects. Samadi-Miarkolaei [9] investigated the relationship between nurses' job burnout and related psychological variables in an Iranian public hospital. The study found that quality of work life and ethics contributed to burnout; while mental health, job burnout, and organizational citizenship behavior were among its effects. These findings highlight the effectiveness of fuzzy DEMATEL in analyzing job stress and emphasize the need for further research in different professional settings, including education.

Although the application of fuzzy DEMATEL has been widely explored in various fields, research focusing on job stress factors among secondary school teachers in Malaysia remains limited, especially with the implementation of Simplified Centroid Defuzzification (SDC) in fuzzy DEMATEL. Addressing this gap, this study applied fuzzy DEMATEL with SDC to provide a valuable insight for educators and policymakers.

The aim of this study is to identify the criteria contributing to job stress and evaluate their degree of influence. It is also to identify which criteria fall under cause or effect based on their significant order, and lastly to propose the relationship among criteria using Influential Relation Map (IRM). The research specifically focuses on three secondary schools in Sabak Bernam, Selangor. The study considers nine key stress-related criteria which are job satisfaction, mental health, burnout, workload, environment discomfort, student's behavior, role conflict, unrelated tasks, and personal problems. Interview sessions were conducted with three experts to collect the data which was further analyzed.

2. METHODOLOGY

The criteria to evaluate job stress among secondary school teachers have been carefully selected based on the previous literature. Nine criteria have been chosen which are job satisfaction (C1), mental health (C2), burnout (C3), workload (C4), environment discomfort (C5), student's behavior (C6), role conflict (C7), unrelated tasks (C8), and personal problems (C9). Details of criteria descriptions are presented in Table 1. Three experts were chosen with at least ten years of teaching experience. Opinions of the experts were collected using guided interview sessions where experts answered questionnaires provided in accordance with the linguistic terms as shown in Table 2.

Criteria	Description
C1 Job satisfaction	The overall feeling about the job.
C2 Mental health	Personal emotional wellbeing.
C3 Burnout	A condition where individuals undergo both physical and mental exhaustion.
C4 Workload	The amount of work performed or capable of being performed within a specific period.
C5 Environment discomfort	Work environment that has poor social surrounding.
C6 Student's behavior	Student's actions, manners and attitude.
C7 Role conflict	A condition where people put high expectation.
C8 Unrelated tasks	Situation where teachers are demanded to do other tasks that are unrelated to academic nature.
C9 Personal problems	Issues, challenges or difficulties that an individual faces in their personal life.

Table 2: Linguistic scales

Scale	Linguistic Terms
0	No Influence (NO)
1	Very Low Influence (VL)
2	Low Influence (L)
3	High Influence (H)
4	Very high influence (VH)

The application of SCD method within the fuzzy DEMATEL framework as introduced by Wang et al. [10], was applied in this study to analyze the cause and effect of job stress among secondary school teachers. The implementation was guided by methodologies and findings, which provided a foundation for evaluating the relationship between the criteria [7], [11-12].

Step 1: Transform the pairwise comparison matrix into the linguistic scale direct-relation matrix.

The data obtained from the guided interview questionnaire was then transferred into a pairwise comparison matrix. The pairwise comparison matrix from each expert was transformed into a linguistic scale direct-relation matrix in relation to the triangular fuzzy number value (TFN). The correspondent TFN proposed by Wang et al. [10] was implemented.

Table 3. Fuzzy linguistic scale

Scale	Linguistic Terms	Correspondence TFN
0	No Influence (NO)	(0,0,0.25)
1	Very Low Influence (VL)	(0.0.25, 0.5)
2	Low Influence (L)	(0.25, 0.5, 0.75)
3	High Influence (H)	(0.5, 0.75, 1)
4	Very high influence (VH)	(0.75,1,1)

The fuzzy initial direct-relation matrix for pairwise comparison of job stress criteria (1) can be written as (2) where $f_{ij}^k, m_{ij}^k, l_{ij}^k$ represents the triangular fuzzy number for the first, middle and last respectively, and t_{ij}^k denotes the influence degree of i^{th} criterion that affects j^{th} criterion evaluated by expert k .

$$T_k = [t_{ij}^k]_{n \times n} = [f_{ij}^k, m_{ij}^k, l_{ij}^k]_{n \times n} \tag{1}$$

$$T_k = [t_{ij}^k]_{n \times n} = \begin{bmatrix} 0 & t_{12}^k & \dots & t_{1n}^k \\ t_{21}^k & 0 & \dots & t_{2n}^k \\ \vdots & \vdots & \ddots & \vdots \\ t_{n1}^k & t_{n1}^k & \dots & 0 \end{bmatrix}_{n \times n} \tag{2}$$

Step 2: Calculate the simplified centroid non-fuzzy number direct relation matrix.

The simplified centroid non-fuzzy number direct-relation matrix was obtained by averaging the triangular fuzzy number between all nine criteria for each expert using (3).

$$\tilde{X}_F(t_{ij}^k) = \frac{1}{3}(f_{ij}^k, m_{ij}^k, l_{ij}^k) \tag{3}$$

Step 3: Obtain the average of centroid non-fuzzy direct relation matrix.

The average of centroid non-fuzzy numbers direct relation matrix P , was calculated using (4) to find the relation influence between each criterion, where k in the formula refers to the number of experts.

$$P_{ij} = \frac{1}{k}(P_{ij}^1 + \dots + P_{ij}^k) \tag{4}$$

Step 4: Determine the generalized non-fuzzy direct relation matrix.

The generalized non-fuzzy direct relation matrix G , was obtained using (5) in reference to the overall non-fuzzy direct relation matrix, $P = (P_{ij})$.

$$G = (G_{ij}) = \frac{P_{ij}}{\max_{1 \leq i \leq n} \sum_{j=1}^n P_{ij}} \tag{5}$$

Step 5: Compute the total relation matrix.

The computation of the total relation matrix S was computed using (6), where I is the identity matrix of $n \times n$.

$$S = G(I - G)^{-1} \tag{6}$$

Step 6: Construct the causal diagram

The value of $r_i + c_j$ and $r_i - c_j$ were calculated to categorize which criteria will be grouped together under cause and effect. The letter r_i in the formula represents the sum of row while c_j refers to sum of column. The casual diagram is constructed where center degree, $r_i + c_j$ and cause degree, $r_i - c_j$ represent the horizontal axis and vertical axis respectively.

Step 7: Construct the Influential Relation Map (IRM)

Adjusted total relation matrix, S_R is constructed by discarding any value within total relation matrix, S that is lower than threshold, T_R . The equation to find threshold value is shown below.

$$T_R = \frac{\sum r_i}{n \times n} \tag{7}$$

IRM is established to analyze the relationship among the criteria according to the S_R obtained before. The criteria are categorized into four quadrants to aid decision makers to identify which criteria should be prioritized first within the system. The mean quadrant is obtained by finding the average of the center degree.

$$Mean\ Quadrant = \frac{\sum r_i + c_j}{n} \tag{8}$$

3. IMPLEMENTATION

The first step in the implementation of fuzzy DEMATEL is transforming the pairwise comparison matrix into a linguistic scale direct-relation matrix in relation to the triangular fuzzy number value (TFN). The samples of the pairwise comparison matrix for each expert are shown in Table 4-6 below. To facilitate the judgement of job stress among secondary school teachers, a linguistic scale was developed for each expert, using the formula in (2). Table 7 illustrates the direct-relation matrix for Expert 1 (T_1).

Table 4. Pairwise comparison matrix for Expert 1

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0	4	3	4	3	3	3	3	2
C2	3	0	3	3	3	2	2	3	2
C3	3	3	0	3	3	2	2	2	2
C4	3	3	3	0	3	3	2	3	3
C5	3	3	2	2	0	2	2	2	3
C6	3	3	3	3	3	0	3	3	3
C7	3	3	3	3	3	2	0	3	3
C8	3	3	3	3	3	2	2	0	3
C9	2	3	3	3	3	2	2	3	0

Table 5. Pairwise comparison matrix for Expert 2

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0	2	3	3	2	4	3	2	2
C2	3	0	2	3	3	4	2	3	3
C3	3	2	0	3	2	3	3	3	1
C4	2	2	3	0	2	2	3	3	1
C5	3	2	2	3	0	4	3	3	1
C6	4	2	3	2	3	0	3	2	1
C7	2	2	3	2	2	4	0	3	1
C8	3	3	3	3	3	2	3	0	1
C9	1	1	1	1	1	2	2	2	0

Table 6. Pairwise comparison matrix for Expert 3

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0	1	3	3	4	4	2	3	1
C2	3	0	3	3	4	4	2	3	3
C3	2	1	0	4	3	4	2	4	2
C4	4	2	4	0	2	3	2	4	1
C5	3	1	2	2	0	2	1	1	2
C6	4	3	4	2	1	0	1	1	2
C7	4	3	3	3	1	4	0	1	1
C8	3	1	3	4	1	1	1	0	1
C9	3	3	3	3	2	3	1	3	0

Table 7. Linguistic scale direct-relation matrix for Expert 1 (T_1)

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	(0,0,0)	(0.75,1,1)	(0.5, 0.75, 1)	(0.75,1,1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)
C2	(0.5, 0.75, 1)	(0,0,0)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)
C3	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0,0,0)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)
C4	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0,0,0)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0.5, 0.75, 1)	(0.5, 0.75, 1)
C5	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0,0,0)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0.5, 0.75, 1)
C6	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0,0,0)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)
C7	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0,0,0)	(0.5, 0.75, 1)	(0.5, 0.75, 1)
C8	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0,0,0)	(0.5, 0.75, 1)
C9	(0.25, 0.5, 0.75)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.5, 0.75, 1)	(0.25, 0.5, 0.75)	(0.25, 0.5, 0.75)	(0.5, 0.75, 1)	(0,0,0)

The linguistic scale direct relation matrix was transformed into centroid non-fuzzy number direct-relation matrix. The value of 0.916667 in $\tilde{X}_F(t_{12}^1)$ was obtained by using (3), as shown in the calculation below. Table 8 displays the sample of centroid non-fuzzy direct relation matrix for Expert 1.

$$\begin{aligned} \tilde{X}_F(t_{12}^1) &= \frac{1}{3}(f_{12}^1, m_{12}^1, l_{12}^1) \\ &= \frac{1}{3}(0.75 + 1.00 + 1.00) \\ &= 0.916667 \end{aligned}$$

Table 8. Centroid non-fuzzy direct-relation matrix for Expert 1

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0	0.916667	0.75	0.916667	0.75	0.75	0.75	0.75	0.5
C2	0.75	0	0.75	0.75	0.75	0.5	0.5	0.75	0.5
C3	0.75	0.75	0	0.75	0.75	0.5	0.5	0.5	0.5
C4	0.75	0.75	0.75	0	0.75	0.75	0.5	0.75	0.75
C5	0.75	0.75	0.5	0.5	0	0.75	0.5	0.5	0.75
C6	0.75	0.75	0.75	0.75	0.75	0	0.75	0.75	0.75
C7	0.75	0.75	0.75	0.75	0.75	0.5	0	0.75	0.75
C8	0.75	0.75	0.75	0.75	0.75	0.5	0.5	0	0.75
C9	0.5	0.75	0.75	0.75	0.75	0.5	0.5	0.75	0

The result of average centroid non-fuzzy direct relation matrix was derived from calculation using (4). Table 9 shows the influence relationship among all nine criteria.

$$\begin{aligned} P_{12} &= \frac{1}{k}(P_{12}^1 + P_{12}^2 + P_{12}^3) \\ &= \frac{1}{3}(0.916667 + 0.5 + 0.25) \\ &= 0.555556 \end{aligned}$$

Table 9. Average non-fuzzy numbers direct relation matrix, P

	C1	C2	C3	C4	C5	C6	C7	C8	C9	Sum of Row
C1	0	0.55556	0.75	0.805556	0.722222	0.861111	0.666667	0.666667	0.416667	5.444444
C2	0.75	0	0.666667	0.75	0.805556	0.777778	0.5	0.75	0.666667	5.666667
C3	0.666667	0.5	0	0.805556	0.666667	0.722222	0.583333	0.722222	0.416667	5.083333
C4	0.722222	0.583333	0.805556	0	0.583333	0.666667	0.583333	0.805556	0.416667	5.166667
C5	0.75	0.5	0.5	0.583333	0	0.722222	0.5	0.5	0.5	4.555556
C6	0.861111	0.666667	0.805556	0.583333	0.583333	0	0.583333	0.5	0.5	5.083333
C7	0.722222	0.666667	0.75	0.666667	0.5	0.777778	0	0.583333	0.416667	5.083333
C8	0.75	0.583333	0.75	0.805556	0.583333	0.416667	0.5	0	0.416667	4.805556
C9	0.5	0.583333	0.583333	0.583333	0.5	0.583333	0.416667	0.666667	0	4.416667

The generalization for the comparison of criteria C_1 until C_9 were derived from equation (5). Table 10 displays the generalized non-fuzzy direct relation matrix G , illustrating the influence relationships among all nine criteria. Next, the total relation matrix, S was calculated using (6), and the result is presented in Table 11.

$$G = (G_{ij}) = \frac{P_{ij}}{\max_{1 \leq i \leq n} \sum_{j=1}^n P_{ij}}$$

$$\sum_{j=1}^3 P_{ij} = \left\{ \begin{matrix} 5.444444, 5.666667, 5.083333, 5.166667, 4.555556, \\ 5.083333, 5.083333, 4.805556, 4.416667 \end{matrix} \right\}$$

$$\max_{1 \leq i \leq n} \sum_{j=1}^3 P_{ij} = 5.666667$$

$$G = (G_{12}) = \frac{0.555556}{5.666667} = 0.98039$$

Table 10. Generalized non-fuzzy direct relation matrix G

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0	0.098039	0.132353	0.142157	0.127451	0.151961	0.117647	0.117647	0.073529
C2	0.132353	0	0.117647	0.132353	0.142157	0.137255	0.088235	0.132353	0.117647
C3	0.117647	0.088235	0	0.142157	0.117647	0.127451	0.102941	0.127451	0.073529
C4	0.127451	0.102941	0.142157	0	0.102941	0.117647	0.102941	0.142157	0.073529
C5	0.132353	0.088235	0.088235	0.102941	0	0.127451	0.088235	0.088235	0.088235
C6	0.151961	0.117647	0.142157	0.102941	0.102941	0	0.102941	0.088235	0.088235
C7	0.127451	0.117647	0.132353	0.117647	0.088235	0.137255	0	0.102941	0.073529
C8	0.132353	0.102941	0.132353	0.142157	0.102941	0.073529	0.088235	0	0.073529
C9	0.088235	0.102941	0.102941	0.102941	0.088235	0.102941	0.073529	0.117647	0

Table 11. Total relation matrix, S

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0.995671	0.904151	1.094861	1.096097	0.983903	1.092550	0.882718	1.010559	0.736639
C2	1.143968	0.841006	1.113679	1.119901	1.024686	1.111324	0.883135	1.052386	0.795727
C3	1.040229	0.846586	0.918599	1.037633	0.923140	1.014066	0.823463	0.964021	0.695818
C4	1.063454	0.871158	1.058830	0.929304	0.925745	1.021363	0.835757	0.990580	0.706493
C5	0.964426	0.775321	0.913908	0.920365	0.741962	0.931363	0.743283	0.852283	0.650204
C6	1.071508	0.874129	1.047482	1.011621	0.916940	0.907987	0.827530	0.937281	0.712054
C7	1.053985	0.875745	1.041865	1.024324	0.905510	1.029205	0.735155	0.950060	0.700606
C8	1.008131	0.822731	0.993185	0.997301	0.874967	0.930397	0.778171	0.813742	0.667157
C9	0.901907	0.765699	0.899670	0.895412	0.800236	0.884057	0.709505	0.853635	0.551941

The causal diagram was obtained based on the value of center degree, $r_i + c_j$ and cause degree, $r_i - c_j$. The summation of row and column is as shown in Table 12. The distribution map was constructed to find the relationship between each criterion. Then, the adjusted total relation matrix, S_R must be obtained first by eliminating any values in S that are lower than threshold, T_R value. By applying (7), the threshold value was obtained. Table 13 presents the output of S_R after removing all values that is lower than T_R .

Table 12. Summation of row and column

	r_i	c_j	$r_i + c_j$	$r_i - c_j$
C1	8.797148	9.243279	18.040427	-0.446131
C2	9.085813	7.576526	16.662339	1.509287
C3	8.263556	9.082079	17.345635	-0.818523
C4	8.402683	9.031958	17.434642	-0.629275
C5	7.493114	8.097088	15.590202	-0.603974
C6	8.306533	8.922311	17.228844	-0.615778
C7	8.316456	7.218718	15.535174	1.097738
C8	7.885781	8.424546	16.310327	-0.538764
C9	7.262062	6.2166	13.478702	1.045422

$$T_r = \frac{(8.797148 + 9.085813 + 8.263556 + 8.402683 + 7.493114 + 8.306533) + 8.316456 + 7.885781 + 7.262062}{9 \times 9} = 0.911273$$

Table 13. Adjusted total relation matrix, S_R

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0.995671	0.904151	1.094861	1.096097	0.983903	1.092550	0.882718	1.010559	0.736639
C2	1.143968	0.841006	1.113679	1.119901	1.024686	1.111324	0.883135	1.052386	0.795727
C3	1.040229	0.846586	0.918599	1.037633	0.923140	1.014066	0.823463	0.964021	0.695818
C4	1.063454	0.871158	1.058830	0.929304	0.925745	1.021363	0.835757	0.990580	0.706493
C5	0.964426	0.775321	0.913908	0.920365	0.741962	0.931363	0.743283	0.852283	0.650204
C6	1.071508	0.874129	1.047482	1.011621	0.916940	0.907987	0.827530	0.937281	0.712054
C7	1.053985	0.875745	1.041865	1.024324	0.905510	1.029205	0.735155	0.950060	0.700606
C8	1.008131	0.822731	0.993185	0.997301	0.874967	0.930397	0.778171	0.813742	0.667157
C9	0.901907	0.765699	0.899670	0.895412	0.800236	0.884057	0.709505	0.853635	0.551941

To establish IRM diagram, the value of mean quadrant was calculated first. By calculating the average of center degree, the mean quadrant was obtained based on the (8).

$$\text{Mean Quadrant} = \frac{\sum r_i + c_j}{n}$$

$$= \frac{(18.040427 + 16.662339 + 17.345635 + 17.434642 + 15.590202) + 17.228844 + 15.535174 + 16.310327 + 13.478702}{9} = 16.402921$$

4. RESULTS AND DISCUSSION

This section presents and analyzes the study findings using causal diagram, distribution map and Influential Relation Map (IRM). These visual representations illustrate the relationship between criteria, providing deeper insights into their influence on secondary school teachers.

4.1 Causal Diagram

Figure 1 below illustrates the causal diagram and the way to determine the group for each criterion which is based on the value of cause degree, $r_i - c_j$. Three out of nine criteria, which are mental health, role conflict and personal problems were grouped together as cause, while the other remaining criteria- job satisfaction, burnout, workload, environment discomfort, student's behavior and unrelated tasks were in the effect group.

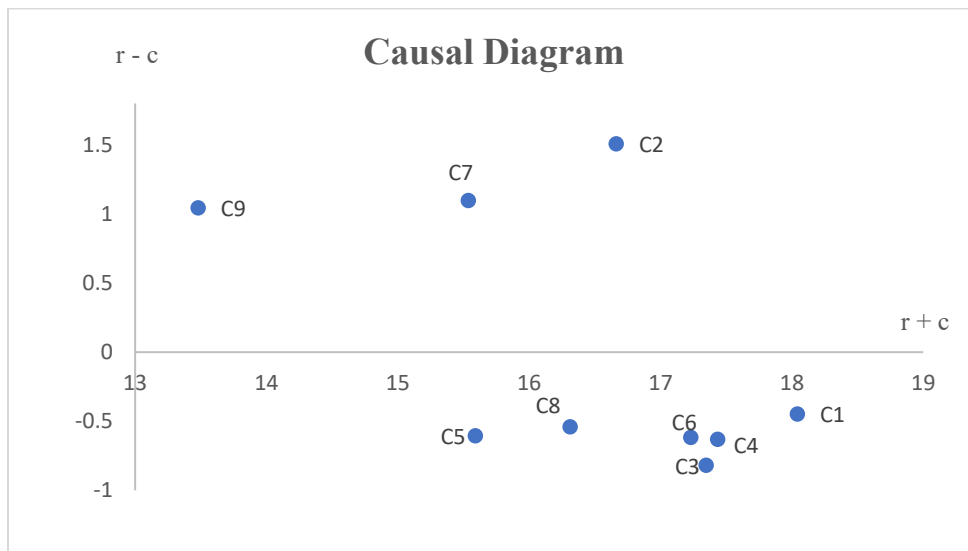


Figure 1. Causal diagram of job stress criteria

In fuzzy DEMATEL, cause degree, $r_i - c_j$ is used to measure the relationship between the criteria. Based on cause degree, researchers can determine which criteria lie under cause-and-effect group. Positive value of cause degree indicates that the criteria is a net cause which exerts more influence on other criteria than it receives. While the negative value of cause degree indicates otherwise [13].

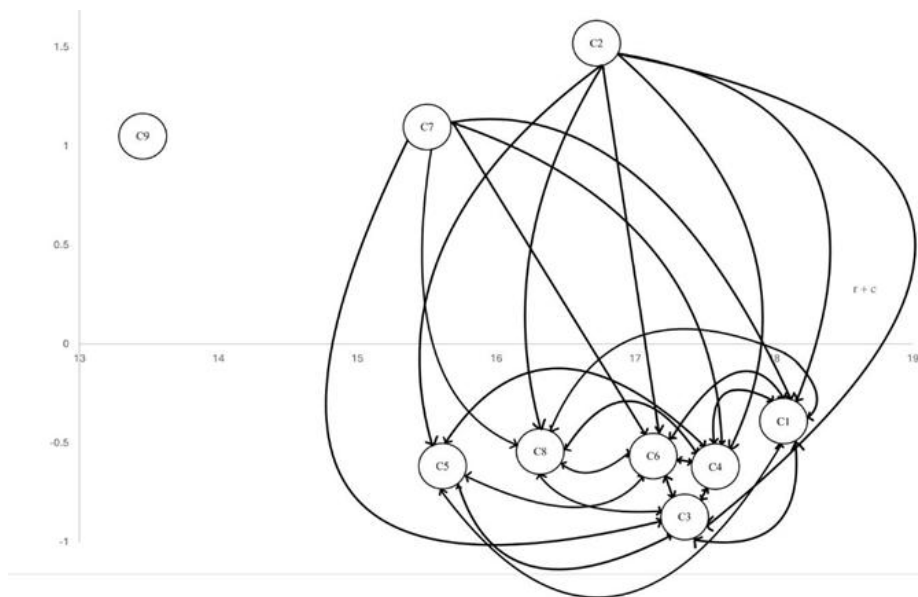
Table 14. Cause degree of job stress criteria

Rank	Criteria	$r_i - c_j$
1	C2 - Mental Health	1.509287
2	C7 – Role Conflict	1.097738
3	C9 – Personal Problems	1.045422
4	C1 – Job Satisfaction	-0.44613
5	C8 – Unrelated Task	-0.53876
6	C5 – Environment Discomfort	-0.60397
7	C6 – Student’s behavior	-0.61578
8	C4 – Workload	-0.62928
9	C3 - Burnout	-0.81852

As shown in Table 14, mental health, role conflict and personal problems were grouped together as cause. This indicates that these three criteria are the driving factors or the root causes of stress among teachers. While the rest of the criteria were classified as the effect of the stress. Poor mental health can significantly cause stress by creating constant worry, reducing motivation, impairing cognitive functioning and leading to physical health issues. Individuals with mental health issues such as anxiety and depression are often reported with higher level of stress [14]. Poor mental health can lead to difficulties in daily functioning, resulting in one’s increased stress level and decreased overall well-being and productivity. When teachers are mentally healthy, they are able to fulfil in their work, manage to cope with demands in their job and maintain a positive job performance [15].

4.2 Distribution Map

The distribution map is used to improve the visualization of the relationship between the criteria and to identify criteria with significant relationship and their degree of mutual influence [9]. The two-way arrow from Figure 2 indicates mutual influence between two criteria while one-way arrow indicates that only the criterion from which the arrow originates influences the criterion to which the arrow points [12].

**Figure 2.** Distribution map for the relationship of job stress criteria

As shown in Figure 2, mental health, (C2) influenced all the effect criteria, as indicated by the arrowheads pointing towards those criteria. Since no arrowhead pointed to C2, it is shown that mental health was the most influencing criteria followed by role conflict. Mutual influence indicates that both criteria affect each other. As for this research, job satisfaction, burnout, workload and student’s behavior had mutual relationship. Therefore, any changes in job satisfaction would eventually impact burnout, workload and student’s behavior, and vice versa [12]. Lastly, personal problems did not have any relationship arrow towards or from other criteria. This means that it was neither influenced by, nor influenced other criteria, making it an isolated criterion. Consequently, personal problems did not have any significant role in the system [9].

4.3 IRM Diagram

The level of importance of the criteria is measured by the value of center degree, $r_i + c_j$. The higher the value of the center degree, the higher the importance of the criteria in the system [16].

Table 15. Ranking of job stress criteria

Rank	Criteria	$r_i + c_j$
1	C1 – Job Satisfaction	18.040427
2	C4 – Workload	17.434642
3	C3 – Burnout	17.345635
4	C6 – Student’s Behavior	17.228844
5	C2 – Mental Health	16.662339
6	C8 – Unrelated Task	16.310327
7	C5 – Environment Discomfort	15.590202
8	C7 – Role Conflict	15.535174
9	C9 – Personal Problems	13.478702

The value of center degree for job satisfaction is 18.040427, making it the most crucial criteria compared to others. Followed by workload with the center value of 17.434642 and burnout with 17.345635. Although workload and burnout have significant center degree values and considered as important criteria, influential relation map (IRM) should be taken into consideration first to determine which criteria should be the primary focus for the improvement.

IRM diagram is used to identify the grouped criteria whether they are core criteria, causal criteria, independent criteria or influenced criteria [12]. This will ensure that the resources for improvement are located effectively and efficiently. These criteria groups are divided based on the average of center degree, $r_i + c_j$.

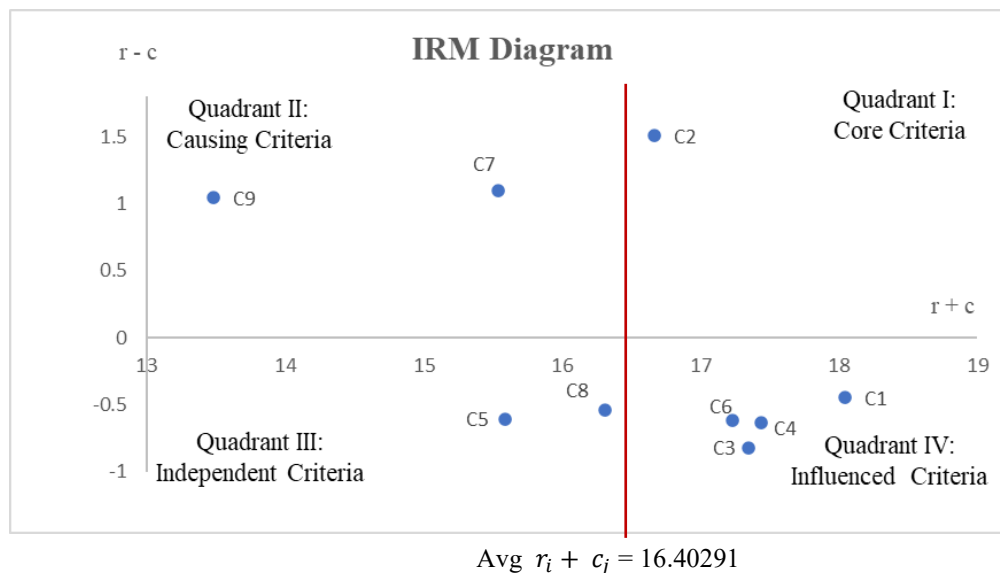


Figure 3. IRM diagram of job stress criteria

There is only one criterion at the first quadrant which is mental health, (C2). According to Hsu and Lee [12], criteria at the first quadrant indicate that they are the most important and highly influence other criteria especially towards criteria in quadrant four. By improving teachers’ mental health, it can directly impact on job satisfaction, workload, burnout and student’s behavior.

Role conflict (C7) and personal problems (C9) are located in the second quadrant. Criteria in the second quadrant are known to have less direct impact on fourth quadrants but if the criteria are improved, it may indirectly affect other criteria. As for criteria in quadrant three, unrelated tasks (C8) and environment discomfort (C5) were considered as independent criteria as they did not have any direct or indirect impact on other criteria. Improving those criteria does not solve the stress issue experienced by teachers since the efficiency of those criteria is not significant.

Moving to the last quadrant, criteria in this quadrant which are also known as influenced criteria, are regarded as criteria that have a direct impact and are easily influenced by other criteria. Although job satisfaction (C1), workload (C4), burnout (C3) and also student’s behavior (C6) have direct impact towards other criteria, improving those criteria are not recommended since it has low influence to other criteria compared to criteria in the first and second quadrant [12]. Therefore, optimum improvements are highly suggested to teachers’ mental health (C2) and role conflict (C7). Personal problems (C9) was not included because it was categorized as isolated criteria according to the distribution map before.

In summary, these findings suggested improving teachers’ mental health and addressing role conflict should be prioritized, as these criteria have the most substantial influence on overall job stress. Schools and policymakers,

particularly the Ministry of Education, should focus on implementing mental health support programs, reducing role conflict and ensuring conducive work environment to alleviate stress among teachers. By addressing these key areas, the well-being of educators can be improved, ultimately enhancing the quality of education and students' achievement.

5. CONCLUSIONS

The factors contributing to job stress among secondary school teachers have been carefully analyzed and closely evaluated in this research. The implementation of fuzzy DEMATEL specialized in SCD method, successfully identifies the key stress factors, determining their degree of influence, and categorize them into cause-and-effect groups. The findings highlight mental health (C2), role conflict (C7) and personal problems (C9) as the primary causes of stress, while job satisfaction (C1), workload (C4), burnout (C3), and student's behavior (C7) are among the affected criteria. Overall, this study emphasizes the importance of identifying and managing job stress among teachers, contributing to better work environments, improved teacher well-being, and enhanced educational outcomes.

As for the recommendation, future researchers are encouraged to improve upon this study by exploring different numbers and types of criteria, including direct input from teachers rather than relying solely on existing literature. Moreover, since personal problems was identified as an isolated criterion with no significant influence on other factors, future research should refine the selection of criteria to ensure a more comprehensive assessment of teachers' stress. Additionally, conducting similar studies in more crowded areas of Selangor, such as Lembah Klang or Shah Alam can also be considered. Researchers may also apply different Multi-Criteria Decision-Making (MCDM) methods, such as the fuzzy Delphi Method, fuzzy TOPSIS, or fuzzy AHP, to refine stress evaluations. Lastly, these methodologies can also be extended beyond teachers to analyze workplace stress in other professions.

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AUTHOR CONTRIBUTIONS

Siti Shakirah Shapri (Conceptualization; Formal analysis; Visualization; Writing - original draft; Writing - review & editing), Nur Solihah Khadhiah Abdullah (Conceptualization; Visualization; Writing - original draft; Writing - review & editing; Supervision; Project administration), Norhamimah Rani (Writing - review & editing; Supervision), Ruhana Jaafar (Writing - review & editing), Nurmuslimah Kamilah Abdullah (Writing - review & editing).

DECLARATION OF ORIGINALITY

The authors declare no conflict of interest to report regarding this study conducted.

GENERATIVE AI DECLARATIONS

The authors declare no conflict of interest to report regarding this study conducted. The authors claim that artificially intelligent-assisted technologies in the form of generative AI were not used to generate content, ideas, or theories. We have just utilised AI to enhance readability and refine the language. This was used with extreme human control and oversight. The authors take full responsibility for reviewing and approving the content.

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