

# Effect of Shift Work on Fatigue, Sleep, and Physiological Conditions of Coal Mining and Onshore Oil Workers in Indonesia

スティブン デビ アンビヤ ムハマド スナルノ

<https://hdl.handle.net/2324/7362178>

---

出版情報 : Kyushu University, 2024, 博士 (工学) , 課程博士  
バージョン :

権利関係 : Public access to the fulltext file is restricted for unavoidable reason (3)



Name: Stevan Deby Anbiya Muhamad Sunarno

Dissertation title: Effect of Shift Work on Fatigue, Sleep, and Physiological Conditions of Coal Mining and Onshore Oil Workers in Indonesia

(シフト勤務がインドネシアの炭鉱および陸上石油労働者の疲労、睡眠、生理状態に及ぼす影響)

Category: 甲

## Abstract of Dissertation

Shift workers, individuals who work outside the typical 9-5 schedule, often struggle with falling asleep and staying asleep. Many industries, such as healthcare and manufacturing, rely on shift work to maintain operations 24 hours a day. In fact, in the European Union, over 20% of the working population is currently engaged in shift work. Common consequences of shift work, such as sleep deprivation, have been associated with cognitive difficulties, contributes to fatigue, accidents, and slower reaction times. In Indonesia, studies have investigated the impact of work-related and non-work-related factors on fatigue among shift workers, revealing high number of workers experiencing fatigue. Furthermore, the role of sleep quality and work fatigue has been explored in coal mining and oil industry workers in Indonesia. The current research in Indonesia has heavily relied on the use of surveys and questionnaires that susceptible to bias. This study aims to identify the various factors that contribute to fatigue and sleep among shift workers through more objective measurements, including physiological assessments. This study has the potential to serve as a pivotal platform for subsequent research endeavors within the domains of occupational health and safety, as well as public health, particularly in Indonesia. Study 1 still utilized a questionnaire to gather the magnitude of the problem at the specific industries and shift type. Study 2 and Study 3 conducted more objective measurements in the field of coal mining industry and oil industry.

Study 1 revealed that day shift workers tend to experience higher levels of physical fatigue, while night shift workers report heightened mental fatigue. Night shift workers are more susceptible to sleepiness, lack of motivation, and lack of energy, which indicates greater strain due to misaligned sleep cycles. Physical discomfort, however, does not significantly differ between shift types. Night shift workers tend to suffer from higher levels of chronic fatigue, whereas acute fatigue is lower for non-shift workers. Non-shift workers also experience better recovery between shifts due to their regular sleep patterns. Night and day shift workers generally have poorer sleep quality compared to non-shift workers, as their circadian rhythms are disrupted. Non-shift workers have reported better sleep hygiene and less daytime sleepiness. Additionally, non-shift workers tend to get the most sleep and have the highest sleep efficiency and shortest sleep latency, highlighting their better overall sleep quality. Study 2 revealed that blood pressure of non-shift workers had the lowest systolic blood pressure ( $119 \pm 3.21$  mmHg), followed by night shift ( $120 \pm 4.37$  mmHg) and day shift workers ( $122 \pm 5.56$  mmHg). Diastolic pressure was also lowest in non-shift workers ( $79 \pm 5.07$  mmHg) compared to day and night shift workers (both  $82 \pm 6.76$  and  $82 \pm 5.22$  mmHg respectively). Heart Rate:

Non-shift workers had the lowest heart rate ( $72 \pm 7.11$  bpm), whereas night shift workers had a higher heart rate ( $76.5 \pm 6.87$  bpm), and day shift workers had the highest ( $78 \pm 6.32$  bpm). Sleep quality of night shift workers had the poorest sleep quality. They had the shortest total sleep time ( $6.10 \pm 0.89$  hours), lowest sleep efficiency ( $83 \pm 3.17\%$ ), and the highest number of awakenings ( $14.5 \pm 7.84$  times). In contrast, non-shift workers enjoyed the highest total sleep time ( $7.00 \pm 0.61$  hours), best sleep efficiency ( $88 \pm 2.62\%$ ), and the fewest awakenings ( $8.50 \pm 4.37$  times). Fatigue and sleepiness of night shift workers experienced the highest levels of fatigue and sleepiness. Fatigue ratings were highest in night shift workers ( $5 \pm 1.19$ ) compared to day shift ( $5 \pm 1.23$ ) and non-shift workers ( $3 \pm 1.05$ ). Sleepiness, measured by the Karolinska Sleepiness Scale, was highest in night shift workers ( $5 \pm 1.37$ ), followed by day shift ( $3 \pm 1.22$ ) and non-shift workers ( $3 \pm 1.08$ ). In study 3 revealed significant findings on the impact of shift work on worker's health performance. Reaction times improved across all groups from Day 1 to Day 10. Stress markers, including salivary alpha-amylase and cortisol levels, were consistently higher in night shift workers, indicating elevated stress (e.g., salivary alpha-amylase: 473.5 vs. 394.41 at awakening; cortisol: 66.08 vs. 52.5 at bedtime). Night shift workers also experienced poorer sleep quality, spending more time in bed but sleeping less overall, with longer sleep latency and more frequent awakenings (e.g., total sleep time: 405.33 vs. 449.41 on Day 10; sleep latency: 6.83 vs. 12.41 on Day 10; awakenings: 20.58 vs. 13.91 on Day 1). Physiological measures showed higher systolic and diastolic blood pressure by Day 10 in night shift workers (e.g., systolic: 133.37 vs. 127.37), increased heart rates (e.g., 76.33 vs. 70.75 on Day 10), and slightly lower oxygen saturation levels (e.g., 95.56 vs. 96.37 on Day 10). These findings highlight the adverse effects of night shifts on stress, sleep quality, and physiological health.

Day shift workers experience higher physical fatigue due to higher work intensity and fewer rest opportunities. Night shift workers show the highest levels of mental fatigue and sleepiness due to disrupted circadian rhythms. Both day and night shift workers report poorer sleep quality compared to non-shift workers. Night shift workers experience significant disruptions in their sleep patterns, including shorter total sleep time, longer sleep latency, and lower sleep efficiency. Night shift workers also exhibit a decline in cognitive performance over time, with slower reaction times and higher stress markers. They also experience increased blood pressure and heart rate, indicating greater cardiovascular strain. Other physiological measures, such as oxygen saturation and forehead temperature, show slight but significant variations.

In order to support the well-being and productivity of shift workers, it's important to implement several strategies. This includes creating flexible work schedules to minimize consecutive night shifts and ensure adequate recovery time between shifts. We should promote good sleep habits and provide a conducive sleep environment. Regular health monitoring is essential for early detection of potential health issues. Additionally, we need to provide access to stress reduction programs, counseling services, and relaxation techniques. Furthermore, making adjustments in the workplace environment to reduce physical and mental fatigue, such as enhancing ergonomic conditions and ensuring a supportive and safe working environment, is crucial.