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Mental Workload and Work Stress among Train Drivers and Their Associated Factors: A Cross-Sectional Study in Indonesia

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Abstract

Background: Employment in the railway sector is one of the professions that involves high challenges and demands, as it requires handling various complex tasks and responsibilities to ensure the safety and comfort of passenger travel. Train driver and train co-driver bear a high workload and face complex mental demands, making them vulnerable to work stress.
Objective: This study aims to examine the relationship between mental workload and work stress, as well as occupational and sociodemographic factors among train driver and train co-driver in DAOP 2 Bandung.
Methods: A cross-sectional analytical observational study was conducted using data from routine medical check-ups. Mental workload was measured using the NASA-TLX questionnaire, while work stress was assessed using the Job Stress Scale (JSS).
Results: Among 106 participants, 53% experienced high mental workload, while 97% reported low to moderate work stress. No significant associations were found between work stress and mental workload (p=0.190), job type, years of service, age, marital status, income, number of dependents, or coworker support. However, work stress was significantly associated with role expectation conflict (p<0.001) and work-life balance (p=0.029). After multivariate analysis, only role expectation conflict remained significantly associated. Workers experiencing moderate to high role expectation conflict had a 14.3-fold higher risk of work stress (CI 4.45–46.17).
Conclusion: Role expectation conflict is a significant factor associated with work stress. Addressing psychosocial factors through clear role definitions and policies supporting work-life balance is essential in reducing stress among train crews.
Keywords: work stress, mental workload, train driver, train co-drivers, role expectation conflict, work-life balance, coworker support.

Abstrak

Pendahuluan: *Pekerjaan di sektor perkeretaapian merupakan salah satu profesi yang memiliki tantangan dan tuntutan tinggi karena dihadapkan pada berbagai tugas dan tanggung jawab yang kompleks demi menjamin keselamatan dan kenyamanan perjalanan penumpang. Masinis dan Asisten Masinis merupakan pekerja dengan beban kerja tinggi dan tuntutan mental yang kompleks, sehingga rentan mengalami stres kerja.*
Tujuan: *Penelitian ini bertujuan untuk mengetahui hubungan antara beban kerja mental dan stres kerja serta faktor okupasi dan sosiodemografi pada masinis dan asisten masinis di DAOP 2 Bandung.*
Metode: *Penelitian ini menggunakan desain analitik observasional dengan pendekatan potong lintang. Data dikumpulkan dari pemeriksaan kesehatan rutin menggunakan kuesioner NASA-TLX untuk beban kerja mental dan Job Stress Scale (JSS) untuk stres kerja.*
Hasil: *Dari 106 responden, 53% mengalami beban kerja mental tinggi, namun 97% menunjukkan tingkat stres kerja rendah hingga sedang. Tidak ditemukan hubungan bermakna antara stres kerja dan beban kerja mental (p=0,190), jenis pekerjaan, masa kerja, usia, status pernikahan, pendapatan, jumlah tanggungan, atau dukungan rekan kerja. Namun, stres kerja berhubungan signifikan dengan konflik peran (p<0,001) dan keseimbangan kerja-kehidupan (p=0,029). Setelah penyesuaian multivariat, hanya konflik peran yang tetap berhubungan signifikan. Pekerja dengan konflik peran sedang-tinggi memiliki risiko 14,3 kali lebih besar mengalami stres kerja dibandingkan yang konflik perannya rendah (IK 4,45–46,17).*
Kesimpulan: *Konflik peran merupakan faktor okupasi yang berhubungan signifikan dengan stres kerja. Penanganan faktor psikososial, seperti kejelasan pembagian peran dan kebijakan keseimbangan kerja-kehidupan, penting untuk mengurangi stres pada pekerja.*
Kata kunci: *Stres kerja, Beban kerja mental, Masinis, Asisten masinis, Masa kerja, Konflik peran, Dukungan rekan kerja, Keseimbangan kerja-kehidupan.*

Introduction

Working as train drivers and co-drivers face physical and mental burden and demands, as it involves complex tasks and responsibilities to ensure the safety and comfort of passenger journeys. A train driver responsible for leading the journey, often 6-10 hours, requires high concentration, quick decision-making, and handling of emergency situations that frequently occur. This inevitably has the potential to cause work stress. This high demands often lead to a high cases of work stress: 602,000 cases in UK, 32.4% in Japan,[4] and about 41-51% in China.[5-7] In Indonesia, 18 of 24 train drivers experienced high work stress.

Stress among train drivers can influence the passenger safety as fatigue and stress can exacerbate human error.[11] One important aspect of railway crew work is mental workload, which refers to the cognitive and emotional demands faced, including high concentration, quick decision-making, and handling of frequent emergencies. Research conducted on train driver in Iran shows that mental workload has a significant correlation with fatigue and stress in train driver.[12]

Research conducted to examine factors associated with work stress indicates that age, years of service, and workload are factors associated with work stress.[13,14] Another study showed that the prevalence of mental health issues among railway workers in China was higher among those aged 30-40 years, with less than 10 years of service, who were unmarried, and with an income of 1,500-2,000 yuan.[6,7] A study conducted by Dong et al. showed that older train driver have better responses in dealing with fatigue and stress.[11]

Work stress can also be caused by poor work management due to poor work design (e.g., lack of control over work processes), poor management, unsatisfying work, and a lack of support from colleagues and superiors.[10] Role conflicts arise when multiple orders or roles are carried out simultaneously, leading to the neglect of other orders or roles. Research shows that role conflicts have a strong influence on stress, which can ultimately lead to work-related fatigue. Such conditions require support from colleagues and supervisors to address them. Research findings indicate that workplace or organizational support can help individuals cope with stress.[15,16]

Work-life balance is closely related to the balance of effort and time devoted to work and personal life. Work stress and work-life balance are two interrelated aspects of daily life. High stress levels in the workplace can disrupt the achievement of work-life balance. An individual may struggle to maintain a healthy relationship between their work and personal life.

Research conducted by Hardiani et al. shows that work stress affects work-life balance.[15] This aligns with other studies stating that disruptions or imbalances between work and personal life can lead to work-related fatigue, which has been proven to have negative impacts on employees' physical and psychological health.[17,18]

Several factors may explain the discrepancy in findings, including the possibility that workers felt pressure during routine health examinations, leading to bias in the results due to concerns about potential penalties if the examination indicated stress, and differences in the stress measurement tools used, specifically the Health and Safety Executive (HSE) Management Standard Indicator Tools. Therefore, further research is needed to confirm the relationship between mental workload, work stress, occupational risk factors, and sociodemographic factors in this population. Additionally, it is hoped that research at DAOP 2 Bandung can achieve a sufficient sample size to adequately represent the study population.

A better understanding of the factors influencing work stress will help organizations develop appropriate intervention strategies to maintain the mental and physical well-being of workers. This study aimed to assess the mental workload and work stress among train driver and train co-driver, and their associated occupational and sociodemographic factors.

Methods

This cross-sectional study applied a quantitative analysis of secondary data, obtained from annual workers' Medical Check-Up in February 2025. The study was conducted at a Bandung railway station, Indonesia, which was purposely selected due to its high volume of train trips. Bandung is the headquarter of the railway company in Indonesia, and Bandung Station is one of the main departure stations with the highest number of departures, especially on weekends/holiday seasons.

The inclusion criteria in this study are train drivers and train co-drivers of DAOP 2 Bandung who are currently working actively within the research area, are

between 18 and 55 years of age, and have been employed as a train driver or co-driver for a minimum of one year. The exclusion criteria in this study are train drivers and train co-drivers of DAOP 2 Bandung who have a history of/currently undergoing treatment for, a diagnosed mental health disorder such as bipolar disorder, who are currently taking antidepressant medications such as Fluoxetine or anxiolytics such as Alprazolam or Xanax, as confirmed by company medical records; or who are unable to communicate effectively in the language used in this research.

To assess mental workload, we used secondary data which were measured with NASA-TLX. Job Stress Scale (JSS) questionnaire was used to assess work stress. Independent Variables

The independent variables examined in this study include: mental workload; occupational factors (type of job, length of employment, role conflict, coworker support, and work-life balance); and sociodemographic factors (age, marital status, socioeconomic status, and number of dependents). The dependent variable in this study is work stress.

Data analysis was conducted using SPSS version 26.0 for Windows. Data were processed through computer-assisted steps including editing, coding, data entry, and cleaning. Univariate analysis was used to describe the distribution of variables, including frequency, percentages for categorical data, and mean, median, standard deviation, and range for numerical data. Bivariate analysis involved appropriate statistical tests based on data type and distribution (e.g., Chi-square, Fisher's exact test, independent t-test, or Mann-Whitney). Normality was tested using the Shapiro-Wilk or Kolmogorov-Smirnov test. Results were presented with crude odds ratios (cOR), adjusted odds ratios (aOR), 95% confidence intervals (CI), and a significance threshold of $p \leq 0.05$.

This study received ethical clearance from the Research Ethics Committee, Faculty of Medicine, Universitas Indonesia (Approval No. KET-280/UN2. F1/ETIK/PPM.00.02/2025).

Results

Out of 125 train drivers and co-drivers who underwent the MCU, 19 were excluded due to having less than one year of service. The total number of workers included in the analysis was 106.

The majority of workers were train driver (88%) and married (96%), with a median tenure of 17 years. Workers' ages ranged from 21 to 55 years, with incomes ranging from Rp 3,500,000 to Rp 11,700,000 and a range of dependents from 0 to 7 people.

More than half of the workers had heavy workloads (n=56, 53%), while 47 (44%) workers had moderate mental workloads, and 3 (3%) workers had low mental workloads.

More than half of the workers experienced low-category work stress (n=74; 70%), while 3 workers (3%) experienced high-category stress. Regarding role conflict, 73 workers (69%) fell into the low category, and 33 workers (31%) fell into the moderate-high category. A total of 79 (75%) workers felt high levels of peer support, while 27 (25%) workers felt moderate peer support. In terms of work-life balance, 86 (81%)

Table 1. Participants characteristics, n = 106

Variable	n	%
Position		
Train driver	93	88
Train co-driver	13	12
Tenure (years) *Median (Min-Max)*	17 (2-34)	
Age (years) *Median (Min-Max)*	38 (21-55)	
Marital status		
Married	96	91
Not married	10	9
Income/salary (IDR) *Median (Min-Max)*	7.700.000 (3.500.000-11.700.000)	
Number of dependents *Median (Min-Max)*	3 (0-7)	

Table 2. Mental workload of train drivers and train co-drivers

Variable	n	%
Mental workload		
Low	3	3
Moderate	47	44
High	56	53

Table 3. Job stress, role conflict, coworker support, and work-life balance among train drivers and train co-drivers in DAOP 2 Bandung

Variable	n	%
Job stress		
Low	74	70
Medium	29	27
High	3	3
Role conflict		
Low	73	69
Medium	31	29
High	2	2
Coworker support		
Low	0	0
Medium	27	25
High	79	75
Work-life balance		
Low	1	1
Medium	85	80
High	20	19

workers were in the low-moderate category and 20 (19%) workers were in the high category.

Due to the small number of workers with high stress levels, this study combined moderate and high stress categories into one category. This study shows that workplace stress incidents do not have a statistically significant relationship with mental workload (p=0.190), job type (p=0.526), tenure (p=0.141), age (p=0.183), marital status (p=0.485), income (p=0.406), and number of dependents (p=0.996).

This study found that coworker support (p=0.680) was not statistically significantly associated with workplace stress. Conversely, workplace stress was statistically associated with role conflict (p<0.001) and work-life balance (p=0.029).

Conversely, work-life balance showed a significant relationship with work stress. Workers who reported high work-life balance showed a much higher proportion of low work stress (90.0%) compared to those with low-moderate balance (65.1%). Thus, efforts to improve work-life balance and reduce role conflict can be key strategies in work stress management.

The analysis results indicate a significant relationship between role conflict and work stress levels. Workers with low role conflict levels predominantly experienced low work stress (84.9%), while those with moderate to high role conflict levels more frequently exhibited moderate to high work stress (63.6%). This finding suggests that the higher the perceived role conflict level, the greater the likelihood of experiencing work stress.

Meanwhile, peer support did not show a statistically significant relationship with work stress levels. Both in the low-moderate and high support groups, the distribution of low and moderate-high work stress was relatively similar, so this variable could not be used as a predictor of work stress in this sample.

This study shows that, after adjusting for other variables, workplace stress is statistically significantly associated only with role conflict. Work stress was found to be 14.3 times higher among workers with high-moderate role conflict compared to those with low role conflict. Work stress was not found to be statistically significant, after adjustment, with mental workload, peer support, work-life balance, and job type.

Role conflict showed a very strong and significant association with work stress, both in bivariate analysis (cOR = 9.86; 95% CI: 3.79–25.66; p < 0.001) and after controlling for other variables in a multivariate model (aOR = 14.34; 95% CI: 4.45–46.17; p < 0.001). This increase indicates that the relationship between role conflict and work stress is not a spurious effect or influenced by confounding variables, but rather becomes more prominent when other variables such as age, tenure, and work-life balance are controlled. This means that role conflict acts as a very strong independent determinant in triggering work stress, regardless of demographic conditions or other work support factors.

Discussion

This study conducted an in-depth analysis of mental workload and stress among train driver and train co-driver at DAOP 2 Bandung, utilizing annual health data from 106 workers. Demographic profiles revealed that most participants were married adults with substantial family responsibilities—factors known to influence how individuals perceive and manage stress. Social

and familial demands may serve as both protective and aggravating factors in work stress, consistent with international studies on shift workers and transportation professionals.[1,5]

More than half of the workers (53%) reported high levels of mental workload, while the remainder experienced light to moderate levels. This aligns with global findings indicating that train driver face

Table 4. Relationship between mental workload and worker characteristics with job stress

Variable	Work stress				p-value
	Medium-high		Low		
	n	%	n	%	
Mental workload					0.190[a]
Heavy	20	35.7%	36	64.3	
Mild-moderate	12	24.0%	38	76	
Position					0.526[b]
Train driver	27	29.0%	66	71.0	
Train co-driver	5	38.5%	8	61.5	
Tenure (years) Median (*Min-Max*)	14 (3-30)		19(2-34)		0.141[c]
Age (years) Median (*Min-Max*)	34.5 (21-54)		39 (21-55)		0.183[c]
Marital status					0.485[b]
Married	28	29.2%	68	70.8	
Not married	4	40.0%	6	60.0	
Income/salary (IDR) Median (*Min-Max*)	7.000.000 (4.200.000-11.500.000)		8.000.000 (3.500.000-11.700.000)		0.406[c]
Number of dependents (people) Median (*Min-Max*)	3 (0-5)		3 (0-7)		0.996[c]

Notes: a: *Chi Square*; b: *Fisher's Exact*; c: *Mann Whitney* test.

Table 5. Role conflict, coworker support, and work-life balance with the incidence of job stress in train drivers and train co-drivers in DAOP 2 Bandung

Variable	Work stress				*p-value*
	Medium-high		Low		
	n	%	n	%	
Role Conflict					<0.001*[a]
Medium-High	21	63.6%	12	36.4%	
Low	11	15.1%	62	84.9%	
Coworker support					0.680[a]
Low-Medium	9	33.3%	18	66.7%	
High	23	29.1%	56	70.9%	
Work-life balance					0.029*[a]
Low-Moderate	30	34.9%	56	65.1%	
High	2	10.0%	18	90.0%	

Description a: *Chi Square;* * Significance value based on p value <0.05 means statistically significant.

Table 6. Mental workload, role conflict, coworker support, work-life balance, and work stress among train drivers

Variable	cOR	*p-value*	aOR	*p-value*
Mental workload *(heavy)*	1.76 (0.75-4.11)	0.190	2.33 (0.76-7.19)	0.141
Role Conflict *(medium-high)*	9.86 (3.79-25.66)	<0.001**	14.34 (4.45-46.17)	<0.001**
Coworker support *(low-medium)*	1.22 (0.48-3.10)	0.680	1.25 (0.36-4.36)	0.725
Work-life balance *(low-medium)*	4.82 (1.05-22.19)	0.029*	5.45 (0.90-32.87)	0.064
Job Type	0.66 (0.20-2.18)	0.526	1.37 (0.10-18.24)	0.814
Tenure	1.04 (0.99-1.09)	0.160	1.18 (0.99-1.40)	0.073
Age	1.03 (0.99-1.08)	0.191	0.91 (0.77-1.08)	0.260
Marital status	0.62 (0.16-2.36)	0.485	0.90 (0.06-13.51)	0.941
Income/Salary	1.00 (1.00-1.00)	0.579	1.00 (1.00-1.00)	0.682
Number of Dependents	1.18 (0.84-1.65)	0.353	1.18 (0.64-2.17)	0.587

significant cognitive demands, including vigilance, rapid decision-making, and continuous information processing. These demands are not unique to Indonesia and have been documented across various national railway systems.[5,11]

Despite high mental workload, the majority of workers (70%) reported low work stress, 27% moderate, and only 3% high stress. In contrast, European and Asian studies typically show a stronger correlation between workload and stress. One explanation may be the high level of peer support within this group, which can buffer the effects of stress. Social support is known to moderate the negative consequences of a demanding work environment.[6,25]

Work-life balance emerged as a key concern. In this study, 81% of workers reported low to moderate balance. Although not statistically significant, poor work-life balance is widely recognized as a risk factor for long-term stress and burnout, particularly in schedule-dependent occupations. Irregular and unpredictable work hours, common in railway jobs, complicate efforts to maintain personal-professional boundaries. However, many workers with poor work-life balance still reported low stress, suggesting the presence of mitigating factors. These may include adaptive coping mechanisms and strong family support, which help buffer psychological strain.[15,18,29]

Role conflict and work-life balance were significantly associated with stress levels ($p = 0.0001$ and $p = 0.029$, respectively). Workers facing role conflict and imbalance between personal and professional demands reported higher stress. This is consistent with literature showing that role conflict—arising from conflicting expectations—can result in significant psychological pressure. In contrast, workers who successfully maintain boundaries between work and life are more resilient

to stress. Organizational clarity, communication, and supportive policies are essential to reduce stress through role definition. Interestingly, coworker support showed no significant correlation with stress in this context, suggesting that interpersonal support alone may not be sufficient when structural stressors dominate.

Notably, mental workload was not significantly associated with work stress (p = 0.190). This diverges from several international studies showing a direct link between high workload and stress. It suggests that other factors—especially role conflict—may play a more dominant role in shaping stress levels. Cultural influences, including collectivist values and familial support common in Indonesia, may help workers withstand high demands without experiencing high stress.[6,29,37]

Various role conflicts that may occur between the train driver and the train co-driver include overlapping responsibilities, pressure from superiors or passengers, and differing opinions during emergency situations. Overlapping responsibilities may arise, for example, when the train co-driver attempts to make decisions that should fall under the authority of the train driver. Pressure from superiors or passengers may occur in situations where the train driver is instructed to make up for lost time despite suboptimal track conditions, while the train co-driver believes such action may compromise safety. Differences of opinion in emergency situations may arise, for instance, when a technical issue occurs and the train driver feels it is still safe to proceed, whereas the train co-driver believes that the journey should be halted.

Nonetheless, high mental workload remains a concern, as prolonged cognitive strain can impair attention, cause fatigue, and increase safety risks. Thus, even with low reported stress, continuous monitoring and preventive measures are essential.[4,11]

Tenure showed a negative correlation with stress; each additional year was associated with a 15% decrease in the odds of stress (aOR = 1.18; 95% CI: 0.99–1.40; p = 0.073). Although not statistically significant, this trend suggests that longer-tenured workers may develop greater adaptive capacity, enhanced coping strategies, and increased emotional stability.[6,37]

To ensure workforce well-being and operational safety, policy must focus on regulating workload, regularly assessing mental health, and integrating mental wellness into occupational frameworks. Evidence-based, flexible regulations with ongoing evaluation are crucial.

Given the strong association between role conflict and stress, organizational policies must emphasize clear role definitions, task allocation, and communication. Effective leadership is central to guiding workers through uncertainty; thus, leadership training should be prioritized.[15]

Stress management training and psychological support access can mitigate risks, especially for employees in cognitively demanding roles. Peer support and mental health workshops, proven effective in other transportation sectors, should be adapted for railway operations.

Technological advancements—such as automation and improved train control—offer relief from cognitive demands but must be implemented carefully to avoid introducing new stressors. Proper training and gradual adaptation are essential, along with regular assessments of technology's impact.

Insights from aviation and maritime sectors highlight similar challenges. Fatigue management and peer support, common in these industries, can be adopted in rail systems. Cross-sector collaboration and shared best practices may enhance safety and mental health outcomes.[25]

Future studies should adopt mixed-methods approaches—combining quantitative surveys and qualitative interviews—to explore coping mechanisms and cultural influences. Stakeholder engagement is crucial to ensure comprehensive and applicable results.[29]

Psychosocial risk assessments should become routine in occupational health programs. Early identification of at-risk workers enables timely intervention. These assessments should be dynamic, with continuous feedback loops for improvement.[10]

Reducing role conflict is vital. Clarifying task divisions and promoting open communication can lower stress levels. Supportive leadership further contributes to stress reduction by fostering transparency, guidance, and emotional safety.[18]

Other priorities include managing shift schedules and ensuring rest. Even in the absence of reported stress, high mental workload can increase fatigue and decrease alertness. Policies supporting work-life balance and education on sleep hygiene are essential.[19,25]

Finally, fostering a transparent, inclusive organizational culture—free from blame—can encourage honest reporting and continuous improvement. A supportive atmosphere enhances both safety and well-being.[36,37]

Despite low levels of reported stress, sustained cognitive demands remain a latent risk. Regular monitoring, cognitive load management, and the integration of mental health into safety systems are imperative for sustainable performance and safety.

It is essential to elevate mental health awareness and allocate sufficient resources to support comprehensive screening, diagnostic, and treatment services. Such as developing personalized mental health-related campaigns and movements, conducting mental health relevant studies at clinical and community settings, incorporating of mental health awareness in teaching curriculum and family's discussion, innovating technology for screening and diagnosing mental health issues, as well as an providing mental health first-aid with wide access to all population.[38]

This study has several limitations that should be considered in interpreting the findings. First, there is a potential for response bias during the completion of self-report surveys as part of the routine medical check-up process. Although responses were collected anonymously, fear of possible administrative consequences—such as sanctions for reporting high levels of stress—may have influenced participants' honesty, particularly in completing stress-related instruments. This social desirability bias may have resulted in underreporting of stress symptoms, potentially compromising the accuracy of the findings and limiting insight into the true extent of work stress.

Second, this study was limited to the Operational Area (DAOP) 2 Bandung, which restricts the generalizability of the findings. Railway work conditions may vary significantly across regions and operational divisions. Comparative studies across different DAOPs and types of rail services could offer broader insights. Collaborative national or international studies are highly recommended to develop more comprehensive and context-sensitive guidelines.

Third, the use of secondary data from annual health examinations provided useful baseline information but may lack the depth of direct psychosocial assessments. Future research would benefit from employing standardized tools such as the NASA-TLX for mental workload and validated stress inventories to identify more specific workload-related challenges and guide targeted interventions.

Fourth, the cross-sectional design used in this study does not allow for causal inference. While it provides a snapshot of associations at a single point in time, the cumulative and long-term effects of stress and workload cannot be fully captured. Longitudinal studies tracking changes in workload, stress levels, and health outcomes over time would offer stronger evidence for causal relationships and support the development of more effective occupational health policies.

Lastly, the exclusion of workers with less than one year of service may limit the applicability of findings to early-career employees, who may experience unique stressors during the adjustment and learning period. Including a broader range of work experience in future studies would enhance understanding of stress dynamics. Orientation and mentoring programs for new employees, along with early stress monitoring, are also recommended to support their transition and long-term well-being.

Conclusion

This study found no statistically significant association between mental workload and work stress among train driver and train co-driver at DAOP 2 Bandung. However, a significant relationship was observed between the occupational factor of role conflict and work stress in this population. Sociodemographic factors such as age, marital status, socioeconomic status, and number of dependents did not show a significant influence on stress levels. Overall, role conflict and imbalance between work and personal life emerged as the two dominant factors contributing to work stress among train driver and train co-driver at DAOP 2 Bandung. These findings highlight the need for organizational interventions that address psychosocial aspects of the work environment, particularly by clarifying role expectations and supporting work-life balance.

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