Fatigue Risk Management System as a Practical Approach to Improve Resilience in 24/7 Operations

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Contents

A growing body of literature indicates that schedules involving extended shifts, night work or other forms of atypical working hours substantially increase workers' fatigue (Chellappa et al., 2019; Doghramji et al., 2018; Czeisler, 2015). These schedules are associated with reduced work performance (Caruso, 2014) and higher risk of errors and accidents (Salminen, 2016; Wirtz, 2010). Despite alarming figures, extended shifts and night work are becoming more common in our so-called 24/7 society. It is estimated that approximately 25% of American workers operate shifts that are not during the daytime (NHLBI, 2005), and nearly 30% work 10 h or more each day (NSF, 2008).

Traditionally, workplace fatigue is almost exclusively managed through limits on the maximum number of hours worked and the minimum duration of rest periods. Governments around the world have imposed a range of legal hours of work limits in attempt to mitigate fatigue-related risk. However, by controlling the amount of worked hours within a specific period, the system does not manage fatigue as a risk factor. Rather, it regulates one – among many others – parameters conditioning operators' fatigue levels. A single-layer normative approach represents a somewhat monolithic view of safety whereby being inside the limits is safe while being

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outside is unsafe. It fails to take into account operational differences and the variability of real-world situations that are likely to affect safety. Forcing a system to adopt norms and practices that proved to be useful in another setting is not only naïve but could actually lead to an increased degradation of the system (Hollnagel et al., 2006). In this context, fatigue risk management systems (FRMS) emerged as a more comprehensive *and pragmatic* approach to mitigate the detrimental effect of fatigue on safety (Dawson et al., 2012). In contrast to traditional prescriptive approaches, FRMS shift the locus of responsibility for safety away from the regulator towards organizations (Gander et al., 2011).

A FRMS can be defined as “a scientifically-based, data-driven addition or alternative to prescriptive hours of work limitations which manages employee fatigue in a flexible manner appropriate to the level of risk exposure and the nature of the operation” (Brown, 2006). Moving away from the traditional hours-of-service restrictions, FRMS propose guidelines on harvesting, developing, implementing and monitoring tentative procedures directed toward fatigue-related risk. The main strength of a FRMS resides in its ecological approach of harvesting and assessing informal strategies currently used within the work group. In that sense, FRMS can be seen as a concrete way to engineer resilience by reintroducing safety managed by humans in addition to safety managed by regulations (Cabon et al., 2011). *Following the principles of resilience engineering (RE), the objective is* to improve the ability of a work system to adjust its functioning during or following disturbances of operators’ alertness level in order to sustain required operations under optimum safety conditions. True to the Safety-II approach, FRMS are not confined to the elimination of hazards and the prevention of malfunctions but also aim to continuously improve an organization’s potentials for resilient performance – namely “the way it responds, monitors, learns and anticipates” (Hollnagel, 2017a, 2017b).

FRMS rely on two kinds of strategies to ensure organizational resilience in the face of fatigue-related risk. In accordance with the Swiss Cheese Model (Reason, 2000), these strategies are conceptualized as successive defence layers acting at different levels of the potential hazard trajectory (Fig. 1). Fatigue reduction strategies (FRS) aim to reduce the likelihood a fatigued individual is operating in the workplace. FRS can be achieved through the prescription of maximum shift and

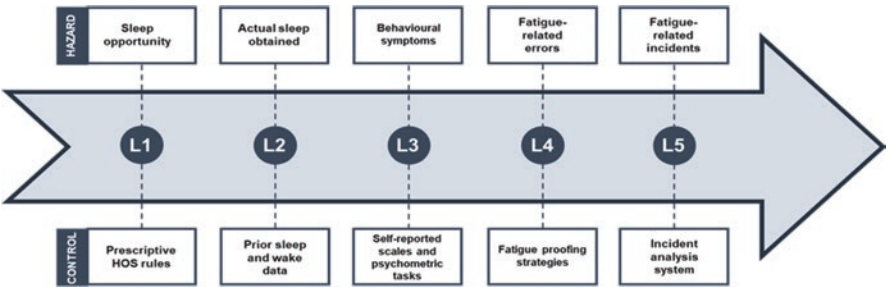

Fig. 1 Fatigue-related risk trajectory with identifiable hazards and controls. (Adapted from Dawson & McCulloch, 2005)

minimum break duration (level 1), the systematic control of sleep hours (level 2), or other behavioural indicators (level 3). In contrast, fatigue proofing strategies (FPS) aim to reduce the likelihood a fatigued individual operating in the workplace will make an error (level 4). FRS and FPS are complementary approaches that must be integrated into a comprehensive FRMS in order to effectively mitigate the level of fatigue-related impairment and its potential consequences (Gander et al., 2017). If a fatigue-related incident occurs despite these four defence layers, level 5 provides an incident analysis framework allowing the organization to improve the effectiveness of level 1–4 and prevent future incidents.

Traditionally, most formal controls addressing fatigue-related risk rely solely on FRS through hours of service regulations (level 1) and do not encompass the notion of fatigue proofing. Interestingly, though, it has been demonstrated that FPS develop as informal work practices in contexts where it is not possible or desirable to further reduce work hours (Bérastégui et al., 2018). The way these informal strategies are developed and consolidated within the workgroup are disorganized, instinctive and unintended. Most of the time, they are observed and passed on through long-standing workplace customs and undocumented mentoring systems (Dawson et al., 2012). Although they emerge as adaptive mechanisms, these individual endeavours may prove to be counterproductive or hazardous. Recently, it has been suggested that the recurrent use of informal FPS may represent a significant risk for the operator in the long run (Bérastégui et al., 2020b). More specifically, the long-term effect of sustained compensatory effort is a draining of workers resources eventually resulting in a breakdown. In this context, the benefits of informal FPS in terms of sustainable performance need to be analysed in relation to the associated costs for the operator. Moreover, individual endeavours participate to widening the gap between work-as-imagined (WAI) by analysts and policymakers, and work-as-done (WAD) by frontline operators (Hollnagel, 2017a). The misalignment of WAI and WAD can make organizations more brittle, as those responsible for managing the work are unaware of the performance adjustments deployed on the job (Sujan et al., 2016). Thus, it is a challenge for fatigue-related risk management to create mutually positive awareness between managers and practitioners in order to reduce this gap and identify counterproductive or harmful strategies. In this context, FRMS proved to be a relevant framework allowing the identification, assessment and formalization of informal strategies (Bérastégui, 2019). Taking advantage of the dynamic nature of WAD (Hollnagel, 2014), FRMS allows resilient performance through a deep understanding of the adjustments that workers undertake on a daily basis.

1 Toward Quantifying Metrics for *Engineering Resilience*

Dawson et al. (2012) outline four main phases for engineering resilience to fatigue-related risk (Fig. 2).

The first phase is to harvest candidate strategies currently used within the work group. The goal is to glean as much information as possible on how fatigue-related

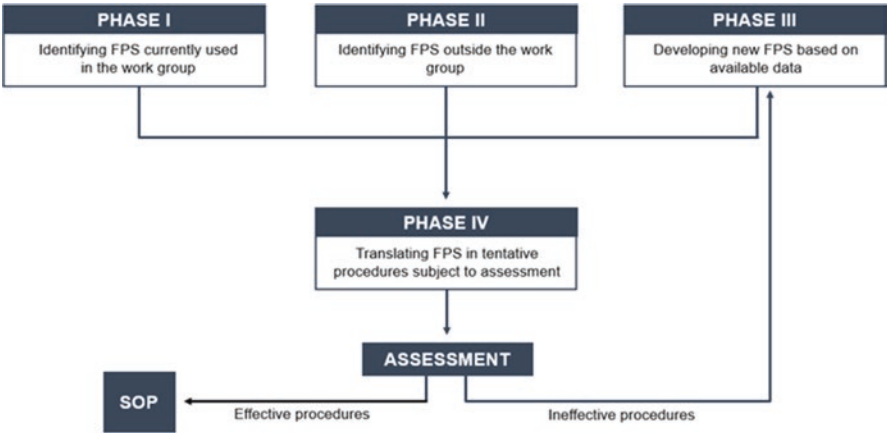

Fig. 2 Phases in the development of a FRMS

risk is handled during day-to-day operations. Field-based qualitative methods such as focus groups or semi-structured interviews are applied to elicit knowledge regarding informal fatigue management. Discussions should revolve around a set of prepared questions to ensure a reasonable level of domain-specific knowledge. Mind mapping adds significant value for generating and structuring ideas during focus groups (Bérastégui et al., 2018). Similarly, visualising or brainstorming specific events may cue additional information during the elicitation process. As a general rule, participants should be encouraged to illustrate their statements with specific events they experienced or witnessed. Ideally, the qualitative knowledge-eliciting techniques should be complemented by a series of parallel workplace observations in order to contextualise the examples communicated during discussions. In cases where an ethnographical focus is unfeasible, supplementary knowledge-eliciting techniques such as open-ended questionnaires can be employed. The end result of this phase will be a comprehensive list of informal FRS and FPS mobilized at the local level. If some of these informal strategies appear to be dysfunctional, countermeasures can be deployed as a matter of priority before moving on to the next step.

The second phase aims to extend strategy identification to similar groups of employees operating outside the work group. The previously described techniques are also suitable here. In addition to discussions with frontline operators, it is valuable to include a subject-matter expert and consult senior managers. Their inputs should shed lights on the organizational specificities likely to hinder the translation of elicited strategies. It may reveal specific professional boundaries and norms in relation to fatigue-risk management, as well as organizational factors or incentives likely to play a role in the integration of standardised strategies into SOP.

During phase 3, the investigators will be looking at developing new strategies based on currently available data. Relevant datasets include records of incidents, near-misses or dangerous occurrences. If necessary, data collection may be expanded using the eliciting techniques described in phase 1. Hazards are then grouped according to thematic areas and prioritised. Selected priority areas are subject to a more in-depth qualitative investigation to determine appropriate countermeasure strategies. Discussions focus on ways to flag the level of elevated risk, to increase levels of error scrutiny or to mitigate error's consequences. Focus groups should include employees at different levels throughout the organization in order to gain a full range of engagement and experience with error management. Information derived from these discussions will be used to support the development of new strategies, adding up to the result of the two preceding phases.

The last phase aims to translate informal strategies harvested during previous phases into tentative procedures subject to assessment. Only procedures that demonstrate clear empirical underpinnings will be integrated into standard operating procedures. Assessment will also provide justification for the deletion of informal strategies at the local level when they are proved to be ineffective or counterproductive. Tentative procedures should be tested individually in order to allow a better understanding of their contribution to the outcomes under study. However, in certain circumstances, it may be more appropriate to evaluate them in clusters based on thematic or technical considerations.

Dawson et al. (2012) propose two distinct assessment approaches. Simulator studies are particularly relevant in settings where observing workers is unfeasible or impractical. It is, however, prone to certain bias making results questionable from an ecological validity standpoint. Participants may exhibit stereotypical behaviours that would not be observed in real-life settings (Peabody et al., 2000). They may be overly watchful due to the expectation of an imminent significant event or exhibit nonchalant attitudes during the exercise due to the absence of real stakes (Datta et al., 2012). Therefore, when possible, a more ecological approach that considers real-life performance should be favoured. Workplace trials have the advantage of being less prone to ecological validity bias but at the expense of a lower degree of control over testing conditions. The main limitation of this approach resides in the difficulty to control for risk exposure. Some external factors are likely to undermine safety in one of the two groups, thus compromising the comparison. Typical cofounders that should be accounted are the number of workers, the number of hours worked, and the proportion of night shifts for each group. Ideally, this approach involves a longitudinal cluster randomised design where workgroups or sites are allocated to experimental (tentative procedures integrated to SOP) or control (SOP only) conditions. The relative performance of the two groups is then compared on the basis of various safety variables (e.g. incident rates, near-misses). If sample size is too small, the allocation to experimental and control conditions is likely to undermine statistical power. In this case, it is preferable to consider procedures' frequency of use as a continuous variable and measure it across all workers. Safety variables are then correlated to identify effective and counterproductive procedures (see Bérastégui et al., 2020b for further details).

Irrespective of which assessment method is put in place, accurate measurement of a wide array of safety performance indicators (SPI) is of paramount importance. There are three types of SPI that should be taken into account for determining procedures' effectiveness.

First are fatigue-related indicators and refer to the first three levels of control of the FRMS (Dawson & McCulloch, 2005). It includes performance tasks such as the Psychomotor Vigilance Task (Basner & Dinges, 2011), and self-reported scales such as the Samn-Perelli Fatigue Scale (Samn & Perelli, 1982). Performance tasks should be favoured since it has been demonstrated that self-reported measures may not always accurately reflect actual fatigue-related impairments (Bérastégui et al., 2020a). The 5-min version of the Psychomotor Vigilance Task is both convenient and sensitive to changes in alertness occurring during extended working hours. However, there may be moments when it is impractical to ask employees to take 5 min to complete a neurobehavioral task. In these circumstances, the use of a single-item subjective rating may be relevant. Other common fatigue-related SPI are sleep-wake histories and can be collected using actigraphy or sleep diaries. Actigraphy is a highly reliable method for objective sleep monitoring with minimal inconvenience to the wearer (Signal et al., 2005). Sleep diaries, on the other hand, are used to collect subjective data on sleep and duty times. They are easy to implement, inexpensive but may show some variability in their accuracy (Gander et al., 2017). Combining the objective data from actigraphy with the subjective data from sleep diaries provides the most accurate assessment of actual sleep-wake history (Girschik et al., 2011).

The second type of SPI are duty-related indictors and include near-misses, errors, incident rates and overall performance (level 4 and 5). These indicators can be collected using self-reporting systems, behavioural checklists or outcome-based approaches. Duty-related SPI are intrinsically linked to the specificities of the operational setting. For data collection to be effective, they should be simple to gather and easy to report. Most importantly, investigators must promote a no-blame culture reflecting an open, trusting and learning atmosphere where everyone can speak about safety issues. Employees participating in the assessment should be assured that no individual information will be shared with colleagues or management. Data collection will preserve anonymity, and analyses will only be conducted to compare and benchmark procedures from a group-level perspective.

Finally, the third type of SPI that should be taken into account relates to employee's quality of work life. Common metrics directly available to the organization are absenteeism, turnover and grievance rates, and tools include the Leiden Quality of Work Questionnaire (van der Doef & Maes, 1999), the Occupational Stress Inventory-Revised (Hicks et al., 2010) and the Maslach Burnout Inventory (Maslach et al., 2016). These metrics are only relevant for long-term workplace trial since they require a certain degree of latency. For shorter trials or punctual simulation sessions, tools such as the NASA Task Load Index (Hart & Staveland, 1988) should be favoured.

2 Aggregating the Data

The success of a FRMS requires the integration of these measurements into a coherent whole, striking a balance between a focus on system safety and employee's quality of work life. This section outlines possible approaches to process the data as well as some of the critical factors that should be considered for data analysis.

It is important to determine the appropriate statistical procedure before starting the investigation. This will determine the size of the required sample and the nature of the conclusions that may be drawn from the results. In cases where the assessment design implies a longitudinal follow-up of employees, statistical analyses have to control for intraindividual correlations (the degree to which repeated measurements for the same participant are correlated). Confounding inter- and intraindividual variability would have enormous consequences for the generalization of the findings. PROC MIXED in the SAS or SPSS software package allows to distinguish the two. Moreover, the use of random coefficients allows for the generalizability of these estimates beyond the particular data sample (IOM, 2004). If the assessment involves only one data point per variable (cross-sectional design), simpler modelling approaches can be employed, such as linear regression for normally distributed data, and Kendall–Theil regression when data are not normally distributed. In all cases, conducted analyses will aim to test the significance of differences between the two groups (control vs experimental) for the variables considered (Fig. 3).

Tentative procedures derived from FRS are assessed based on fatigue-related SPI (level 1–3). It is considered inadvisable to make conclusions based on a single measure of functional status (Gander et al., 2017). Procedures' assessment should involve the widest array of fatigue-related SPI as possible in order to ascertain the validity and accuracy of findings. The hypothesis under study (H_1) is that participants in the experimental condition (implementation of tentative procedures) show significantly lower levels of fatigue than the control condition (SOP only). Typical confounders accounted for include age, drugs intake and sleep history.

Tentative procedures derived from FPS are assessed based on duty-related SPI (level 4–5). The hypothesis under study is that the experimental condition is significantly safer than the control condition (H_2). As described earlier in this chapter, risk exposure differences between conditions should be controlled for. Typical confounders include operator's level of fatigue as well as the number of workers, hours worked and the proportion of night shifts for each group.

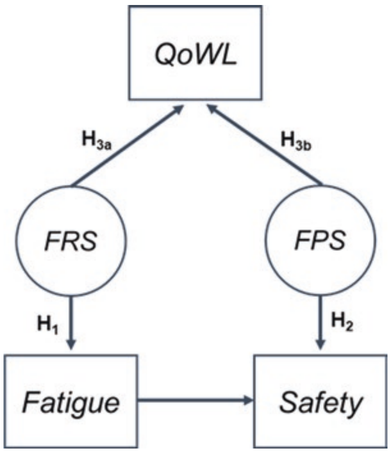

Fig. 3 Tentative procedures assessment

Additionally, both types of tentative procedures should be evaluated from of a quality of work life standpoint (H_{3a} and H_{3b}). The idea is to ensure that, beyond their operational efficiency, these new procedures are not contributing to create an unfavourable work environment for employees (Nyssen & Bérastégui, 2017).

Once the assessment comes to a conclusion, a last round of focus groups may be organized in order to discuss potential optimizations for dysfunctional or unsatisfactory procedures. Reworked procedures should then be subject to a new assessment phase, and so on, until they meet the organization safety standards.

3 Follow-Up and Continuous Improvement

The core principle of a FRMS is to establish a closed-loop process of safety management involving the continuous monitoring of fatigue-related risks and an ongoing development of mitigation procedures. In preceding sections, we outlined the steps for its initial implementation as well as a set of guidelines for data collection and analysis. This final section describe a few key factors that should be considered in follow-up interventions.

Besides developing tentative procedures, a comprehensive FRMS should also pursue its efforts to guarantee their successful implementation in the workplace. The challenge is to disseminate and generalize the new set of procedures to the entire workforce. To this end, procedures should be turned into training materials and integrated into formal education programmes. Employees' learning achievements should be closely monitored to ensure new procedures are properly mastered. Additionally, awareness programmes on fatigue could provide additional support for employees. The objective is to ensure that employees receive regular training on the physiologic consequences of fatigue and learn strategies for maintaining a good sleep hygiene.

Employees should also be given the opportunity to report dysfunctions or failures in the application of procedures. These situations will be thoroughly reviewed in order to identify possible room for improvement. The different control levels described earlier can be employed to strengthen the longitudinal follow-up and tweaking of procedures. Again, due emphasis must be placed on the non-punitive nature of self-reporting. It is crucial to establish an open reporting culture where failures or incidents are considered as learning opportunities rather than faulty behaviours. Otherwise, it is unlikely that an employee will self-identify as fatigued or voluntarily provide information related to a fatigue-related error. Concealing such information could result in a failure to implement new procedures correctly and may potentially pose a greater risk to safety.

4 Example of Implementation

FRMS first appeared in the aviation industry as an alternative approach to the 'one-size-fits-all' model of Flight Time Limitations (FTL). Over the past decades, regulatory authorities gradually allowed airline companies to engineer their own schemes based on an assessment of the conditions that create fatigue in a specific setting. The effectiveness of these initiatives has been demonstrated through a steady decline in the percentage of pilots reporting duty-related fatigue between 1993 and 2006 (ICAO, 2015). Despite these promising results, there have been very few attempts to implement FRMS outside of the aviation industry. This approach could greatly benefit other sectors where fatigue is a significant safety issue.

In a recent study, we deployed a FRMS in the Emergency Department (ED) of a tertiary-care centre in Belgium (Bérastégui, 2019). Emergency physicians (EP) are particularly vulnerable to fatigue due to inconsistent shift rotation, extended duty periods and overnight calls. Following the methodology described in this chapter, we harvested and assessed fatigue management strategies for further integration in SOP.

First, we conducted four focus groups with a total of 25 EP in order to identify strategies deployed to manage fatigue-related risk. EP were asked to describe how on-the-job fatigue affected their efficiency at work and to report any strategies they use to cope with these effects. Using inductive qualitative content analysis, we revealed content themes for fatigue management strategies. Strategies aiming to reduce the subjective experience of fatigue were categorised as FRS, while strategies aiming to mitigate the impact of fatigue on work performance were labelled as FPS. The next step was to assess the efficiency of these strategies. Given the small size of the sample, we opted for a single group design. Each reported strategy was converted in a behavioural item and integrated in a questionnaire assessing frequency of use. We collected fatigue-related SPI using the Psychomotor Vigilance Task (Basner & Dinges, 2011) and the Karolinska Sleepiness Scale (Åkerstedt & Gillberg, 1990). Duty-related SPI were derived from the self-assessment component of the Physician Achievement Review (Hall et al., 1999), and quality of work life SPI consisted of the Maslach Burnout Inventory (Maslach et al., 2016). All instruments were combined into a practical and functional Android-based application installed on a smartphone device. Each physician was briefed on when and how to report each type of SPI on the smartphone. Analyses were conducted to determine the association between SPI and strategies' frequency of use. By doing so, we were able to identify effective strategies and dysfunctional ones.

We were able to identify 12 FRS and 21 FPS (see Bérastégui et al., 2018 for details). FRS mainly consisted of rest-time management, physical exercise and food or energy drink intake. FPS were comprised of self-regulation, task-reallocation and error-monitoring strategies. For instance, EP working night shifts tend to complete patient records as and when it comes rather than letting things pile up to compensate for the impact of fatigue on short-term memory. Similarly, physicians reported deferring complex but not urgent tasks during the night shift to colleagues working the following morning. Other examples included double-checking for tasks regarded as 'vulnerable' to fatigue-related risk, and verbalizing acts or prescriptions to avoid omission.

Assessment revealed that the use of FRS was associated with decreased levels of fatigue while preserving satisfactory levels of quality of work life. Similarly, FPS allowed EP to sustain adequate work performance despite sleep deprivation. However, the analysis of quality of work life revealed that some FPS represent a significant risk for EP's well-being over the longer term. Specifically, scores on the emotional exhaustion sub-dimension of MBI were found to be positively associated with FPS frequency of use. Besides demonstrating the feasibility of applying this methodology in emergency care, our findings also stress the importance of considering quality of work life SPI as some strategies resulted in a trade-off between work efficiency and quality of working life. It allowed the ED to identify these dysfunctional strategies and engage a reflection on potential countermeasures. Effective strategies, on the other hand, were considered for implementation in SOP. The identification of at-risk operators, task redistribution within the team, or increasing standard checks for at-risk operators are examples processes that are still, at the time of writing, under further scrutiny (Bérastégui, 2019).

Other sectors may greatly benefit from the implementation of FRMS. This is especially the case of the ride-hailing industry that has grown exponentially in recent years. The sector faces unparalleled transformations due to the emergence of the so-called gig economy, transforming into a fee-for-service, unregulated taxi industry. With this transformation comes two key regulatory and safety challenges that deserve attention. First, most drivers are employed in a primary job and work in the ride-hailing industry during their time off. Cumulating multiple jobs is likely to lead to extended periods of wakefulness or during nights – two factors that increase the risk of driving accidents. Second, drivers are employed as independent contractors and, in this respect, are not obliged to undergo a medical examination. This poses a significant risk for safety as medical problems such as obstructive sleep apnoea are associated with reduced levels of alertness. In face of these challenges, the gig economy mostly promotes the 'internalisation of external risks' (Holts, 2018) by shifting most of the risk of doing business from the company to individual gig workers. This general trend toward self-management strengthens the economic model of platform work at the expense of hidden human costs. Recently, the American Academy of Sleep Medicine (AASM) stated that fatigue and sleepiness are inherent safety risks in the ride-hailing industry and urged companies and regulatory authorities to work together to address this public safety issue. According to the AASM, this collaborative effort should be in the form of FRMS and more stringent regulations (Berneking et al., 2019). Applying this framework would allow to fully grasp the scope of this issue in the gig economy and to engineer countermeasures tailored to the specificities of platform work. Moreover, mobile applications used by ride-hailing companies offer many possibilities for collecting SPI in a timely and systematic manner. However, the primary obstacle remains the lack of incentives or enforcement measures for platform companies to take responsibility of risk management.

5 Conclusion

The ongoing development of 24/7 operations in various industries stress the need of a more tailored and comprehensive approach to manage fatigue-related risk. The main limitation of the traditional prescriptive approach is that it does not take into account the specific conditions that creates fatigue in a given environment. Moreover, it overlooks the importance of preserving margin of manoeuvre in complex adaptive systems. Organizations with insufficient margin of manoeuvre are likely to fall into maladaptive traps leading to systems failures (Woods Branlat, 2011). With FRMS, organizations move from the illusion that fatigue-related risk can be managed through one-size-fits-all prescriptive measures, and develop procedures tailored to the specificities of the work environment. By relying on a wide range of means and resources, FRMS enable more robust safety management than the single defensive layer of prescriptive regulations (Gander et al., 2017).

In line with the RE perspective, it encapsulates a broader focus than identification of safety hazards only. Specifically, it acts on the four abilities that are necessary for a system to be resilient (Hollnagel, 2011):

- *Knowing what to look for* (what is or can become a threat), through constant monitoring of relevant SPI
- *Knowing what to expect* (how to anticipate threats and opportunities), through successive defence layers acting at different levels of the potential hazard trajectory
- *Knowing what to do* (how to respond to disturbances), through the development, assessment and implementation of effective countermeasures
- *Knowing what has happened* (how to learn from experience), through an incident analysis framework aiming to prevent future fatigue-related incidents

In that sense, a FRMS is about how resilience can be engineered in the context of fatigue-related risk through concrete measures acting on each of these four factors. Moreover, by building on current hours of service regulations, it combines both regulated and managed safety – two notions that are regarded as complementary from a RE standpoint (Falzon, 2014). It relies on all of the available resources, namely, the existing rules and standards enacted by regulatory authorities, and the ad hoc procedures constructed locally to cope with the variability of real-world situations. Such approach is often described as 'adaptive safety' (Falzon, 2011) as it relies on the intelligence of the agents involved in everyday activities. The FRMS literature is laying great emphasis on the fact that employee's expertise can provide critical insights regarding safety issues. This view is comforted by several studies showing that mitigation strategies develop as informal work practices when they are not addressed at the organizational level (Bérastégui et al., 2018; Schulte et al., 2015; Dawson et al., 2012). Similarly, RE research has demonstrated the value of performance variability of frontline practitioners to deal with uncertainty (Sujan et al., 2015; Nyssen & Blavier, 2013). Variability in everyday performance is the reason why things go right as it ensures a certain degree of system flexibility in response to varying conditions. True to Safety-II, FRMS are moving from a 'quick fix' philosophy and introduce a closed-loop process of safety management through the ongoing development of second-order solutions. It explores the ways in which workers have the potential to be flexible when systems may not have been perfectly designed or when conditions are challenging. The insights gained by such naturalistic approaches allow a deep understanding of the causal dynamics at stake (Sheps & Wears, 2019) in a manner conducive to learning and system improvement.

It may be tempting to conclude that the spontaneous development of informal practices demonstrates the underlying capacity of the work system to self-regulate. However, especially in occupations associated with a high level of motivation and commitment, this can lead to pushing individual resources to their limits and losing all margins of manoeuvre. In this case, resilience at the organization level solely relies on resilience of individuals, at the expense of a draining of resources eventually resulting in a breakdown (Bérastégui et al., 2020b). Moreover, individual endeavours may represent a significant risk for the overall organization in the long term resulting from the misalignment of WAI and WAD (Hollnagel, 2017a). Thus, it is the responsibility of the organization to support the development of formal procedures and to provide employees with appropriate resources to keep pace with work demands. Otherwise, the lack of formal procedures will shift the strain to the employees' own resources to sustain safety, causing a subsequent risk of depletion. It is our belief that moving the 'burden' of adaptation from the individual to the system is a key element in achieving resilient performance in 24/7 operations, and that the FRMS framework provide a concrete approach to do so.

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