



REVISTA INGENIO

Improving Workplace Safety: A Delphi Study On OSH Monitoring And Management

Mejorar la Seguridad en el Trabajo: un Estudio Delphi Sobre la Supervisión y la Gestión de la SST

Ferenc Faragó | Óbuda University -Hungría

Fernando Rene Flores Benítez | Instituto Superior Universitario 17 de Julio -Ecuador

Gyula Szabó | Óbuda University -Hungría

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ABSTRACT

Improving OSH performance in today's rapidly changing technological and economic environment is a major challenge for organizations. While there are many studies on OSH practices and interventions, there is little research on the information used by managers to make effective decisions in this area. This study aims to address this by identifying the main sources of information used to make such decisions and the key factors influencing them. A 16-person panel of OSH professionals and managers were asked in three rounds of the Delphi method for their views. In the first round, they provided qualitative feedback on information sources and factors that influence decisions. These were analysed and used to create questions for the next rounds. A 70% agreement threshold was used to determine consensus. The panel agreed on four key sources of information for OSH decisions: compliance, employee feedback, risk assessments, and accident analysis results. The study identified influential factors affecting how this information is interpreted, including organisational culture, leadership commitment and resource availability. Effective OSH decision-making also depends on broader contextual and organisational factors, not just information availability.

PALABRAS CLAVE

Seguridad, gestión, salud ocupacional SSO, gestión en desempeño en seguridad, monitoreo, toma de decisiones

RESUMEN

Mejorar el desempeño en Seguridad y Salud Ocupacional (SSO) en el entorno actual, caracterizado por rápidos cambios tecnológicos y económicos, representa un gran desafío para las organizaciones. Aunque existen numerosos estudios sobre prácticas e intervenciones en SSO, hay poca investigación sobre la información que utilizan los directivos para tomar decisiones eficaces en este ámbito. Este estudio busca abordar esa brecha identificando las principales fuentes de información utilizadas para tomar decisiones en SSO y los factores clave que las influyen. Un panel de 16 personas, compuesto por profesionales y directivos en SSO, fue consultado en tres rondas mediante el método Delphi para conocer sus opiniones. En la primera ronda, proporcionaron comentarios cualitativos sobre las fuentes de información y los factores que influyen en la toma de decisiones. Estos comentarios fueron analizados y utilizados para elaborar preguntas para las siguientes rondas. Se utilizó un umbral de consenso del 70 % para determinar acuerdos. El panel coincidió en cuatro fuentes clave de información para la toma de decisiones en SSO: cumplimiento normativo, retroalimentación de los empleados, evaluaciones de riesgos y resultados del análisis de accidentes. El estudio también identificó factores que influyen en cómo se interpreta esta información, como la cultura organizacional, el compromiso del liderazgo y la disponibilidad de recursos. La toma de decisiones eficaz en SSO también depende de factores contextuales y organizacionales más amplios, y no solo de la disponibilidad de información.

I. INTRODUCTION

Evaluation of risks is a fundamental component of guaranteeing safe and healthy working conditions in addition to being required by law [1]–[3]. For OSH managers and professionals, enhancing occupational safety and health (OSH) in a quickly changing scientific and

financial context continues to be a constant struggle. The number of work-related accidents in the European Union (EU) has decreased somewhat over the last ten years, but it is still alarmingly high. The substantial impact on workers, businesses, and society at large is highlighted by the over three million non-fatal and 3347

fatal work accidents that happened in EU nations in 2021 alone, according to Eurostat [4], [5].

Employers, particularly those in big companies, have a complicated and essential obligation to prevent workplace accidents and job-related disorders [6], [7]. Companies need to satisfy consumer demands with their goals to conduct sustainable operations, with these goals serving as a guide for operational decisions [8]–[10].

Employees, who want safe working conditions, are among the important consumers. These expectations are met, and operational performance is improved by excellent OSH management. In addition to improving productivity and lowering accident-related expenses, it also raises employee engagement. OSH is positioned as a competitive advantage and a crucial success factor due to its high safety culture and positive work environment, which also help to attract and retain talent [11]–[16].

It is imperative to regularly evaluate safety-related operations in a changing organizational structure. To evaluate hazards and comprehend the safety posture of the company, professionals need to handle complex data. Rapid, well-informed decision-making is necessary at all organizational levels due to the growing complexity of technology settings and changing production needs [17]–[19].

An essential ability for management is problem-solving, which starts with recognizing an undesirable circumstance and concludes with coming up with an innovative solution. Enough high-quality information is necessary to make effective decisions. Choosing the best course of action comes after recognizing and comprehending the situation, according to psychological theory. Therefore, decisions are the result of transforming information into actions or even more information [20]–[27].

The type and quality of information used depend heavily on the nature of the problem and the decision-maker's experience. Chikan describes two stages in corporate decision-making: preparing and making decisions [21]. These are often separated across organizational levels, resulting in interpretational differences and information gaps. The function and managerial level affect how information is perceived and utilized, especially in OSH, where risk minimization is paramount.

Continuous access to pertinent information is crucial for assessing risks and recognizing hazards in rapid production situations. Proactive and based on data corporate safety management is essential. Organizational decisions pertaining to safety are greatly impacted by the availability of timely, pertinent, and well-structured information. The organizational level at which the information is obtained and internal business elements like culture, structure, and communication flow that influence how information is interpreted and used both affect how effective these choices are.

Managing occupational safety and health (OSH) remains a constant challenge for companies operating in increasingly technologically advanced and economically unstable situations. However, while there are several frameworks and regulatory procedures in place to support OSH compliance, the quality and accessibility of relevant organisational data play a significant role in the effectiveness of managerial decision-making in this area. In contrast, little is known about the specific types of information that managers use, how this information is processed at different organisational levels, and which internal factors facilitate or hinder managers from making sound OSH decisions. This gap poses a significant difficulty in advancing proactive and evidence-based safety practices. The present study seeks to identify and analyse the key information sources and organisational factors that influence OSH decision-making. The aim is to support more effective and informed management strategies that will improve safety performance [17], [19].

2. METHODOLOGY

Expert opinions on monitoring and handling occupational safety and health (OSH) performance were gathered for this study using a modified electronic Delphi approach that was administered during three survey rounds (see Figure 1).

Figure 1.

Research methodology



Through anonymous and iterative communication, the Delphi technique is a systematic expert consultation procedure intended to promote consensus on complicated subjects [28], [29]. In contrast to conventional group discussions, the Delphi method guarantees anonymity, reducing the impact of dominating personalities and enabling participants to formulate their answers on their own. It usually consists of several rounds, in which par-

Participants answer questions and get controlled feedback along with a rundown of the outcomes from the previous round before moving on to the next. Because experts can revise their answers considering group comments while retaining their unique viewpoints, this format promotes reflective thinking [30]–[33].

Expert opinions on the data and corporate variables that influence occupational safety and health (OSH) decisions are systematically gathered and refined using the three-round Delphi technique. This format was chosen in accordance with generally recognised scientific guidelines, which suggest that three rounds are typically sufficient to minimise participant fatigue and attrition, while also achieving a firm consensus among experts. In the first round, open-ended questions were used to gather qualitative data and pinpoint important ideas and variables. In the second round, these preliminary results were organised into more specific topics, enabling specialists to assess group input more effectively. The third round was then used to reach a consensus, clarify any remaining differences and confirm areas of agreement. A predetermined consensus threshold of 70% agreement among participants was set [34].

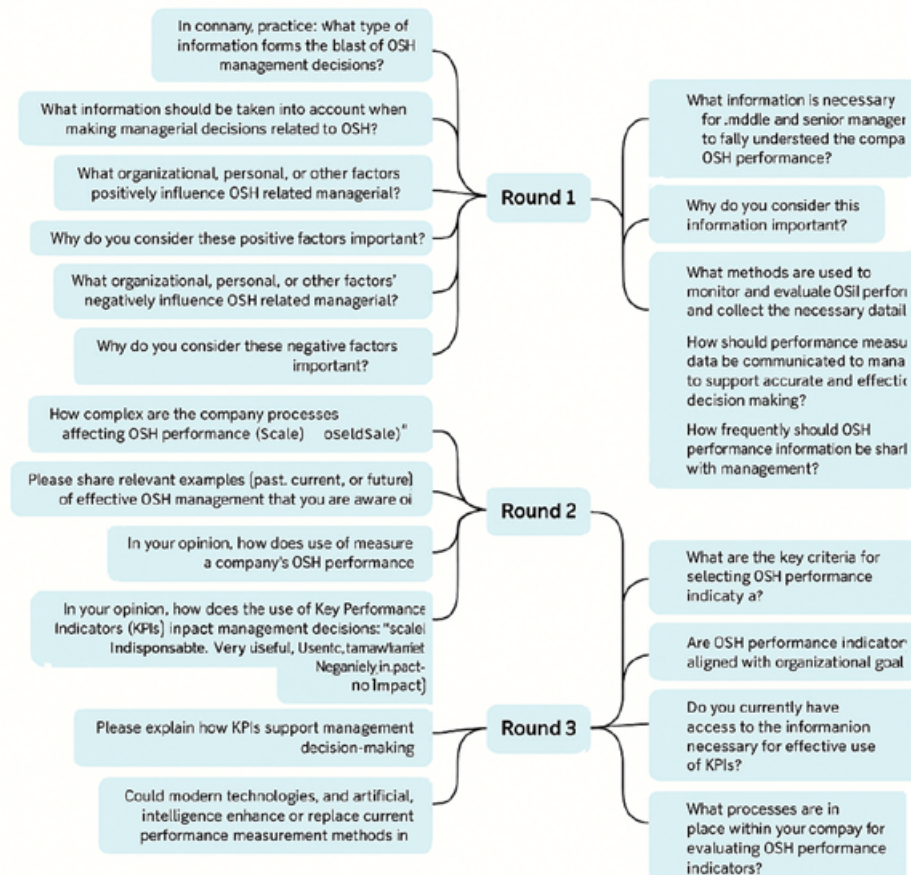
The initial phase of the Delphi study, which is shown in Figure 2, was to investigate the fundamental factors that affect occupational safety and health (OSH) management

decision-making. In addition to evaluating organizational and individual factors that could have a positive or negative impact on these decisions, participants were asked to identify the kinds of information commonly used in corporate OSH decisions.

This round also aimed to gather actual instances of successful OSH practices and comprehend the perceived difficulty of OSH-related procedures within businesses. The notion of Key Performance Indicators (KPIs) was also introduced, and expert opinions regarding their influence on managerial choices were gathered. The study focused its attention to the methods and procedures for tracking OSH performance and sharing findings in the second round. To get their opinions on the kind of information middle and senior managers require to properly assess OSH, experts were asked to participate. The round looked at how best to share updates with leadership, how often to do so, and whether contemporary technology like artificial intelligence could improve present procedures. With special focus on the flow and display of information to assist strategic decision-making, this phase expanded the investigation into the operational aspects of OSH management. The final round focused on choosing and assessing Key Performance Indicators to improve knowledge of OSH performance measurement. In addition to determining if these indicators are in line with the organization's more general

Figure 2.

Research questions



strategic objectives, experts were asked to provide criteria for selecting suitable KPIs. The availability of pertinent data needed for KPI use and the internal procedures used by businesses to evaluate these indicators were also examined in this round.

Between March and November 2023, two expert teams conducted the study. The four members of the preparatory team were an experienced audit specialist, two doctoral research students from the Doctoral School of Security Sciences at the University of Óbuda, and a senior associate professor. The design and coordination of the study fell within the purview of this group. The specialists on the second team were chosen based on their responses to the study questions. These specialists were either seasoned researchers, senior managers in big businesses, or those with significant OSH competencies. Participants had to have proven proficiency in OSH management, senior-level experience in major organizations, or noteworthy academic research credentials in the field in order to meet the inclusion criteria. A sample size of at least 15 was required to guarantee trustworthy consensus. The Delphi survey was accepted by 32 experts out of the 124 who were first invited in March 2023, and 16 completed all three rounds.

Questionnaires were developed based on a preliminary review of literature concerning occupational safety and health (OSH) and how company decisions are made. In the first round, open-ended questions were used to elicit qualitative insights and identify key categories of information and influencing factors. These responses were analysed using inductive content analysis and thematic coding. This process was supported using word cloud visualization to validate the prominence of recurring terms and themes. These initial findings informed the design of the second and third rounds, which employed structured questions and scale evaluations to assess levels of agreement. To ensure content validity, each version of the questionnaire was reviewed and refined by the research team, who were professionals with extensive experience in OSH and Delphi methodology.

Strict protocols were put in place to ensure that the study's participants remained anonymous. During the analysis and feedback phases, all replies were anonymised, and each expert was assigned a unique identification number. The identities of other participants weren't shown to the experts. To minimise the possibility of dominance bias or a hierarchical effect, communication took place online using Excel spreadsheets for the second and third rounds, and Survio for the first.

3. RESULTS

The research identifies key types of information that influence managerial decisions in OSH. Experts reached

consensus on four main sources: legal and standard compliance, employee feedback, risk assessment results, and accident data. Additional factors considered included cost-effectiveness, technical feasibility, audit findings, and employee satisfaction. Other responses touched on benchmarking, business impact, risk timelines, process integration, and sustainability.

In the first round, qualitative responses were categorized into 16 distinct informational themes. Quantitative aggregation of expert responses revealed consensus—defined as agreement by at least 70% of participants—for four key items: (1) compliance with legal and standard requirements (100% agreement), (2) employee feedback and suggestions (81%), (3) results from risk assessments (78%), and (4) accident statistics and analysis (70%). Additional factors such as cost-effectiveness (58%) and technical feasibility (52%) did not meet the consensus threshold but were retained for further evaluation in subsequent rounds. A total of 16 distinct statements summarising these observations were compiled and presented in Table 1.

Table 1.

Information underpinning OSH decisions, own-editing.

Information to inform decisions on OHS	Agreement (%)
<u>compliance with legislation, standards</u>	100
<u>employee ideas, opinions, feedback, lobbies</u>	81
<u>risk assessments</u>	78
<u>accident statistics (events, near-misses) and analysis, root cause analysis</u>	70
<u>cost, cost-effectiveness and available resources</u>	58
<u>technical feasibility</u>	52
<u>results of management reviews, internal audits</u>	39
<u>employee skills, satisfaction</u>	39
<u>safety first philosophy, parent company expectations</u>	19,5
<u>reduce risks, new risks emerge</u>	19,5
<u>priority order of occupational safety and health</u>	13
<u>benchmark results</u>	6,5
<u>the achievement of occupational safety and health objectives and programmes</u>	6,5
<u>order, working environment</u>	6,5
<u>own professional judgement</u>	6,5
<u>training, education</u>	6,5

A total of 36 elements were found after the positive and negative aspects were filtered out (e.g., lack of commitment, lack of good communication). A five-point Likert scale was used to gauge the experts' responses to questions about how complex business procedures impact OSH (Table 2). All the experts agreed that business pro-

cedures that impact OSH are intricate and difficult to understand.

Table 2.

Assessment of the complexity of company processes affecting OSH

Complexity of business procedure that impact OSH	No of responses
They are simple, easy to understand and easy to track	2
They are not very simple, but easy to understand and track	1
They are not simple; they are not easy to understand	1
Complex processes that are not easy to understand	11
Highly complex processes, not easy to understand and monitor	1

The significance of tracking and assessing OSH-related procedures was acknowledged by experts, who pointed out that it facilitates managerial decision-making, enhances information flow within the company, allows for comparisons, and aids in identifying key areas of attention. Key Performance Indicators (KPIs) were thought to be very useful for OSH management. Although one expert believed KPIs had little bearing on decision-making, two others thought they were crucial.

KPIs were found to serve five main purposes: (a) identifying problems and priority areas; (b) supporting decision-making; (c) managing processes and giving feedback; (d) improving communication; and (e) enabling comparison and long-term tracking. Regarding the utilization of KPIs, a total of 28 criteria were identified. Experts also underlined that for KPIs to be useful; they must be employed in certain circumstances. Among the worries were that KPIs might not provide enough context on their own and that their appropriate application necessitates professional knowledge, training, interpretation, and open, two-way communication across the organization.

In the second round, structured statements based on round one findings were presented to experts using closed-ended formats. The expert panel agreed on 20 of the 118 specific statements, with a consensus of more than 70%. Panellists were asked to reevaluate their answers for things that did not receive consensus in the first round, with the goal of promoting a range of opinions rather than coercing them into agreement. Requests for clarification followed differing viewpoints. Despite having been carried out, rounds two and three's specific results are not presented in this page. Lastly, for confirmation, the experts were given access to the combined results from all three rounds. Two of the sixteen participants did not reply, but fourteen of them acknowledged agreement with the results.

The third round further refined items that lacked clear consensus. Of the 92 items presented, 14 achieved the 70% consensus level. Notably, strong agreement was reached regarding the sources for defining OSH key performance indicators (e.g., OHSAS management systems and corporate expectations), and on the necessity of linking KPIs to organizational goals. However, participants expressed limited confidence in their own readiness to apply these indicators effectively, with only 37.5% affirming adequate knowledge. The main KPIs are presented in Table 3.

Table 3.

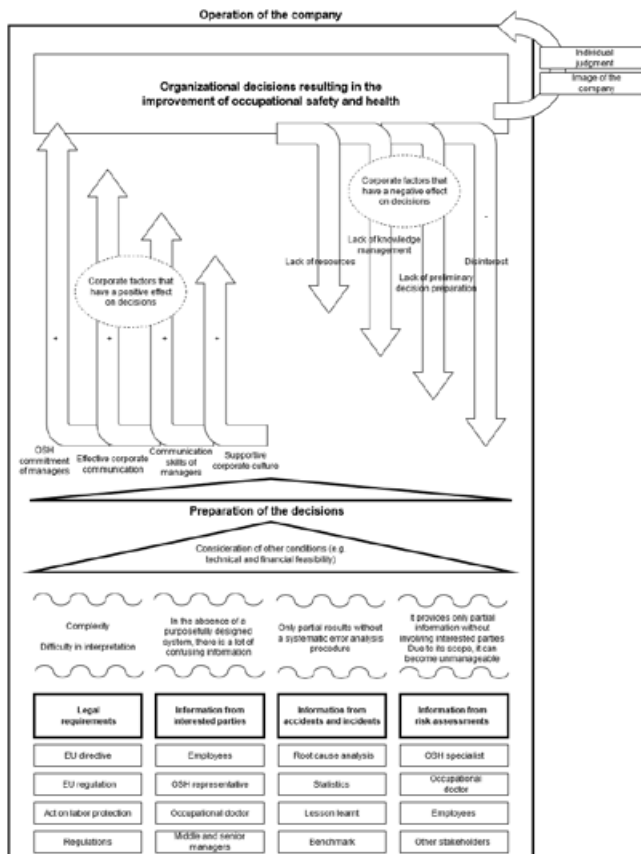
Key Performance Indicators (KPIs) for OSH Identified Through Expert Consensus.

KPI Source or Criterion	Description	Consensus Level
OHSAS Management Systems	KPIs should be based on standards from Occupational Health and Safety Assessment Series (OHSAS).	Achieved (>70%)
Parent Company Expectations	KPIs should reflect the expectations and strategic directions of the parent company.	Achieved (>70%)
Linkage to Organizational Objectives	KPIs should be aligned with company-level strategic goals.	Achieved (>70%)
Expert Knowledge and Experience	KPIs should be selected by professionals with expertise in OSH and process control.	Not Consensual
Usability Across Organizational Levels	KPIs must be understandable and applicable at all management levels.	Partial Support
Information Flow and Communication	KPIs should facilitate two-way communication and support decision-making transparency.	Partial Support
Complementarity with Other Business KPIs	OSH KPIs are not typically integrated with financial or production indicators.	Achieved (100%)
Supportive Tools and Training Required for Interpretation	Proper interpretation of KPIs requires training and documentation.	Partial Support

OSH management decisions are influenced by a number of firm aspects. A supportive business culture, managers' communication abilities, and effective two-way communication within the organization are the primary elements that favourably influence managers' dedication to OSH. The primary impediments include lack of resources, lack of expertise and knowledge management, lack of enthusiasm, and unprofessional decision-making. Both the company's and employees' personal opinions are impacted by wise OSH actions (Figure 3).

Figure 3.

Information and company factors influencing OSH decisions



3.1. DISCUSSION

The study highlights the multifaceted and complex nature of information sources that underpin OSH decision-making processes. One of the main results is that OSH managers base their judgments mostly on adherence to national and EU legislative frameworks. Despite providing a strong foundation for safety requirements, many companies find the legislation to be too complicated, indicating the need for improved support systems and more precise interpretation guidelines. Although it also highlights disparities in understanding and implementation across different firms, this is consistent with other research showing that legal compliance successfully enhances workplace safety [11], [19], [35], [36].

The significance of involving stakeholders in OSH decisions is another important subject. It is seen to be essential to get input from employees, occupational health specialists, and management, particularly in sophisticated technological workplaces where frontline staff frequently have the most practical experience. Frequent feedback systems allow for the early detection of risks and promote a preventive culture. However, OSH professionals may become overwhelmed and lose concentration if they receive too much unfiltered feedback, so this process needs to be handled carefully. The creation of organized and effective feedback mechanisms is therefore necessary to guarantee that pertinent information influences choices without becoming irrelevant.

All members of the expert panel agreed that risk assessments are the cornerstone of OSH strategy. The institutional significance of both qualitative and quantitative risk assessments is further supported by legislative requirements. A number of obstacles were identified, too, such as the inability to effectively handle intricate evaluations and convert results into administrative decisions that could be put into practice. Particularly in situations involving new or developing technology, experts underlined the necessity of trustworthy, transparent, and controllable risk assessment procedures.

The results of the research emphasize the importance of diversified, organized, and context-aware information flows in making OSH judgments of the highest caliber. Stakeholder participation, empirical accident data, legislative requirements, and thorough risk assessments interact to form the basis of good safety governance. The availability of resources, organizational communication, and managerial commitment are necessary to support these, nevertheless [2], [12], [37]–[39]. According to the research, the efficiency and sustainability of OSH procedures can be greatly increased by combining these components in a comprehensive way while taking confounding variables into account.

The findings of the Delphi study indicate the need to support a change in OSH management, shifting the focus from reactivity to proactivity and embracing data-driven decision-making, strategy alignment and cultural commitment. Implementing these insights could enhance employee satisfaction, operational effectiveness and safety performance, ultimately leading to long-term commercial success. The study shows that, in practical terms, good OSH governance necessitates an organizational culture that encourages candid communication, prompt feedback, and proactive risk management in addition to regulatory compliance. The general agreement that managerial commitment and effective internal communication are essential for facilitating safety decisions highlights the need of leadership development and internal communication procedures that are adapted to the information flows associated with safety [40].

4. CONCLUSIONS

Expanding the body of knowledge on the data supporting OSH choices and the business variables influencing them was the aim of this study. In order to make management decisions that result in better workplace health and safety, the experts agreed that information from many sources and at various organizational levels is required. Decision-making about OSH is also influenced by a few additional factors. Confounding variables that complicate the interpretation of data from many sources and the corporate elements that have the biggest impact on management choices have been brought to light by the study. The expert view that emerged from the process made clear that corporate efforts to enhance OSH performance enhance employee engagement and the company's reputation, both of which support long-term corporate success.

To make informed decisions, OSH practitioners will benefit from the study's findings. Guidelines for OSH practitioners, managers, and business decision-makers can be developed using them to enhance their OSH management decision-making procedures.

One of the study's main limitations is the expert panel's diversity and representativeness. Despite the participants' extensive backgrounds in occupational safety and health (OSH), the final group only included 16 experts, most of whom were connected to major Hungarian institutions and companies. The findings' applicability to different organizational sizes, cultural contexts, or industrial sectors is limited by the sample's modest size and geographic concentration. More varied viewpoints should be incorporated into future studies to improve the results' external validity and wider applicability.

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