



# Preventing the Fall

## Global Innovation in Fall-From-Height Safety Technologies

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## **About this briefing paper**

This briefing paper is part of a series developed under the Global Initiative for Industrial Safety (GIFIS), led by Lloyd's Register Foundation, Cambridge Industrial Innovation Policy (CIIP), and the United Nations Industrial Development Organization (UNIDO).

This paper provides an expert analysis of technology development related to fall-from-height risks, drawing on patent evidence from the WIPO Patent Landscape Report on Occupational Health and Safety. It has been prepared to support the broader GIFIS community by providing structured insight into how patented technologies are evolving to address fall-related safety risks.

Drawing on expert input, the paper is intended to inform practitioners, policymakers, researchers, and technology developers interested in safer work-at-height practices and the role of innovation in industrial safety.

This paper has not undergone formal editorial review by Lloyd's Register Foundation or GIFIS, and the views expressed do not necessarily reflect the official positions of these organisations. References to firm names, patent examples, or commercial products do not imply endorsement by the authors, GIFIS, or Lloyd's Register Foundation.

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# Key messages

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- **Falls from height remain a critical industrial safety risk**, especially in sectors where work at elevation is routine, such as construction, manufacturing, utilities, mining, and logistics.
- **This report analyses more than 19,000 patent records** relating to fall-from-height safety technologies, drawing on the WIPO Patent Landscape Report on Occupational Health and Safety.
- **The analysis classifies technologies into four categories:**  
**Prevention** removes or reduces exposure to height-related risks; **Precaution** reduces the likelihood of falls during operations and the severity of their consequences; **Prediction** anticipates risks using data and analytics; and **Protection** reduces injury severity after a fall.
- **Patent activity is dominated by Precaution technologies**, especially fall-arrest systems, scaffolds, ladders, working platforms, guardrails, and anchoring systems. This shows that innovation remains concentrated on managing risks where workers still operate at height.
- **Prevention and Prediction technologies remain smaller but are emerging**, including robotics, remote inspection, monitoring tools, and predictive analytics. Their growth points to a gradual shift towards more proactive, data-enabled, and exposure-reducing safety approaches.
- **Construction is the primary application sector**, reflecting its high exposure to height-related hazards. Manufacturing, healthcare, logistics, agriculture, and mining show smaller but relevant patent activity.
- **China leads in both patent volume and recent momentum**, while South Korea and the United States show notable activity in emerging digital and predictive technologies. Europe and Japan appear more concentrated in mature, incremental innovation areas.
- **Future fall-risk management is likely to combine traditional safety hardware with sensing, analytics, automation, and remote operation**, moving from equipment-based protection towards more integrated and preventive safety systems.

# 1. Why falls from height remain a critical industrial safety risk

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Occupational safety and health remains a major global challenge. Each year, more than 2.93 million people die from work-related causes, while an estimated 395 million workers suffer non-fatal occupational injuries.<sup>1</sup> Within this wider burden, falls from height represent one of the most severe and persistent categories of industrial safety risk, particularly in sectors where vertical exposure is embedded in daily operations. According to a joint report by the World Health Organization (WHO) and the International Labour Organization (ILO), nearly 35,000 deaths in 2016 were caused by falls resulting from work-related conditions.<sup>2</sup>

Falls from height are especially relevant in industries such as construction, manufacturing, utilities, mining, and logistics, where workers frequently operate on scaffolds, ladders, rooftops, elevated platforms, storage systems, and other raised structures. These environments expose workers to risks that can result in fatal injuries, long-term disability, operational disruption, and significant economic costs. International safety organisations, including the Occupational Safety and Health Council (OSHC), emphasise that work at height requires rigorous hazard identification, appropriate safety precautions, and continuous risk control to prevent serious injuries and fatalities.<sup>3</sup>

The importance of this risk area is also reflected in sustained innovation activity. According to the 2025 WIPO Patent Landscape Report on Occupational Health and Safety, more than 19,000 patented technologies filed between 2004 and 2024 specifically address fall protection.<sup>4</sup> This substantial volume of patenting activity indicates that falls from height are not a marginal safety issue, but a structural and innovation-intensive challenge within industrial systems.

Taken together, the scale of consequences, breadth of sectoral exposure, and intensity of technology development all point to the need for a focused assessment of fall-from-height risks. A dedicated technology landscape analysis, therefore, could provide structured insight into how solutions are evolving, how different technologies contribute to risk mitigation, and where future safety gains may be achieved.

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<sup>1</sup> International Labour Organization (ILO), *A Call for Safer and Healthier Working Environments*, Geneva: ILO, 2023.

<sup>2</sup> WHO and ILO (2021). WHO/ILO joint estimates of the work-related burden of disease and injury, 2000-2016: global monitoring report

<sup>3</sup> Occupational Safety and Health Council, “Work at Height”, [OSHC website](#).

<sup>4</sup> World Intellectual Property Organization (WIPO), *Patent Landscape Report: Occupational Health and Safety*, Geneva: WIPO, 2025, <https://www.wipo.int/web-publications/patent-landscape-report-occupational-health-and-safety-ohs/en/index.html>

## 2. Patent-based insights into technology development

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This section examines how technological innovation addressing fall-from-height risks evolved between 2004 and 2024, and how different technological approaches contribute to risk mitigation.

The analysis draws on a large-scale patent dataset comprising more than 19,000 patent records relating to fall-from-height safety technologies. These records were identified from the WIPO Patent Landscape Report on Occupational Health and Safety and further enriched using The Lens database. A large language model (LLM) was then used to extract and classify technological features based on information contained in patent abstracts and technical descriptions.

### 2.1. Technology classification for fall-from-height solutions

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To provide a structured view of the technology landscape, this report adopts a classification approach informed by the white paper published by the Global Initiative for Industrial Safety (GIFIS).<sup>5</sup> As shown below, patents are classified into four primary categories: Prevention, Precaution, Prediction, and Protection. These categories reflect different approaches to managing fall-related risks, ranging from eliminating exposure to height-related hazards to reducing injury severity through personal protective equipment (PPE).

Alongside these four categories, more granular sub-categories were developed inductively based on the observed patent content. In particular, the high-volume categories of Precaution and Protection were further refined by grouping recurring technical solutions identified in patent descriptions.

- **Prevention** refers to technologies that eliminate or reduce exposure to height-related risks, typically through automation or robotics.
  - Robotics
- **Precaution** includes technologies that reduce both the likelihood of falls during operations and the severity of their consequences. These are primarily structural and equipment-based safety solutions, such as scaffolds, guardrails, anchoring systems, monitoring tools, and fall-arrest devices.
  - Guardrails
  - Scaffolds
  - Anchoring systems

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<sup>5</sup> GIFIS (2026). [Making safety tech work: A practical framework for identifying and selecting safety technology solutions for industry](#)

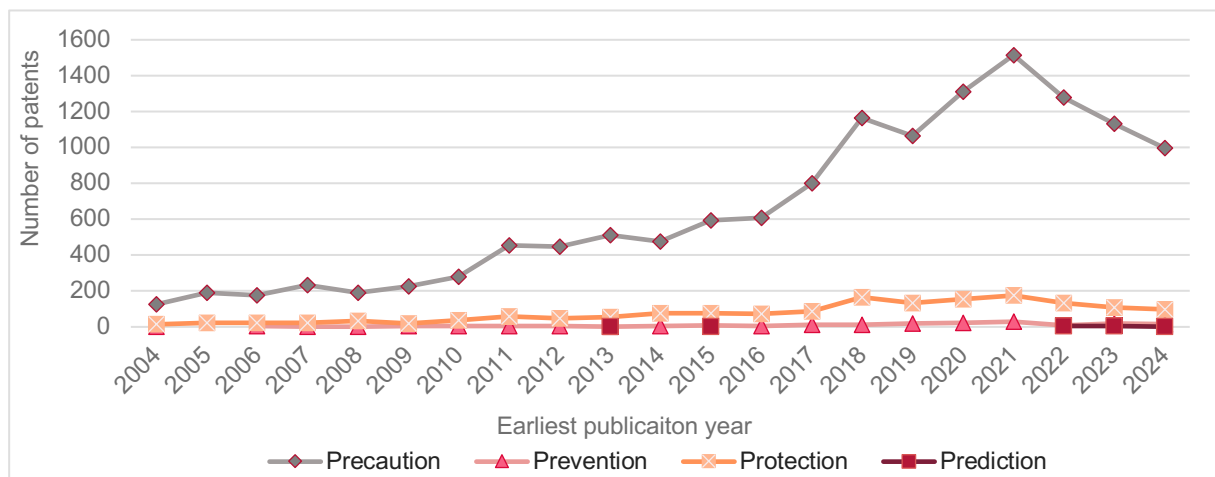
- Monitoring tools
- Fall-arrest systems
- **Prediction** captures data-driven technologies that identify and anticipate risks before incidents occur, including monitoring systems, sensors, and predictive analytics. These technologies primarily contribute to reducing the likelihood of falls.
  - Prediction
- **Protection** focuses on reducing injury severity after a fall has occurred, including impact-mitigation systems and personal protective equipment (PPE).
  - PPE
  - Impact Mitigation

This approach provides a practical analytical framework for examining how different technologies contribute to eliminating hazards, reducing exposure, anticipating risks, and mitigating injuries associated with falls from height.

## 2.2. Key patent trends

Figure 1 illustrates the evolution of patent activity related to fall-from-height safety technologies between 2004 and 2024, grouped according to the four technology categories applied in this report: Prevention, Precaution, Prediction, and Protection.

**FIGURE 1** TRENDS IN FALL-FROM-HEIGHT PATENTS BY TECHNOLOGY CATEGORY



**Source:** Author’s analysis based on patent information from the [WIPO Patent Landscape Report on Occupational Health and Safety](#)

Patent activity has grown substantially over the past two decades. The total number of annual patents increased from fewer than 200 in the early 2000s to a peak of nearly 1,800 around 2021. This upward trend reflects growing global attention to occupational safety risks and the role of technological innovation in addressing height-related hazards.

Precaution technologies dominate the fall-from-height patent landscape. Across the full period, they account for the largest share of patent activity by a wide margin. These technologies include engineering and equipment-based solutions designed to reduce the likelihood of falls during operations, such as fall-arrest systems, scaffolds, ladders, working platforms, and guardrails. Their dominance suggests that most innovation efforts continue to focus on improving safety within existing work environments through structural and operational safeguards.

Prevention and prediction technologies remain emerging areas. Patent activity in these categories is still relatively limited, covering technologies such as robotics and remote inspection systems that reduce human exposure to height-related risks, as well as monitoring and predictive analytics tools that anticipate fall hazards. Their smaller presence indicates that the current patent landscape remains largely centred on improving safety in situations where human presence at height is still required, or on mechanical and structural safety solutions. By contrast, automation- and data-driven approaches are still developing as potentially important areas of future innovation.

Protection technologies play a smaller but important role. These patents mainly focus on reducing injury severity after a fall has occurred, including impact-mitigation systems and personal protective equipment. Although they account for a smaller share of overall patenting, they remain important where fall risks cannot be fully eliminated or prevented.

### 2.3. Interpreting the technology landscape

Table 1 presents the distribution of patents related to fall-from-height safety technologies, using the classification framework developed in this report. The patent landscape is highly concentrated in precaution-oriented technologies, which account for the majority of innovation activity. On the other hand, technologies focused on hazard elimination (Prevention) or data-driven risk prediction represent only a small share of the patent landscape.

**TABLE 1** INTERPRETING THE TECHNOLOGY LANDSCAPE OF FALL-FROM-HEIGHT SAFETY SOLUTIONS

Tech categories	Sub-categories	Number of patents (2004-2024)
Prevention	Robotics	179
	Fall-arrest systems	6860
Precaution	Scaffolds	4427
	Guardrails	1423
	Anchoring systems	631
	Monitoring tools	543
Prediction	Prediction	11
Protection	Impact mitigation	1459
	PPE	163

**Source:** Author’s analysis based on patent information from the [WIPO Patent Landscape Report on Occupational Health and Safety](#)

- **Prevention technologies**

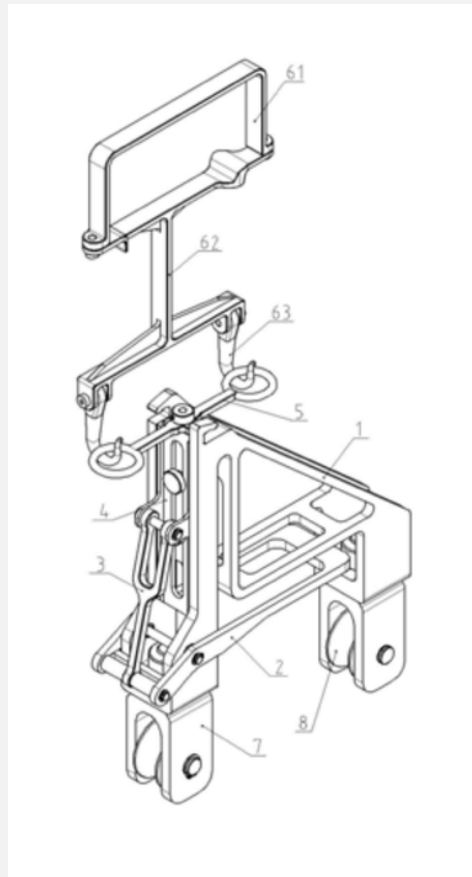
Prevention technologies appear only marginally in the dataset. The main relevant technology area is robotics and exposure elimination, referring to solutions that remove workers from hazardous work-at-height tasks by replacing human exposure with automated or remotely operated systems.

**BOX 1 PATENT EXAMPLE: ROBOTIC INSPECTION SYSTEM FOR HIGH-VOLTAGE TRANSMISSION LINES**

**Category:** Prevention \_ Robotics

**Patent title:** Power transmission line high-altitude anti-falling device convenient for unmanned aerial vehicle installation and installation method thereof

**Patent number:** CN113054588



**What is the patent about:** This patent describes a robotic system for inspecting and maintaining high-voltage transmission lines. Instead of requiring workers to climb towers or operate at height, the robot performs inspection tasks autonomously. By removing workers from hazardous elevated environments, the invention eliminates direct exposure to fall risks. This makes it a clear example of Prevention, where automation and robotics address the hazard at its source.

- **Precaution technologies**

Precaution technologies dominate the patent landscape, accounting for the overwhelming majority of patents. Within this category, innovation is concentrated in a small number of core technology areas:

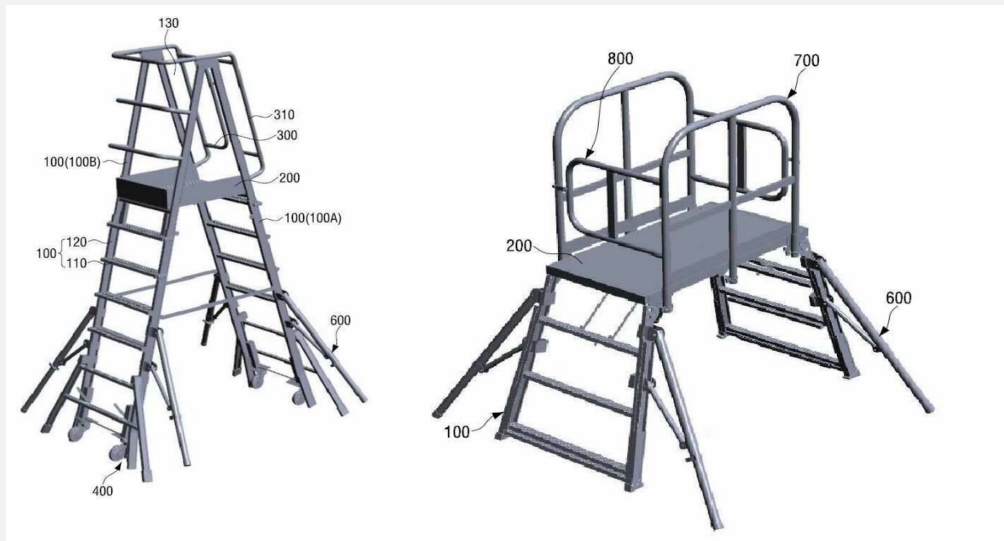
- **Fall-arrest systems** (approx. 49%)  
Systems designed to stop a worker after a fall has begun, including harnesses, lifelines, and self-retracting devices. This is the largest sub-category, indicating a strong focus on mitigating fall incidents during work at height.
- **Scaffolds, ladders and working platforms** (approx. 32%)  
Structural access solutions that provide stable working environments for tasks performed at height. Their prominence reflects the continuing importance of infrastructure-based safety in height-exposed industries.
- **Guardrails and edge protection** (approx. 10%)  
Physical barrier systems designed to prevent workers from falling from edges, including guardrails, fences, and parapet extensions. These solutions focus on preventing exposure to edge-related fall hazards.
- **Anchoring and connector systems** (approx. 5%)  
Structural attachment components that secure workers or equipment to stable points, including anchor points, clamps, and connectors. These systems play a supporting role in enabling fall-arrest and restraint mechanisms.
- **Monitoring and smart detection** (approx. 4%)  
Sensor-based and wearable technologies that detect unsafe behaviours or hazardous conditions in real time, including IoT devices and camera-based monitoring systems.

Together, fall-arrest systems and access infrastructure, including scaffolds, ladders, and working platforms, account for more than 80% of precaution-related patents. This indicates that innovation remains heavily concentrated on equipment-based solutions that manage risks during operations, rather than on technologies that eliminate exposure or predict incidents before they occur.

**Category:** Precaution \_ Scaffolds

**Patent title:** Safety ladders for preventing overturn

**Patent number:** KR10-2028043



**What is the patent about:** This patent describes a fall-protection safety device designed for elevated workplaces. Under normal operating conditions, the system functions as a protective barrier structure that restricts workers' movement near hazardous edges and reduces the likelihood of accidental falls. If a worker loses balance or slips, the device can physically intercept the falling body and provide a degree of impact buffering, preventing the worker from directly hitting the ground.

By combining structural fall prevention with physical interception during a fall, the invention provides a dual safety function that both reduces fall risk and mitigates potential injuries. The system therefore represents a precautionary protection technology, where safety is enhanced through integrated structural safeguards at elevated work sites.

- **Prediction technologies**

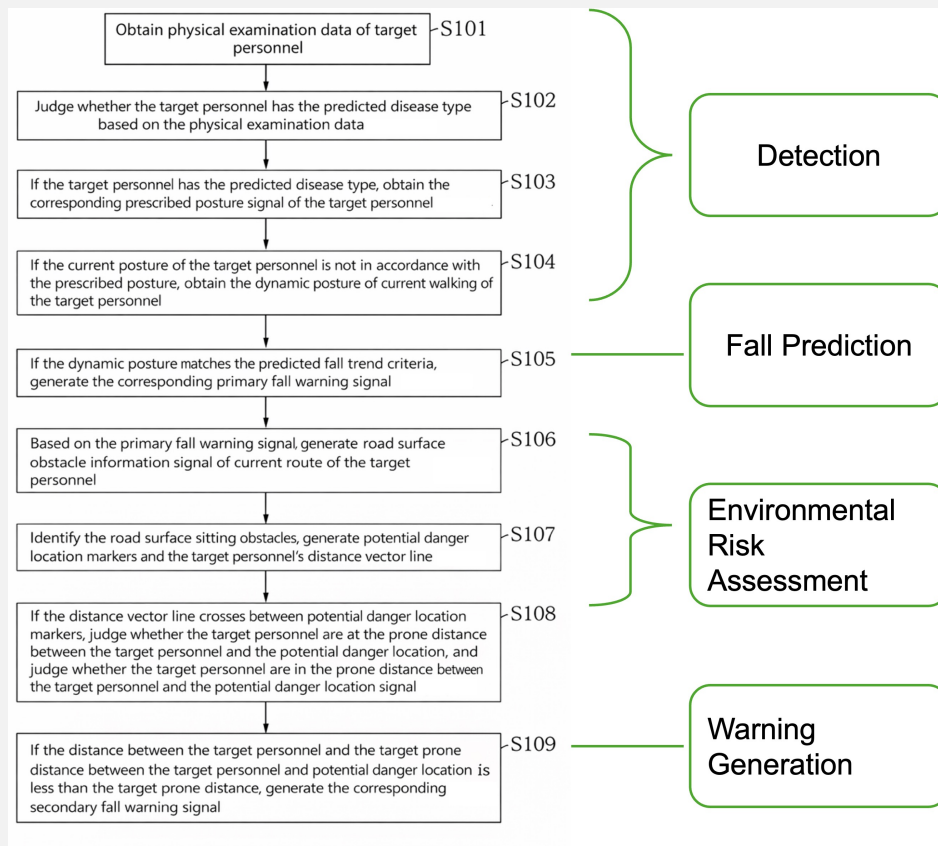
Prediction technologies remain at an early stage of development. The main relevant technology area is prediction and risk analytics, referring to data-driven systems that anticipate safety risks before accidents occur. Examples include predictive risk models, machine-learning safety analytics, and early-warning systems.

**BOX 3 DATA-DRIVEN FALL-RISK PREDICTION SYSTEM**

**Category:** Prediction \_ risk analytics

**Patent title:** Fall pre-judging method, system, terminal equipment and storage medium

**Patent number:** CN116229675



**What is the patent about:** This invention proposes a data-driven system designed to predict fall risks before accidents occur. By analysing environmental and behavioural data collected through sensors or monitoring devices, the system assesses potential fall hazards and generates early warnings when unsafe conditions are detected. The invention reflects an emerging direction in occupational safety, in which data analytics and intelligent monitoring technologies are used to anticipate risks in advance, rather than relying solely on mechanical safety devices or post-incident responses.

- **Protection technologies**

Protection technologies represent a smaller but still significant share of the overall patent landscape. These technologies focus on reducing injury severity after a fall has occurred, rather than preventing the fall itself. Within this category, two main sub-categories can be identified:

- **Impact-mitigation and cushioning systems** (approx. 90%)  
Technologies designed to reduce the force of impact during a fall, including safety nets, airbags, and shock-absorbing structures. This is the largest sub-category within protection, indicating a strong focus on limiting physical harm at the point of impact.
- **Personal protective equipment** (approx. 10%)  
Wearable safety equipment, such as helmets and protective clothing, designed to protect specific parts of the body during a fall. Although widely used in practice, PPE accounts for a smaller share of patent activity compared with impact-mitigation systems.

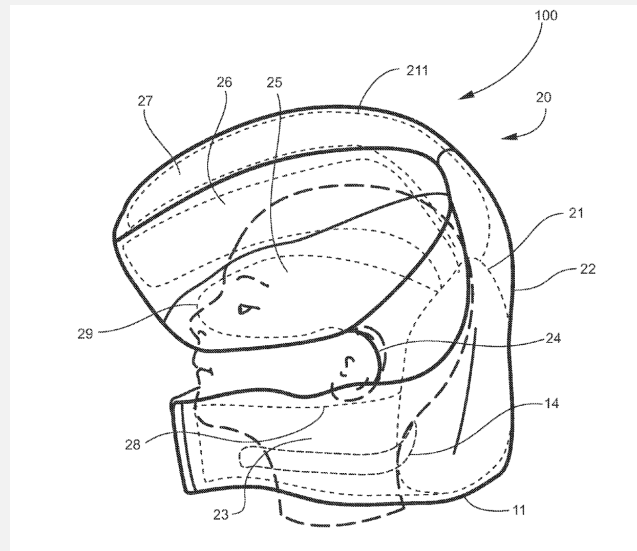
Protection-related innovation is heavily concentrated in impact-mitigation solutions, suggesting that technology development in this area focuses more on system-level cushioning mechanisms than on wearable protection.

**BOX 4** WEARABLE AIRBAG HELMET FOR FALL IMPACT PROTECTION

**Category:** Protection \_ PPE

**Patent title:** Dual functioning head protection device

**Patent number:** US20200288808

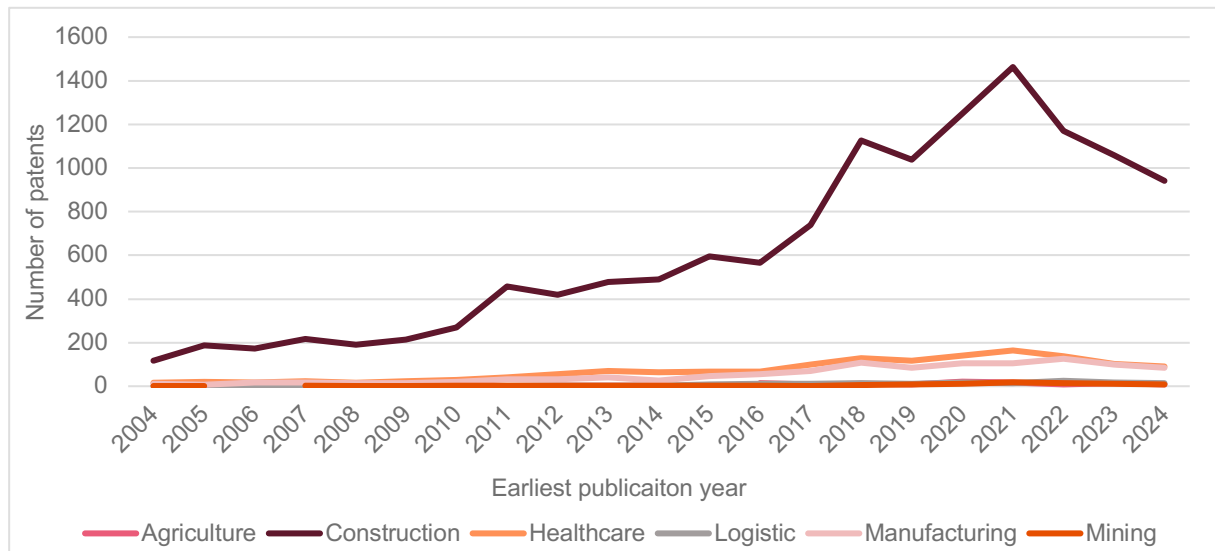


**What is the patent about:** This patent describes a wearable head-protection device designed to reduce injuries caused by sudden falls. The system consists of a neck-mounted collar containing an expandable airbag helmet that automatically deploys when a fall is detected. Upon activation, the airbag inflates around the user's head within milliseconds, forming a protective cushion that absorbs impact energy. In addition, the collar compresses the jugular veins to increase cranial blood volume, helping to reduce brain movement inside the skull during impact.

## 2.4. Industrial distribution

The industry classification used in this analysis follows the approach proposed in the WIPO Patent Landscape Report on Occupational Health and Safety.<sup>6</sup> Based on information provided in patent abstracts and application contexts, each patent was then assigned to a primary industry category reflecting its most likely area of application. As shown in Figure 2, innovation patterns are strongly shaped by sector-specific operational risks.

**FIGURE 2** PATENT TRENDS IN FALL PROTECTION TECHNOLOGIES BY INDUSTRY



**Source:** Author's analysis based on patent information from the [WIPO Patent Landscape Report on Occupational Health and Safety](#)

The construction sector overwhelmingly dominates the technology landscape. Across the full period, construction accounts for the majority of patent activity, reflecting the fact that work at height is a routine and high-risk feature of construction operations. Patent filings in this sector grew consistently and peaked in the early 2020s, before showing a slight decline in the most recent years. This decline is likely to reflect the typical 18-month patent publication lag, suggesting that recent activity may be under-represented rather than indicating a genuine slowdown in innovation.

Manufacturing and healthcare show moderate increases in patent activity over time, indicating that fall-related safety technologies are also relevant to industrial maintenance, facilities management, and certain healthcare contexts. Logistics, agriculture, and mining remain relatively minor contributors,

<sup>6</sup> World Intellectual Property Organization (WIPO), *Patent Landscape Report: Occupational Health and Safety*, Geneva: WIPO, 2025, <https://www.wipo.int/web-publications/patent-landscape-report-occupational-health-and-safety-ohs/en/index.html>

although they show occasional innovation activity linked to specific use cases such as warehouse operations, agricultural machinery maintenance, and mining infrastructure.

**TABLE 2** TECHNOLOGY DISTRIBUTION OF FALL PROTECTION PATENTS BY INDUSTRY

Technology categories	Sub-categories	Industries					
		Agriculture	Const.	Healthcare	Logistic	Mfg.	Mining
Prevention	Robotics	1	125	42	4	7	0
Precaution	Guardrails	3	1355	4	8	49	4
	Scaffolds	102	3847	78	83	273	44
	Anchoring systems	1	540	12	4	70	4
	Monitoring tools	0	232	277	6	25	3
	Fall-arrest systems	8	5749	530	41	504	28
Prediction	Prediction	0	1	11	0	0	0
Protection	PPE	1	46	93	0	21	2
	Impact Mitigation	4	1053	323	9	64	6

**Source:** Author’s analysis based on patent information from the [WIPO Patent Landscape Report on Occupational Health and Safety](#)

Table 2 further illustrates the distribution of fall-from-height safety technologies across major industrial sectors. Within construction, fall-arrest systems and access infrastructure, including scaffolds, ladders, and working platforms, represent the largest technology areas. This reinforces the finding that the current patent landscape is dominated by structural and equipment-based solutions designed to manage fall risks during operations.

Other sectors, including manufacturing, healthcare, logistics, agriculture, and mining, account for smaller shares of patent activity. However, their presence indicates that fall-from-height risks extend beyond construction and are relevant in diverse industrial contexts, including maintenance, warehousing, machinery access, patient handling, and infrastructure inspection.

Digital and automation-oriented safety technologies, such as monitoring systems, predictive analytics, and robotics, appear across several sectors but remain underrepresented. This suggests that the current innovation landscape is still largely centred on mechanical safety solutions, while digitally enabled and data-driven approaches remain emerging areas with potential for future growth.

## 2.5. Jurisdictional distribution

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The jurisdictional distribution of fall-from-height safety technologies (Figure 3) shows that competitive positioning is shaped not only by the volume of patent activity, but also by the timing and momentum of that activity. Emerging technology areas tend to show lower overall patent volumes but stronger recent growth, while mature technology domains show the opposite pattern: large, accumulated patent portfolios but more incremental recent development.

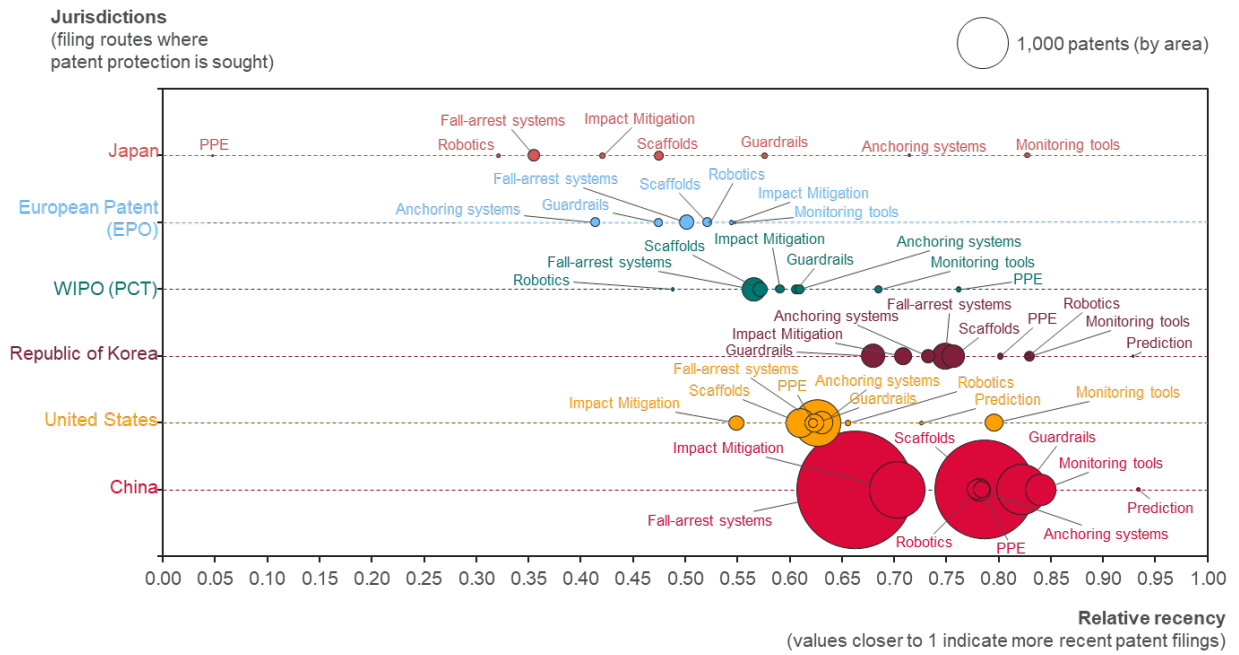
China dominates both the scale and recent momentum of patent activity across most fall-from-height safety technologies. It leads in total patent volume across nearly all categories and also shows strong recent filing activity. This suggests a dual advantage: a large existing technology base combined with sustained innovation, particularly in core safety systems such as fall-arrest devices and scaffolding.

Europe and Japan reflect mature innovation systems with more limited recent acceleration. Both show relatively lower patent volumes and slower recent growth in several categories, especially in traditional protection technologies. This suggests that their innovation activities are more incremental and historically established, with fewer signs of rapid expansion compared with leading jurisdictions.

Digital and predictive technologies are emerging rapidly but remain unevenly distributed. Technologies such as monitoring and prediction show strong recent filing activity but relatively low overall patent volumes, indicating that they are still in an early growth phase. Their activity is concentrated in a small number of leading jurisdictions, notably China, South Korea and the United States, suggesting that these areas represent emerging innovation frontiers with limited global diffusion.

Traditional safety technologies remain high-volume but increasingly mature. Core engineering-based solutions, such as fall-arrest systems, scaffolding, and guardrails, account for the largest share of patents across regions. However, their filing patterns appear more stable, suggesting that these technologies are well established and evolving incrementally rather than through rapid breakthrough-driven growth.

**FIGURE 3 JURISDICTIONAL DISTRIBUTION OF FALL-FROM-HEIGHT SAFETY TECHNOLOGIES**



**Note:** For the methodological calculation of ‘Relative recency’, see WIPO (2024), [Mapping Innovations: Patents and the Sustainable Development Goals](#); only six major jurisdictions are included in the chart.

**Source:** Author’s analysis based on patent information from the [WIPO Patent Landscape Report on Occupational Health and Safety](#)

## 3. Conclusion

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This report shows that falls from height remain a critical industrial safety risk and a sustained focus of technological innovation. Patent activity has increased substantially over the past two decades, indicating continued demand for solutions that address height-related hazards across industrial settings.

The analysis finds that the current technology landscape is dominated by precaution-oriented, equipment-based solutions. Fall-arrest systems, scaffolds, ladders, working platforms, guardrails, and anchoring systems account for the majority of patent activity, particularly in construction. This reflects the continued importance of structural safeguards in managing risks where human presence at height remains necessary.

At the same time, the patent evidence points to an emerging shift. Although still smaller in scale, technologies related to robotics, monitoring, predictive analytics, and remote operation show signs of growing momentum. These approaches suggest a gradual movement from managing falls during work operations towards reducing exposure, detecting risks earlier, and enabling more proactive safety interventions.

The jurisdictional analysis further indicates that innovation is unevenly distributed. China shows both a large patent base and strong recent filing activity, while South Korea and the United States are active in emerging digital and predictive technologies. In contrast, Europe and Japan appear more concentrated in mature, incremental innovation areas.

Overall, the fall-from-height technology landscape remains centred on mechanical safety systems, but its future direction is likely to be shaped by more integrated and data-enabled solutions. For practitioners, technology developers, and policymakers, the key opportunity lies in connecting established physical safeguards with sensing, analytics, automation, and remote inspection to support more preventive and systematic fall-risk management.

# Appendix

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## A.1. Data Sources, Methodology and Limitations

This report is based on patent families, used as a proxy for inventions and referred to here as “patents”, consistent with the approach adopted in the WIPO Patent Landscape Report on Occupational Health and Safety.

To enrich the dataset with additional bibliographic and textual information, the patent identifiers were matched with records retrieved from The Lens.org patent database. Additional fields such as patent abstracts, applicant information, filing dates, and jurisdictions were obtained through The Lens API and used as the basis for further analysis.

Technology and industry classifications were conducted using a large language model (LLM) approach. Patent abstracts were analysed using two structured prompts designed to identify the relevant technology category and industry application context of each patent. The classification process was performed using the DeepSeek-V3 model accessed through the Volcengine platform. The full prompts used in the classification process are provided in the Appendix.

To evaluate the reliability of the automated classification, a random subset of patents was manually reviewed. The results indicate that the classification accuracy exceeds 90%, suggesting that the LLM-based categorisation provides a reliable representation of the technological landscape.

Several limitations should be noted. First, some patents in the dataset do not contain English abstracts, which limits the ability of text-based classification methods to accurately interpret their technical content. Second, because the original WIPO dataset was constructed using keyword-based search strategies, a portion of the retrieved patents are not directly related to fall-from-height safety technologies. After manual inspection, these patents were grouped into an “Other” category, which accounts for approximately 20% of the dataset. These records were excluded from the main analytical results presented in this report.

Finally, the original WIPO search strategy is strongly associated with precaution-oriented safety technologies, such as fall-arrest systems and structural safety equipment. As a result, the distribution of technologies observed in this analysis may partially reflect the characteristics of the initial search strategy. In particular, the relative dominance of precaution technologies may be influenced by this search bias.

Despite these limitations, the dataset provides a useful and structured overview of global innovation trends in fall-from-height safety technologies and supports the identification of key technological patterns and emerging directions.

## A.2. Classification Logic Used for LLM-based Coding

### Technology classification

The LLM-based classification followed a single-label coding approach. Each patent was assigned to one primary technology category based on the main function described in its abstract or technical description. The classification prioritised the dominant safety mechanism of the invention rather than secondary or incidental features.

The technology categories used in the analysis were:

Category	Classification logic
<b>PPE_HeadBody</b>	Personal protective equipment worn by workers to reduce injury severity, such as helmets, protective clothing, gloves or safety vests.
<b>FallArrest_Systems</b>	Systems designed to stop a worker after a fall has started, such as harnesses, lifelines, lanyards, self-retracting devices or rope brakes.
<b>Guardrails_EdgeProtection</b>	Physical barriers designed to prevent workers from falling from edges, such as guardrails, edge protection systems, barriers or roof safety fences.
<b>Anchoring_Connectors</b>	Structural attachment points or connectors used to secure workers, equipment or fall-arrest systems to safe structures.
<b>Scaffolds_Ladders_Platforms</b>	Temporary or permanent elevated access systems that enable safer work at height, such as scaffolds, ladders, platforms or lifts.
<b>ImpactMitigation_Cushioning</b>	Technologies designed to reduce injury severity after impact, such as safety nets, airbags, shock absorbers or cushioning mats.
<b>Monitoring_SmartDetection</b>	Real-time monitoring or detection systems that identify unsafe conditions or behaviours, such as sensors, wearable alarms, smart harnesses, cameras or IoT systems.
<b>Prediction_RiskAnalytics</b>	Data-driven or AI-based systems that predict safety risks before accidents occur, such as predictive dashboards, risk models or machine-learning analytics.
<b>Robotics_ExposureElimination</b>	Technologies that reduce or remove human exposure to height-related hazards through automation, robotics, drones or remote-operation systems.
<b>Other</b>	Used only when the patent did not fit any of the defined technology categories.

**Industry classification**

The LLM-based industry classification also followed a single-label approach. Each patent was assigned to the industry sector that best reflected its primary application context, based on the abstract, technical description and use-case information.

The industry categories used in the analysis were:

Industry	Classification logic
<b>Manufacturing</b>	Factory production, assembly lines, industrial plants and equipment maintenance contexts.
<b>Construction</b>	Building construction, scaffolding, roofs, bridges, construction sites and other built-environment work-at-height contexts.
<b>Healthcare</b>	Hospitals, medical equipment, patient handling systems and healthcare-related fall-risk contexts.
<b>Agriculture</b>	Farming, crops, livestock, agricultural machinery and rural work-at-height applications.
<b>Mining</b>	Mining operations, underground mines, mineral extraction and mining infrastructure.
<b>Logistics</b>	Warehouses, cargo transport, freight handling and logistics operations.
<b>Other</b>	Used only when the patent could not be clearly assigned to one of the defined industries.



## The Global Initiative for Industrial Safety

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The Global Initiative for Industrial Safety (GIFIS) unites global policymakers, innovators, and industry leaders to safeguard working environments through emerging technologies. Through knowledge sharing and community-driven solutions, we reduce risks, enhance resilience, and elevate workplace safety worldwide.

[www.industrialsafetyinitiative.com](http://www.industrialsafetyinitiative.com)