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Safety Beyond Numbers: Learning from Business as Usual Prevent Serious Accidents

"Safety Beyond Numbers: Learning from Normal Work to Prevent Major Accidents"

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Summary

Occupational safety has traditionally been defined by the absence of accidents, creating the illusion that operations with low incident rates are intrinsically safe. This perspective proved inadequate in the face of disasters such as the Texas City refinery explosion (2005) and the Deepwater Horizon accident (2010), which occurred in operations considered safe by conventional metrics. This article proposes a paradigmatic shift through the concept of "Learning from Normal Work," which focuses on understanding successful daily activities rather than solely learning from failures. Using a qualitative methodology based on a systematic literature review and analysis of practical implementation cases in multinational companies, this study demonstrates how procedural deviations can be understood as necessary adaptations to real-world work.

Keywords: Occupational Safety; Normal Work; Human Factors; Risk Management; Safety Culture; Human Performance.

Abstract

Occupational safety has traditionally been defined by the absence of accidents, creating the illusion that operations with low incident rates are intrinsically safe. This perspective proved inadequate in the face of disasters such as the Texas City refinery explosion (2005) and the Deepwater Horizon accident (2010), which occurred in operations considered safe by conventional metrics. This article proposes a paradigmatic shift through the concept of "Learning from Normal Work," which focuses on understanding successful daily activities rather than solely learning from failures. Using a qualitative methodology based on a systematic literature review and analysis of practical implementation cases in multinational companies, this study demonstrates how procedural deviations can be understood as necessary adaptations to current work.

Keywords: Occupational Safety; Normal Work; Human Factors; Risk Management; Safety Culture; Human Performance.

1 INTRODUCTION

Occupational safety management has evolved significantly over the last few years. decades, moving from reactive approaches centered on post-mortem analysis of accidents to increasingly proactive prevention strategies. However, a fundamental premise continues to dominate organizational thinking: safety is measured by the absence of adverse events. This view, while seemingly logical, creates a dangerous illusion of control and understanding of the real risks present in industrial environments.

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The traditional "Security-I" paradigm, as defined by Hollnagel (2018), is based on the identification and elimination of failures, focusing on what went wrong and seeking to avoid the repetition of these events. This approach has generated significant advances, leading to reductions dramatic changes in industrial accident rates throughout the 20th century. However, as incidents become rarer, paradoxically, our ability to learn from them decreases, creating a growing gap between the perception of security and the actual risks.

Catastrophic events such as the BP refinery explosion in Texas City (2005), which resulted in 15 deaths and 180 injuries, and the Deepwater Horizon disaster (2010), which caused the largest oil spill in US history, dramatically illustrate this problem. Both operations had excellent safety indicators before of accidents, with low personal injury rates and strong compliance with procedures established (HOPKINS, 2008; WATER, 2011).

These events revealed an inconvenient truth: the absence of accidents does not guarantees the absence of risks. Even more worrying, they demonstrated that the conditions that lead to serious accidents often exist latently in systems, masked for successful worker adaptations that allow operations to continue functioning despite underlying vulnerabilities.

In this context, the concept of "Learning from Normal Work" emerges. from Normal Work), initially proposed by Conklin (2019) and later developed by several researchers in the area of human factors and operational safety. This approach represents a fundamental shift in perspective: instead of expecting failures occur in order to learn, we seek to proactively understand how the work is really executed on a daily basis, identifying the conditions that both allow success and can sow future failures.

This study used a mixed methodological approach, consisting of a review systematic review of the literature (2000–2025), analysis of practical cases in industrial organizations and synthesis of findings. The objective was to integrate concepts of "Learning from Work" Normal", Human Factors and Safety-II, resulting in a practical and recommendations for application in companies.

The main objective of this study is to investigate how the implementation of "Learning from Normal Work" approach can transform safety management work, providing a deeper understanding of real risks and creating systems more resilient. Specifically, we seek to: (1) analyze the limitations of the approaches traditional safety measures based on accident metrics; (2) examine how deviations from procedures emerge as necessary adaptations to real work; (3) evaluate the impact of "discipline and punish" cultures in organizational learning capacity; and (4) propose practical strategies for implementing a safety culture based on the author accountability and continuous learning.

2 THEORETICAL BASIS

2.1. The Evolution of Security Paradigms

The understanding of workplace safety has gone through several evolutionary phases, each reflecting the knowledge and limitations of its time. The first phase, characterized by technicist approach of the 19th and early 20th centuries, focused exclusively on barriers physical and mechanical protections, treating accidents as random and inevitable events (HEINRICH, 1941).

The second phase brought recognition of the human factor, but in a simplified and often blaming. Heinrich's (1941) model, widely adopted during decades, postulated that 88% of accidents were caused by "unsafe acts" of workers, laying the foundation for a culture of blame that still permeates many organizations.

The third phase, emerging from the 1980s onwards, introduced systemic concepts through the work of researchers such as James Reason (1990) and his "Swiss cheese" theory. This model recognized that accidents result from failures in multiple layers of defense, not only of individual errors. However, it maintained the primary focus on failures and their causes.

The fourth, current phase is marked by the emergence of Resilience Engineering and Security-II concepts. Hollnagel (2018) proposes that, instead of focusing only on what gives wrong (Safety-I), organizations must understand and optimize what works most of the times (Security-II). This change in perspective is fundamental to the concept of "Learning from Normal Work".

2.2. The Concept of Normal Work

"Normal work" refers to the daily operational activities that are performed with successful, without resulting in incidents, but which are rarely subject to systematic analysis (CONKLIN, 2019). This concept recognizes the existence of a fundamental gap between the "work as imagined" (described in procedures and plans) and "work as executed" (the operational reality in the field).

Dekker (2017) argues that this gap does not necessarily represent a disability, but rather an inherent characteristic of complex systems. Workers constantly adapt to changing conditions, limited resources, time pressures and other operational constraints to achieve organizational objectives. These adaptations, although often successful, they can create latent vulnerabilities in the system.

Woods and Hollnagel (2006) introduce the concept of "equivalence of results", suggesting that the same conditions that allow success can, under different circumstances, lead to failures. This perspective is crucial to understanding why the study of normal work may reveal precursors to future accidents.

2.3. Work Restrictions and Adaptations

Conklin (2019) distinguishes between "hazards" - conditions with inherent potential to cause harm - and "constraints" - factors that limit people's choices and influence their decisions. While hazards are traditionally the focus of risk assessments, constraints often go unnoticed, despite their significant role in creating conditions conducive to errors. Table 01 presents some examples of restrictions operational.

Table 01 - Examples of Operational Restrictions.

Operational Restrictions	**Examples**
Procedural Restrictions	Outdated or incompatible procedures with operational reality
Resource Constraints	Inadequate or unavailable tools at the time needed
Design Constraints	Confusing interfaces or layouts that make it difficult to perform tasks
Temporal Restrictions	Deadline pressures that compromise the proper execution of procedures
Environmental Restrictions:	Physical conditions that prevent the application of standard methods.

Vicente (1999) argues that workers develop adaptive strategies to deal with these constraints, creating what he calls "ecological knowledge" - a

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deep understanding of how to effectively navigate the real work environment. This knowledge is often tacit and undocumented, representing an asset critical but vulnerable organizational.

2.4. Human Factors and Performance

The Human Factors approach recognizes that human error is a natural consequence of the interaction between people and systems, not a moral or competence (DEKKER, 2017). This perspective is fundamental to understanding how implement "Learning from Normal Work" strategies.

Human Factors theory suggests that rather than trying to eliminate human error - a practical impossibility – systems must be designed to be error-tolerant and resilient to their consequences (NORMAN, 1988). This philosophy aligns perfectly with the principles of "Learning from Normal Work".

Reason (1990) identified two main categories of human error: "slips" and "lapses" (execution errors) and "mistakes" (planning errors). Most importantly, it demonstrated how system features can create "error traps" that increase the probability of human error.

2.4.1. Slips and Lapses (errors in execution)

These are errors that occur during the execution of an activity or when retaining information needed to carry it out, regardless of whether the plan is correct or not achieve the final goal.

Slips are visible, external, and unintentional actions that occur during execution of a procedure. For example, on an oil rig, the operator opens the wrong valve during the oil transfer operation, even though you know which one it should be the correct one.

Lapses, in turn, are more related to memory failures, usually internal and not immediately observable. They can manifest themselves only to the person themselves. One An example would be a maintenance technician forgetting to register in the system that he has already performed the inspection of critical equipment, which may cause delays or duplication in the process.

2.4.2. Mistakes (planning errors)

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Deception is characterized as a failure in the process of judgment or reasoning used in defining an objective or choosing the means to achieve it, regardless of whether the following actions were carried out as planned or not (REASON, 1990).

Knowledge-Based Mistakes (KBs) happen when choosing a plan incorrect due to lack of knowledge or understanding of the situation. For example, in a drilling operation, the engineer selects an unsuitable type of drilling fluid for a given geological formation, because there is not enough knowledge about the pressure of pore of that layer.

Rule-based errors (RBIs), on the other hand, occur when there is a failure in the application of known rules or procedures. An example would be an operator applying incorrectly follow the standard procedure for pressurizing a gas line, using parameters of another operation that do not apply to that specific situation.

3 ILLUSION OF "ZERO ACCIDENTS SAFETY"

The pursuit of "zero accidents" has become an almost universal mantra in the industry modern, representing the legitimate aspiration to protect human lives and assets organizational. However, this metric, when used as the main indicator of security, can create a dangerous illusion of control and understanding of real risks.

3.1. Limitations of Traditional Indicators

Organizations with low accident rates, traditional safety indicators significantly lose their predictive ability. When incidents become events rare, natural statistical variability can mask important trends, creating false signs of improvement or deterioration in safety.

Furthermore, the exclusive focus on result metrics (lagging indicators) means that organizations only discover problems after damage has already occurred. This reactive approach is particularly problematic in high-risk environments where a single event could have catastrophic consequences.

Companies that have managed to significantly reduce their accident rates face a paradox: the fewer incidents occur, the less information managers have about what is really happening in the operational processes (HENDRICKS & PERES, 2021).

3.1. The Phenomenon of Normalization of Deviation

Vaughan (1996), in his analysis of the Space Shuttle Challenger disaster, introduced the concept of "normalization of deviance" - the gradual process by which behaviors that deviate from established standards become accepted as normal due to the absence of immediate negative consequences.

This phenomenon is particularly relevant in the context of normal work. When adaptations and deviations are repeatedly successful, they can be erroneously interpreted as evidence that the risks are lower than initially assessed, leading to the gradual erosion of safety margins.

The 2005 accident at the BP refinery in Texas City is a tragic example of this. this process. The explosion, which killed 15 workers and injured more than 170, was a consequence of a series of diversions that had become routine. Among them were the operation of towers distillation and equipment beyond their designed useful life, recurring failures in systems alarm and the practice of performing starting procedures under inadequate conditions. Investigations also showed that management problems, pressures to reduce costs and maintenance cuts have created an environment in which the abnormal has become “normal,” allowing that critical risks were systematically ignored (HOPKINS, 2008).

3.1. The Behavior-Based Security Fallacy

Many organizations have adopted "Behavior-Based Safety" programs (BBS - Behavior-Based Safety) as the main strategy to achieve zero accidents. Although these programs can produce improvements, especially in low-severity accidents, they often fail to address the systemic factors that contribute to disaster events. high potential.

Dekker (2017) highlights that excessive focus on individual behavior can create the illusion that safety depends only on the choices of workers, diverting attention of design flaws, organizational gaps, and structural problems that shape the environment in which these behaviors occur. Thus, there is a risk of creating a false sense of control, while the most critical dangers remain latent.

Case Study: Deepwater Horizon Platform

The Deepwater Horizon rig, operated by Transocean for BP, symbolizes this paradox. By the time of the disaster on April 20, 2010, which resulted in 11 deaths, 17 injuries and the largest oil spill in US history, the unit boasted excellent personal safety indicators. In previous years, he had received awards for safety based on traditional metrics, such as the lost-time accident rate and the compliance with procedures.

However, official investigations (Water, 2011) revealed that behind this "good statistical appearance", there was a worrying scenario:

- **Normal deviations:** risky drilling practices and engineering decisions that prioritized saving time and costs over safety.
- **Technical deficiencies:** flaws in the cement used to seal the well, which was not adequately tested before operation.
- **Safety barriers ignored:** gas detection system alarms were disabled to avoid "false positives" and interruptions to the routine.
- **Organizational pressures:** critical decisions were made under the logic of productivity and cost containment, reducing safety margins.
- **Organizational blindness:** the emphasis on **behavioral safety indicators and personnel** masked the deterioration of **process safety,** which involved failures of design, maintenance and management of critical barriers.

Thus, the Deepwater Horizon case shows that programs focused only on individual behavior is not capable of preventing **events of great magnitude,** precisely because these arise from a complex interaction between technical factors, organizational and human.

3.2 The Need for a New Perspective

The transition from Security-I to Security-II, as proposed by Hollnagel (2018), represents a fundamental paradigm shift. Instead of defining security as the absence of negative events, Safety-II defines it as the presence of capabilities to deal with variability and succeed under challenging conditions.

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This perspective recognizes that in complex systems, variability is inevitable and often necessary for operational success. The goal is not to eliminate all variability, but rather understanding and managing it in order to maximize the resilience of the system.

4 UNDERSTANDING NORMAL WORK

4.1 The Gap Between Planned and Executed

One of the most consistent findings in the human factors literature is the existence of a systematic gap between work as it is imagined by planners and managers (Work-as-Imagined - WAI) and the work as it is actually performed by operators. front line (Work-as-Done - WAD) (HOLLNAGEL, 2017).

This gap does not necessarily represent a failure of the planning system or of workers, but rather an inherent characteristic of complex systems. The planners, however competent, cannot anticipate all the variabilities and contingencies that will occur during the actual execution of tasks.

In the oil and gas sector, this difference between what is planned and what is executed is particularly evident:

- **Offshore drilling:** The drilling plan provides for an ideal sequence of operations, but drillers can modify the circulation rate of the drilling fluid by perceive signs of influx (kick), even before the sensors confirm it officially the anomaly.
- **Maintenance on platforms:** “Lockout-tagout” procedures (blocking and labeling) are prescribed to isolate equipment, but, faced with tight deadlines, teams can improvise with controlled deviations — such as using additional barriers unforeseen — to ensure the continuity of the operation.

These examples show that **practical adaptations are inevitable** and often essential to maintain safe and efficient operations. However, if they are not monitored and analyzed, such adaptations can become **normalizations of deviation,** where practices risky activities become seen as acceptable. Figure 01 illustrates the difference between work planned (WAI) and work done (WAD), highlighting the learning space organizational.

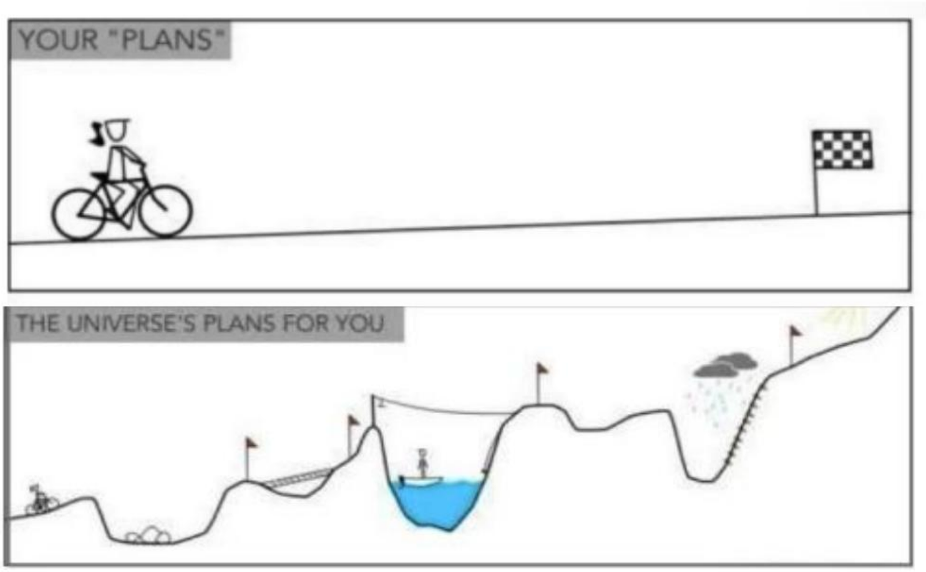

Figure 1: Representation of the gap between work planned (WAI) and work executed (WAD), highlighting the area of organizational learning.

4.2 Characteristics of Normal Work

Normal work is characterized by several dimensions that distinguish it from both ideal work (according to procedures) and work during emergencies or failures. Conklin (2019) identifies the following main characteristics:

Continuous Adaptability: Workers constantly adjust their actions in response to response to changing conditions, using experience and judgment to navigate situations not fully provided for in the procedures.

Multi-Objective Management: In addition to safety, workers must simultaneously meet production, quality, efficiency and other demands organizational, often creating tensions that require complex choices.

Tacit Knowledge: Much of the knowledge needed to perform the task work is not effectively documented, being developed through experience and transmitted informally between colleagues.

Complex Interdependence: Tasks are rarely performed in isolation, involving coordination with multiple people, systems and processes, creating dynamics that are not captured in traditional task analyses.

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4.3 Types of Adaptations in Regular Work

Detailed analysis of case studies on workplace performance reveals that adaptations made during normal tasks can be classified into different types. Each category has different implications for workplace safety and efficiency, which can impact both the results and the associated risks. These adaptations generally arise in response to unforeseen changes, resource limitations or demands optimization. Table 02 shows the main categories identified, along with their descriptions, practical examples and estimation of risk potential.

Table 02 - Main types of adaptations and risk potential

Type of Adaptation	**Description**	**Example**	**Potential Risk**
Sequential	Modification of order of execution of steps	Perform checks finals before the middle of the process	Average
Substitute	Use of tools or methods alternatives	Use similar equipment when the specified no this available	High
Omissive	To jump steps considered unnecessary	Do not perform redundant verification on an already tested system	Variable
Additive	Include extra steps no expected	Perform verification additional as a precaution	Low
Temporal	Modification of timing or duration	Extend wait time beyond specified	Average

5 RESULTS AND DISCUSSIONS

5.1 Theoretical Implications

The "Learning from Normal Work" approach constitutes a relevant advance in field of occupational safety, by shifting the focus from a reactive model, centered on failure investigation, for a proactive perspective that values everyday practices adaptation and success. This paradigm shift challenges long-held assumptions decades and generates theoretical implications that are linked to different currents of thought contemporary. Among the main ones, the following stand out:

Redefinition of the Concept of Security: Security is no longer conceived only as the absence of accidents or deviations and is now understood as the presence of organizational, cognitive and technological capabilities that allow adaptation in the face of variability of real work. This redefinition is similar to the contributions of systems theory complexes, organizational resilience and resilience engineering, which highlight the importance of understanding nonlinear dynamics and emergent properties of the system socio-technical.

Reconceptualizing Human Error: Rather than reducing error to individual failure or deviation from procedures, the perspective emphasizes error as a phenomenon systemic and inevitable, emerging from the interaction between people, processes, productive pressures and technologies. This conception dialogues with the theory of human factors and cognitive ergonomics, approaching models such as Safety-II (Hollnagel, 2017), which argue that the same human variations that can lead to incidents are also those that allow for resilience and operational success.

Valuing Tacit and Collective Knowledge: Real work is sustained by largely due to undocumented practices, local adjustments and tacit knowledge that, traditionally remain invisible to organizations. By recognizing this knowledge as a critical safety asset, the approach establishes a link with learning theories organizational, communities of practice and knowledge management. This recognition expands the notion of competence, not restricted to normative compliance, but including the ability practice of managing contradictions, improvising solutions and dealing with ambiguities.

Integration with Complexity and Adaptability Approaches: Beyond Challenging classical conceptions of linear causality, the perspective reinforces the need for models theoretical frameworks that account for continuous adaptation and the ability to learn in real time. This highlights the relevance of theories of organizational complexity and sensemaking (Weick) and resilience, which deal with how organizations interpret, learn and respond adjust to changing and often uncertain conditions.

5.2. Implementation Challenges

Despite the benefits demonstrated, the implementation of the "Learning from" approach "Normal Work" presents significant challenges that need to be carefully considered. One of the main obstacles concerns cultural resistance, since transition from a blame-centered culture to a learning-centered culture requires profound transformations in beliefs, values and organizational practices, a process that tends to be long and complex.

Added to this is the difficulty of measurement, since, unlike indicators traditional safety measures based on accident rates, the results of this approach are often qualitative, distributed over time and therefore difficult to translate into immediate return on investment metrics. Another relevant aspect is the need to specialized skills, as the facilitation of learning teams and the conduct of practices aligned with real work require specific knowledge in human factors, participatory methods and learning management, which are not always available internally in organizations.

Furthermore, regulatory pressures constitute an additional barrier, as many regulatory frameworks prioritize strict compliance with procedures, which may come into tension with approaches that value intelligent adaptability and operational flexibility as central elements for security.

5.3. Critical Success Factors

The analysis of successful implementation experiences highlights the existence of some critical factors that condition the success of organizational transformation. The first theirs is the commitment of leadership, since profound cultural changes require visible and sustained involvement of senior management. This commitment is not limited to resources financial or formal statements, but includes the dedication of personal time by leaders to understand the approach, model the new expected behaviors and legitimize the practices in the organization's daily routine.

Another essential factor is psychological safety, understood as the creation of a environment in which workers feel encouraged to report errors, adaptations and difficulties without fear of punishment. This climate of trust is essential for crucial information about the actual work appear, becoming valuable inputs for the learning process collective.

Furthermore, the systemic integration of the approach represents a determining point. In order to produce lasting results, it should not be conceived as a stand-alone program. or parallel, but organically incorporated into existing operational processes, in order to align safety practices with daily production flows.

Finally, the importance of developing balanced metrics is highlighted. Indicators exclusively focused on measuring accidents or failures do not capture the the entire security phenomenon. Therefore, it is necessary to build monitoring systems that simultaneously consider traditional outcomes, such as incident rates, and proactive indicators, capable of reflecting resilience, learning and organizational adaptability.

5.4. Study Limitations

It is important to acknowledge the limitations of this research. First, most of the data empirical data comes from specific sectors (oil and gas, mining), limiting generalization to other industries. Second, many of the reported results come from case studies provided by the implementing organizations themselves, and may contain biases confirmation.

Additionally, the qualitative nature of many benefits (such as improved culture organizational) makes rigorous quantitative comparisons with traditional approaches difficult. Future research could benefit from controlled longitudinal studies that compare different approaches to security management.

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6 CONCLUSION

This research demonstrates that the "Learning from Normal Work" approach offers a promising and necessary alternative to traditional management paradigms security. The evidence presented suggests that organizations focused exclusively on accident metrics may be operating with a false sense of security, ignoring systemic vulnerabilities that can lead to catastrophic events.

The main findings include: (1) the demonstration that the absence of accidents does not guarantees the absence of risks; (2) the identification that deviations from procedures frequently represent intelligent adaptations to systemic constraints; (3) evidence that cultures punitive measures may inadvertently increase risks by suppressing critical information; and (4) the validation that approaches based on self-accountability and continuous learning can produce measurable improvements in both safety and operational efficiency.

Successful implementation of this approach requires cultural transformation deep, supported by practical tools such as Learning Teams and Walk-Through/Talk-Through, integrated into existing operational processes. The development of organizational competencies at multiple levels is fundamental to sustaining the transformation. For organizations interested in implementing this approach, it is recommended:

(1) start with pilot projects in high-risk areas; (2) invest significantly in the development of facilitation skills; (3) establish balanced metrics that capture both results and capabilities; (4) maintain constant focus on creating and maintaining psychological safety; and (5) gradually integrating concepts into processes existing programs rather than implementing isolated programs.

The journey towards truly resilient, high-performance organizations reliability requires more than compliance with procedures and the absence of accidents. It requires a deep understanding of how work is actually performed, an appreciation of intelligent adaptations of workers and creation of systems that thrive on complexity and variability inherent in modern industrial environments.

The future of workplace safety lies not in the elimination of human variability, but in its understanding and optimization. "Learning from Normal Work" offers a path for this future, where security is co-created through intelligent collaboration between people, systems and organizations.

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