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A Systematic Review of Cognitive Stress in Complex Operational Tasks: Identifying Critical Success Factors and Stress Management Practices.

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***Abstract*—Human–Computer Interaction (HCI) environments with complex operational tasks require continuous monitoring, rapid decision-making, and time-sensitive responses, impacting safety, productivity, and organizational performance. These environments often lead to operators experiencing higher cognitive stress, fatigue, reduced concentration, and decision errors. The primary objective of this study is to identify the Critical Success Factors (CSFs) and Stress Management Practices (SMPs) for mitigating mental stress and improving human performance in complex operational settings. An academic publication database from 2006 to 2026 was utilised to carry out a Systematic Literature Review (SLR) based on the PRISMA framework. Descriptive statistical methods were employed in a systematic analysis of the chosen studies to determine the major trends and findings.**

Research on Critical Success Factors (CSFs) and Stress Management Practices (SMPs) has grown significantly. It highlights the role of organizational safety culture, fatigue management, adaptive task allocation and wearable technologies in reducing cognitive stress. The findings underscore the significance of multi-disciplinary, technology-enabled and human-centred interventions for performance and safety enhancement in complex operational environments. However, existing studies still suffer from sample sizes, industry-specific focus and lack of Human–Computer Interaction (HCI) perspectives and thus may be limited in application to the various operational contexts.

***Index Terms*—Cognitive stress; Control room operator; Critical Success factors; Human factors; Stress Management Practices**

I. INTRODUCTION

Cognitive stress is the mental load or burden people feel when they have to do many things at the same time, understand complex data, or make decisions under duress. Cognitive stress is most noticeable in environments that require multitasking, rapid decision-making and sustained attention. Stress is pervasive and has deep effects on human performance, safety, and efficiency in high-stake operational environments like aviation, railway transportation, healthcare, and industrial process control (Matthews et al., 2017). The cognitive load hypothesis proposes that high mental strain may exceed the capacity of working memory, leading to problems in decision-making and performance decline (Sweller et at., 1988).

The effects are particularly important when operators need to make rapid decisions and maintain continuous attention, as they are more susceptible to fatigue, decreased attentional control and errors (Gaba et al., 2001; Baumeister et al., 2007). It's also important to study human performance and decision-making in high-stress situations, especially in industries where efficiency and safety are paramount. Stress and workload are mentioned as a major influence on human cognitive capabilities that can result in task performance and errors (Sam et al., 2024). In these contexts, there is system complexity, uncertainty and unpredictability but operators are expected to perform well.

Their jobs require cognitive resilience, flexibility and continuous interaction with technology systems while having to meet deadlines and being held to a high responsibility (Reason, 1997). There has been research in many different fields on the physiological and psychological effects of cognitive stress. High speed train drivers often exhibit performance drops when they are tired (Dong et al., 2024; Mani et al., 2014). Station managers face occupational stress that affects negatively the quality of work life. In the safety-critical industries like construction and manufacturing, organisational and human factors are major contributors to the variability of operations and accident risk (Gonyora and Ventura-Medina, 2024; Nnaji et al., 2021). Yanhui et al., 2024 noted strategies for safety management and emphasised significant accident factors.

Even though cognitive stress in operational contexts is becoming more widely acknowledged, the research is still dispersed across domains and lacks a cohesive viewpoint on which cognitive stressors are most important and which mitigation techniques work best. The cross-sectoral critical success factors (CSFs) that promote resilience under cognitive stress have also not been thoroughly identified, despite the fact that much research has examined therapies. CSFs, including organisational culture, process standardisation, technological support, and human knowledge, are essential to attaining operational success, according to Rockart (1979) and Pinto and Slevin (1987). Moreover, flexibility and the ability to react to unanticipated obstacles are important success factors in high-risk situations (Hollnagel et al., 2006). Ping et al. (2018) systematically identified and ranked CSFs for safety management in subway construction, emphasising technical, policy-based, and psychological remedies. The research highlights the significance of proactive monitoring, employee participation, and organised safety frameworks in improving workplace safety in high-risk sectors.

Yuling et al. (2018) looked into the integration of safety management systems (SMS) into a particular organisational structure utilising audit tools, risk analysis, and theories. According to a different study by Mani et al. (2014), station managers' (operators') Quality of Worklife (QWL) was significantly impacted by occupational stress. This research also examined the effects and created creative solutions to workplace stressors including workload overload, role conflict, etc. in order to improve the operator's work-life balance.

Table 1 overviews previous articles on critical factors, cognitive load, Human factor and safety management. Several studies have emphasized the importance of safety management strategies and accident prevention mechanisms in complex operational environments. Wang et al. (2024), Liu et al. (2023), and Crawford and Kift (2018) applied advanced analytical approaches such as DEMATEL, FRAM, and semantic network analysis to identify critical safety factors and operational vulnerabilities. Their findings revealed that organizational policies, operational complexity, and human interaction within technological systems significantly influence safety

performance and risk management.

The literature further highlights that Human and Organizational Factors (HOFs) are essential for improving operational resilience and minimizing human error. Accou and Carpinelli (2022) demonstrated that the SAFRAN methodology enhances performance variability and organizational safety, while Janota et al. (2022) reported that automation and ergonomic interventions can effectively reduce operator workload and human error probability. However, semi-automated systems may increase cognitive demands, thereby requiring adaptive and human-centered system designs.

Ergonomic and workplace-related challenges were also widely discussed in the reviewed studies. Grozdanovic (2020) identified ergonomic mismatches between workstation design and operator interaction, whereas Mani et al. (2014) found that role overload, stressful working conditions, and inadequate organizational support negatively affect operators' quality of work life and overall well-being. These findings emphasize the necessity of integrating ergonomic principles into operational environments to reduce both physical and cognitive strain.

Moreover, organizational culture, mentoring, and collaboration were identified as critical factors influencing safety performance and operational efficiency. Liu et al. (2021) highlighted that formal mentoring positively contributes to safety performance through psychological and organizational support mechanisms. Similarly, Ghosh and Sar (2020) identified collaboration and teamwork as critical success factors that enhance communication, coordination, and employee performance in railway operational systems.

An integrated framework integrating safety management, human factors, and cognitive stress in complicated operational activities is lacking in the literature currently in publication. Human–Computer Interaction (HCI)-based therapies, technology-driven stress management, and Critical Success Factors (CSFs) have all received little study attention. Additionally, there are still few multidisciplinary and practical operational research, which limits the creation of all-encompassing and long-lasting stress reduction techniques.

Therefore, to address the above-mentioned research gaps, the following Research Questions (RQs) are proposed:

RQ 1: What are the Critical Success Factors (CSFs) that affect operators' mental health, cognitive stress, and operational performance in challenging operating environments?

RQ 2: To what degree do Safety Management Practices (SMPs) enhance safety performance and lessen cognitive strain during control room operations?

RQ 3: What are the main obstacles and difficulties associated with human factors that impact the application of Stress Management Practices (SMPs) in control rooms and other operational settings where safety is crucial?

RQ 4: In what ways may human-centered and technology-driven methods help operators in complex operating contexts reduce cognitive workload and task complexity?

This systematic review aims to address the identified research gaps by critically analyzing published studies related to cognitive stress, human factors, safety management, and operational performance through a structured methodological approach. The review systematically examines the Critical Success Factors (CSFs), Safety Management Practices (SMPs), and technology-driven interventions influencing cognitive workload and operator well-being in complex operational environments. Furthermore, the study highlights the existing human factor-related challenges, limitations of current operational practices, and the lack of multidisciplinary integration within Human–Computer Interaction (HCI) and safety-critical systems. By synthesizing the existing literature, this review contributes toward developing a comprehensive conceptual framework and provides practical implications for creating safer, adaptive, and human-centered operational environments.

II. METHODOLOGY

This systematic literature review was designed to analyse studies related to cognitive stress, Critical Success Factors (CSFs), Safety Management Practices (SMPs), human factors, and technology-driven solutions in complex operational and control room contexts. The review followed the PRISMA framework to establish a systematic, transparent, and reliable research technique for discovering, screening, selecting, and adding the relevant papers.

The procedure for choosing articles is presented in Figure 1, which includes Identification, screening, and inclusion as the three processes in the process.

2. 1. Search Criteria:

To perform systematic literature review, two major bibliographic databases, Scopus and Web of Science, were used to locate relevant studies. The search approach focused on articles relating to Management Practices (SMPs), human factors, and technology-driven solutions within complex operational and control room contexts.

To initiate the literature search process, keywords such as “Cognitive Stress,” “Control Room Operator,” “Critical Success Factors,” “Human Factors,” and “Stress Management Practices” were used to identify relevant studies related to complex operational and control room environments.

2.2. Screening:

An initial total of 7,766 documents were found, comprising 602 records from registered research repositories and 7,164 studies from major academic databases like Web of Science and Scopus. Following the elimination of 475 duplicate entries, 7,291 distinct studies were left for additional screening. Ten records were then eliminated by automatic screening processes because they did not meet predetermined eligibility requirements. Furthermore, 465 studies were manually eliminated due to publication type, non-English language, poor methodological quality, or lack of relevance to the study's goals.

After the initial identification stage, various inclusion and exclusion criteria were applied to refine the selected studies. Initially, 127 articles were shortlisted for further screening. The screening process considered only journal articles and review papers published between 2010 and 2026. In addition, only studies published in the English language were included in the review. To ensure source quality and academic relevance, the study further restricted the selection to journals indexed in the Australian Business Deans Council (ABDC) list, including journals ranked as "A," "B," and "C." After applying these screening criteria, 66 articles remained and were subsequently assessed during the eligibility stage for detailed review and final inclusion.

2.3. Inclusion:
There was final 66 articles remained for detailed evaluation and content analysis. These studies satisfied the predefined inclusion criteria and were considered relevant to the research objectives related to cognitive stress, human factors, safety management practices, and control room operational environments. Subsequently, a comprehensive quality assessment was conducted to evaluate the methodological rigor, relevance, and academic quality of the selected studies. Based on this final assessment, 30 research papers were ultimately included in the systematic literature review for detailed analysis and interpretation.

III. CONTENT ANALYSIS

These studies were found to be relevant to the research objectives on cognitive stress, human factors, safety management methods and control room operational environments and met the pre-defined inclusion criteria. Next, a detailed quality assessment was conducted to examine the methodological rigour, relevance and academic quality of the selected papers. Based on this final assessment, 30 research papers were selected for further analysis and interpretation in the systematic literature review. We used R studio for both quantitative and qualitative content analysis, combining thematic synthesis, graphical visualisations, and descriptive statistics from peer-reviewed journal articles to pinpoint research concerns and trends.

3.1. Quantitative approach
3.1.1. Data analysis based on year-wise distribution:
Using RStudio, the selected studies were categorized by publication year, and frequency analysis was performed to determine the annual distribution of research articles, as shown in Figure 2.
Although there was little to no publishing activity from 2006 to 2017, there was a noticeable uptick starting in 2018. Through 2021, the trend indicates a steady increase, but in 2024, when the number of publications reached its greatest point to date, there was a rapid increase. This upward trend reflects the topic's growing significance in both academic and industry research and shows a growing scholarly interest in the subject, especially in recent years.

3.1.2. Temporal source distribution:
As shown in Figure 3, the temporal distribution of the chosen studies shows a steady rise in research publications pertaining to our keyword search; research production was comparatively low between 2006 and 2017, with only a few publications recorded during this time.
But starting in 2018, there was a discernible increase in publication patterns, which suggests that research interest in safety-critical situations, human factors, cognitive stress, and stress management is growing. The number of articles increased significantly in 2021, which is indicative of the growing significance of technology-supported treatments, organisational safety, and human aspects in operational research.
Additionally, the greatest number of papers was noted in 2024, indicating that it has recently emerged as a very relevant research topic. Human–Computer Interaction (HCI), ergonomic solutions, automation, and operator well-being in complicated operational activities are all becoming more and more of a multidisciplinary focus.

3.1.3. Country-wise scientific distribution:
As a reflection of national contributions to the study of cognitive stress in operational situations, Figure 4 shows the distribution of scientific publications by nation. With four articles (1), the United Kingdom is the most prolific contributor, followed by China with three (2). Two articles each from Australia and India (3), and one publication each from the Netherlands, Italy, and Serbia (6), are represented. The global distribution of academic interest is shown by this pattern, with significant activity focused in both established and developing research economies.
The growing number of participating nations shows that operator mental health, system dependability, workplace safety, and technology adaptation in challenging operational environments are worldwide

concerns. Additionally, the variety of national contributions demonstrates the interdisciplinary and cooperative character of this field of study, fostering knowledge sharing, methodological development, and cross-cultural viewpoints in the creation of successful stress management and safety intervention techniques.

3.1.4. Keywords Frequency and Thematic Analysis:
Important insights into the prevalent study themes and recurrent research patterns in the field of cognitive stress and complex operational contexts are provided by the thematic analysis of keywords taken from the chosen studies. The research emphasis on transport systems, operational safety, and infrastructure management in safety-critical environments is evident from the keyword frequency analysis, which showed that terms like railway, safety, and traffic were among the most frequently occurring keywords (Figure 5).
The expanding importance of human-centered, technology-supported operational systems in complex situations was also noted by the thematic analysis. Keywords related to sectors like railroads, construction, aircraft, and control room operations show that safety management and cognitive stress are still very important in high-risk, time-sensitive employment. In order to improve operational resilience and human performance, current research trends are increasingly shifting toward multidisciplinary approaches that integrate safety management, ergonomics, human factors, cognitive workload assessment, and technology-driven interventions, according to the keyword frequency and thematic analysis.

3.1.5. Keywords Co-Occurrence analysis:
The keyword pair safety and management had the highest frequency of occurrence, according to the analysis of 20 words from the literature that is displayed in Figure 6. This suggests that safety management practices continue to be one of the most important research topics in complex operational environments. The significant study focus on transport systems, operational control activities, and human engagement in safety-critical operations is further highlighted by the frequent co-occurrence of traffic & control and human & railway.
It also enables the identification of crossings that have not gotten enough attention and potential directions for future research, such as more extensive cross-domain applications of traffic management frameworks or a more comprehensive integration of adaptation techniques with real-time cognitive monitoring.

3.1.6. Industry Specific distribution:
The distribution of scholarly papers in different industrial sectors is shown in Figure 7, which illustrates the range of interest in operational settings for cognitive stress research. From the AEC (Architecture, Engineering, and Construction) sector to urban rail transit, every industry has contributed at least one piece, according to the statistics. Interestingly, the industries with the most representation include the railway, construction, and aviation sectors, indicating that these sectors are especially significant from an academic and practical perspective when it comes to researching cognitive stress. Even if the number of articles per industry is evenly distributed, the dataset's multidisciplinary and cross-sectoral significance is demonstrated by the diversity of industries it comprises, such as automotive, manufacturing, warehousing, chemical processing, and healthcare.

3.2. Qualitative Content Analysis
Several significant developments in the field of cognitive stress research are revealed by the qualitative content analysis of the selected publications, particularly in the areas of control room safety management, wearable biosensor technology, and human-machine interface design. Despite these advancements, comprehensive cross-industry comparative research and safety management practices are still needed to pinpoint success factors, particularly the ways that adoption barriers and automation-induced cognitive strain vary across domains.
This study focuses on important aspects such as research methodology, industry-specific settings, technology solutions, and the impact of human factors on stress and safety-related issues in order to address our research questions (RQs). To find recurrent themes and research trends in the field, a qualitative analytic approach is used. In order to systematically address the research topics, this analytical approach is also employed to assess the body of existing literature.
3.2.1. Analysis based on research methodology:
The methodological strategies used in the 30 papers that made up this systematic review are presented in

Table 2. The five main kinds of research designs include literature reviews, mathematical modelling, statistical analysis, case-based studies, and empirical studies. Each category is linked to particular authors, methods, and resources, and salient points about their contributions to the study of cognitive stress. Utilizing the following instruments, the literature review-based research is conducted: PRISMA and Meta-Analysis (Ma et al., 2024); Bibliometric Analysis (Ciani et al., 2022); Comparative Analysis (Nnaji et al., 2021); Survey-based Questionnaire (7-Point Likert Scale) (Xiahou et al., 2018); and Relative Importance Index (RII) (Sar et al., 2020). Finding gaps in the knowledge of cognitive stress and synthesising prior results are common uses of the literature review technique.

Quantifying cognitive stress and forecasting performance outcomes in complex situations is made easier with the use of mathematical models. This approach uses machine learning, statistical regression, and fuzzy logic models. To quantify the relationships between variables affecting cognitive stress and safety, the following models are used, per the literature search: SPSS 28, FRAM (Functional Resonance Analysis Model) (Foster et al., 2021), Human Resource Performance Models (HPM) (Craig et al., 2021), Multilinear Regression Models (Gonyora et al., 2024), Balanced Scorecards (BSC) for Safety Performance Measurement (Vogt et al., 2010), and Fuzzy Logic Models (Franciszek et al., 2024).

Statistical techniques have a major role in evaluating ergonomic risks, human factors, and stress levels in work environments. Ergonomic assessments and biomechanical analysis, anthropometric measurements for workstation design, and statistical correlation analysis (SPSS 17) all use statistical techniques (Miroljub et al., 2020). This technique is essential for identifying ergonomic discrepancies in control room workstations and their impact on operator stress and performance.

The focus of qualitative case-based research is on real-world observations, adaptive frameworks, and system analysis. This study employs the adaptation model framework, qualitative insights, and observational research (Stanton et al., 2021). People's behaviour in critical work environments, such as industrial process control and signalling, may be effectively studied using this approach.

The most common research was empirical ones (e.g., Dong et al., 2024; Mani et al., 2014), which included 13 papers and concentrated on gathering data using the following techniques: Process Macro for Survey-Based Data Analysis; One-Way Repeated Measures ANOVA for Quantitative Analysis; Psychological Tests (Adaptability Questionnaire by Maklakova & Chermyanina); Stress Coping Mechanisms (SACS by Hobbfoll); and Convenience Sampling for the Quality Work-Life Scale (QWLS) and Occupational Stress Index (OSI) (Mani et al., 2014). With the use of statistical and psychological tools that have been shown to be effective, this research methodology provides profound insights into the consequences of occupational stress in the actual world. Nevertheless, a small sample size and self-report biases might sometimes impair outcomes (Liddell et al., 2024).

3.2.2. Industry Specificity analysis:

Operating environments are impacted by cognitive stress in diverse ways based on industry-specific demands, job structures, and safety regulations. In railway traffic operations, operators are often required to perform complicated control tasks and extended periods of attentiveness, which may result in fatigue-induced judgment mistakes and weakened situational awareness (Dong et al., 2024). On the other hand, occupational safety is a major problem in the automotive and construction industries due to the dangerous working circumstances, strong human-machine interactions, and real-time task switching that cause elevated cognitive stress (Ma et al., 2024). According to Gonyora and Ventura-Medina (2024), stress affects both hazard detection and system responsiveness, while the chemical process sector prioritises real-time risk assessment and procedure adherence.

These sectoral differences in Table 3 highlight the need for tailored stress reduction strategies that fit the operational and cognitive characteristics of every business. In order to improve human performance and reduce mistake rates under cognitive load, it is essential to employ ergonomic interventions and specialised safety management practices (SMPs) that are appropriate to each industrial sector.

3.2.3. Technological interventions:

In operational situations, technological advancements have greatly improved the monitoring and reduction of cognitive stress. Because of their ability to identify physiological signs of stress in real time, wearable biosensors, especially those that use sweat-based biomarkers- are among the most revolutionary instruments (Ma et al., 2024). Their use has grown since 2018. Continuous, non-invasive data on operator status is provided by these sensors, allowing for dynamic stress evaluation in settings including construction sites, automobile assembly lines, and railroad control rooms. Organizations have been able to optimize work allocation, lessen mental stress, and improve operator performance under duress by integrating AI-driven decision-support tools with adaptive control systems (Sam et al., 2024). Still, obstacles, including inconsistent biomarker thresholds, integration issues, and accuracy concerns, prevent broad acceptance from happening (Liddell et al., 2017). Their provision of adaptive intervention skills and real-time information establishes the foundation for a more robust and responsive strategy for reducing cognitive stress in high-risk industries.

3.2.4. Human Factor variables concern:

Human variables including cognitive load, emotional states, personality traits, and ergonomic interactions—are central to understanding how cognitive stress influences safety in complex operational environments. Excessive cognitive load significantly impairs working memory, decision-making accuracy, and attention, especially under time constraints or in high-risk domains such as healthcare, aviation, and transport. As per our literature search, Cognitive load theory was first proposed by Sweller et al., (1988), who emphasised the constraints of working memory and the significance of instructional design in managing cognitive resources. High cognitive demands have been associated with worse performance and higher levels of stress, especially in complex contexts (Sweller et al., 1988; Ma et al., 2024). As per Dong et al. (2024), operator fatigue and performance degradation are caused by poor information processing and task-switching.

According to Ottaviani et al. (2015), perseverative cognition has an influence on the activity of the cardiovascular, autonomic, and endocrine nervous systems. It also has a negative correlation with subjective well-being, indicating that perseverative cognition has an impact on both mental and physical health. Sam et al. (2024) and Liddell et al. (2024) assert that human factors and ergonomic design are important in lowering stress. The operators' mental effort is reduced, and their reaction accuracy is enhanced when systems and interfaces are in line with cognitive ergonomics. From an organizational standpoint, Dollard and Bakker (2010) indicate that a robust psychosocial safety environment (PSC) highlights the importance of organizational climate for employee well-being.

When considered together, the research emphasises how crucial it is to address human factors in order to improve complex systems' resilience and safety. The reduction of operator cognitive load and the preservation of system integrity need multidisciplinary interventions such as cognitive training, real-time feedback systems, ergonomic redesign, and organizational culture change.

IV. DISCUSSION

We used descriptive statistics and content analysis, which revealed substantial growth in research on cognitive stress, human factors, safety management practices, and operational performance between 2006 and 2024. This systematic literature review (SLR) follows the PRISMA guidelines, ensuring a comprehensive and transparent selection of research of 7,164 papers originally identified, 45 research papers were selected after evaluation of methodology, empirical strength, and relevance to examine 30 peer-reviewed papers, combining qualitative content synthesis with quantitative bibliometric analysis. Most of the research is empirical (43%), followed by literature reviews (23%) and mathematical modeling (27%). The temporal distribution analysis indicated that research publications increased significantly after 2018, reflecting the growing academic and industrial interest in human-centered operational systems and technology-driven safety interventions. The country-wise distribution showed that the United Kingdom, China, Australia, and India were among the major contributors to this research domain, highlighting global concerns about operational safety and cognitive workload management.

The content analysis identified recurring themes related to cognitive workload, operator fatigue, human error, safety management practices, and technology-driven interventions. The literature emphasized that organizational safety culture, ergonomic interventions, adaptive technologies, and Human–Computer Interaction (HCI)-based systems play a critical role in reducing cognitive stress and improving operational safety and performance.

Based on our above literature survey, we are looking for a few important research such as-

In industries such as railway (Dong et al., 2024), automotive and construction (Ma et al., 2024), and chemical processing (Gonyora & Ventura-Medina, 2024), cognitive stress has a substantial impact on operational performance, according to the literature study. Publication frequency increased significantly in 2024, according to a quantitative study using bibliometric methods (Figure 2). Safety Science and Applied Ergonomics were the most well-known journals, according to source distribution analysis (Figure 3), highlighting the multidisciplinary character of the topic. The sectoral comparison (Figure 7) supported the need for customized interventions, with construction emphasizing ergonomic safety design and communication, and railway operations focusing on fatigue management. The railway (23%) and automotive (17%) industries dominate sector-specific research on cognitive stress, whereas the chemical and healthcare sectors have fewer studies.

The descriptive and thematic analyses reveal significant growth in research on cognitive stress, human factors, and safety management practices in complex operational environments between 2006 and 2024. The year-wise and temporal distribution analyses showed limited publication activity before 2018, followed by a substantial increase in research output after 2018, with the highest number of publications recorded in 2024. This trend highlights the increasing academic and industrial focus on operator cognition, safety-critical systems, automation, and Human–Computer Interaction (HCI)-based operational environments.

The country-wise distribution demonstrated that the United Kingdom, China, Australia, and India were major contributors to the research domain, indicating growing global concern regarding operator mental health, operational safety, and system reliability. The keyword and thematic analyses identified dominant research themes, including safety, management, railway, traffic, control, and human factors, underscoring the importance of transportation systems, operational control, and infrastructure safety in cognitive stress research.

Furthermore, keyword co-occurrence analysis revealed strong thematic relationships between safety & management, traffic & control, and human & railway, highlighting the interconnected role of operational safety, human-system interaction, and management strategies in high-risk environments. The industry-specific analysis further indicated that the railway, construction, and aviation sectors received the greatest research attention due to their operational complexity and safety-critical nature. Overall, the findings suggest that current research is increasingly moving toward multidisciplinary, human-centered, and technology-supported approaches to reduce cognitive stress and improve operational resilience.

The reviewed literature employed diverse methodological approaches because it emphasizes the comprehensiveness of the review and keeps readers engaged to examine cognitive stress, human factors, safety management practices, and operational performance in complex environments. Mathematical modeling techniques such as machine learning, fuzzy logic, multilinear regression, FRAM, Human Performance Models (HPM), and Balanced Scorecards (BSC) were commonly used to predict cognitive workload and safety outcomes. Statistical and ergonomic assessment methods, including anthropometric measurements, biomechanical analysis, and SPSS-based correlation analysis, helped evaluate workstation design, operator stress, and performance efficiency.

Empirical studies, which were the dominant research approach, used surveys, psychological assessments, repeated-measures ANOVA, the Quality of Work Life Scale (QWLS), and the Occupational Stress Index (OSI), providing valuable operational insights. However, several studies reported limitations related to small sample sizes and self-reporting bias, highlighting the need for cautious interpretation of findings.

Additionally, Sam et al. (2024) highlighted how organisations can optimise workload allocation, lessen mental fatigue, and enhance operator decision-making under high-pressure scenarios by integrating artificial intelligence-based decision-support systems with adaptive control mechanisms. In complex systems, these technology-driven solutions help to improve human reliability, situational awareness, and operational resilience. However, a number of studies have found restrictions related to the use of technology. Large-scale operational adoption is still hampered by issues with biomarker standardization, integration complexity, data accuracy, and system dependability, according to Liddell et al. (2017).

Such challenging operational situations frequently result in fatigue-induced decision-making errors, less situational awareness, and lower operational efficiency, according to Dong et al. (2024). The literature highlights the significance of cognitive training, intelligent decision-support systems, and fatigue management programs as ways to address these problems.

Perseverance cognition affects cardiovascular, autonomic, and endocrine nervous system activities, which lowers operational efficiency and subjective well-being, according to Ottaviani et al. (2015). Furthermore, ergonomic and human-centered design methods were found to be crucial mechanisms for reducing cognitive load and enhancing operator reaction accuracy (Sam et al., 2024; Liddell et al., 2024). Dollard and Bakker (2010) highlighted that from an organizational standpoint, a robust psychosocial safety environment (PSC) promotes worker well-being and lowers hazards associated with workplace stress.

In order to lower cognitive stress and increase operational resilience in complex systems, multidisciplinary interventions such as ergonomic redesign, cognitive training, adaptive technologies, organisational support systems, and real-time feedback mechanisms are required, according to the reviewed studies. Cognitive stress, operational safety, and human performance in complicated operational situations are all significantly influenced by human characteristics. Operators' decision-making skills, situational awareness, and task performance in safety-critical domains like healthcare, aviation, transportation, and control room operations are directly impacted by factors like cognitive workload, emotional state, fatigue, personality traits, and ergonomic interaction. John Sweller claims that the Cognitive Load Theory explains how an overwhelming amount of mental effort can overwhelm working memory capacity, leading to decreased cognitive efficiency and elevated stress levels (Sweller et al., 1988). Similarly, high cognitive demands have a negative impact on performance and stress management in complicated operational scenarios, according to Ma et al. (2024). Additionally, Dong et al. (2024) found that job switching and inadequate information processing play a major role in operator fatigue and performance decline.

Through the integration of human factors, Critical Success Factors (CSFs), Safety Management Practices (SMPs), and technology-driven interventions into a single conceptual framework, this Systematic Literature Review (SLR) offers a multidisciplinary perspective of cognitive stress management. This review examines cognitive stress in the railway, aviation, construction, automotive, and chemical industries using descriptive statistics, thematic analysis, keyword co-occurrence analysis, and industry-specific interpretation using RStudio, in contrast to previous studies that concentrated on isolated operational issues. Additionally, wearable biosensors, adaptive automation, AI-driven decision-support systems, and human-computer interaction (HCI) are highlighted in the study (Ma et al., 2024; Sam et al., 2024).

Nonetheless, there are a few restrictions. The review may have excluded pertinent studies because it only looked at English-language journal articles that were listed on the ABDC. Additionally, limited sample numbers, self-reported evaluations, and methodological variation restrict generalizability (Liddell et al., 2024). Technology-driven solutions also confront issues with integration complexity, dependability, and practical validation.

The literature study identifies a number of areas that require further investigation concerning cognitive stress and operational safety in complicated contexts. Studies that are now available demonstrate a limited integration of organizational safety frameworks, cognitive ergonomics, and human–computer interaction (HCI). The majority of studies rely on self-reported data, limited sample sizes, and industry-specific studies, which restricts their wider application (Liddell et al., 2024). There is still no real-world validation for wearable biosensors, AI-driven monitoring systems, and adaptive automation, despite their growing discussion (Ma et al., 2024; Sam et al., 2024).

After extensive analysis of the content, the findings yielded some notable outcomes that contribute both theoretically and practically to the understanding of cognitive stress in complex operational environments. As per a systematic review, the focused outcomes are as follows: i. Significant rise of scholarly interest in

terms of subjects, publication trends, and sectoral divergence globally over the year.
ii. Identified the Success factor in the operation control task environment within the balanced methodology application. iii. The influence of human variables leads to optimizing the cognitive load and psychological safety climate. iv. Technological integration for monitoring stress.
Instead of the above positive outcomes, we identified several research gaps, such as the scarcity of sectoral comparisons, the inefficiency of assessment, and the organization's role involvement to manage stress and system performance. To address the research gap, a few questions for further research on understanding important success factors and safety intervention techniques may be facilitated by stress management in operational tasks. Significant research issues or areas where industry and academics are interested in key industries like railway, aviation, and automobiles could conduct their study are outlined in this section.

Most relevant future research questions should be-

i. How do safety-critical industries like aviation, transportation, construction, and chemical processing differ in terms of cognitive stressors and mitigation techniques?
ii. How can human performance be maintained through adaptive training programs?
iii. Which system-level interventions—such as organizational policy, workload distribution, and process design—are most successful in lowering cognitive stress in challenging operational settings?
iv. How can safety concerns and performance degradation under high cognitive workload situations be predicted using predictive algorithms that incorporate human variables?

V. CONCLUSION

This Systematic Literature Review (SLR) provides a comprehensive understanding of cognitive stress, human factors, Critical Success Factors (CSFs), and Safety Management Practices (SMPs) in complex operational environments. Using the PRISMA framework, the study systematically reviewed literature and identified a substantial rise in scholarly interest in cognitive stress management, particularly after 2018.
We rigorously evaluated 30 research publications in our analysis, methodically documenting various aspects of Cognitive stress, Safety management practices and Human factor role on Operators performance. Notably, we saw an exponential rise in the number of articles published in this sector and data analysis provides the proper distribution of these articles based on various factors. The findings revealed that cognitive workload, fatigue, decision-making pressure, ergonomic challenges, and human-system interaction significantly influence operator performance, situational awareness, and operational safety across industries such as railway transportation, aviation, construction, automotive, and chemical processing.
The novelty of this review lies in its multidisciplinary integration of human factors, cognitive ergonomics, organizational safety practices, and technology-driven interventions within a unified conceptual framework. Through descriptive statistical analysis, thematic interpretation, keyword co-occurrence analysis, and industry-specific evaluation using RStudio, the study identified emerging research trends associated with Human–Computer Interaction (HCI), adaptive automation, wearable biosensors, AI-driven decision-support systems, and real-time stress monitoring technologies. The review further highlighted the importance of organizational safety culture, ergonomic interventions, fatigue management programs, adaptive task allocation, and cognitive training as major contributors to reducing cognitive stress and improving operational resilience.
From an industry and managerial perspective, the findings emphasize the need for human-centered operational systems, technology-supported safety interventions, and adaptive organizational strategies to enhance operator well-being and minimize human error in safety-critical environments. The study also identified several research gaps, including limited multidisciplinary integration, insufficient cross-sectoral investigations, small empirical sample sizes, and limited real-world validation of technology-driven stress management systems.
Future research should focus on longitudinal empirical investigations, predictive cognitive stress models, adaptive training systems, and ethical considerations related to biometric monitoring technologies. Overall, this review contributes both theoretically and practically by establishing a strong academic

foundation for future research and by supporting the development of safer, adaptive, and resilient operational environments.

VI. HELPFUL HINTS

A. Figures and Tables: Added in a separate file

B. Authors contribution:
The authors confirm contribution to the paper as follows: study conception and design: Wasim Akram, Rauf Iqbal; data collection: Wasim Akram, Rauf Iqbal; analysis and interpretation of results: Wasim Akram; draft manuscript preparation: Wasim Akram. All authors reviewed the results and approved the final version of the manuscript.

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