The International Review of Multidisciplinary Research
Volume 1, Issue 5, May 2026, pp. 819-834
https://doi.org/10.5281/zenodo.20269386

A Comparative Analysis of Cognitive Fatigue and Operational Efficiency Between Day- Shift and Night-Shift Employees in BPO Environments

[1]Justine L. Alaban, [2]Dezrel Marie V. Baldomar, [3]John Reignzie C. Cabugnason, [4]Marife N. Cabajon, [5]Charldy P. Wencesalao

[1234]Foundation University, [5]University of San Carlos

[1]justine.alaban@foundationu.com, [2]dezrelmarie.baldomar@foundationu.com, [3]johnreignzie.cabugnason@foundationu.com, [4]marife.cabajon@foundationu.com, [5]cpwenceslao@usc.edu.ph

Article Details:

Received: 20 April 2026
Revised: 30 April 2026
Accepted: 5 May 2026
Published: 18 May 2026
Corresponding Email:
justine.alaban@foundationu.com

Recommended Citation:

Alaban, J. L., Baldomar, D M. V., Cabugnason, J R. C., Cabajon, M. N., Wencesalao, C. P. (2026). A Comparative Analysis of Cognitive Fatigue and Operational Efficiency Between Day- Shift and Night-Shift Employees in BPO Environments. The International Review of Multidisciplinary Research. 1 (5), 819-834.
https://doi.org/10.5281/zenodo.20269386

Index Terms:

cognitive fatigue, operational efficiency, shift schedules, BPO industry, customer service representatives

Abstract. This study examined cognitive fatigue and perceived operational efficiency among voice-based Customer Service Representatives (CSRs) in selected Business Process Outsourcing (BPO) companies in Dumaguete City. It compared day-shift and night-shift employees and analyzed the relationship between cognitive fatigue and performance outcomes. A quantitative, descriptive-comparative, and correlational research design was employed using stratified sampling. A total of 384 full-time CSRs participated in the study. Data were analyzed using percentage, mean, Shapiro–Wilk test, Mann–Whitney U test, and Spearman's rank correlation coefficient. Results indicated that respondents experienced moderate levels of cognitive fatigue in terms of intrinsic and extraneous load, while germane load remained low, suggesting that higher-order cognitive processes were generally sustained despite continuous task demands. Perceived operational efficiency, measured through processing speed and quality accuracy, was also moderate, reflecting acceptable but not optimal performance levels under routine working conditions. No significant differences were found between day- and night-shift employees in both cognitive fatigue and operational efficiency, indicating comparable work experiences across schedules. Similarly, no significant relationship was observed between cognitive fatigue and operational efficiency overall, although a weak but significant relationship emerged among day-shift employees. Age demonstrated a weak but significant relationship with operational efficiency, whereas tenure showed no significant relationship with either variable. These findings indicate that performance is largely sustained through structured workflows, system support, adaptive work behaviors, and familiarity with tasks rather than shift schedule or demographic factors. Overall, the study underscores the importance of fatigue management, continuous performance monitoring, and organizational support mechanisms in promoting employee well-being, minimizing cognitive strain, and sustaining consistent operational efficiency in BPO environments.

Introduction

Globally, the expansion of 24-hour service industries increased reliance on shift work, making cognitive fatigue a growing occupational concern. Studies showed that nonstandard work schedules, particularly evening and night shifts, were associated with sleep disruption, psychological strain, and reduced work performance (Silva & Costa, 2023). Research further indicated that night-shift employees often experienced impaired alertness and decreased

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

operational efficiency due to circadian rhythm misalignment (Ganesan et al., 2019). In call center environments, employees are exposed to high workload, performance pressure, and continuous customer interaction, which contribute to stress and cognitive fatigue (Chaudhary et al., 2023).

In the Philippine context, workplace health conditions in the BPO industry highlight the importance of addressing employee well-being, particularly in relation to workload, fatigue, and organizational support systems (Candelario et al., 2022). Since many BPO companies in the Philippines, including those in Dumaguete City, primarily operated during nighttime hours, employees were frequently exposed to high cognitive demands and emotionally intensive interactions. These conditions required sustained attention and may have contributed to cognitive fatigue, which could affect both performance and well-being.

Previous research has consistently linked night-shift work to sleep disruption and reduced cognitive performance due to circadian misalignment (Ganesan et al., 2019). Furthermore, cognitive fatigue is influenced not only by shift timing but also by workload, task complexity, and organizational support (Kecklund & Axelsson, 2021).

However, limited evidence existed on how these factors influenced employees in localized BPO settings such as Dumaguete City. Customer Service Representatives (CSRs) were required to maintain continuous attention, process information efficiently, and make accurate decisions under time pressure. Any decline in cognitive functioning could affect service quality and productivity. Despite this, it remained unclear whether shift schedules significantly influenced cognitive fatigue and operational efficiency in the local setting.

This study addressed this gap by examining cognitive fatigue and perceived operational efficiency among voice-based CSRs in selected BPO companies in Dumaguete City. It compared day-shift and night-shift employees and explored the relationship between cognitive fatigue and performance outcomes, particularly processing speed and quality accuracy. The findings of this study were expected to provide insights for improving fatigue management, work conditions, and performance support systems in the BPO industry. This study was aligned with Sustainable Development Goal (SDG) 8: Decent Work and Economic Growth, which promotes productive employment and safe working environments. It also supported SDG 3: Good Health and Well-being by addressing cognitive fatigue and its impact on employee functioning.

Statement of the Problem

This study aims to compare cognitive fatigue and perceived operational efficiency between day-shift and night-shift voice-based Customer Service Representatives (CSRs) in selected Business Process Outsourcing (BPO) companies in Dumaguete City, in order to develop a recommended intervention program.

Specifically, it seeks to answer the following questions:

1. What is the demographic profile of the respondents in terms of:

    1.1 age;
    1.2 sex;
    1.3 tenure in the BPO industry; and
    1.4 shift rotation frequency?

2. What is the perceived level of Cognitive Fatigue experienced by the respondents when grouped by shift schedule (Day vs. Night) in terms of:

    2.1 Intrinsic Load;
    2.2 Extraneous Load; and
    2.3 Germane Load?

3. What is the level of perceived Operational Efficiency of the respondents when grouped by shift schedule (Day vs. Night) in terms of:

    3.1 Perceived Processing Speed; and
    3.2 Perceived Quality Accuracy

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

4. Is there a significant difference between day-shift and night-shift employees in terms of cognitive fatigue and operational efficiency?

5. Is there a significant relationship between the respondents' level of cognitive fatigue and their perceived operational efficiency?

6. Is there a significant relationship between the respondents' demographic profile in terms of age and tenure, and their levels of cognitive fatigue and perceived operational efficiency?

Null Hypotheses

The hypothesis will be tested at a 0.05 level of significance.
H_{o1}: There is no significant difference in the level of cognitive fatigue and perceived operational efficiency between day-shift and night-shift employees.
H_{02}: There is no significant relationship between the respondents' level of cognitive fatigue and their perceived operational efficiency.
H_{03}: There is no significant relationship between the respondents' demographic profile (age and tenure) and their level of cognitive fatigue and perceived operational efficiency.

Methodology

Design

This study employed a quantitative descriptive–comparative and correlational research design. It was descriptive–comparative in nature because it aimed to determine and compare the levels of cognitive fatigue, specifically intrinsic, extraneous, and germane load, and perceived operational efficiency between day-shift and night-shift Customer Service Representatives (CSRs). No manipulation of variables was conducted, as respondents were already assigned to their respective work schedules.

The design was also correlational, as it examined the relationship between cognitive fatigue and perceived operational efficiency in terms of processing speed and quality accuracy. This approach allowed the researchers to determine the strength and direction of association between variables without implying causation.

Environment

The study was conducted in Dumaguete City, Negros Oriental, Philippines, a growing hub for the Business Process Outsourcing (BPO) industry. The selected research sites included four BPO companies: Wonders, Inspiro, Straive, and Qualfon. These companies operate 24/7 and provide voice-based services to international clients, requiring employees to perform cognitively demanding tasks under varying shift schedules.

Respondents

The participants of the study were 384 full-time voice-based Customer Service Representatives (CSRs) from the selected BPO companies. Participants were categorized into two groups based on shift schedule: 192 day-shift employees and 192 night-shift employees.
To ensure comparability, respondents were required to have at least one year of BPO experience and a minimum of six months' tenure in their current company. Supervisory personnel, working students, and individuals with secondary employment were excluded.
A stratified sampling technique with equal allocation was employed to ensure balanced representation across companies and shift groups.

Instruments

A structured questionnaire served as the primary research instrument in this study, carefully designed to address the research questions. The instrument consisted of several parts. Part I included a disclosure statement that informed respondents about the purpose of the research, emphasized that participation was voluntary, and assured that all collected data would remain confidential. It also addressed ethical considerations by allowing anonymous responses and

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

encouraging honest and accurate feedback. Part II gathered the demographic profile of the respondents, including age, sex, tenure in the BPO industry, and shift rotation frequency. Part III assessed the level of cognitive fatigue using items adapted from the Cognitive Load Scale (Leppink et al., 2013), covering intrinsic load, extraneous load, and germane load. Part IV measured perceived operational efficiency using items adapted from the WHO Health and Work Performance Questionnaire (Kessler et al., 2003), focusing on processing speed and quality accuracy. Responses were collected using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

To ensure the quality of the instrument, both validity and reliability were established. Content validity was achieved through evaluation by a panel of experts in psychology, statistics, and industrial engineering. These experts assessed whether the questionnaire accurately represented the constructs of cognitive fatigue and operational efficiency. Based on their recommendations, necessary revisions were made to improve clarity and relevance. Reliability was evaluated through a pilot study, and Cronbach's Alpha coefficient was used to determine internal consistency, with a threshold of 0.70 indicating acceptable reliability. The results showed that cognitive fatigue demonstrated good to excellent reliability, with intrinsic load obtaining 0.88 (good), extraneous load 0.93 (excellent), and germane load 0.92 (excellent). For operational efficiency, perceived processing speed obtained 0.88 (good), while perceived quality accuracy recorded 0.91 (excellent). The overall reliability of the instrument was 0.90, which is interpreted as excellent. These results indicate that the questionnaire was both valid and reliable in measuring cognitive fatigue and perceived operational efficiency, ensuring the consistency and credibility of the data collected in this study.

Ethical Considerations

The study was conducted following established ethical principles to ensure the protection of participants' rights, dignity, and well-being. Prior to data collection, approval was obtained from the appropriate institutional authority and from the management of the participating BPO companies. All respondents were provided with an informed consent form and a disclosure statement explaining the purpose, procedures, and academic use of the study. Participation was strictly voluntary, and respondents were informed of their right to decline or withdraw at any time without any negative consequences.

Confidentiality and anonymity were strictly maintained throughout the research process. No personally identifiable information was collected, and respondents were allowed to omit any questions they were not comfortable answering. Data were gathered during working hours with proper instructions to ensure accurate and honest responses.

All collected data were handled in compliance with the Data Privacy Act of 2012. Information was securely stored in password-protected files and used solely for academic purposes. Results were presented in aggregated form to prevent the identification of individual respondents or organizations.

The researchers also acknowledge the use of AI-assisted tools, including ChatGPT, Gemini, and QuillBot, strictly for language enhancement. All outputs were reviewed and validated by the researchers, who assume full responsibility for the accuracy and integrity of the study.

Procedure

Following the design hearing, the researchers incorporated the revisions and recommendations provided by the panel members to finalize the research instrument. Upon approval from the Dean of the Graduate School, formal request letters were submitted to the Operations Managers or Human Resources Departments of Wonders, Inspiro, Straive, and Qualfon to seek permission to conduct the study. Once authorization was granted, the approved requests were coordinated with the respective shift supervisors for proper scheduling and distribution of the survey. Prior to data collection, the researchers oriented the selected voice-based Customer Service Representatives (CSRs) regarding the objectives and significance of the study. Participants were screened to ensure compliance with the inclusion criteria, specifically having at least one year of BPO experience and no additional academic workload that could influence the results. To ensure accuracy in capturing the effects of shift schedules, the survey was administered during the respondents' actual working hours.

Completed questionnaires were collected immediately after completion to ensure data integrity and minimize response bias. The gathered data were then encoded using Microsoft Excel and subsequently analyzed using JAMOVI statistical software. Appropriate statistical tools were applied to interpret the results and generate meaningful findings for the study.

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Statistical Treatment of the Data

The data were analyzed using both descriptive and inferential statistics. Percentage was used to describe the demographic profile of respondents, while mean was used to determine the levels of cognitive fatigue and perceived operational efficiency. The Shapiro–Wilk test was conducted to assess normality, and results indicated a non-normal distribution. Thus, non-parametric tests were applied. The Mann–Whitney U test was used to determine significant differences between day-shift and night-shift employees, while Spearman's rank correlation was used to determine the relationship between cognitive fatigue and operational efficiency.
To aid in the interpretation of results, appropriate descriptive scales were used to classify the levels of cognitive fatigue and operational efficiency based on the computed mean values.

Perceived Cognitive Fatigue Scale

Mean Range	Verbal Description	Level of Fatigue	Interpretation
4.21 – 5.00	Strongly Agree	Very High	Exhaustion and concentration lapses are consistent.
3.41 – 4.20	Agree	High	Fatigue symptoms are frequent and noticeable.
2.61-3.40	Neutral	Moderate	Fatigue is present but currently controlled.
1.81 – 2.60	Disagree	Low	Fatigue symptoms are minimal.
1.00 – 1.80	Strongly Disagree	Very Low	Cognitive fatigue is negligible.

Perceived Operational Efficiency

Mean Range	Verbal Description	Level of Fatigue	Interpretation
4.21 – 5.00	Strongly Agree	Very High	Productivity and accuracy are consistently optimal.
3.41 – 4.20	Agree	High	Performance is strong with only minor lapses.
2.61-3.40	Neutral	Moderate	Efficiency is adequate but shows inconsistencies.
1.81 – 2.60	Disagree	Low	Efficiency is below optimal; requires improvement.
1.00 – 1.80	Strongly Disagree	Very Low	Efficiency is significantly low; limited productivity.

To identify the degree of relationship between two variables, the researcher will apply the following descriptions (Statistical Correlation, 2009):

Value of r	Strength of Relationship
Between ± 0.50 to ± 1.00	± strong relationship
Between ± 0.30 to ± 0.49	± moderate relationship
Between ± 0.10 to ± 0.29	± weak relationship
Between ± 0.01 to ± 0.09	± very weak relationship

Results and Discussion

This section presents the results of the study in a clear and systematic manner, aligned with the research specific problems. It also provides a corresponding discussion of the findings, supported by relevant literature and studies to offer deeper insights and interpretations.

Age	**Day Shift**		**Night Shift**		**Overall**	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
19–24	50	13.00	48	12.50	98	25.50
25–34	99	25.80	106	27.60	205	53.40
35 and above	43	11.20	38	9.90	81	21.10
Total	**192**	**50.00**	**192**	**50.00**	**384**	**100**

Table 1. Age Profile of the Respondents

Table 1 shows that the majority of respondents belong to the 25–34 age group (53.40%), followed by 19–24 (25.50%) and 35 years and above (21.10%). This indicates that the BPO workforce is predominantly composed of individuals in the early to mid-career stage. A similar distribution is observed across both day- and night-shift groups, where the 25–34 age category remains the most represented.

This pattern suggests that the study reflects a relatively young and adaptable workforce capable of functioning in fast-paced, technology-driven environments. Employees within this age group are typically exposed to high cognitive demands,

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

including multitasking, continuous customer interaction, and performance pressure, which may contribute to cognitive fatigue. The comparable age distribution across shifts also indicates that age is unlikely to significantly influence differences in cognitive fatigue and operational efficiency.

Existing studies support this observation, indicating that employees in high-demand work environments are required to sustain attention and adapt to continuous cognitive and operational demands (Ganesan et al., 2019). Moreover, work-related cognitive load and task complexity have been shown to contribute to mental strain and fatigue, particularly in roles involving sustained interaction and performance requirements (Bufano et al., 2024).

Sex	**Day Shift**		**Night Shift**		**Overall**	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Male	79	20.60	84	21.90	163	42.50
Female	113	29.40	108	28.10	221	57.50
Total	**192**	**50.00**	**192**	**50.00**	**384**	**100**

Table 2. Sex Profile of the Respondents

Table 2 presents that out of 384 respondents, female employees comprise the majority (57.50%), while male employees account for 42.50%. This pattern is consistent across both day- and night-shift groups, where female respondents slightly outnumber males in each schedule.

This distribution indicates that the BPO workforce in the selected companies is predominantly female, which may reflect the communication-oriented and service-driven nature of customer service roles. The relatively balanced representation across shifts suggests that sex is unlikely to significantly influence comparisons of cognitive fatigue and operational efficiency.

While female employees demonstrate strengths in communication and multitasking, differences in how individuals perceive workload and respond to work-related demands may influence workplace experiences. Studies have shown that employees in high-demand environments experience varying levels of cognitive strain and performance outcomes depending on task demands and environmental conditions (Young et al., 2014). Additionally, research indicates that sustained cognitive workload and multitasking requirements can contribute to fatigue and stress across employees, regardless of demographic characteristics (Bufano et al., 2024).

Tenure (Years)	**Day Shift**		**Night Shift**		**Overall**	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1–2	95	24.70	95	24.70	190	49.40
3–4	56	14.60	56	14.60	112	29.20
5–6	39	10.20	35	9.10	74	19.30
7 and above	2	0.50	6	1.60	8	2.10
Total	**192**	**50**	**192**	**50**	**384**	**100**

Table 3. Tenure in the BPO Industry Profile of the Respondents

Table 3 shows that the majority of respondents have a tenure of 1–2 years (49.40%), followed by 3–4 years (29.20%) and 5–6 years (19.30%), while only a small proportion have 7 years and above (2.10%). This pattern is consistent across both day- and night-shift groups, indicating that most employees are relatively new to the BPO industry.

This distribution suggests that the workforce is largely composed of early-tenure employees, reflecting the dynamic and transitional nature of employment in the sector. Employees at this stage are typically in the process of adapting to work demands, developing familiarity with systems, and meeting performance expectations. As a result, they may be more susceptible to cognitive fatigue due to continuous task engagement, multitasking, and performance pressure.

These findings are supported by existing literature indicating that employees in high-demand work environments must continuously manage cognitive workload and adapt to complex task requirements, which can contribute to mental strain (Ganesan et al., 2019; Young et al., 2014). Furthermore, prolonged cognitive workload and task complexity, particularly

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

during the learning or adjustment phase, have been shown to contribute to fatigue and reduced efficiency (Bufano et al., 2024).

In general, the low proportion of long-tenured employees suggests potential retention challenges and highlights the importance of understanding how experience levels relate to cognitive fatigue and operational efficiency in high-demand BPO settings.

Shift Rotation	**Day Shift**		**Night Shift**		**Overall**	
Frequency	Frequency	Percent	Frequency	Percent	Frequency	Percent
Weekly	5	1.30	11	2.90	16	4.20
Bi-Weekly	1	0.30	2	0.50	3	0.80
Monthly	45	11.70	45	11.70	90	23.40
Quarterly/ Rarely	59	15.40	44	11.50	103	26.90
Fixed/ Permanent	82	21.40	90	23.40	172	44.80
Total	**192**	**50**	**192**	**50**	**384**	**100**

Table 4. Shift Rotation Frequency Profile of the Respondents

Table 4 displays that the largest proportion of respondents are assigned to fixed or permanent shifts (44.80%) that followed by those with quarterly or rarely changing schedules (26.90%) and monthly rotations (23.40%). Only a small percentage experience weekly (4.20%) and bi-weekly rotations (0.80%), indicating that most employees are exposed to stable or infrequently changing work schedules. This pattern is consistent across both day and night shift groups with slightly higher fixed scheduling observed among night-shift employees.

This distribution suggests that BPO companies tend to implement stable scheduling systems to support consistent work performance. Stable schedules enable employees to maintain more regular sleep patterns and adapt to work demands more effectively, which can help reduce cognitive strain. In contrast, frequent shift rotations may disrupt circadian rhythms and increase mental fatigue, potentially affecting alertness and task performance.

Existing studies support these findings, indicating that shift work and irregular schedules can negatively affect sleep quality, alertness, and overall performance due to circadian misalignment (Ganesan et al., 2021; Kecklund & Axelsson, 2021; Booker et al., 2019). Moreover, sustained cognitive workload in demanding work environments has been associated with increased fatigue, particularly when work conditions require continuous adjustment (Bufano et al., 2024).

In relation to the present study, shift rotation frequency is an important factor in understanding cognitive fatigue and operational efficiency, as employees with more stable schedules are better positioned to maintain consistent performance compared to those exposed to frequent schedule changes.

	Indicators	**Day Shift**			**Night Shift**			**Composite**		
		$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF
1.	The customer accounts I handled today were mentally overwhelming.	2.77	N	M	2.74	N	M	2.76	N	M
2.	Handling these specific client issues required excessive mental effort.	2.77	N	M	2.70	N	M	2.74	N	M
3.	The logic required to solve customer problems was naturally complicated.	2.71	N	M	2.68	N	M	2.69	N	M
4.	I had to hold a large amount of technical info in my mind while talking.	2.66	N	M	2.63	N	M	2.65	N	M
5.	Coordinating the different steps of a call felt mentally exhausting.	2.64	N	M	2.65	N	M	2.65	N	M
6.	The inherent difficulty of the account was high, regardless of my energy.	2.61	N	M	2.62	N	M	2.62	N	M
7.	Understanding the relationship between different software tools was challenging.	2.57	D	L	2.60	D	L	2.59	D	L

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

8.	Navigating between multiple software tools during a call was difficult.	2.56	D	L	2.58	D	L	2.58	D	L
9.	I found it challenging to resolve issues that required multitasking.	2.57	D	L	2.57	D	L	2.57	D	L
10.	The technical procedures required for these calls were hard to grasp.	2.47	D	L	2.50	D	L	2.48	D	L
	Factor Average	**2.63**	**N**	**M**	**2.63**	**N**	**M**	**2.63**	**N**	**M**

Table 5. Cognitive Fatigue in Terms of Intrinsic Load Among Day-Shift and Night-Shift Respondents

Table 5 presents the level of cognitive fatigue in terms of intrinsic load among day- and night-shift respondents. The overall mean of 2.63 indicates a moderate level of fatigue, suggesting that tasks require sustained mental effort but remain generally manageable across both groups. Higher ratings were observed in handling mentally overwhelming customer accounts ($\bar{x}$ = 2.76) and tasks requiring excessive mental effort ($\bar{x}$ = 2.74), indicating that customer interaction and problem-solving demands are the primary sources of intrinsic cognitive load. Other aspects, including logical complexity ($\bar{x}$ = 2.69), information retention ($\bar{x}$ = 2.65), and coordination of tasks ($\bar{x}$ = 2.65), further reflect the continuous cognitive engagement required in call center operations.

At the same time, lower ratings in understanding technical procedures ($\bar{x}$ = 2.48) and system navigation ($\bar{x}$ ≈ 2.57–2.59) suggest that these areas are generally manageable, although minor difficulties in technical comprehension and system integration may still influence efficiency. The identical mean scores for both day- and night-shift respondents (2.63) indicate that intrinsic cognitive fatigue is not dependent on shift schedule but is primarily driven by task complexity. This suggests that employees across shifts are exposed to similar cognitive demands inherent in the nature of the work.

These findings indicate that while employees operate within manageable cognitive limits, improvements in system usability, workflow design, and technical training may further reduce cognitive burden and enhance performance consistency. Prior research emphasizes that intrinsic cognitive load is determined by task complexity and simultaneous information processing, which increase mental workload in high-demand environments (Sweller et al., 2019). Similarly, managing multiple streams of information and sustained cognitive effort has been shown to influence attention and performance even when tasks remain manageable (Bufano et al., 2024; Young et al., 2014).

	Indicators	**Day Shift**			**Night Shift**			**Composite**		
		$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF
1.	I felt my mental energy was consumed by fighting off sleepiness.	2.95	N	M	2.81	N	M	2.88	N	M
2.	I had to re-read internal chat/email updates multiple times due to low energy.	2.82	N	M	2.76	N	M	2.79	N	M
3.	Drowsiness made it difficult for me to understand work instructions.	2.81	N	M	2.72	N	M	2.77	N	M
4.	Environmental distractions (noise/lighting) made the work feel unclear.	2.76	N	M	2.71	N	M	2.74	N	M
5.	I experienced confusion where I could not process simple tasks easily.	2.76	N	M	2.70	N	M	2.73	N	M
6.	Exerting effort to inhibit the urge to sleep significantly drained my focus.	2.74	N	M	2.69	N	M	2.72	N	M
7.	I found myself losing focus due to shift timing, forcing me to refocus.	2.73	N	M	2.67	N	M	2.70	N	M
8.	Information presented to me felt confusing because of my low energy levels.	2.71	N	M	2.67	N	M	2.69	N	M
9.	I struggled to focus because I was using all my energy just to stay awake.	2.67	N	M	2.60	N	M	2.64	N	M
10.	I felt my mind was working harder to stay awake than to perform the job.	2.55	D	L	2.53	D	L	2.54	D	L
	Factor Average	**2.75**	**N**	**M**	**2.69**	**N**	**M**	**2.72**	**N**	**M**

Table 6. Cognitive Fatigue in Terms of Extraneous Load Among Day-Shift and Night-Shift Respondents

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Table 6 presents the level of cognitive fatigue in terms of extraneous load among day- and night-shift respondents. The overall mean of 2.72 indicates a moderate level of fatigue, suggesting that external factors such as sleepiness, reduced alertness, and environmental conditions moderately affect employees' cognitive functioning.

Higher ratings were observed in mental energy consumed by fighting off sleepiness ($\bar{x}$ = 2.88), re-reading information due to low energy ($\bar{x}$ = 2.79), and difficulty understanding instructions ($\bar{x}$ = 2.77). These results indicate that a portion of cognitive resources is allocated to maintaining alertness rather than task performance, which may lead to slower processing and increased effort in completing routine tasks.

Similarly, indicators related to environmental distractions ($\bar{x}$ = 2.74), confusion ($\bar{x}$ = 2.73), and difficulty sustaining focus ($\bar{x}$ ≈ 2.69–2.72) suggest that external conditions contribute to intermittent lapses in attention and information processing. The lowest-rated indicator ($\bar{x}$ = 2.54) shows that fatigue does not fully override performance, indicating that employees are still able to function despite these challenges.

The slightly higher mean for day-shift (2.75) compared to night-shift (2.69) suggests that extraneous fatigue is present across both groups and is not solely dependent on shift schedule. This highlights the influence of broader work conditions and energy management on cognitive performance.

Collectively, these findings suggest that while employees operate under manageable levels of extraneous load, improvements in workplace conditions, fatigue management, and attention-support systems may reduce unnecessary cognitive burden and enhance efficiency. Prior research indicates that extraneous load arises from non-essential demands such as distractions and reduced clarity, which consume cognitive resources and affect performance (Sweller, 2019). Furthermore, fatigue and sleep-related disruptions have been shown to impair attention, reaction time, and cognitive processing, contributing to decreased work efficiency (Lim & Dinges, 2010; Ganesan et al., 2019; Borragán et al., 2021).

	Indicators	**Day Shift**			**Night Shift**			**Composite**		
		$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF
1.	I felt my mind was too tired to find better ways to handle difficult calls.	2.61	N	M	2.61	N	M	2.61	N	M
2.	I felt unable to maintain my full mental concentration throughout the shift.	2.59	D	L	2.59	D	L	2.59	D	L
3.	I struggled to concentrate during the most demanding parts of my shift.	2.58	D	L	2.58	D	L	2.58	D	L
4.	I found it hard to see the main problem the customer was facing.	2.56	D	L	2.58	D	L	2.57	D	L
5.	I lacked the mental "space" to think critically about complex issues.	2.57	D	L	2.56	D	L	2.56	D	L
6.	I found it difficult to apply my training to new customer problems today.	2.53	D	L	2.56	D	L	2.54	D	L
7.	I struggled to automate routine tasks that I usually do easily.	2.52	D	L	2.53	D	L	2.52	D	L
8.	I lacked the mental capacity to improve the quality of my work today.	2.51	D	L	2.53	D	L	2.49	D	L
9.	I found it difficult to relate new problems to things I learned in training.	2.48	D	L	2.50	D	L	2.49	D	L
10.	It was hard to remember the relationship between different software tools.	2.45	D	L	2.47	D	L	2.46	D	L
	Factor Average	**2.54**	**D**	**L**	**2.55**	**D**	**L**	**2.54**	**D**	**L**

Table 7. Cognitive Fatigue in Terms of Germane Load Among Day-Shift and Night-Shift Respondents

Table 7 displays the level of cognitive fatigue in terms of germane load among day- and night-shift respondents. The overall mean of 2.54 indicates a low level of fatigue, suggesting that employees are generally able to sustain higher-order cognitive processes such as critical thinking, learning application, and problem-solving.

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

The highest-rated indicator, difficulty in finding better ways to handle calls ($\bar{x}$ = 2.61), reflects occasional mental strain in optimizing performance. However, most indicators, including maintaining concentration ($\bar{x} \approx 2.58–2.59$), recognizing problems ($\bar{x}$ = 2.57), and applying training ($\bar{x}$ = 2.54), were rated low, indicating that employees are generally capable of sustaining cognitive functioning and task effectiveness. Additional results, such as automating routine tasks ($\bar{x}$ = 2.52) and recalling system relationships ($\bar{x}$ = 2.46), further suggest that difficulties in learning and adaptation are minimal.

The nearly identical mean scores between day-shift (2.54) and night-shift (2.55) respondents indicate that germane cognitive fatigue is not influenced by shift schedule. This suggests that employees across both groups maintain similar capacities for learning, knowledge application, and performance improvement.

Taken together, these findings indicate that employees retain sufficient cognitive capacity to support continuous learning and decision-making despite moderate demands in other domains. Strengthening training, coaching, and knowledge reinforcement programs may further enhance performance optimization. Existing literature supports that germane load represents mental effort directed toward learning and schema development, which contributes to improved performance and efficiency (Sweller, 2019). Furthermore, effective management of cognitive workload has been associated with improved attention, problem-solving, and decision-making in complex work environments (Young et al., 2014; Ganesan et al., 2019).

	Indicators	Day Shift			Night Shift			Composite		
		$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF
1.	I was able to conclude interactions within the expected time without feeling rushed.	2.91	N	M	2.81	N	M	2.86	N	M
2.	I processed customer information quickly and moved to the next call without hesitation.	2.90	N	M	2.80	N	M	2.85	N	M
3.	My ability to move through routine tasks was not impaired by the time of day.	2.88	N	M	2.81	N	M	2.85	N	M
4.	My response time to customers was as fast as it should be.	2.90	N	M	2.78	N	M	2.84	N	M
5.	I felt mentally "sharp" and quick when navigating system alerts.	2.89	N	M	2.79	N	M	2.84	N	M
6.	My typing and data entry speed felt consistent from start to finish.	2.86	N	M	2.76	N	M	2.81	N	M
7.	I successfully maintained my target Average Handling Time (AHT).	2.84	N	M	2.78	N	M	2.81	N	M
8.	I felt my reaction time to customer pings or system alerts was optimal.	2.84	N	M	2.75	N	M	2.80	N	M
9.	I moved through my workflow without any mental slowing or delays.	2.80	N	M	2.73	N	M	2.77	N	M
10.	I did not feel any lag in my decision-making speed during this shift.	2.81	N	M	2.72	N	M	2.77	N	M
	Factor Average	**2.86**	**N**	**M**	**2.77**	**N**	**M**	**2.82**	**N**	**M**

Table 8. Perceived Operational Efficiency in Terms of Processing Speed Among Day-Shift and Night-Shift Respondents

Table 8 presents the level of perceived operational efficiency in terms of processing speed among day- and night-shift respondents. The overall mean of 2.82 indicates a moderate level of efficiency, suggesting that employees maintain acceptable processing speed, although performance has not reached an optimal level.

Higher ratings were observed in completing interactions within the expected time ($\bar{x}$ = 2.86), processing customer information efficiently ($\bar{x}$ = 2.85), and maintaining workflow regardless of time of day ($\bar{x}$ = 2.85). These results indicate that employees are generally able to meet key performance metrics and sustain workflow continuity. Other indicators, including response time and system navigation ($\bar{x} \approx 2.84$) and typing consistency ($\bar{x}$ = 2.81), further reflect stable operational performance.

At the same time, slightly lower ratings in decision-making speed and absence of delays ($\bar{x}$ = 2.77) suggest minor inefficiencies, reflecting occasional cognitive slowing during task execution. Although day-shift respondents (2.86)

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

demonstrated slightly higher performance than night-shift respondents (2.77), both groups remained within the moderate range, indicating minimal practical differences across shifts.

These findings indicate that employees demonstrate stable but not fully optimized processing speed, where minor delays may accumulate and affect productivity over time. Enhancing workflow design, improving system responsiveness, and implementing fatigue management strategies may support faster and more consistent task execution. Prior research shows that processing speed is closely linked to cognitive alertness and mental energy, which are influenced by workload and fatigue (Lim & Dinges, 2010). Similarly, Cognitive Load Theory explains that when cognitive resources are partially consumed, fewer resources remain available for efficient processing, resulting in slower performance (Sweller et al., 2019).

	Indicators	Day Shift			Night Shift			Composite		
		$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF	$\bar{x}$	VD	LoF
1.	I followed every step of the Standard Operating Procedure (SOP) correctly.	2.93	N	M	2.80	N	M	2.87	N	M
2.	My attention to detail remained strong, even toward the end of my shift.	2.93	N	M	2.80	N	M	2.87	N	M
3.	I maintained high Quality Assurance (QA) accuracy throughout the shift.	2.88	N	M	2.81	N	M	2.85	N	M
4.	I successfully avoided "near-miss" mistakes that usually happen when tired.	2.89	N	M	2.80	N	M	2.84	N	M
5.	I remained free of minor data entry slips or miscommunications.	2.87	N	M	2.80	N	M	2.84	N	M
6.	My ability to spot and correct potential mistakes remained high.	2.88	N	M	2.77	N	M	2.82	N	M
7.	I successfully avoided small technical mistakes in the system.	2.86	N	M	2.76	N	M	2.81	N	M
8.	My ability to monitor for errors remained effective as the shift progressed.	2.85	N	M	2.74	N	M	2.80	N	M
9.	I was able to avoid documentation errors in my call notes.	2.76	N	M	2.69	N	M	2.73	N	M
10.	I felt confident in my work without needing to double-check excessively.	2.77	N	M	2.68	N	M	2.72	N	M
	Factor Average	**2.86**	**N**	**M**	**2.76**	**N**	**M**	**2.81**	**N**	**M**

Table 9. Perceived Operational Efficiency in Terms of Quality Accuracy Among Day-Shift and Night-Shift Respondents

Table 9 shows the level of perceived operational efficiency in terms of quality accuracy among day- and night-shift respondents. The overall mean of 2.81 indicates a moderate level of efficiency, suggesting that employees maintain acceptable accuracy, although performance is not consistently optimal.

Higher ratings were observed in following Standard Operating Procedures ($\bar{x}$ = 2.87) and maintaining attention to detail ($\bar{x}$ = 2.87), indicating that employees generally comply with required processes and sustain focus during task execution. Additional indicators, including Quality Assurance accuracy ($\bar{x}$ = 2.85) and avoidance of errors ($\bar{x} \approx$ 2.84), further reflect stable performance in maintaining work quality.

Meanwhile, slightly lower ratings in avoiding documentation errors ($\bar{x}$ = 2.73) and confidence without excessive checking ($\bar{x}$ = 2.72) suggest minor lapses and occasional uncertainty, particularly under sustained cognitive demands. Although day-shift respondents (2.86) demonstrated slightly higher accuracy than night-shift respondents (2.76), both groups remained within the moderate range, indicating minimal practical differences across shifts.

In light of these findings, the results indicate that employees demonstrate stable but not fully optimized quality accuracy, where minor inconsistencies may persist over time. Strengthening quality assurance practices, improving attention-support systems, and implementing fatigue management strategies may enhance consistency and precision. Prior research shows that cognitive demands and fatigue can reduce attention to detail and increase the likelihood of errors in tasks

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

requiring sustained concentration (Lim & Dinges, 2010). Likewise, Cognitive Load Theory explains that limited cognitive resources reduce the capacity to monitor accuracy and prevent errors during task performance (Sweller et al., 2019).

Variables	Median		U-value	p-value	Decision	Remark
	Day	Night				
Cognitive Fatigue	2.57	2.63	17397	0.341	Fail to Reject H_o	Not Significant
Operational Efficiency	2.88	2.80	18284	0.892	Fail to Reject H_o	Not Significant

Table 10. Difference in Cognitive Fatigue and Operational Efficiency Between Day-Shift and Night-Shift Employees

Table 10 displays the analysis of the difference in cognitive fatigue and operational efficiency between day-shift and night-shift employees. The results show no significant difference in cognitive fatigue (U = 17397, p = 0.341) and operational efficiency (U = 18284, p = 0.892), as both p-values exceed the 0.05 level of significance. This indicates that the levels of fatigue and performance are statistically comparable across both groups.

Although night-shift employees reported slightly higher cognitive fatigue (Median = 2.63) than day-shift employees (Median = 2.57), and day-shift employees showed marginally higher operational efficiency (Median = 2.88) than night-shift employees (Median = 2.80), these differences are minimal and not statistically significant.

This pattern suggests that shift schedule alone does not substantially influence cognitive fatigue or operational efficiency in BPO settings. Instead, performance outcomes appear to be shaped by shared work characteristics such as task complexity, continuous cognitive demands, and structured workflows. As employees across both shifts perform similar tasks, their cognitive load and performance levels remain comparable.

In light of these findings, the results imply that cognitive fatigue is not a distinguishing factor between day- and night-shift performance. Rather, organizational factors such as system support, workflow design, and employee adaptation play a more critical role in sustaining efficiency. Existing literature indicates that cognitive fatigue is primarily driven by sustained mental effort and workload demands rather than shift timing alone (Sweller, 2019). Furthermore, employees in high-demand environments can maintain stable performance despite variations in work schedules, particularly when tasks are structured and supported by effective systems (Ganesan et al., 2019; Young et al., 2014).

Variables	r_s	p-value	Decision	Remark
Day-Shift	0.143	0.048	Reject H_o	Significant
Night-Shift	-0.032	0.656	Fail to Reject H_o	Not Significant
Overall	**0.051**	**0.318**	**Fail to Reject H_o**	**Not Significant**

Table 11. Relationship Between the Level of Cognitive Fatigue and the Perceived Operational Efficiency of the Respondents

Table 11 presents the relationship between cognitive fatigue and perceived operational efficiency when grouped by shift schedule. For day-shift employees, a statistically significant relationship was observed (rs = 0.143, p = 0.048), although the correlation is weak, indicating that cognitive fatigue has only a minimal influence on performance within this group.

For night-shift employees, no significant relationship was found (rs = -0.032, p = 0.656), suggesting that variations in cognitive fatigue do not meaningfully affect operational efficiency. Similarly, the overall results show no significant relationship (rs = 0.051, p = 0.318), indicating that cognitive fatigue does not consistently predict performance across both shifts.

This pattern suggests that operational efficiency in BPO environments is largely maintained despite variations in cognitive fatigue. While a slight association is present among day-shift employees, its weak magnitude and absence in other groups indicate limited practical impact. Performance outcomes may instead be influenced by structured workflows, system support, and employees' adaptive strategies, which help sustain consistency under cognitive demands.

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Prior research indicates that the effects of cognitive fatigue on performance are often moderated by task structure, environmental support, and individual adaptation (Sweller, 2019; Brady et al., 2024). Moreover, in structured work environments, system-guided processes and standardized workflows can help buffer the impact of cognitive strain, allowing employees to maintain stable performance despite varying levels of fatigue (Ganesan et al., 2019; Young et al., 2014).

Variables	r_s	p-value	Decision	Remark
Age and…				
Cognitive Fatigue	-0.126	0.083	Fail to Reject H_o	Not Significant
Operational Efficiency	-0.146	0.044	Reject H_o	Significant
Tenure and…				
Cognitive Fatigue	0.092	0.207	Fail to Reject H_o	Not Significant
Operational Efficiency	0.073	0.312	Fail to Reject H_o	Not Significant

Table 12. Relationship Between Profile and Cognitive Fatigue and Perceived Operational Efficiency of the Respondents

Table 12 shows the relationship between demographic profile (age and tenure) and the levels of cognitive fatigue and perceived operational efficiency. The results show that age is not significantly related to cognitive fatigue (rs = -0.126, p = 0.083), indicating that variations in age do not meaningfully influence fatigue levels. However, age demonstrates a statistically significant but weak negative relationship with operational efficiency (rs = -0.146, p = 0.044), suggesting that increases in age are associated with a slight decrease in perceived performance, although the practical effect is minimal.
For tenure, no significant relationships were found with cognitive fatigue (rs = 0.092, p = 0.207) or operational efficiency (rs = 0.073, p = 0.312), with both correlations classified as very weak. This indicates that length of experience in the BPO industry does not substantially affect fatigue or performance levels.

Existing literature indicates that performance in structured environments is more strongly influenced by cognitive demands and task design than by demographic variables (Sweller, 2019). Moreover, in system-driven work settings, standardized procedures and consistent workflows can reduce the influence of individual characteristics such as age and experience, allowing employees to maintain stable performance levels (Ganesan et al., 2019; Young et al., 2014).

Taken together, these results suggest that demographic factors have limited influence on cognitive fatigue and operational efficiency. While age shows a statistically significant association with performance, its weak magnitude indicates minimal practical impact. Performance and fatigue outcomes appear to be more strongly shaped by work-related factors such as task demands, system support, and organizational processes rather than demographic characteristics.

Conclusion and Recommendations

This study demonstrates that cognitive fatigue among Customer Service Representatives (CSRs) in BPO environments is present but manageable, allowing employees to maintain adequate levels of performance. Despite moderate cognitive demands, operational efficiency remains stable, suggesting that fatigue does not directly hinder productivity but is regulated through experience, system familiarity, and adaptive work behaviors.

The absence of significant differences across shift schedules and most demographic factors indicates that performance is not primarily influenced by shift timing or individual characteristics. Instead, it reflects the role of structured work environments, where standardized procedures, system-guided workflows, and continuous monitoring support consistent outcomes. These findings suggest that organizational systems play a more critical role in sustaining efficiency than physiological or demographic variations.

Moreover, the weak relationships among cognitive fatigue, age, tenure, and operational efficiency indicate minimal practical influence of these factors on performance. This highlights that employee productivity is largely shaped by work design, system support, and adaptive capacity rather than isolated individual variables.

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Overall, sustaining operational efficiency in BPO settings depends less on eliminating fatigue and more on optimizing work processes, strengthening support mechanisms, and enhancing employee adaptability. These insights emphasize the importance of integrated strategies that promote both employee well-being and consistent performance in high-demand environments. Consistent with existing literature, workplace health promotion and fatigue management initiatives play a crucial role in sustaining employee performance, as organizational interventions focused on workload management, employee well-being, and health support systems have been shown to improve both productivity and overall working conditions in BPO settings (Candelario et al., 2023).

Based on the findings and conclusions drawn, the following recommendations are proposed:

1. BPO companies: Implement fatigue management strategies (e.g., micro-breaks), provide integrated technical and performance training, improve ergonomic conditions, promote employee wellness programs, and enhance system usability to reduce cognitive load.

2. Supervisors and team leaders: Regularly monitor performance and well-being, provide timely coaching, encourage proper break practices, and support continuous skill development.

3. Employees (CSRs): Apply self-management strategies such as time management and cognitive breaks, maintain healthy lifestyle habits, and utilize system tools effectively to improve efficiency.

4. Future researchers: Examine additional factors (e.g., stress, sleep quality, organizational support), incorporate objective performance measures, expand study contexts, and consider mixed-method approaches for deeper insights.

Acknowledgements

The completion of this study would not have been possible without the support and contributions of several individuals, to whom the researchers express their sincere appreciation.

The researchers extend their profound gratitude to Engr. Charldy Wenceslao, whose guidance, patience, and valuable insights played a crucial role throughout the development of this research. His encouragement and trust in the researchers' capabilities greatly contributed to the successful completion of this work.

Appreciation is also given to Engr. Marife N. Cabajon, Dean and class adviser, for her continued support and encouragement, as well as for fostering an environment that promotes academic excellence.

The researchers are deeply thankful to Dr. Maria Chona Z. Futalan for her expertise in statistical analysis and for providing meaningful suggestions that strengthened the study.

Grateful acknowledgment is also extended to the members of the panel, Engr. Clint C. Absin, Engr. Rodelle Yap Dacumos, and Dr. Maria Chona Z. Futalan, for their constructive feedback and recommendations that contributed to the improvement of this research.

The researchers likewise express their appreciation to the management and the participating voice-based Customer Service Representatives (CSRs) from Wonders, Inspiro, Straive, and Qualfon for their cooperation and willingness to take part in the study.
Special thanks are given to the researchers' families for their constant support, understanding, and encouragement, which served as a source of motivation throughout the research process. The researchers also acknowledge their friends, classmates, and colleagues for their encouragement and assistance in completing this endeavor.

Above all, the researchers offer their deepest gratitude to Almighty God for His guidance, strength, and blessings, which made the completion of this study possible.

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Funding

This research received no external funding from any public, commercial, or not-for-profit funding agency, and no organization provided financial support for the conduct of the study, authorship, or publication of this article.

Competing Interests Statement

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

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

References

Brady, C., Sawant, S., Madathil, K. C., & McNeese, N. (2024). A Systematic review on the effect of cognitive fatigue in teams. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 68(1), 1287–1291. https://doi.org/10.1177/10711813241275515

Booker, L. A., Sletten, T. L., Alvaro, P. K., Barnes, M., Collins, A., Chai-Coetzer, C. L., Naqvi, A., McMahon, M., Lockley, S. W., Rajaratnam, S. M. W., & Howard, M. E. (2019). Exploring the associations between shift work disorder, depression, anxiety and sick leave taken amongst nurses. Journal of Sleep Research, 29(3), e12872. https://doi.org/10.1111/jsr.12872

Borragán, G., Slama, H., Bartolomei, M., & Peigneux, P. (2017). Cognitive fatigue: A Time-based Resource-sharing account. Cortex, 89, 71–84. https://doi.org/10.1016/j.cortex.2017.01.023

Bufano, P., Di Tecco, C., Fattori, A., Barnini, T., Comotti, A., Ciocan, C., Ferrari, L., Mastorci, F., Laurino, M., & Bonzini, M. (2024). The effects of work on cognitive functions: a systematic review. *Frontiers in Psychology*, *15*, 1351625. https://doi.org/10.3389/fpsyg.2024.1351625

Candelario, C. M. C., Fullante, M. K. A., Pan, W. K. M., & Gregorio, E. R. (2024). Integrative Review of Workplace Health Promotion in the Business Process Outsourcing Industry: Focus on the Philippines. *Public Health in Practice*, *7*, 100476. https://doi.org/10.1016/j.puhip.2024.100476

Chaudhary, S., Nasir, N., Rahman, S. U., & Sheikh, S. M. (2023). Impact of Work Load and Stress in Call Center Employees: Evidence from Call Center Employees. Pakistan Journal of Humanities and Social Sciences, 11(1), 160–171. https://doi.org/10.52131/pjhss.2023.1101.0338

Ganesan, S., Magee, M., Stone, J. E., Mulhall, M. D., Collins, A., Howard, M. E., Lockley, S. W., Rajaratnam, S. M. W., & Sletten, T. L. (2019). The impact of shift work on sleep, alertness and performance in healthcare workers. *Scientific Reports*, *9*(1), 4635. https://doi.org/10.1038/s41598-019-40914-x

Kansal, D., Gupta, R. K., & Dev, K. (2019). Fatigue assessment in night shift call centre workers. International Journal of Research and Analytical Reviews, 6(1), 308–315. https://ijrar.com/upload_issue/ijrar_issue_20544256.pdf

Kecklund, G., & Axelsson, J. (2016). Health consequences of shift work and insufficient sleep. *BMJ*, *355*, i5210. https://doi.org/10.1136/bmj.i5210

Kessler, R. C., Barber, C., Beck, A., Berglund, P., Cleary, P. D., McKenas, D., Pronk, N., Simon, G., Stang, P., Ustun, T. B., & Wang, P. (2003). The World Health Organization Health and Work Performance Questionnaire (HPQ). *Journal of Occupational and Environmental Medicine*, *45*(2), 156–174. https://doi.org/10.1097/01.jom.0000052967.43131.51

Leppink, J., Paas, F., Van Der Vleuten, C. P. M., Van Gog, T., & Van Merriënboer, J. J. G. (2013). Development of an instrument for measuring different types of cognitive load. *Behavior Research Methods*, *45*(4), 1058–1072. https://doi.org/10.3758/s13428-013-0334-1

Lim, J., & Dinges, D. F. (2010). A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. *Psychological Bulletin*, *136*(3), 375–389. https://doi.org/10.1037/a0018883

Silva, I., & Costa, D. (2023). Consequences of shift work and night Work: a literature review. *Healthcare*, *11*(10), 1410. https://doi.org/10.3390/healthcare11101410

Sweller, J. (2011). Cognitive load theory. In J. P. Mestre & B. H. Ross (Eds.), *The psychology of learning and motivation: Cognition in education* (pp. 37–76). Elsevier Academic Press. https://doi.org/10.1016/B978-0-12-387691-1.00002-8

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Young, M. S., Brookhuis, K. A., Wickens, C. D., & Hancock, P. A. (2014). State of science: mental workload in ergonomics. *Ergonomics*, *58*(1), 1–17. https://doi.org/10.1080/00140139.2014.956151

Appendices

No appendices are attached to this study.

© 2026 The International Review of Multidisciplinary Research. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.