

# Human Performance in Security Operations: A Survey on Burnout, Well-Being and Flow State Among Practitioners

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**Abstract**—The increasing complexity and criticality of cybersecurity operations have placed immense cognitive and emotional demands on Security Operation Center (SOC) practitioners. These demands frequently result in burnout, diminished well-being, and reduced engagement, which negatively impact both individual performance and overall SOC effectiveness. This paper envisions a transformative approach to SOC productivity and practitioner well-being through targeted interventions that prevent burnout, enhance well-being, and foster engagement. By addressing the psychological challenges inherent in high-stress cybersecurity roles, our work seeks to promote holistic resilience in SOC environments.

This study focuses on evaluating the mental health landscape of SOC practitioners using validated psychological scales. Leveraging the Copenhagen Burnout Inventory (CBI), Secure Flourish Index (SFI), and Short Flow Scale (SFS), we quantitatively assess burnout, well-being, and flow states among 19 SOC practitioners. The results highlight alarmingly high levels of personal and work-related burnout among participants (approx. 31-36% of participants met the criteria for high burnout), with considerable deficiencies in mental and physical health, life satisfaction, and social connectedness compared to normative workplace benchmarks. Simultaneously, participants report a sense of meaning and purpose, high financial security and flow experiences, reflecting their ability to engage deeply with challenging tasks and derive intrinsic rewards, despite a reduced sense of control, concentration and increased self-consciousness.

The findings underscore the dual-edged nature of SOC roles—practitioners find purpose and fulfillment in their tasks yet face significant risks to their well-being. Broader conclusions from this work reveal the urgent need for structured interventions tailored to SOC environments. Key recommendations include fostering work environments that support mental health, promoting psychological safety, and implementing systems to address chronic stressors and workload imbalances. Moreover, the study highlights the importance of leveraging flow states as a mechanism to enhance practitioner engagement and productivity.

## I. INTRODUCTION

Mental health challenges are a global concern: the World Health Organization (WHO) estimated that ~300 million

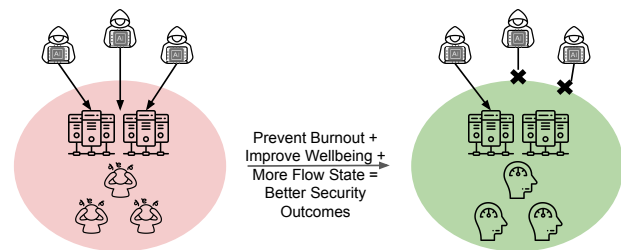


Fig. 1. Graphical abstract of our vision to transform SOC productivity and effectiveness. Stress and burnout increase the adversaries chance of success. Technology has limited benefits [2]. Inspired by the Developer Experience [3] we propose enhancing well-being and flow state among SOC practitioners.

people lived with anxiety and ~280 million people lived with depression in 2019 which have been estimated to result in productivity losses worth 1 trillion US Dollars to the global economy [1].

Cybersecurity professionals, e.g., security analysts, consultants, managers, Chief Information Security Officer (CISO)s, also experience mental health challenges. A survey of CISOs in 2024 [4] reported that 80% of CISOs rated themselves as “highly stressed”, another survey of CISOs in 2019 [5] reported that every CISO surveyed believed their role to be stressful with 91% having experienced moderate or high stress and 88% of CISOs clocking in more than 40 hours/week. A survey of over 1,000 cybersecurity professionals reported by Tines.com in 2022 [6] found that 64% stated that their productivity is affected by their mental health. For some cybersecurity professionals who are headed towards burnout, the only solution is to leave their current employer [7].

Scientific research on stress and burnout in cybersecurity began in 2015 when Sundaramurthy et al. [8], [9] conducted extensive anthropological research on burnout in SOCs. In 2017-2018, Dykstra et al. [10], [11] highlighted the relevance and importance of understanding the link between stress, fatigue and cybersecurity operations (performance) by developing the cyber operations stress survey (COSS). Nobles [12] raised the alarm in 2022 on stress, burnout and security fatigue and Kailani et al. [13] described experiences of burnout in their interviews with security operation professionals during the COVID-19 pandemic. In 2023 Reeves et al. [14] measured the

level of burnout among Australian cybersecurity professionals to be higher than healthcare workers after the COVID-19 pandemic followed by a study of the same population on their sleep quality [15]. In 2024 Nepal et al. [16] conducted extensive quantitative and qualitative analysis of burnout and well-being among 35 incident responders using the Job-Demands-Resources model and identified workload (among others) to be a major cause for burnout among their population.

Subpar cognitive performance due to stress or burnout not only impacts the individual but also the overall productivity and effectiveness of Security Operation Centers, as demonstrated by the following real-world scenarios:

- **High-Stress Incident Response.** A security analyst’s stress levels during a high priority incident response might be exacerbated by the increasing workload, changing priorities and time pressure demands [16] which can impact the response times, problem-solving and decision making skills of the analyst.
- **CISO Challenges.** Limited resources or organizational support can lead to stress, feeling isolated [17], [18], resulting in short tenure tracks (approx. 2 years), as well as impaired quality of work (e.g., regulatory oversight).
- **Practitioner Disengagement.** A lack of fairness or recognition may increase the risk of insider threats, e.g., acts of espionage [19].

Automation and technology, including Security Information and Event Management (SIEM), Security Orchestration and Response (SOAR), playbooks [20] and AI tools [21], can reduce repetitive tasks and lighten workloads. However, as Perumal et al. [2] warn, new technologies often increase operational complexity, degrade human performance, and diminish security posture beyond a certain threshold.

Despite automation and technology, practitioners face high cognitive load as critical situations often need a quick and deep understanding of tools, commands, operational environment, alerts, threats, incidents, intelligence reports, etc. Thus, human performance remains critical to the success of the SOC.

**Our vision** is to transform the productivity and effectiveness of Security Operation Centers by reducing the chance of burnout, improving the well-being and engagement among practitioners. In the first phase of manifesting our vision we draw inspiration from validated research on the productivity and well-being of software development [3], [22]–[25] which has shown that software engineering productivity hinges on (a) the well-being of developers and; (b) developers being able to be in the flow-state (commonly experienced as “being in the zone”). We hypothesize that preventing burnout and improving practitioner well-being and engagement will make SOCs more effective as illustrated in Figure 1.

**In this paper** we focus on the well-being and engagement of security operations practitioners using psychologically validated scales. Based on the results from the surveys we quantify the presence of burnout and exhaustion, the domains of well-being respondents flourish in and the characteristics of flow state that practitioners experience. Using previously published data from the respective surveys we then compare the mean

scores of our population with the other job roles and cast light on the difference SOC practitioners experience. Finally, we initiate new lines of inquiry based on our findings and carve out the next phase of our research.

This paper makes the following **contributions**:

- We present a hypothesis linking the effectiveness of Cybersecurity Operations to preventing burnout, improving well-being and engagement.
- We collect and share a dataset on burnout, well-being and flow state among SOC practitioners based on psychologically validated scales.
- We measure the presence of burnout, state of well-being and flow experiences among SOC practitioners.
- We share insights from our survey that can be used to improve the effectiveness of Security Operations.

**Paper Structure:** The remainder of this paper is organized as follows. In Section II we describe the concepts of Stress, Burnout and the Flow State. In Section III we present our survey and its components. In Section IV we describe the results from our survey followed by a Discussion in Section V, Related Work in Section VI and then conclude this paper in Section VII.

## II. BACKGROUND & RELATED WORK

### A. Stress & Burnout

Stress is the brain’s behavioural and physiological response to detecting a threat [26]. The relation between stress and performance has been shown to follow an inverted U-shape curve [27], popularly known in the literature as Yerkes-Dodson Law, i.e., performance increases as stress increases up to a point after which it declines with increasing stress. In this paper, we focus on chronic stress, which is the prolonged state of physical and psychological tension that often can be observed in security operations [7], [10], [16]. Research on chronic stress has shown that it can have severe physiological implications on the brain. For example, stress can shrink parts of brain cells (neurons) in the hippocampus and prefrontal cortex [28]. Work-related chronic stress studies by Golkar et al. [29] revealed that people with chronic stress have difficulty regulating their negative emotional responses. Eventually, chronic stress negatively influences work performance [30] and employee satisfaction [31].

Thus chronic stress can lead to burnout which the WHO defines as an occupational phenomenon in the International Classification of Disease (ICD-11) [32]. Maslach et al. [33] defined burnout as an extended response to chronic emotional and interpersonal job stressors and characterized burnout along three dimensions: exhaustion, cynicism and inefficacy. Exhaustion is the most widely reported manifestation of burnout and what many people typically identify with, e.g., work overload. However, exhaustion can also occur through the emotional demands of human services, e.g., first-responders. Cynicism results from exhaustion and typically involves creating distance between one’s self and work. A common manifestation of cynicism is an attitude of indifference towards the people

and/or work environment. Inefficacy is believed to stem from a lack of relevant resources and could arise in parallel with exhaustion and cynicism.

Overall, burnout impairs cognitive functioning, particularly executive functions such as attention and memory [34]. This has direct implications on creativity, problem solving and focus.

### B. Well-Being

Well-being is the state of having basic needs met, and feeling physically healthy, mentally balanced, socially connected, and fulfilled. Well-being has two dimensions: one being objective and the other more subjective [35]. Objective well-being deals with the basic human needs, e.g., food, shelter, security, health and education. Objective well-being fluctuates with social, cultural and political changes. Subjective well-being instead relies on an individual's perception of *how they feel* about their well-being, which is what we refer to in this paper. It typically deals with life satisfaction, social connectedness, happiness, sense of meaning and purpose, and engagement. A sense of wellness comes together when objective and subjective well-being come together.

Empirical studies on well-being have shown that the subjective experience of well-being can be highly influenced by physical exercise. For example, even low levels of periodic physical activity improves memory [36], attention [37] and academic and cognitive performance [38], [39]. Well-being has shown to improve learning and productivity; both critical aspects in knowledge work [40]. While well-being represents a general state of happiness and health across all aspects of life, there is another concept that specifically addresses the psychological conditions where someone feels fully engaged and focused in an activity, often losing track of time and self-consciousness: flow state.

### C. Flow State

*Flow* as defined by Csíkszentmihályi [41], [42] is the psychology of optimal experience where people typically report to be “in the zone”. Flow is an integral aspect of Positive Psychology and falls under the umbrella of Positive Engagement in the so-called PERMA theory [43]. Therefore, in this paper we use the terms Flow and Engagement interchangeably. It is in the flow state where we feel and perform our best [44]. Being in the flow state can be characterized by the following:

- **Challenge-skill balance** is what determines whether the task at hand *slightly* exceeds our skill level. If a task is too challenging we get frustrated and anxious, if a task is too easy we get bored.
- **Merging of action and awareness** occurs when our attentional resources are directed towards a specific activity or problem.
- **Clear goals** is what drives our attentional resources to the *specifics* of the task at hand which enables us to enter the flow state more easily.

- **Immediate feedback** is what we perceive while engaging in the activity, e.g., the haptic feedback of typing or the line of code showing up on the screen.
- **Complete concentration** requires focusing our attentional resources on the task at hand. This results in engagement, joy and a sense of absorption in the present moment.
- **A sense of control** is what we feel in the flow state even if the system we are interacting with is typically beyond our control.
- **Loss of self-consciousness** is the absence of what we commonly refer to as our inner critic. This is a result of hypofrontality, which is when parts of our brain's prefrontal cortex reduces activity.
- **Time transformation** is when our sense of time is distorted. A few seconds might feel really long or an hour might feel like a few minutes.
- **Autotelic experience** is when we do something for the sake of the experience and not the result.

## III. HUMAN PERFORMANCE IN CYBERSECURITY OPERATIONS

Our vision is to transform SOC productivity and effectiveness by preventing burnout and enhancing practitioner well-being and engagement. We hypothesize that practitioners who are not burnt out, have a strong sense of well-being, and are positively engaged in their security activities contribute to a more productive and effective SOC. While this hypothesis is plausible, there is currently no publicly available scientific dataset from SOCs to validate it.

To test this hypothesis, our long-term goal is to quantify the relationship between practitioner well-being and SOC performance by correlating psychological measures with operational metrics. However, in this initial phase, we did not have access to SOC-specific performance metrics. Therefore, we focus on designing and testing surveys to measure practitioner burnout, well-being, and flow state. These surveys provide a foundation for understanding the psychological dimensions of SOC work, which can later be linked to performance metrics.

Importantly, this study does not aim to clinically diagnose participants. Next, we outline the study's goals, detailing our measurement methodology, and describing the questionnaires utilized.

**Goals.** We had the following goals in designing this study. (i) design a validated, normalised and standardised, psychological survey that is capable of measuring burnout, well-being and engagement in the cybersecurity domain; (ii) generate a dataset of cybersecurity practitioner burnout, well-being and engagement; (iii) open up new lines of inquiry on burnout prevention, improvement of the well-being and engagement of cybersecurity practitioners.

**Measurement methodology.** We chose a quantitative approach towards measuring burnout, well-being and engagement using three psychologically validated self-rated surveys: The CBI to measure burnout, the SFI to measure well-being and SFS to measure engagement (flow state). We adopted

a quantitative approach as (a) our overarching goal is to correlate the scores from these surveys with SOC metrics and Key Performance Indicators (KPIs); (b) we can collect more specific data compared to a qualitative approach and; (c) it takes less time than an interview.

**Copenhagen Burnout Inventory.** The first section of our survey is the CBI [31]. CBI offers a standardised, normalised, and validated methodology for measuring burnout. It has been designed for any type of worker (i.e., not necessarily a healthcare worker). Moreover, it is focused on exhaustion (physical and emotional) which is one of the most commonly reported problems from non-academic surveys on burnout among cybersecurity professionals [7], [45], [46]. CBI is available in the public domain.

As per the CBI, there are six questions for Personal burnout, seven for Work-related burnout and six for Client-related burnout. Each item on the scale has a score of 0, 25, 50, 75 or 100. Respondents are considered non-responders if less than three, four and three questions have been answered in the personal, work-related and client-related burnout respectively. The score for each of the burnout categories is given by the mean score of the items in the respective category. Mean score of 50 or higher in a category is reported to be a high degree of burnout whereas a score less than 50 is not considered to be burnout.

**Secure Flourish Index.** To measure well-being, we chose the SFI [47]. The Secure Flourish Index is a survey developed to measure a person’s subjective well-being by combining indicators of both security (physical safety and economic stability) and human flourishing (education, health, and life satisfaction). The index has been validated for research in workplace settings for human performance and productivity [48]. The six domains contained within the SFI are nearly universally applicable: social relationships, character and virtue, meaning and purpose, physical and mental health, happiness and life satisfaction, and financial and material stability.

The SFI comprises of 12 questions in total. Each item is measured on a 0-10 scale with 0 being the least and 10 being the highest. Unlike the CBI there is no cutoff score for well-being. The final score for each domain is the average of the two questions.

**Short Flow Scale.** To measure flow, there are numerous scales available, however, in this paper we chose to use the SFS [49] as it is a concise psychological measurement tool which has been validated for use in work settings and it is designed to offer an aggregate profile of flow characteristics in time restricted situations.

The short flow scale is a 9 item scale wherein each item reflects one of the nine flow characteristics (see Section II-C). Each item is rated between 1 (Strongly disagree) and 7 (Strongly agree). We obtain a final mean score by taking the average of all the ratings. The higher the score, the more likely the individual is perceived to be in the flow state during the questioned activity.

TABLE I  
PARTICIPANT DEMOGRAPHICS

<b>Region</b>	North America	15	<b>Industry Sectors</b>	Information Technology	9
	Europe	4		Finance & Insurance	4
<b>Age Range</b>	20-29	1		Retail	2
	30-39	1		Manufacturing	3
	40-49	10		Transportation & Logistics	2
	50-59	7		Commercial Packed Goods	1
<b>Job Role</b>	CISO	18		Healthcare	1
	Manager	1		Media	1

#### IV. CASE STUDY

We now describe our pilot study using our survey.

##### A. Participant Recruitment

The survey was conducted online between June and July 2024. It had a brief introduction and five distinct sections (demographics, CBI, SFI, SFS and comments), with a total of 51 questions. We recruited participants by sharing a link to the survey at a CISO conference in California. We received a total of 25 responses of which 19 were involved in security operation activities. The demographics of the 19 participants are tabulated in Table I.

##### B. Data Processing & Analysis

Participants were not asked for their names or affiliations to remain anonymous. However, if they wanted a copy of their results or were interested in a qualitative interview, we asked for a (one-time) email address. We obtained their consent at the end of the survey for collecting and processing their personal information. We used a GDPR compliant data processor for our survey.

We analyzed only submitted responses and filtered for participants who selected security operations as one of their job activities. We wrote a custom Python script to extract and analyze the relevant data. Given the time constraints that practitioners face in their daily work, we decided to make all questions optional. This led to two unintentional disadvantages for our data analysis. First, since not all questions were answered by all participants, we cannot compare answers between the group that we identified as burnout, and the non-burnout group. Second, we cannot compute an overall mean score as  $N$  is different for each question. To overcome those challenges, we present and analyze the mean score per question.

##### C. CBI Results

The results for each of the questions on the CBI scale are tabulated in Table II. The rightmost column includes the mean scores from the CBI PUMA study [31] of human service workers (which comprised of Social Workers, Nurses, Hospital Doctors, Administrative staff, Prison wards, Midwives, Hospital secretaries, Chief Doctors, etc. from Denmark). We note the range of  $N$  being 5-11 with the average being 7.36 meaning each question was answered by nearly 7/19 participants on average. Based on the CBI scoring system, we found 7 participants with personal burnout, 6 with work-related burnout and

TABLE II  
COPENHAGEN BURNOUT INVENTORY SCORE FOR OUR POPULATION COMPARED TO THE CBI PUMA STUDY OF HUMAN SERVICE WORKERS.

	Response category and scoring:					N	Mean (Stddev)	PUMA-CBI Mean (Stddev)
	Always <sup>a</sup> or To a very high degree <sup>b</sup> (Scoring 100)	Often <sup>a</sup> or To a high degree <sup>b</sup> (Scoring 75)	Sometimes <sup>a</sup> or Somewhat <sup>b</sup> (Scoring 50)	Seldom <sup>a</sup> or To a low degree <sup>b</sup> (Scoring 25)	Never <sup>a</sup> or To a very low degree <sup>b</sup> (Scoring 0)			
<b>Personal burnout</b>								
How often do you feel tired? <sup>a</sup>	4	5	0	0	0	9	86.11 (13.18)	52.5 (20.2)
How often are you physically exhausted? <sup>a</sup>	0	4	2	0	0	6	66.67 (12.91)	41.5 (20.7)
How often are you emotionally exhausted? <sup>a</sup>	2	7	2	0	0	11	75.00 (15.81)	37.7 (21.6)
How often do you think: "I can't take it anymore"? <sup>a</sup>	0	0	6	2	0	8	43.75 (11.57)	23.5 (22.2)
How often do you feel worn out? <sup>a</sup>	2	4	0	0	0	6	83.33 (12.91)	37.3 (22.2)
How often do you feel weak and susceptible to illness? <sup>a</sup>	0	4	0	2	0	6	58.33 (25.82)	22.8 (20.8)
<b>Work-related burnout</b>								
Is your work emotionally exhausting? <sup>b</sup>	0	4	2	1	0	7	60.71 (19.67)	43.9 (24.1)
Do you feel burnt out because of work? <sup>b</sup>	3	3	2	1	1	10	65.00 (33.75)	31.9 (25.8)
Does your work frustrate you? <sup>b</sup>	0	2	5	1	1	9	47.22 (23.20)	38.6 (24.8)
Do you feel worn out at the end of the working day? <sup>a</sup>	4	3	1	0	0	8	84.38 (18.60)	47.8 (25.2)
Are you exhausted in the morning at the thought of another day at work? <sup>a</sup>	2	3	3	2	0	10	62.50 (27.00)	25.6 (23.6)
Do you feel that every working hour is tiring for you? <sup>a</sup>	0	2	7	2	0	11	50.00 (15.81)	17.1 (19.6)
Do you have enough energy for family and friends during leisure time? <sup>a</sup> (inverse scoring)	2	1	4	2	0	9	41.67 (27.95)	28.0 (21.8)
<b>Client-related burnout</b>								
Do you find it hard to work with clients? <sup>b</sup>	1	0	2	1	1	5	45.00 (37.08)	34.9 (23.5)
Do you find it frustrating to work with clients? <sup>b</sup>	1	1	1	0	2	5	45.00 (44.72)	24.3 (21.1)
Does it drain your energy to work with clients? <sup>b</sup>	3	1	1	1	0	6	75.00 (31.62)	36.7 (24.1)
Do you feel that you give more than you get back when you work with clients? <sup>b</sup>	2	1	2	0	0	5	75.00 (25.00)	39.8 (26.5)
Are you tired of working with clients? <sup>a</sup>	1	0	2	1	0	4	56.25 (31.46)	23.4 (20.7)
Do you sometimes wonder how long you will be able to continue working with clients? <sup>a</sup>	1	0	2	2	0	5	50.00 (30.62)	26.9 (23.3)

2 with client-related burnout. Based on the *non-responder* criteria, we had 7, 6 and 2 valid responses in the personal, work-related and client-related categories respectively. Therefore, even though the overall percentage of burnout participants in personal and work-related is 31.5-36.8%, considering valid responses we have 85-87% of burnout participants.

From the personal CBI items, we first observe that on average feelings of tiredness, emotional exhaustion and feeling worn out occur between *Always* and *Often*. 4/9 respondents selected *Always* and 5/9 selected *Often* to *How often do you feel tired?*. To *How often are you emotionally exhausted?* 7/11 stated *Often* and 2/11 *Always*. 4/6 respondents stated feeling worn out *Often* and 2/6 stated *Always*. Compared to the PUMA study, the question on feeling worn out has the largest difference in mean scores followed by feeling emotionally exhausted.

From the work-related burnout items, we see that feeling worn out at the end of the working day had the highest mean score of 84.38 with 4/8 respondents stated *Always* and 3/8 stated *Often*. 3/10 Respondents stated *To a very high degree* and 3/10 stated *To a high degree* respectively to the question of feeling burnt out because of work. 7/11 respondents answered *Sometimes* to feeling that every working hour is tiring, and 3/10 and 2/10 answered *Often* and *Always* respectively to the item on feeling exhausted in the morning at the thought of another day at work. Compared to the PUMA study, the largest differences in the mean scores are in the four questions previously described.

From the client CBI items we had fewer responses. From those responses, we note that the mean scores for *does it drain your energy to work with clients* and *do you feel that you give more than you get back when you work with clients* was 75 (To a high degree). *Somewhat* was the average score to *do you find it hard to work with client*, *do you find it frustrating to work with clients* and *do you sometimes wonder how long you will be able to continue working with clients*. The questions

from the three highest mean scores were also the questions that had the highest difference with the PUMA study.

**Key takeaways:** Compared to the scores from the original PUMA study, we observe that our population scored categorically higher, indicating that the CISO role with security operations activities is more tiring and exhausting than the comparison group. Moreover 31-36% of CISOs were classified as burnout to a high degree suggesting further and immediate research into the causes for such a high degree of burnout as well as designing and implementing targeted interventions. However, we also observe that our data has more variance due to small *N* which we intend to address in the next iteration of our survey.

#### D. SFI Results

We make the following observations based on the results from the SFI tabulated in Table III. The rightmost column includes the mean scores from the SFI study used in a workplace setting: employees from two Fortune 500 manufacturing companies in the USA. We note the range of *N* in our sample population is 10-18 with the average being 14.08—meaning each question was answered by roughly 14/19 participants on average.

Our population had lower scores in most domains compared to the manufacturing company employees particularly in: Happiness and Life Satisfaction (5.50 and 5.20 vs 7.51 and 7.45), Mental and Physical Health (3.80 and 4.29 vs 7.05 and 7.78) and Close Social Relationships (4.33 and 4.33 vs 7.42 and 7.28). In the domains of Meaning and Purpose (5.73 and 5.80 vs 7.77 and 7.69) our population was above the absolute mean indicating that the participants do find their roles meaningful, however, they are lower than the SFI workplace average. In the domain of Character and Virtue (7.64 and 5.41 vs 8.16 and 7.57) the CISOs scored moderate to high with the average score for promoting good in all circumstances, even in difficult and challenging situations contrasted by being able to give up some happiness now for greater happiness later. Only in the

TABLE III  
SECURE FLOURISH INDEX SCORE FOR OUR POPULATION COMPARED TO EMPLOYEES FROM TWO USA FORTUNE 500 MANUFACTURING COMPANIES.

Domain	Item	N	Mean (Stddev)	SFI-Workplace Mean (Stddev)
D1. Happiness and life satisfaction	Overall, how satisfied are you with life as a whole these days? (0 = Not Satisfied, 10 = Completely Satisfied)	10	5.50 (2.01)	7.51 (1.63)
	In general, how happy or unhappy do you usually feel? (0 = Extremely Unhappy, 10 = Extremely Happy)	10	5.20 (1.99)	7.45 (1.65)
D2. Mental and physical health	In general, how would you rate your physical health? (0 = Poor, 10 = Excellent)	10	3.80 (2.62)	7.05 (1.74)
	How would you rate your overall mental health? (0 = Poor, 10 = Excellent)	10	4.00 (2.11)	7.78 (1.86)
D3. Meaning and purpose	Overall, to what extent do you feel the things you do in your life are worthwhile? (0 = Not at All Worthwhile, 10 = Completely Worthwhile)	11	5.73 (2.20)	7.77 (1.66)
	I understand my purpose in life. (0 = Strongly disagree, 10 = Strongly Agree)	15	5.80 (2.31)	7.69 (2.06)
D4. Character and virtue	I always act to promote good in all circumstances, even in difficult and challenging situations. (0 = Not True of Me, 10 = Completely True of Me)	14	7.64 (1.65)	8.16 (1.53)
	I am always able to give up some happiness now for greater happiness later. (0 = Not True of Me, 10 = Completely True of Me)	17	5.41 (2.87)	7.57 (1.77)
D5. Close social relationships	I am content with my friendships and relationships. (0 = Strongly Disagree, 10 = Strongly Agree)	18	4.33 (2.70)	7.42 (2.04)
	My relationships are satisfying as I would want them to be. (0 = Strongly Disagree, 10 = Strongly Agree)	18	4.33 (2.63)	7.28 (2.05)
D6. Financial and material stability	How often do you worry about being able to meet normal monthly living expenses? (0 = Worry All of the Time, 10 = Do Not Every Worry)	18	7.33 (2.54)	6.70 (2.99)
	How often do you worry about safety, food, or housing? (0 = Worry All of the Time, 10 = Do Not Every Worry)	18	8.22 (1.80)	7.56 (2.93)

Financial and Material Stability domain did our population score higher than the SFI workplace average (7.33 and 8.22 vs 6.70 and 7.56). The data also included higher variability, indicating different perceptions between the respondents but also due to small  $N$ .

**Key takeaways:** The higher average  $N$  indicates that participants were more open to answering questions on well-being, particularly on character and virtue, and financial and material stability. Mental and Physical Health and Social Relationships stand out as critical areas of concern for our participants. Although participants find meaning in their work and have a high sense of financial and material stability, their overall happiness and well-being appear to be compromised, probably due to the exhausting nature of their roles, as reflected in the results of the CBI survey. More qualitative and quantitative research is required to uncover the reasons for the current state of well-being. Tailored interventions may be necessary to address these discrepancies and improve well-being in these critical domains.

#### E. SFS Results

The results from the SFS are tabulated in Table IV. The rightmost column includes the mean scores from a study conducted by the Flow Research Collective (FRC) and Deloitte on knowledge workers [50]. We note the range of  $N$  in our sample population is 7-15 with the average being 8.22—meaning each question was answered by roughly 8/19 participants on average.

For the challenge-skill balance and feedback items, the SOC practitioners reported high scores. Sense of control, self-

consciousness and complete concentration were below the absolute mean while time transformation, autotelic experience, clear goals and merging of action and awareness were moderate. Comparing our sample population to the knowledge workers in the FRC-Deloitte study CISOs scored higher on the items challenge-skill balance (5.14 vs 4.45), action and awareness merging (4.71 vs 3.61), clear goals (5.00 vs 4.03), immediate feedback (5.57 vs 4.12), time transformation (4.10 vs 3.32) and autotelic experience (4.67 vs 3.69) except sense of control (3.29 vs 3.56). The scores on complete concentration (3.86 vs 3.76) and loss of self-consciousness (3.43 vs 3.33) were very close.

**Key Takeaways:** Although well-being scores were absolutely and relatively lower in the SFI, in the flow state our sample population had better absolute and relative scores suggesting that CISOs are engaged in their security activities. Across most dimensions, CISOs report higher flow scores compared to knowledge workers in the FRC-Deloitte study. This suggests that the nature of their work—highly challenging, goal-oriented, and feedback-driven—facilitates flow states. And, while knowledge workers may have more stable and predictable roles, CISOs thrive in dynamic, high-stakes environments that foster flow. It is worth noting that the item on autotelic experience was answered the most and had a relatively high score here suggesting the meaningful and rewarding nature of the job. Despite their high flow scores, CISOs report a lower sense of control. Further research is necessary to understand such perceptions. The average scores on self-consciousness hint at the potential lack of psychological safety [51] our population experiences. By addressing these concerns we could further

TABLE IV

FLOW SHORT SCALE SCORES FOR OUR POPULATION COMPARED TO A STUDY OF KNOWLEDGE WORKERS BY THE FLOW RESEARCH COLLECTIVE (FRC) AND DELOITTE.

Flow Characteristic	Item	N	Mean (Stddev)	FRC-Deloitte Mean (Stddev)
Challenge-Skill Balance	I feel I am competent enough to meet the high demands of the situation (1 = Strongly disagree, 7 = Strongly agree)	7	5.14 (1.07)	4.45 (0.60)
Action & Awareness Merging	I do things spontaneously and automatically without having to think (1 = Strongly disagree, 7 = Strongly agree)	7	4.71 (1.60)	3.61 (1.00)
Clear Goals	I have a strong sense of what I want to do (1 = Strongly disagree, 7 = Strongly agree)	7	5.00 (1.00)	4.03 (0.75)
Immediate Feedback	I have a good idea while I am performing about how well I am doing (1 = Strongly disagree, 7 = Strongly agree)	7	5.57 (0.98)	4.12 (0.72)
Complete Concentration	I am completely focused on the task at hand (1 = Strongly disagree, 7 = Strongly agree)	7	3.86 (2.04)	3.76 (0.86)
Sense of Control	I have a feeling of total control (1 = Strongly disagree, 7 = Strongly agree)	7	3.29 (1.38)	3.56 (0.99)
Loss of Self-Consciousness	I am not worried about what others may be thinking of me (1 = Strongly disagree, 7 = Strongly agree)	7	3.43 (1.27)	3.33 (1.14)
Time Transformation	The way time passes seems to be different from normal (1 = Strongly disagree, 7 = Strongly agree)	10	4.10 (1.20)	3.32 (0.97)
Autotelic Experience	The experience is extremely rewarding (1 = Strongly disagree, 7 = Strongly agree)	15	4.67 (1.72)	3.69 (0.89)

enhance the flow experiences of practitioners.

## V. DISCUSSION

Based on the results from the previous section we now draw broader conclusions from the survey, highlight areas for improvement and carve out future work.

### A. Broader conclusions from this study

**Completion rates.** We observed that questions on well-being and flow on average had higher participation than on burnout. This could have two reasons: it may be that our population was more open to sharing positive experiences, or the generic questions of CBI seem less relevant to participants, and would need to be adapted to the cybersecurity domain.

**Presence of burnout.** Burnout is indeed a phenomenon that we observed in roughly 35% of our population. This scientifically validates the “market research” surveys that are shared online. Furthermore, it is a call to arms to the community (government, industry and academia) to support and promote the mental health of SOC practitioners.

**Well-being.** The results from the CBI and SFI make it clear that happiness and life satisfaction, physical and mental health, and close social relationships are serious issues and threats to the practitioners and the enterprises they work in. Not only do we need to understand what are the causes for such high levels of exhaustion but we need to have organizational measures in place to ensure the well-being of SOC practitioners. Clearly, financial and material security is insufficient as CISOs fall short in other domains of well-being.

**Improving Flow Experiences.** The population we studied appeared to have high flow experiences, however, the lack of control (or autonomy), feeling self-conscious and lack of

complete concentration warrant further investigation. What are the reasons for the lack of control? Limited resources, lack of understanding in the board room, unpredictable nature of threats/attacks? Is there a lack of psychological safety for the security team due to the high stakes environment where mistakes could cost the team their job and the company fines and loss of reputation? How could these concerns be resolved?

### B. Threats to validity

**Number of Participants.** Our study is limited by the number of participants, which restricts the generalizability of our findings. A larger and more diverse sample, including SOC analysts, managers, and other roles, experience levels, knowledge across various organizations, would provide a broader perspective and enhance the validity of our results.

**Optional Questions.** Since some participants chose not to answer specific questions, we were unable to compute an overall mean score for certain metrics or directly compare our results with original datasets. This limitation reduces the ability to draw comprehensive conclusions from the data and highlights the importance of designing future surveys with mandatory key questions.

**Differences in Occupational Burnout.** Previous studies have shown that occupational burnout depends on the region and culture [52]. The CBI was designed for and validated on a Danish population. Given that our sample population is from USA and Europe, a supplementary survey such as the Single Item Burnout Inventory would be needed to confirm the number of burnout participants.

### C. Future Research

**Collaboration with SOCs.** A critical next step is to collaborate directly with one or more SOCs to test our hypothesis that practitioner well-being and engagement positively impact SOC productivity. Such collaborations will allow access to real-world operational data and provide opportunities to develop and implement solutions tailored to specific SOC environments. This partnership would also enable longitudinal studies to observe changes in well-being and performance over time.

**Use a Mixed-Methods Approach to Test Our Hypothesis.** To strengthen our findings, future work will incorporate a mixed-methods approach combining quantitative and qualitative research. While quantitative surveys provide measurable insights, qualitative interviews or observational studies can uncover individual stories, perceptions, workflows and challenges faced by SOC practitioners, providing a richer and more nuanced understanding of the data. Insights from these interviews can also guide the design of targeted interventions for improving well-being and engagement. This holistic methodology will provide a deeper understanding of the relationship between well-being, burnout, and operational effectiveness in SOCs.

**Broaden the Surveys Used.** Expanding the range of surveys can ensure a comprehensive evaluation of practitioner well-being. For example, including scales to measure sleep quality, as suggested by Nepal et al. [16], could provide insights into how rest influences stress and performance. Broader surveys could also capture additional psychological and behavioral dimensions relevant to SOC practitioners.

**Investigate the Factors for Burnout, Low well-being, and Low Flow Scores:** Delving deeper into the factors causing burnout, low well-being, and low flow scores is essential. Using the Job-Demands-Resources model [53] and established burnout triggers [54], we can investigate how demands like high workloads or lack of autonomy exacerbate stress. Studying manifestations of cynicism can provide insights into how exhaustion affects the attitudes and performance of SOC practitioners.

## VI. RELATED WORK

In software engineering there have been multiple studies of developer productivity [22], [55]–[57], well-being [3], [23]–[25] and burnout [58], [59]. However, within the domain of cybersecurity, especially security operations, research on stress, burnout and human performance is sparse.

Sundaramurthy et al. [8] identified the presence of burnout by embedding researchers in a SOC. They identified that burnout occurs when an analyst does not have enough skills, lacks empowerment, lacks creativity and lacks growth over time and in that order. In this paper, we measured burnout via our survey and observed that respondents scored low on having a sense of control which correlates with their findings.

To measure stress and fatigue of cybersecurity operations, Dykstra et al. [10], [11] proposed the Cybersecurity Operations Stress Survey. The authors conducted multiple studies and also validated their survey. The scope of our work in this paper

has been on the wellbeing and engagement of the individual and not on the specific security activity. We view COSS as complementary to our work and useful in our future work when studying specific security activities/missions.

Singh et al. [60] conducted an extensive literature review of stress in information security and identified four major findings, one being the lack of research on stress-related outcomes such as job satisfaction and productivity. In this paper we measured the happiness and life-satisfaction of participants using the SFI and noted low scores in this domain.

Reeves et al. [14], [15] were the first to study burnout among Australian cybersecurity professionals using the validated Maslach Burnout Inventory [61]. The authors' papers collected data on burnout and sleep quality but did not measure aspects of well-being and flow. In this paper, we used the CBI to measure burnout and included well-being and engagement.

Sembhi et al. [62] published a report in 2023 that resonates with the vision of this paper. The report describes the relationship between stress and burnout and human performance in cybersecurity, suggests factors that influence mental health in cybersecurity, e.g., skills-shortage, job insecurity, scapegoating, etc. and launched a charter for organizations to pledge their recognition towards mental health in cybersecurity. This paper not only substantiates the claims of burnout made by Sembhi et al. but also broadens the view by looking at the positive aspects of mental health and engagement.

Nepal et al. [16] used a mixed-methods approach to study burnout among incident responders and also identified multiple cases of burnout in their sample population. The authors used several surveys, included qualitative interviews and digital activity to provide a holistic view of the phenomenon. The authors identified the causes for burnout to be: workload, limited control, poor teamwork, and inadequate recognition. The surveys used by Nepal et al. [16] and us are different—we used the CBI and SFS for burnout and engagement compared to the Burnout Assessment Test and Utrecht Work Engagement Scale—and so are participants recruited for the study: our sample is dominated by CISOs compared to Incident Responders.

Nobles et al. [63] highlight the critical connection between human error and human performance in cybersecurity. They advocate for a broader view of human factors, encompassing not only end-user mistakes but also human capabilities and limitations. This paper cast light on the limitations and capabilities of CISOs from a psychological perspective.

## VII. CONCLUSION

In this paper we introduced a normalized methodology for assessing burnout, well-being and flow among cybersecurity practitioners. Participation and data from our pilot study appears promising as we were able to illuminate the mental health landscape of 19 SOC practitioners. Practitioners reported very high financial and material stability, meaningful engagement in their roles, driven by intrinsic rewards and the satisfaction of security activities. These findings demonstrate the potential for cybersecurity work to be fulfilling and



purpose-driven, offering opportunities for professional growth and accomplishment.

However, the pilot survey also revealed pervasive challenges, including emotional exhaustion, physical and mental health deficits, and diminished life satisfaction among practitioners. These issues highlight the dual-edged nature of SOC roles, which can be both rewarding and tiring. Addressing this dichotomy requires organizations to implement structured interventions that alleviate burnout, enhance well-being, and sustain engagement. By fostering healthier work environments, SOCs can maximize both practitioner satisfaction and operational effectiveness.

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