A Field Study on Evaluating Mental Workload in "Kerupuk Emping" Small and Medium-Sized Enterprise in Hanau Berak Village, Lampung

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A R T I C L E I N F O

A B S T R A C T

This study examined the mental workload of employees in small and medium-sized enterprises (SMEs) engaged in the production of "Kerupuk Emping" in Hanau Berak Village, Lampung. Using both qualitative and quantitative techniques for data collection, a mixed-methods strategy was employed. The NASA-TLX questionnaire was utilized to measure mental burden, including mental demand, physical demand, temporal demand, performance, effort, and frustration. In addition, semi-structured interviews were used to acquire a deeper understanding of the experiences of the participants. The findings revealed that employees of "Kerupuk Emping" small and medium-sized enterprises experienced a substantial mental burden. This study's findings can inform interventions aimed at reducing mental burden in the workplace, resulting in improved employee health and well-being and increased SME productivity

INTRODUCTION

Small and medium-sized enterprises (SMEs) are crucial to the economic development of many nations, particularly developing nations like Indonesia (Erdogan, 2023). The contribution of SMEs to employment, income generation, and poverty reduction is substantial (Parida et al., 2021). In 2020, the SME sector employed approximately 97.3 million employees, representing approximately 73.55% of Indonesia's total workforce. Through exports, SMEs also play a crucial role in the country's foreign exchange earnings. By supplying larger companies that export their products, SMEs reduce the country's reliance on imports, increase foreign exchange earnings, and have a positive effect on economic growth, exchange rate value, and national foreign exchange reserves (Sarfiah et al., 2019). In addition, SMEs serve as a counterbalance to the dominance of large corporations in the economy, as they are more adaptable to market and technological changes and can satisfy local demands that large corporations cannot (Hanim et al., 2022).

Despite these benefits, small and medium-sized enterprises (SMEs) suffer a myriad of issues that have a negative impact on the health and well-being of their workforce (Amin & Okou, 2020). According to Nurmasari et al. (2018), a significant challenge that small and medium-sized enterprise (SME) workers confront is a high mental workload, which is the result of long working hours, inadequate pay, and excessive workloads. According to Fallahi et al. (2016), a high mental burden can lead to negative health consequences, a drop in productivity, and an increase in employee turnover.

The production of "Kerupuk Emping" is a vital industry in Hanau Berak Village, Lampung, Indonesia, composed primarily of small and medium-sized enterprises (SMEs) that employ a substantial portion of the local population. However, little research has been conducted on the mental workload of personnel in "Kerupuk Emping" small and medium-sized enterprises in this region.

To address this gap in the literature, the present study sought to investigate the mental workload encountered by workers in "Kerupuk Emping" small and medium-sized enterprises (SMEs) in Hanau Berak Village, Lampung, using a mixed-methods approach that included qualitative and quantitative data collection techniques. The findings of this study have the potential to inform interventions aimed at minimizing mental workload among employees of "Kerupuk Emping" small and medium-sized enterprises, resulting in improved employee health and well-being and increased productivity of SMEs. In addition, the results of this study may have implications for other industries confronting comparable challenges, highlighting the need for proactive workplace measures to reduce mental workload.

LITERATURE REVIEW

Mental burden is a crucial concept closely related to ergonomics and human factors (Nikulin et al., 2019). Despite the lack of a universal standard to precisely define mental burden, it has been linked to workplace productivity, satisfaction, comfort, and safety. Measuring mental burden is essential for preventing and anticipating fatigue, which may result from an excessive workload and ultimately have a negative impact on performance. There are three distinct methods for estimating mental workload: procedural, subjective, and physiological (Pradhana & Suliantoro, 2018).

Multiple disciplines, such as psychology, human factors, and engineering, have conducted extensive research on mental workload (de Winter, 2014; Santiana et al., 2018). Mental workload is the amount of cognitive resources required to complete a particular endeavor or activity. An excessive mental burden can result in diminished performance, an increase in errors, and exhaustion. To measure mental exertion, numerous techniques, including subjective ratings, physiological measurements, and performance measures, have been developed. Multiple factors, such as task complexity, time pressure, and expertise, can impact mental workload, according to studies. In addition, interventions such as automation and training have been proposed as means of reducing cognitive burden. Understanding mental workload is essential for designing duties and systems that are efficient and safe for individuals to execute (Mohammadian et al., 2022).

The concept of mental workload has significant implications for performance, safety, and well-being, especially in high-stakes and high-stress domains such as aviation, healthcare, and military operations. Mental workload is the quantity of cognitive resources required to complete a task, and it is influenced by task complexity, task duration, environmental demands, and individual differences. Multiple Resource Theory, one of the earliest models of mental workload, proposes that the human cognitive system consists of multiple channels or resources that can be allocated to various tasks. These resources differ in terms of their capacity, speed, and susceptibility to interference, and depending on the demands of the task, they can be depleted or overloaded. The NASA Task Load Index, which measures perceived burden across six dimensions including mental demand, physical demand, temporal demand, performance, effort, and frustration (Hart & Staveland, 1988), is another influential model.

Mental workload research has revealed insights into the effects of various factors on cognitive performance and happiness. Studies have shown, for instance, that increasing task complexity or time constraint can increase mental workload and decrease performance, whereas providing feedback or reducing distractions can improve performance and decrease workload. Age, expertise,

and personality characteristics also play a role in determining mental workload, with older adults and novices typically experiencing a greater mental workload than younger adults and experts.

Mental burden has implications for a variety of fields, such as aviation, healthcare, education, and human-computer interaction. High workload has been identified as a contributing factor in numerous aviation accidents and incidents, and interventions such as personnel resource management and automation have been developed to reduce workload and enhance safety. Workload has been linked to errors, fatigue, and patient outcomes in healthcare, and strategies including workload management and team-based care have been proposed to address these problems. Workload has been studied in relation to interface design and usability in human-computer interaction with the aim of developing interfaces that are both efficient and simple to use.

Mental exertion is the cognitive, perceptual, and psychomotor demands that a task places on an individual. Workplace mental burden is crucial because it can have a substantial impact on employee health, safety, and performance. High levels of mental exertion can result in fatigue, tension, and burnout, leading to decreased employee retention, quality of work, and productivity.

A task's requirements are determined by its uniqueness, complexity, and unpredictability. Individuals must allocate more cognitive resources to tasks involving a great deal of mental effort. Noise, temperature, and social support can also influence mental burden. Individual differences such as age, gender, cognitive abilities, neuroticism, and conscientiousness can also influence mental workload, with those high in neuroticism experiencing higher levels of stress and workload and those high in conscientiousness being better able to manage workload and prioritize tasks (Shan et al., 2023).

Physiological measures, such as heart rate variability and skin conductance, can also be used to assess mental exertion (Tao et al., 2019). These metrics are predicated on the premise that mental workload is related to changes in autonomic nervous system activity, which can be detected by physiological signals (Wang et al., 2016). For instance, when mental workload is elevated, heart rate variability tends to decrease, indicating an increase in sympathetic nervous system activity and a decrease in parasympathetic nervous system activity (Nur et al., 2020).

Understanding and quantifying mental burden is essential for designing and optimizing work environments that promote optimal performance, safety, and well-being. By taking into consideration factors such as task complexity, time pressure, environmental demands, and individual differences, organizations can foster employee well-being and maximize performance. In high-stress domains,

interventions such as automation, feedback, and training can also reduce mental workload and enhance performance and safety (Fallahi et al., 2016)

METHODOLOGY

This study employed a mixed-methods research design that combines qualitative and quantitative approaches. Through semi-structured interviews with workers, it was possible to acquire a comprehensive understanding of their mental workload experiences. The NASA-TLX questionnaire was used to collect quantitative data that measured employees' mental workload. NASA-TLX was developed by Hart & Staveland (1988) to evaluate the ergonomic elements of prototypes used in the aerospace industry, and subsequent case studies in a variety of disciplines have confirmed NASA-TLX's empirical findings (de Winter, 2014). NASA-TLX has demonstrated its ease of use and consistent responsiveness to significant experimental variations over the past two decades, according to the findings. In particular, NASA-TLX evaluates a wide variety of complex factors to estimate the workload of users while they are conducting a task or just prior to its completion. Mental demand (level of mental activity), physical demand (degree of physical exertion), temporal demand (perception of time), performance (extent of achieving objectives), effort (amount of physical and mental exertion), and frustration level (feelings of pressure, discouragement, and insecurity) are taken into account by NASA-TLX when assessing workload. These factors are weighted and added together to produce an aggregate workload score.

NASA-TLX's measurement procedure comprises six steps: (1) Weighting, (2) Rating, (3) Product value calculation, (4) Weighted Workload (WWL) calculation, (5) Weighted Workload (WWL) average calculation, and (6) Score interpretation based on a predefined scale. During the weighting process, participants are asked to select the indicator that they believe contributes the most to mental burden at work. The format of the questionnaire's paired comparisons is used to total and evaluate each indicator for mental workload calculation. Selecting a level that represents the respondent's condition on the six indicators is required to provide a rating. The mental burden score is then determined by dividing fifteen by the total score. Calculating the product value involves multiplying the rating by the factor weight for each descriptor to determine the product value for each of the six indicators. Calculating WWL entails summing the six product values. The average WWL is determined by dividing the WWL by fifteen, which is the total weight. As shown in Table 1, the score is interpreted according to Hart & Staveland' (1988) criteria, which classify workload scores as low (0-9), moderate (10-19), somewhat high (20-29), high (30-39), very high (40-49), and excessive (50-100).

Table 1. NASA-TLX Weighted Workload (WWL) Categories

Score	Category
0 - 9	Very low
10 - 29	Low
30 - 49	Medium
50 - 79	High
80 - 100	Very High

Participants were selected using purposeful sampling based on their availability and willingness to participate. Eight employees of "Kerupuk Emping" SMEs in a singular location in Indonesia, aged between 25 and 45 and having worked for at least six months, participated in the study. In the first phase of data collection, the NASA-TLX questionnaire was administered to assess the mental workload of employees across six domains: mental demand, bodily demand, temporal demand, performance, effort, and frustration.

Then, semi-structured interviews were conducted to gain a deeper understanding of the mental burden experiences of workers. These interviews were audio recorded and verbatim transcribed.

Quantitative data was analyzed using descriptive statistics, including means and standard deviations, while semi-structured interview data was analyzed utilizing theme analysis. The transcripts were meticulously reviewed to identify themes and patterns, which were then organized into a narrative describing the mental workload experienced by workers.

Throughout the research procedure, ethical considerations were carefully considered. Prior to participation, participants were apprised of the purpose of the study and provided signed informed consent. In addition, they were informed that they could leave the study at any time without penalty. The collected data were kept anonymous and only used for the intended purpose of the study.

RESULT

The present section presents the findings of an investigation into the mental workload of employees in small and medium-sized enterprises (SMEs) engaged in the production of "Kerupuk Emping" in Hanau Berak Village, Lampung. Using both qualitative and quantitative techniques for data collection, a mixed-methods strategy was employed. The NASA-TLX questionnaire was utilized to measure mental burden, including mental demand, physical demand, temporal demand, performance, effort, and frustration. In addition, semi-structured interviews were used to acquire a deeper understanding of the experiences of the participants.

Quantitative Results

Utilizing the NASA-TLX questionnaire, a widely used instrument for measuring mental workload, the present study assessed the mental workload experienced by workers in six dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration. Eight workers from a single SME participated in the research. The findings revealed that the employees of "Kerupuk Emping" SMEs were subjected to a substantial mental burden. As shown in Table 2, high scores on all dimensions of mental burden indicate high levels of mental demand, physical demand, temporal demand, performance, effort, and frustration.

In particular, the average mental demand score was 56.6, indicating that the employees were subjected to a high level of cognitive demand. The mean score for physical demand was 51.5, indicating a moderate level of physical exertion. The average temporal demand score for workers was 52.50, indicating a moderate level of time pressure. The average performance score was 51,6, indicating a moderate level of accomplishment with the task. The average effort score was 65,1, indicating a significant level of exertion was required. Lastly, the mean frustration score was 64,4, indicating a considerable level of irritation among the employees.

Table 2. Questionnaire Result

Participant	Age	Sub-Scale	Rate	Bobot	WWL	Score	Participant	Age	Sub	Rate	Bobot	WWL	Score
1	25	MD	80	2	1240	82.67	5	38	MD	70	2	1000	66.67
		PD	80	3					PD	70	2		
		TD	70	1					TD	75	2		
		PO	90	5					PO	75	2		
		EF	80	4					EF	75	4		
		FR	80	0					FR	60	2		
2	27	MD	30	1	960	64	6	33	MD	60	2	945	63
		PD	50	4					PD	75	4		
		TD	70	2					TD	60	1		
		PO	80	3					PO	70	2		
		EF	80	4					EF	65	5		
		FR	30	1					FR	40	0		
3	30	MD	30	1	1010	67.34	7	40	MD	55	3	835	55.67
		PD	50	4					PD	65	2		
		TD	70	2					TD	60	2		
		PO	80	4					PO	50	4		
		EF	80	4					EF	55	4		
		FR	10	0					FR	55	0		
4	35	MD	65	2	1010	67.33	8	42	MD	65	2	795	53
		PD	65	5					PD	55	3		
		TD	65	3					TD	50	0		
		PO	70	3					PO	60	1		
		EF	75	2					EF	55	5		
		FR	50	0					FR	55	3		

Qualitative Results

To acquire a deeper understanding of participants' experiences, semi-structured interviews were conducted. The interviews revealed that the employees were exposed to a variety of occupational stressors, including time constraints, multitasking, and a lack of rest breaks. According to the workers, they were frequently required to complete duties within short timeframes, resulting in high mental and physical demands. In addition, they reported being required to multitask, which made it difficult to concentrate on a single task and increased mental demand. In addition, employees reported not receiving sufficient rest breaks, which led to increased fatigue and frustration.

In addition, semi-structured interviews were used to acquire a more in-depth understanding of the workers' experiences in "Kerupuk Emping" small and medium-sized enterprises (SMEs). The findings revealed a number of causes for the high mental workload, including the repetitive and complex nature of the task, lengthy working hours, insufficient breaks and rest periods, inadequate training and assistance, and inadequate work processes.

DISCUSSION

The findings of this study indicate that employees of "Kerupuk Emping" small and medium-sized enterprises (SMEs) in Hanau Berak Village, Lampung, encounter a substantial mental workload. This is consistent with previous research indicating that employees of small and medium-sized enterprises frequently experience high mental workloads due to a lack of resources and support.

This study's findings have significant implications for the health and well-being of employees and the productivity of small and medium-sized enterprises. Stress, burnout, and other health issues can be exacerbated by a high mental burden. Moreover, high levels of mental workload can result in decreased productivity, as employees may be unable to execute their duties effectively (Pradhana & Suliantoro, 2018).

To address the mental workload of personnel of "Kerupuk Emping" small and medium-sized enterprises, proactive measures are required. These may include providing employees with training and support, enhancing work processes, and ensuring sufficient breaks and rest periods. By addressing mental workload, SME employers can improve the health and well-being of their employees, resulting in greater productivity and profitability (Idkham et al., 2022).

The findings of this study highlight the significance of managing the mental workload of employees in small and medium-sized businesses (SMEs) due to the substantial influence on their health and productivity. The high mental workload encountered by workers in "Kerupuk Emping" small and medium-sized enterprises (SMEs) is cause for concern, as it can result in adverse health effects, decreased productivity, and increased employee turnover. The substantial mental effort required of SME employees is consistent with these findings. The results of the study indicate that other factors, such as the repetitiveness and complexity of tasks, lengthy working hours, inadequate training and support, and inefficient work processes, also contribute to the high mental workload. Therefore, it is suggested that the management of "Kerupuk Emping" small and medium-sized enterprises (SMEs) implement measures to improve work practices, provide worker training and support, and guarantee adequate breaks and rest periods to reduce the mental workload of employees (Longo et al., 2022).

The implications of this study extend beyond the administration of Indonesian small and medium-sized enterprises to policy formulation. The elevated mental workload of employees of small and medium-sized enterprises highlights the need for sustained efforts to promote sustainable growth in the nation. Policies that promote equitable compensation, reasonable working hours, and sufficient breaks and rest periods can improve working conditions, promote employee health and well-being, and boost productivity. In conclusion, this study contributes to the literature on the challenges encountered by SME employees, sheds light on the factors contributing to excessive mental workload, and

highlights the need for SME employees to manage mental workload. The findings can inform future research on working conditions in small and medium-sized enterprises (SMEs) and the effect of mental workload on employee health and productivity.

CONCLUSION

Employees of small and medium-sized enterprises (SMEs) in Hanau Berak Village, Lampung, specifically "Kerupuk Emping" SMEs, experience a heavy mental workload, according to the present study. The findings suggest that a number of factors contribute to the high mental workload, including the repetitive and complex character of the task, long working hours, inadequate breaks and rest periods, inadequate training and assistance, and inappropriate work processes. It is recommended that management of "Kerupuk Emping" SMEs improve work practices, provide training and support for workers, and guarantee adequate breaks and rest periods in order to reduce the mental workload of SME employees.

These interventions can improve the health and well-being of employees, resulting in increased productivity and, ultimately, the success of the SME. In addition to having implications for policy development in Indonesia, the study's findings contribute to the literature on the challenges encountered by SME employees.

This study has several limitations that must be acknowledged. First, the sample size is small, with only eight employees from a single SME included. Consequently, the findings may have limited applicability to other SMEs. Second, the study assessed mental workload solely using the NASA-TLX questionnaire and did not account for other factors that may contribute to mental strain, including job demands, workplace resources, and personal factors. Future research should employ a more inclusive methodology to assess mental burden in SMEs. Thirdly, the study did not collect worker demographic information, such as age, gender, and education level, which could have influenced their perceptions of mental burden. Future research should collect such data to investigate potential differences in mental effort between employees.

REFERENCES

Amin, M., & Okou, C. (2020). Casting a shadow: Productivity of formal firms and informality. *Review of Development Economics*, *24*(4), 1610–1630. https://doi.org/10.1111/rode.12697

de Winter, J. C. F. (2014). Controversy in human factors constructs and the explosive use of the NASA-TLX: A measurement perspective. *Cognition, Technology and Work*, *16*(3), 289–297. https://doi.org/10.1007/s10111-014-0275-1

Erdogan, A. I. (2023). Drivers of SME Growth: Quantile Regression Evidence From Developing Countries. *SAGE Open*, *13*(1), 1–15. https://doi.org/10.1177/21582440231163479

Fallahi, M., Motamedzade, M., Heidarimoghadam, R., Soltanian, A. R., Farhadian, M., & Miyake, S. (2016). Analysis of the mental workload of city traffic control operators while monitoring traffic density: A field study. *International Journal of Industrial Ergonomics*, *54*, 170–177. https://doi.org/10.1016/j.ergon.2016.06.005

Hanim, L., Soponyono, E., & Maryanto, M. (2022). Pengembangan UMKM digital di masa pandemi Covid-19. *Prosiding Seminar Nasional Penelitian Dan Pengabdian Kepada Masyarakat*, *2*(1), 30–39. https://doi.org/10.24967/psn.v2i1.1452

Hart, S. G., & Staveland, L. E. (1988). Development of Nasa Tlx (Task Load Index): Results of Empirical and Theoretical Research. Human Mental Workload. *Human Mental Workload*, 139–183.

Idkham, M., Dhafir, M., Safrizal, & Aulia, M. R. (2022). Workload analysis during operation coconut coir peeler operation. *IOP Conference Series: Earth and Environmental Science*, *1116*(1). https://doi.org/10.1088/1755-1315/1116/1/012035

Longo, L., Wickens, C. D., Hancock, P. A., & Hancock, G. M. (2022). Human Mental Workload: A Survey and a Novel Inclusive Definition. In *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2022.883321

Mohammadian, M., Parsaei, H., Mokarami, H., & Kazemi, R. (2022). Cognitive demands and mental workload: A filed study of the mining control room operators. *Heliyon*, *8*(2), e08860. https://doi.org/10.1016/j.heliyon.2022.e08860

Nikulin, C., Lopez, G., Piñonez, E., Gonzalez, L., & Zapata, P. (2019). NASA-TLX for predictability and measurability of instructional design models: case study in design methods. *Educational Technology Research and Development*, *67*(2), 467–493. https://doi.org/10.1007/s11423-019-09657-4

Nur, I., Iskandar, H., & Ade, R. F. (2020). The measurement of nurses' mental workload using NASA-TLX method (a case study). *Malaysian Journal of Public Health Medicine*, *20*(Specialissue1), 60–63.

https://doi.org/10.37268/MJPHM/VOL.20/NO.SPECIAL1/ART.705

Nurmasari, E., Ushada, M., & Suwondo, E. (2018). Analysis of the influence of physical and mental workload on worker productivity in bakery SME. *Digital Press Life Sciences*, *1*, 00004. https://doi.org/10.29037/digitalpress.21248

Parida, P. C., Mitra, A., & Pradhan, K. C. (2021). The missing middle phenomenon in Indian manufacturing sector: myths or realities? *Journal of Economics and Development*, *23*(3), 317–331. https://doi.org/10.1108/jed-09-2020-0120

Pradhana, C. A., & Suliantoro, H. (2018). Analisis beban kerja mental menggunakan Metode NASA-TLX pada bagian shipping perlengkapan di PT. Triangle Motorindo. *Industrial Engineering Online Journal*, *7*(3), 1–9.

Santiana, I. M. A., Lokantara, W. D., Yusuf, M., & Sutapa, I. N. (2018). *Workload analysis of rice field workers in Bali*. *1*(Icst), 504–507. https://doi.org/10.2991/icst-18.2018.105

Sarfiah, S., Atmaja, H., & Verawati, D. (2019). UMKM sebagai pilar membangun ekonomi bangsa. *Jurnal REP (Riset Ekonomi Pembangunan)*, *4*(2), 1–189. https://doi.org/10.31002/rep.v4i2.1952

Shan, Y., Shang, J., Yan, Y., & Ye, X. (2023). Workflow interruption and nurses' mental workload in electronic health record tasks: An observational study. *BMC Nursing*, *22*(1), 1–14. https://doi.org/10.1186/s12912-023-01209-9

Tao, D., Tan, H., Wang, H., Zhang, X., Qu, X., & Zhang, T. (2019). A systematic review of physiological measures of mental workload. *International Journal of Environmental Research and Public Health*, *16*(15), 1–23. https://doi.org/10.3390/ijerph16152716

Wang, L., He, X., & Chen, Y. (2016). Quantitative relationship model between workload and time pressure under different flight operation tasks. *International Journal of Industrial Ergonomics*, *54*, 93–102. https://doi.org/10.1016/j.ergon.2016.05.008