



Occupational Health and Safety Management Research in Jordan: Application of Performance Metrics

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Abstract

Safety incidents worldwide result in the loss of millions of dollars yearly, primarily due to medical treatment costs, injury settlements, and production delays. Enhancing work conditions and applying safe practices can significantly lessen such costs. Thus, creating safety monitoring and management schemes to evaluate safety performance using quantitative metrics (i.e., Leading and Lagging Performance Indicators) is crucial. Lagging indicators measure previous performance and may establish performance patterns. While, leading indicators are forward-predicting and protective metrics that allow deeper look into the adequacy of safety practices and identify potential related issues. Using a combination of lagging and leading PIs to gauge safety performance has become a standard practice in industries. This paper examined the literature on safety management, concentrating on using leading and lagging performance indicators across different sectors. The review explored how these indicators influence the efficacy of safety management, with a particular emphasis on research conducted by Jordan researchers. The findings revealed a significant gap in research on performance measurement at the corporate level among Jordanian researchers. Specifically, leading indicators are notably absent from local studies, while lagging indicators are mainly found in national-level and sector-specific research, primarily used to evaluate past performance.

Paper type: Review paper

Keywords: Occupational health and safety management, Safety performance metrics, Lagging indicators, Leading indicators, Process safety.

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1. Introduction

The Social Security Corporation records show that around twenty thousands occupational incidents occur yearly, injuring about 12 per 1,000 workers. Regarding mortalities, the industries account for roughly 25% of deaths, compared to approximately 18% by the trade sector. In addition, industries cause about 32% of the injured, while the healthcare services is responsible for 22%. The newer workforce makes up more than 50% of the wounded, stressing the necessity for better awareness and targeted training to guarantee their well-being (Jordan Times, 2022). The above statistics may raise fears about the safety practices in Jordanian industries and the effectiveness of work environment risk management. Consequently, evaluation of the management of occupational safety schemes in these sectors is necessary.

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Performance indicators (PIs), or metrics, are essential for evaluating the efficacy of managing various facets of business performance. To calculate these metrics, data collection and monitoring schemes are necessary. Moreover, implementing standard operating procedures is critical for establishing an efficient monitoring system. Additionally, the variables used to calculate these metrics must be accurate and cost-effective. A Performance Indicator (PI) is a metric used to monitor and evaluate how well a company realizes its objectives. The PI should have a distinctive definition and be exact, quantifiable, attainable, pertinent, and time-restricted. PIs demonstrate a hierarchical structure, with Key Performance Indicators (KPIs) at the highest level. Other PIs assess the company's operations and activities, while KPIs gauge the corporation's advancement toward its primary objectives, including safety. Performance indicators are either leading or lagging (Hinze and Hallowell, 2013). Lagging indicators assess past performance, giving insights into over-time performance patterns. Leading indicators assess ongoing practices, offering an immediate reflection of organizational enactment and forecasting the prospect of attaining objectives. Using indicators for measuring safety may help link personal safety to process safety. Best practices consider occupational safety management (OHSM) as a critical input for productivity; a healthy workplace is essential for sustainability and growth (Amrina & Yusof, 2011; Grabowski et al., 2007).

The current research aims to examine and analyze literature on the use of Leading and Lagging Performance Indicators (LPIs) in gauging occupational safety, focusing on research from Jordan. This review evaluates how these indicators enhance safety performance and reduce workplace incidents.

2. Materials and Methods

A review of the safety publications was conducted to fulfill the study's objective. A structured review, which focused on the pertaining literature by Jordanian academics and researchers, specifically addressed the application of PIs in occupational safety management. This review aligned with the classifying the indicators into leading and lagging.

The search criteria for the literature review on using indicators (i.e., lagging and leading) in occupational health and safety (OHS) management included the following steps:

- Conducting keyword searches, focusing primarily on abstracts to identify relevant literature.
- Examining cited references within the pertinent literature reviewed to identify additional relevant studies.
- Screening and categorizing the literature into two main categories: Leading and lagging performance indicators based on their relevance and context.

The review of the literature published by Jordanian researchers involved the following steps:

- Searching for relevant terms in titles, author names, and cited references focusing on studies authored by Jordanian researchers or those focused on Jordan.
- Screening and organizing relevant publications into leading and lagging indicators, then categorized as studies at country-level, sectoral level (e.g., industry, healthcare), or others as appropriate.

The review period spanned from the year 1995 to 2025.

3. Results and Discussion

This part provides and discusses the literature review results per the methodology structure. The first two sections address the global review of research associated with lagging and leading indicators. The section "Occupational Health and Safety Management Research in Jordan" presents research by Jordanian authors, which is sub-sectioned further per the categorization of the methodology.

3.1 Lagging Indicators

Lagging indicators assess performance based on data collected from previous periods, annually, every sixth month, quarterly, or monthly. As a result, they quantify safety enactment after incidents have occurred. However, lagging indicators are the most widely utilized technique for safety management. Lagging indicators can not effectively foresee forthcoming performance, especially when comparing performance between cycles. Despite that, they can still offer valuable understandings of an organization's safety performance by highlighting historical patterns.

Many researchers have examined the efficacy of lagging indicators in managing occupational safety. Researchers characterized these indicators as tailing since they assess the performance of earlier periods rather than reflecting the present status (Toellner, 2001). Other studies have offered similar criticisms (Hinze & Hallowell, 2013; Grabowski et al., 2007; Mengolini & Debarberis, 2008; Manuele, 2009; Peterson, 1998; Stricoff, 2000). These studies suggest that lagging indicators are not the lone conceivable choice to evaluate safety management. Lagging indicators, however, might still be an essential tool for forecasting performance tendencies, assesses, and

shortcomings. Thus, performance enhancement programs can incorporate lessons learned from past results. Employing a hybrid indicators system to evaluate performance could increase the importance of lagging indicators and lead to a better diagnosis of safety status. Occupational safety events and accidents are often the result of several interrelated factors requiring leading and lagging metrics to assess (Grabowski et al., 2007; Reiman & Pietikäinen, 2012). In addition, the simultaneous use of lagging indicators with leading ones may result in efficient safety administration, reaffirming its ongoing significance in monitoring safety performance. For regulatory purposes, authorities in charge of jurisdiction rely on lagging indicators to ensure that businesses adhere to pertaining regulation, standard operating procedures, OHS guidelines, and other relevant requirements. (Mengolini & Debarberis, 2008; Peterson, 2008; Reiman & Pietikäinen, 2012). **Table 1** presents a selection of common safety lagging indicators.

Table 1. Common lagging indicators

	Metric
1	Injury severity
2	Injury frequency
3	Death rate
4	Incidents lost time
5	Number of medical claims
6	Number of compensations and their costs
7	Incident and accident frequency
8	severity of incidents
9	Missed man days

3.2 Leading Indicators

Much of the published research recommends that relying solely on lagging indicators to assess a company's safety performance is unsatisfactory; the simultaneous use of leading indicators is of prime importance. In other words, a more dynamic structure to anticipate future risks is crucial for effective safety management (Hale, 2009; Rajendran & Gambates, 2009; Mengolini & Debarberis, 2008; Manuele, 2009; Peterson, 1998; Stricoff, 2000). Rajendran & Gambates (2009) supported using leading indicators to make safety management systems more proactive. These indicators must, therefore, enable predicting deviations that could elevate risks or cause accidents (Tomlinson et al., 2011; Manuele, 2009; Al-Waqfi, 2025). **Table 2** shows a set of common leading indicators.

Based on the findings from the reviewed global literature, local industry practitioners should develop and implement more dynamic and integrated safety management systems. These systems should incorporate appropriate leading and lagging indicators. This dual approach enables organizations to identify risks before they result in accidents, promoting proactive safety management rather than relying on reactive responses. In other words, relying mainly on past performance data can conceal current safety issues and impede safety performance improvement. Industry professionals should emphasize continuous feedback from ongoing activities instead of solely analyzing historical data to evaluate safety.

Table 2. Common leading indicators

	Metric
1	Proportion of incident reports for which a root cause analysis was conducted.
2	Frequency of safety checks
3	EspecializedTraining
4	Safety audits
5	Near misses documentation
6	Hazard identification and mitigation
7	Workers consultation, communication.
8	Workers participation in safety issues (hazard identification, etc.)
9	Behavioral monitoring
10	Ergonomic defficiencies recognized and addressed.
11	Related committees
12	Scheduled maintenance
13	House keeping
14	Periodic instrument calibration

3.3 Occupational Health and Safety Management Research in Jordan

The current part analyses the literature on safety and occupational health management authored by Jordanians: the focus of the current investigation. The works reviewed included studies conducted both in Jordan and internationally.

3.3.1 Country Level

Considerable safety-related research in Jordan has focused on comparing trends and analyzing historical data. These studies often relied on lagging indicators and trailing statistics, which provided insights into past incidents, accidents, and safety performance. While some research attempted to compare safety outcomes regionally, the analysis was mainly retrospective, concentrating on previous occurrences rather than real-time monitoring or predictive insights. While this method is essential for identifying trends, it may complicate developing innovative risk management and prevention plans and hinder the ability to respond quickly to emerging safety concerns (Al-Tammemi et al., 2024; Dababneh et al., 2018; Jadaan et al., 2018; Albaali & Al Saidi, 2018; Assbeihat, 2015; Al-Abdallat et al., 2015; Al Kilani et al., 2013; Refaie, 2013; El-Mashaleh et al., 2010). No research has investigated occupational health and safety monitoring within corporations. Prudent practices advise that institutions create monitoring schemes with lagging and leading indicators to gauge safety enactment.

For instance, Dababneh et al. (2018) compared safety performance in Jordan's industries to those in the neighboring countries. According to the examination of ILO data from 2002 to 2009 and those of Social Security from 2010 to 2014, the death rate was comparable to the regional average. The assessment also covered PIs such as numbers of injured, disabled, and 3-days-cured injured. Like previous related investigations, this study had several flaws, including insufficient accident documentation and unreliable data. Furthermore, a significant limitation is that many employees are not on the Social Security database, which is the key to occupational-related incidents (Aljbour, 2022; Albaali & Al Saidi, 2018).

A ten-year-road safety study (from 2003 to 2013) indicated that the EU zone witnessed a significantly lower death rate per hundred thousand people than emerging nations, including Jordan. This discrepancy could result from the fact that socioeconomic factors influencing road safety differ considerably between EU and developing nations. In underdeveloped countries, death rates were increasing compared to wealthier nations, thus unfavorably affecting their GDP and the costs associated with casualties (Jadaan et al., 2018).

3.3.2 Sectoral Level

A significant portion of Jordan's safety research has focused on specific sectors, concentrating mainly on the transportation and construction industries, with less emphasis on the healthcare sector. Similar to country-level studies, this research often relied on trailing indicators, such as fatality rates and historical data, to assess the effectiveness of safety measures over time.

Construction Sector

Jordan's building sector has attracted significant interest from academics (El-Mashaleh et al., 2010a; El-Mashaleh et al., 2010b; Alkilani et al., 2013; Sarireh and Tarawneh, 2014; Assbeihat, 2015; al-Nawayisah, 2016; Abdelnoor, 2019; Alubaid et al., 2020; AL-Smadi et al., 2021; Alkasasbeh, et al., 2022). Research on safety practices in this sector has identified multiple factors contributing to bad performance. The main reasons include inadequate training, occasional safety checks and meetings, inadequate protective measures, and resistance to wearing PPE (Alkilani et al., 2010). Abdelnoor (2019) observed comparable results, attributing them to insufficient safety practices at building sites. Moreover, the building firm's type has affected the devotion to integrating safety issues into work procedures (Alubaid et al., 2020). Companies in the top rank have demonstrated a greater focus on various factors, including personal protective equipment, related engineering measures and policies, and the pertaining rules. The firms under study have mostly ignored adopting key safety aspects like training, praising good performers, and having frequent safety meetings. Forty-three percent of businesses did not have safety policy guidelines.

Overall, research in this sector has attributed underperformance to insufficient safety inspections, inadequate training, and a lack of personal protective equipment (PPE). These studies typically adopted a retrospective approach, focusing on historical data rather than utilizing forward-looking or real-time metrics. This limitation restricted their ability to create proactive safety management strategies.

Traffic Sector

Traffic and road safety in Jordan have received high priority from researchers. Most of this research relied on earlier data, questionnaires, or comparisons with other countries, lacking predictive metrics and administrative research (Albatayneh et al., 2024; Al-Tammemi et al., 2024; Alshannaq, 2023; Jadaan et al., 2018; Jadaan et al., 2017; Magableh et al., 2021; Shotar et al., 2014; Al-

Kheder et al., 2016; Shabeeb & Awad, 2016; Obaidat et al., 2012).

Over 25 years (from 1989 to 2014), Jordan's government has introduced multiple safety actions to improve road safety. However, the evaluation showed that these efforts were not sustainable. The introduced actions included regulation and law enforcement but lacked technical or organizational interventions. The mortality rate was the primary indicator for assessing this strategy (Shabeeb & Awad, 2016). As previously mentioned, the evaluation of road safety performance in Jordan over ten years, compared to EU countries, mainly utilized the mortality rate (Jadaan et al., 2018). This approach failed to consider socioeconomic and behavioral factors, which vary considerably between Jordan and the EU region and may significantly affect traffic safety. These factors could serve as leading indicators for forecasting future trends.

In conclusion, research in both sectors heavily depends on past data. It lacks predictive or real-time safety indicators that could enhance current safety conditions and help prevent future accidents.

Healthcare Sector

Many researchers have investigated the safety of healthcare services (Albsoul et al., 2025; Alamsidin et al., 2023; Ashour et al., 2018; Ashour & Hassan, 2019; Al-Abdallat et al., 2015). Ashour et al. (2018) suggested a plan to promote safety in the healthcare by examining the causal relationship with safety factors. Such factors include management dedication and adequate training, which can significantly improve the sector's safety (Rajendran & Gambatese, 2009). However, none of the local studies addressed unit monitoring systems employing such factors as performance metrics.

Qualifying Industrial Zones

A review of occupational safety practices at companies within the QIZ (Qualifying Industrial Zone) showed serious shortcomings. Among the businesses, 86% had a safety policy, and safety budgets accounted for 62%. Most corporations conform to safety regulations, requiring periodic and pre-employment medical examinations for employees. About 85% of firms supplied workers with PPEs. However, approximately 66% of businesses lacked adequate monitoring schemes to evaluate the efficiency of their safety measures. None of the companies documented work-related diseases. The injured were ten per thousand employees (Al-Wreidat & Rababa, 2011) versus eight per thousand in Ireland (Health and Safety Authority, 2013). Khrais et al. (2013) reported similar findings. They assessed safety procedures and rules at companies in Jordan industrial parks, where they highlighted hazards related to noise, ergonomics, toxins, and chemicals. The evaluation concentrated on key metrics while overlooking operational ones necessary to identify performance deficiencies and strengths.

Others

Other studies covered the safety of dams, surface mines, and the safety of hotels (Khrais et al., 2024; Salamah et al., 2023; Alananzeh, 2017).

Overall, the literature reviewed in all categories did not primarily focus on monitoring systems and their role in managing occupational health and safety. Instead, it concentrated on key indicator values from previous times to assess safety management. Although these indicators offer some beneficial information, their capacity to precisely characterize and diagnose the present state of safety is limited. As a result, they are insufficient to create effective policies to enhance hazard management and reduce incidents. Based on that, monitoring techniques that employ leading and lagging metrics are crucial for managing and understanding safety. Furthermore, many of the studies were surveys, which could produce findings that don't accurately represent the organization's occupational health and safety circumstances.

3.4 Process Safety Risk Assessment

Industrial process safety, safety culture and risk assessment have rarely been the subject of local research (Al-Waqfi, 2025; Rbehat et al., 2023; Jildeh & Matouq, 2021; Shaqadan, 2021; Ab-Khader, 2003). Through identification, evaluation, and classification of associated risks from low to high, Rbehat et al. (2023) recently examined the possible accidents in the water bottling sector. The study also offered recommendations for reducing these risks. They did not discuss the establishment's safety. There was no review of safety performance reports, monitoring, safety management system evaluation, or connection between process safety and performance metrics. They mostly used staff meetings, inspections, and walkthroughs to gather information on possible risks. Jildeh & Matouq (2021) have applied the PDCA and the FMEA techniques to enhance the sustainability of operational safety. The use of both qualitative and quantitative risk analysis techniques can augment the process's life cycle and protect facilities from possible mishaps by linking individual safety and process safety indicators. Al-Waqfi (2025) has recently proposed a safety culture assessment tool, which took the cultural and local Jordanian context into consideration.

Finally, the reviewed studies indicate that although they covered hazard detection and risk evaluation, incorporating leading metrics, continuous monitoring, and safety administration are often neglected or not thoroughly explored. Leading indicators are essential for proactively managing risks and enhancing safety performance. Further research in this area might provide significant advantages.

3.5 Study Limitations

The literature review determined the main research themes relevant to the paper's objective: construction, traffic, healthcare, and industrial safety. A limitation in this search for the literature published by Jordanian authors is the inability to apply specific keyword criteria, as this applies only universally. As a result, this could lead to an incomplete or biased selection of relevant works, potentially overlooking significant publications that align with the research focus.

3.6 Distribution of Literature Reviewed

Figure 1 illustrates the distribution of the identified safety research in Jordan, categorized by sectors: traffic, construction, healthcare, and other industries, as well as process safety risk assessment and qualified industrial zones (QIZ). It reveals that Jordanian workers focus primarily on the building sector safety, followed by traffic and road safety.

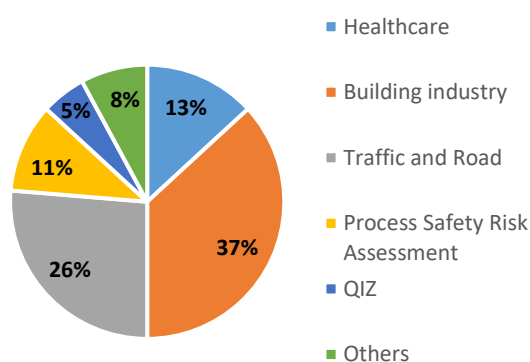


Fig. 1. Reviewed safety research per industry by Jordanian authors.

3.7 An Overview of OHS Research in Jordan Compared to Other Developing Countries

Table 3 compares the safety research in Jordan with Egypt, Saudi Arabia, and the UAE. The selected countries share similar social contexts, making them ideal candidates for comparison in terms of safety research. These countries face common challenges, such as the protection of migrant labor, the integration of safety protocols in expanding industries, and the enforcement of safety regulations. They are also pertinent for this comparison due to their shared cultural, religious, and economic dedication to development. Examining safety research in these countries seeks to uncover insights into the research focus areas and unveil possible collaboration of Jordan regionally.

The table reveals that the UAE is pioneering in research, especially in the construction industry and migrant worker safety, with heavy reliance on technology and proactive measures, which utilize leading and lagging indicators. Egypt still lacks research on performance measurement despite an increasing focus on SMEs and health-related studies, particularly in the building industry. SA is focusing on large-scale construction projects and the oil and gas sector while increasingly engaging in research based on leading indicators. Research in Jordan is still developing and focuses on sectoral (construction and traffic) and national-level research using lagging indicators.

Table 3. Comparison of OHS research in selected Arab countries

Country	Focus Areas	Leading Indicators	Lagging Indicators
Jordan	Sectoral at country level	Lacking	Primarily used at sectoral and national levels
SA ¹	Construction mega projects and oil and gas industries	Becoming more integrated	Heavily used
UAE ²	Construction, migrant worker safety, technological integration (wearables, AI), smart safety monitoring technologies	Heavily used especially in proactive measures for construction safety.	Heavily used particularly in construction and migrant labor sectors
Egypt ³	SMEs, stronger focus on occupational disease prevention and construction industry	Lacking	Strong focus

1 (Choudhry et al., 2023; Halloul, 2023; Kaud et al., 2021; Mosly, 2015; Alolah, 2014; Basahel, 2014; Madbuli et al., 2013)

2 (Balasubramanian et al., 2023; Shanti et al., 2021; Afzal et al., 2021; Al Zarooni, 2024; Zafar et al., 2024; Gupta & Agarwal, 2022)

3 (Zhou et al., 2020; El-Feky et al., 2021; Sehsah et al., 2020; Elsebaei et al., 2021; El-Deeb et al., 2020; Ellaban et al., 2018; Elsafty et al., 2012; Abdalfatah et al., 2023; Elsebaei et al., 2020).

4. Conclusions and Recommendations

The study objective was to explore the works on occupational safety management conducted by Jordanians to reveal gaps that require further investigation.

Studies by Jordanians have primarily concentrated on country and sectoral levels using lagging indicators. There is a notable lack of research on safety within organizations. Additionally, relying solely on surveying and assessing past performance may not accurately reflect the current safety standing, potentially hindering safety enhancements. Studies that connect process safety to individual safety by employing leading and lagging metrics are crucial.

In light of these gaps, policymakers may establish regulations that require organizations to implement OHSM systems for monitoring purposes using both types of PIs.

Studying integrated OHSM systems that employ leading and lagging metrics at the organizational level is essential. Specifically, such research could explore ways to develop a hybrid framework that enhances predictive capabilities while evaluating historical safety performance. This approach would help safety frameworks become more proactive.

Conducting benchmarking studies among local enterprises and their counterparts regionally or internationally to learn from high-performing ones. By examining various approaches and models from developed and developing countries, this research can identify best practices transferable to Jordan's context, particularly at the corporate level.

Assessing the efficiency of OHSM in augmenting organizational safety. One way to attain this is by evaluating the long-term influence of internal policies, leadership, and corporate culture on safety performance. Such a technique can effectively examine how safety outcomes evolve with time.

Carrying out studies on leading and lagging indicators to reveal how process safety initiatives influence personal behaviors and vice versa, to link personal safety to process safety.

CRedit Author Contribution Statement

Al-Waqfi, M. El-Ali: Conceptualization, Writing – original draft, Review & Editing, Data Curation, Methodology.

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Conflicts of Interest

The author declares no conflict of interest.

Nomenclature

Symbol	Description
<i>AI</i>	Artificial Intelligence
<i>EU</i>	European Union
<i>FMEA</i>	Failure Mode and Effects Analysis
<i>GDP</i>	Gross Domestic Product
<i>ILO</i>	International Labour Organization
<i>KPI</i>	Key Performance Indicator
<i>OHS</i>	Occupational Health and Safety
<i>OHSM</i>	Occupational Health and Safety Management
<i>PDCA</i>	Plan-Do-Check-Act
<i>PI</i>	Performance Indicator
<i>QIZ</i>	Qualified Industrial Zones

References

- Abdalfatah, Z., Elbeltagi, E., & Abdelshakor, M. (2023). Safety performance evaluation of construction projects in Egypt. *Innovative Infrastructure Solutions*, 8(240), 1-15. <https://doi.org/10.1007/s41062-023-01181-y>
- Abdelnoor, Y. N. (2019). *Site safety management for the implementation of construction projects in Amman- Jordan* (Master's thesis, Isra University). <https://search.mandumah.com/Record/991129>
- Abu-Khader, M. (2003). Evaluation study of risk assessment procedures for small-scale chemical factories in Jordan. *IChemE symposium series*, (149). Institution of Chemical Engineers (IChemE).
- Ahmed, H., Dennis, J., Badran, O., Ismail, M., Ballal, S.G., Ashoor, A., & Jerwood, D. (2001). Occupational noise exposure and hearing loss of workers in two plants in eastern Saudi Arabia. *The Annals of Occupational Hygiene*, 45(5), 371-380. [https://doi.org/10.1016/S0003-4878\(00\)00051-X](https://doi.org/10.1016/S0003-4878(00)00051-X)
- Afzal, M., & Shafiq, M. (2021). Evaluating 4D-BIM and VR for effective safety communication and training: A case study of multilingual construction job-site crew. *Buildings*, 11(8), 1-24. <https://doi.org/10.3390/buildings11080319>
- Al-Abdallat, E.M., Oqailan, A.M., Al Ali, R., Hudaib, A. A., & Salameh, G.A.M. (2015). Occupational fatalities in Jordan. *Journal of Forensic and Legal Medicine*, 29, 25-29. <https://doi.org/10.1016/j.jflm.2014.11.001>
- Alamsidin, A., Alyahya, M., Suliman, M., Al-Sheyab, N., & ALBashtawy, M. (2023). Perceived patient safety culture among healthcare providers in southern Jordanian hospitals during COVID-19 pandemic. *Jordan Journal of Nursing Research*, 2(1). <https://doi.org/10.14525/JJNR.v2i1.04>
- Alananzeh, O. (2017). The impact of safety issues and hygiene perceptions on customer satisfaction: A case study of four and five star hotels in Aqaba, Jordan. *Journal of Tourism Research & Hospitality*, 6(1), 1-7. <http://dx.doi.org/10.4172/2324-8807.1000161>
- Albaali, G., & Al Saidi, G. (2018). Examining the state of OSH in Jordan. *Asian Journal of Agriculture & Biology*, 6(Special Issue),72-77.
- Albatayneh, O., Gharaibeh, E., Husein, D., Malkawi, D., Jaber, T., & Alomaireyeen, Y. A. (2024). Study on traffic awareness at Jordanian universities: A case study of the German Jordanian University. In *Proceedings of the 4th International Conference: Coordinating Engineering for Sustainability and Resilience* (pp 63-72). *Lecture Notes in Civil Engineering* (Vol. 489). Springer. https://doi.org/10.1007/978-3-031-57800-7_5
- Albsoul, R., Alshyyab, M., Alomari, S., AlHammouri, H., Al-Abed, Z., Kofahi, Z., Atiyeh, R., Alsyoof, R., Jamrah, A., Alkandari, A., Borkoles, E., Alkhalidi, S., & Fitzgerald, G. (2025). Baseline assessment and benchmarking of patient safety culture in Jordan: A cross-sectional study. *Journal of Health Organization and Management*, 39(1), 46-65. <https://doi.org/10.1108/JHOM-02-2024-0066>

- Aljbour, S. (2022). Occupational accidents and work injuries in Jordan's economic sectors between 2010 and 2019. *Jordanian Journal of Engineering and Chemical Industries*, 5(2), 32-45. <https://doi.org/10.48103/jjeci562022>
- Alkasasbeh, M., Mujalli, R., Abudayyeh, O., & Alalhoni, A. (2022). Bayesian network models for evaluating the impact of safety measures compliance on reducing accidents in the construction industry. *Buildings*, 12(11), 1-28. <https://doi.org/10.3390/buildings12111980>
- Al-Kheder, S., Al-Malabeh, A., & Al-Momani, R. (2016). Spatial analysis and transportation system review for tourism areas in Jordan: Ajloun city as a case study. *Jordan Journal of Civil Engineering*, 10(4), 501-514.
- Alkilani, S., Jupp, J., & Sawhney, A. (2013). Issues of construction health and safety in developing countries: A case of Jordan. *The Australasian Journal of Construction Economics and Building*; 13(3), 141-156. <https://doi.org/10.5130/AJCEB.v13i3.3301>
- Almazrouei, M., Khalid, K., Abdallah, S. & Davidson, R. (2020). Assessing the health, safety, and environment culture in the United Arab Emirates oil and gas industry. *Journal of Engineering, Design and Technology*, 18, 495-512. <https://doi.org/10.1108/JEDT-07-2019-0188>
- Alolah, T., Stewart, R., Panuwatwanich, K., & Sherif, M. (2014). Developing a comprehensive safety performance evaluation framework for Saudi schools. *International Journal of Productivity and Performance Management*, 63, 446-476. <http://dx.doi.org/10.1108/IJPPM-05-2013-0096>
- Al-Refaie, A. (2013). Factors affect companies' safety performance in Jordan using structural equation modeling. *Safety Science*, 57, 169-178. <https://doi.org/10.1016/j.ssci.2013.02.010>
- Alshannaq, M., Imam, R., & Alsarayreh, D. (2023). Modelling of traffic accident severity in Jordan using machine Learning. *International Review of Civil Engineering*, 14(5), 373-382. <https://doi.org/10.15866/irece.v14i5.22730>
- AL-Smadi, S., Supeni, E., & Voon, W. (2021). A study on safety and health good practices at construction sector in Jordan. *East African Journal of Engineering*, 3, 57-71. <https://doi.org/10.37284/eaje.3.1.399>
- AlTammemi, A., Altarawneh, S., Abu Ghazaleh, L., Jaradat, T., Abu Judeh, R., Almbaidin, M., & Hasan, H. (2024). Navigating road traffic accidents in Jordan: A retrospective exploration of the health and economic impacts. *Cureus*, 16(5). <https://doi.org/10.7759/cureus.60497>
- Alubaid, F., Alhadeethi, R. H., & Mohamed, R. H. (2020). Assessment the safety policy management for building construction companies in Jordan. *Journal of Applied Engineering Science*, 18 (1), 120-131. <https://doi.org/10.5937/jaes18-23488>
- Al-Waqfi, M. E. (2025). Development of a safety culture assessment tool for Jordanian enterprises. *International Journal of Safety and Security Engineering*, 15(4), 643-651. <https://doi.org/10.18280/ijss.150402>
- Al-Wreidat, A., & Rababa, A. (2011). *Working conditions for migrant workers in the qualifying industrial zones of the Hashemite Kingdom of Jordan*. (CARIM Research Report). Consortium for Applied Research on International Migration.
- Alzarooni, A. O. (2024). Enhancing safety management in UAE construction sites through site manager performance evaluation. *JES*, 20(4s), 2129–2138. <https://doi.org/10.52783/jes.2319>
- Amrina, E., & Yusof, S. M. (2011). Key performance indicators for sustainable manufacturing evaluation in automotive companies. In *Proceedings of the IEEE International Conference on Industrial Engineering and Engineering Management* (pp 1093-1097). IEEE. <https://doi.org/10.1109/IEEM.2011.6118084>
- Ashour, A. & Hassan, Z. (2019). The role of the work environment on the safety performance and safety management practices: Its influence on the attitudes of nurses in the Jordanian hospitals. *American Journal of Applied Sciences*, 16(11), 314-326. <https://doi.org/10.3844/ajassp.2019.314.326>
- Assbeihat, J. M. (2015). Construction safety in Jordan – conditions and obstacles. *International Journal of Operations and Logistics Management*, 4(3), 193-203.
- Balasubramanian, S., Shukla, V., Islam, N., Upadhyay, A., & Duong, L. (2023). Applying artificial intelligence in healthcare: lessons from the COVID-19 pandemic. *International Journal of Production Research*, 63(2), 594–627.. <https://doi.org/10.1080/00207543.2023.2263102>
- Basahel, A. (2021). Safety leadership, safety attitudes, safety knowledge and motivation toward safety-related behaviors in electrical substation construction projects. *International Journal of Environmental Research and Public Health*, 18(8), 4196. <https://doi.org/10.3390/ijerph18084196>
- Choudhry, R., Zafar, I., & Almatawa, M. (2023). Proactive approach to measure safety management on building projects in Saudi Arabia. *Advances in Civil Engineering*, 2023(1), 1-17. <https://doi.org/10.1155/2023/6306157>
- Dababneh, A., Fouad, R., & Majeed, A. H. (2018). Assessment of occupational safety and health performance Indicators for Jordan. *Journal of Fundamental and Applied Sciences*, 10(6S), 162-169. <https://doi.org/10.4314/jfas.v10i6s.111>
- EL-Deeb, A., Ibrahim, A.H., & Basha, I. (2020). Minimum requirement for safety acts in Egyptian construction market. *International Journal of Scientific & Technology Research*, 9(11), 290-296.
- El-Feky, A. A., Kabbash, I.A., & Zayet, H. (2021). Health disorders and safety measures among workers in Tanta Flax and Oil Company, Egypt. *Environmental Science and Pollution Research*, 28, 13981–13990. <https://doi.org/10.1007/s11356-020-11588-0>
- Ellaban, M., Rady, M., Hebat Allah, G., & Mostafa, N. (2018). Risk perception and occupational accidents among a group of Egyptian construction workers in a construction company in Cairo. *Medical Integrated Student Research Journal*, 1, 9-18. <https://doi.org/10.21608/misrj.2018.12811>
- El-Mashaleh, M., Rababeh, S., & Hyari, K. (2010a). Utilizing data development analysis to benchmark safety performance of construction contractors. *International Journal of Project Management*, 28(1), 61-67. <https://doi.org/10.1016/j.ijproman.2009.04.002>
- El-Mashaleh, M. S., Al-Smadi, B., Hyari, K. H., & Rababeh, S. M. (2010b). Safety Management in the Jordanian Construction Industry.

- Jordan Journal of Civil Engineering*, 4(1), 47–54.
- El-nagar, R., Hosny, H., & Askar, H. (2015). Development of a safety performance index for construction projects in Egypt. *American Journal of Civil Engineering and Architecture*, 3(5), 182-192. <http://pubs.sciepub.com/ajcea/3/5/5>
- ElSafty, A., & Malek, M. (2012). Construction safety and occupational health education in Egypt, the EU, and US firms. *Open Journal of Civil Engineering*, 2(3), 174-182. <http://dx.doi.org/10.4236/ojce.2012.23023>
- Elsebaei, M.A., Elnawawy, O., Othman, A. A., & Badawy, M. (2021). A framework to activate the health and safety regulations in the Egyptian construction industry. *Journal of Engineering, Design and Technology*, 19(5), 1158-1191. <https://doi.org/10.1108/JEDT-05-2020-0194>
- Elsebaei, M., Elnawawy, O., Othman, A., & Badawy, M. (2020). Elements of safety management system in the construction industry and measuring safety performance – A brief . *IOP Conference Series. Materials Science and Engineering*, 974, 1-11. <https://dx.doi.org/10.1088/1757-899X/974/1/012013>
- Grabowski, M., Ayyalasomayajula, P., Merrick, J., Harrald, J. R., & Roberts, K. (2007). Leading indicators of safety in virtual organizations. *Safety Science*, 45(10), 1013-1043. <https://doi.org/10.1016/j.ssci.2006.09.007>
- Gupta, B., & Agarwal, R. (2022). Strategic performance measurement system and its impact on organizational effectiveness: A study of United Arab Emirates based organizations. *European Journal of Business and Management Research*, 7(3), 266-276. <https://doi.org/10.24018/ejbmr.2022.7.3.1452>
- Jadaan, K., Al-Braizat, E., Al-Rafayah, S., Gammoh, H., & Abukahlil, Y. (2018). Traffic safety in developed and developing countries: A comparative analysis. *Journal of Traffic and Logistics Engineering*, 6(1), 1-5.
- Jadaan, K., & Braizat, E. (2017). Best practice approach for a national road safety strategy. *International Journal of Research in Chemical, Metallurgical and Civil Engineering*, 4(1), 2349-1450. <https://doi.org/10.15242/IJRCMCE.H0117301>
- Jildeh, N., & Matouq, M. (2021). Process safety management strategies and risk assessment. *Jordanian Journal of Engineering and Chemical Industries*, 4(2), 52-61. <https://doi.org/10.48103/jjeci472021>
- Hale, A. (2009). Why safety performance indicators?. *Safety Science*, 47(4), 479-480.
- Halloul, A. H. (2023). *Relationships between leading and trailing indicators at construction sites in Yanbu industrial city, Saudi Arabia* (Doctoral dissertation, University of South Florida). <https://digitalcommons.usf.edu/etd/9876>
- Hassan, Z., & Alekam, J. M. (2018). A conceptual framework for upgrading safety performance by influence safety training, management commitment to safety and work environment: Jordanian hospitals. *IJBSR*, 8(07), 25-35.
- Hassanein, A., & Hanna, R. (2008). Safety performance in the Egyptian construction industry. *Journal of Construction Engineering and Management*, 134(6), 2-9. [https://doi.org/10.1061/\(ASCE\)0733-9364\(2008\)134:6\(451\)](https://doi.org/10.1061/(ASCE)0733-9364(2008)134:6(451))
- Health and Safety Authority. (2013, May 22). *Summary of workplace injury, illness and fatality statistics 2011-2012*. <https://www.hsa.ie>
- Hinze, J., & Hallowell, M. (2013). *Going beyond zero using safety leading indicators*. Construction Industry Institute, University of Texas at Austin.
- Kaud, Y., Lydon, S., & O'Connor, P. (2021). Measuring and monitoring patient safety in hospitals in Saudi Arabia. *BMC Health Services Research*, 21, 1224, 1-12. <https://doi.org/10.1186/s12913-021-07228-z>
- Khrais, S., Al-Araidah O, Aweisi A. M., Elias F., & Al-Ayyoub, E. (2013). Safety practices in Jordanian manufacturing enterprises within industrial estates. *International Journal of Injury Control and Safety Promotion*, 20(3), 227-238. <https://doi.org/10.1080/17457300.2012.686043>
- Khrais, S.K., Yared, T.E., Saifan, N.M., Al-Hawari, T.H., & Dweiri, F. (2024). Occupational safety assessment for surface mine systems: The case in Jordan. *Safety*, 10(40), 1-13. <https://doi.org/10.3390/safety10020040>
- Magableh, F., Al Matawah, J., & Freeman, B. (2021). Investigating the impact of income, belief and culture on road safety. *American Journal of Traffic and Transportation Engineering*, 6(3), 81-94. <https://doi.org/10.11648/j.ajtte.20210603.13>
- Manuele, F. A. (2009). Leading & lagging indicators. *Professional Safety*, 54(12), 28-33.
- Mengolini, A., & Debarberis, L. (2008). Effectiveness evaluation methodology for safety processes to enhance organisational culture in hazardous installations. *Journal of hazardous materials*, 155(1), 243-252. <https://doi.org/10.1016/j.jhazmat.2007.11.078>
- Mosly, I. (2015). Safety performance in the construction industry of Saudi Arabia. *International Journal of Construction Engineering and Management*, 4, 238-247. <http://dx.doi.org/10.5923/j.ijcem.20150406.03>
- Noweir, M., Alidrisi, M. M., Al-Darrab, I., & Zytoon, M. (2013). Occupational safety and health performance of the manufacturing sector in Jeddah Industrial Estate, Saudi Arabia: A 20-years follow-up study. *Safety Science*, 53, 11-24. <https://doi.org/10.1016/j.ssci.2012.09.005>.
- Obaidat, T. A., Bandura, F., & Al-Masaeid, H. R. (2012). Traffic safety at roundabout in urban areas– case study in Jordan. In *Proceedings of the 5th Jordanian international civil engineering conference*. jea.
- Peterson, D. (1998). What measures should we use and why?. *Professional Safety*, 42(10), 37-40.
- Rajendran, S., & Gambatese, J. A. (2009). Development and initial validation of sustainable construction safety and health rating system. *Journal of Construction Engineering and Management*, 135(10), 1067-1075. [https://doi.org/10.1061/\(ASCE\)0733-9364\(2009\)135:10\(1067\)](https://doi.org/10.1061/(ASCE)0733-9364(2009)135:10(1067))
- Rbehat, D., Al-Waqfi, M.S., & Al-Jarrah, J. (2023). Qualitative risk assessment in water bottling production: A case study of Maan Nestlé Pure Life factory. *International Journal of Safety and Security Engineering*, 13(6), 1025-1038. <https://doi.org/10.18280/ijssse.130605>
- Reiman, T., & Pietikäinen, E. (2012). Leading indicators of system safety—monitoring and driving the organizational safety potential. *Safety science*, 50(10), 1993-2000. <https://doi.org/10.1016/j.ssci.2011.07.015>

- Salamah, E., El-Hasan, T., & Abu-Jamah, M. (2023). Dam safety in Jordan: Factors affecting dam safety, responsibilities and required actions. *Engineering*, 15, 514-532. <https://doi.org/10.4236/eng.2023.159038>
- Sarireh, M., & Tarawneh, S. (2014). Safety concept, value and cost in construction projects in Jordan. *Civil and Environmental Research*, 6(5), 60-71.
- Sehsah, R., El-Gilany A. H., & Ibrahim, A. M. (2020). Personal protective equipment (PPE) use and its relation to accidents among construction workers. *Medicina del Lavoro*, 111(4), 285-295. <https://doi.org/10.23749/mdl.v111i4.9398>
- Shabeeb, L., & Awad, W. (2016). Road traffic safety perception in Jordan. *Cogent Engineering*, 3(1), 1127748. <https://doi.org/10.1080/23311916.2015.1127748>
- Shanti, M. Z., Cho, C. S., Byon, Y. J., Yeun, C. Y., Kim, T. Y., Kim, S. K., & Altunaiji, A. (2021). A novel implementation of an AI-based smart construction safety inspection protocol in the UAE. *IEEE Access*, 9, 166603-166616. <https://doi.org/10.1109/ACCESS.2021.3135662>
- Shaqadan, A. (2021). Developing framework for safety analysis and risk assessment in construction site environment in Jordan. *Global Change Peace & Security*.
- Shotar, A., Alzyoud, S., Obeidat, J., & Alhawamdeh, K. (2014). Road traffic accidents casualties in the north of Jordan: An epidemiological study. *European Scientific Journal*, 10(26), 262-268. <https://doi.org/10.19044/esj.2014.v10n26p%25p>
- Stricoff, R. S. (2000). Safety performance measurement: Identifying prospective indicators with high validity. *Professional Safety*, 45(1), 36-39.
- Tayseer, R. (2023, April 28). Workplace injuries occur once every 25 minutes in Jordan, report reveals. *The Jordan times*, <https://www.jordantimes.com>
- Toellner, J. (2001). Improving safety & health performance: Identifying & measuring leading indicators. *Professional Safety*, 46(9), 42-47.
- Tomlinson, C. M., Craig, B. N., & Meehan, M. J. (2011). Enhancing safety performance with a leading indicators program. In *Proceedings of the Royal Institution of Naval Architects (RINA): International Conference on Human Factors in Ship Design and Operations* (pp 1-8). The Royal Institution of Naval Architects. <https://doi.org/10.3940/rina.hf.2011.06>
- Zafar, K., Bahri, S., Tamrin, M., Hamedon, T., & Ahsan, M. (2024). Relationship between safety climate and safety performance of migrant workers in Abu Dhabi's construction industry. *Malaysian Journal of Medicine and Health Sciences*, 20(2), 158-167. <https://doi.org/10.47836/mjmhs.20.2.21>
- Zhou, L., Xie, L. Z., & Han, L. (2020). Analysis of occupational health in Egypt. *Chinese Journal of Industrial Hygiene and Occupational Diseases*, 38(4), 304-306. <https://doi.org/10.3760/cma.j.cn121094-20190428-00173>