Patent Landscape Report

Occupational Health and Safety

WIPO

Patent
Landscape
Report

Occupational Health and Safety

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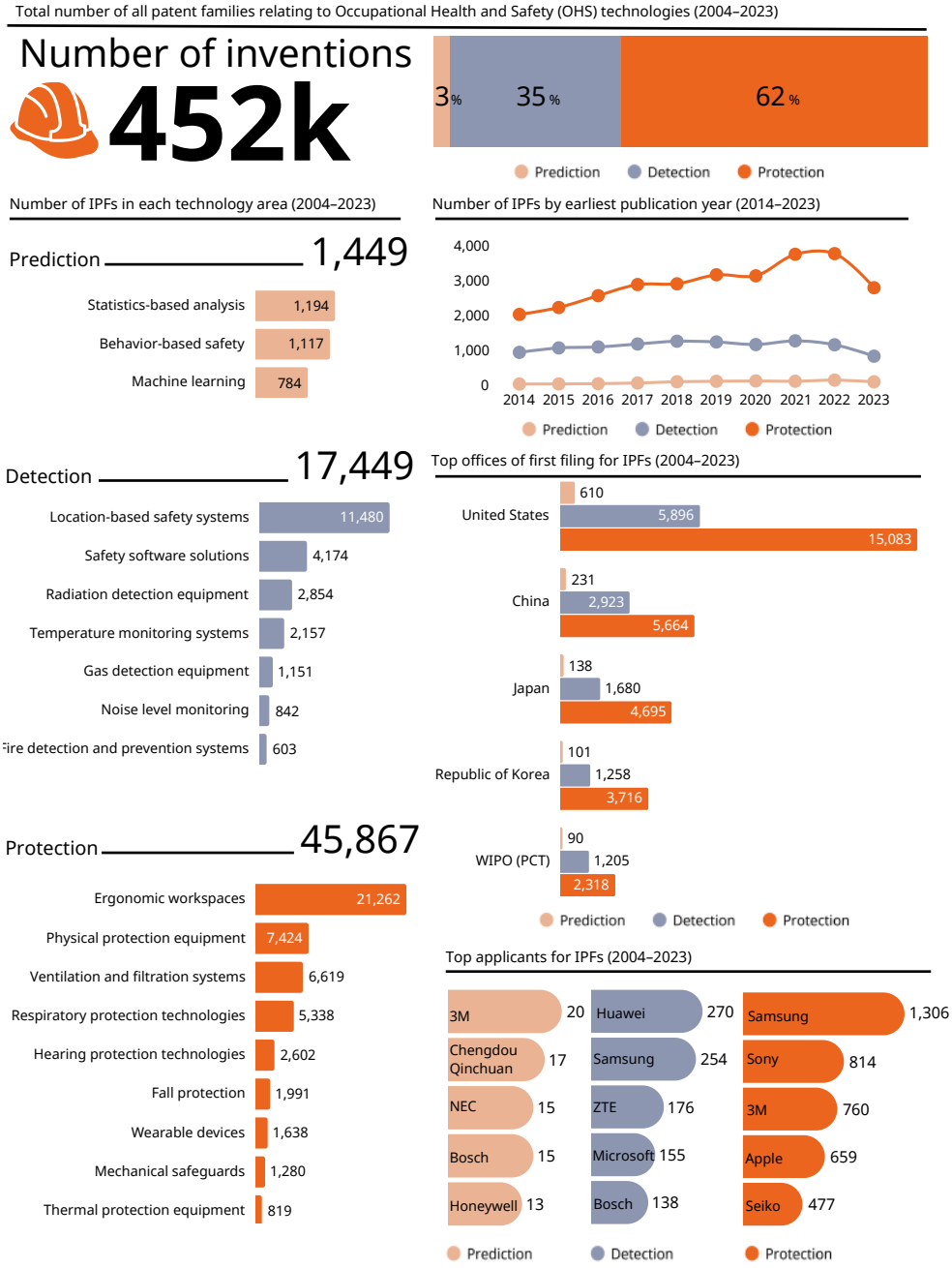
Executive summary

This report provides a comprehensive analysis of the global patent landscape in the field of Occupational Health and Safety (OHS) technologies, focusing on three key areas: Prediction, Detection, and Protection technologies. These innovations aim to enhance workplace safety through advanced methods like statistical analysis, machine learning, and real-time monitoring systems. The study reveals a dynamic field driven by technological advancements, regulatory requirements, and increasing awareness of workplace hazards.

- Around 452,000 inventions (patent families) filed in the OHS field over the last 20 years have been identified (including around 65,000 international patent families (IPFs)).
- Prediction technologies account for around 15,000 patent families (3% of the OHS dataset), with a 26.4% compound annual growth rate (CAGR) between 2018 and 2023. Technologies like AI-driven machine learning and behavior-based safety are gaining prominence, while traditional statistical methods are declining. China dominates the patent landscape, accounting for 75% of published patents, followed by the Republic of Korea and the United States. The shift toward behavior-based and AI-driven safety measures reflects the sector's growing reliance on predictive and data-driven solutions.
- Detection technologies account for 160,000 patent families (35% of the OHS dataset). This field has experienced significant growth, peaking in 2021, driven by advancements in IoT, AI and wearable devices. Technology areas such as safety software, fire and gas detection, and location-based safety systems have been pivotal in improving real-time hazard identification and response. While China leads in the number of published patents, the United States and European countries focus on internationalized inventions (IPFs). However, a decline in filings after 2021 is visible overall (including in the number of IPFs).
- Protection technologies represent the largest share, almost 280,000 patent families, which constitutes approximately 62% of overall OHS dataset. These technologies encompass innovations in personal protective equipment (PPE), ventilation systems, ergonomic workspace design, and wearable devices. This area saw a surge of patent filings during the COVID-19 pandemic, particularly in respiratory protection and filtration systems, which peaked in 2021. Despite a slight decline in recent years, steady interest remains in wearable devices and ergonomic solutions. China again leads with over 120,000 patent families, followed by the United States and European countries.

Overview of the occupational health and safety technologies



Source: WIPO, Questel.
Note: IPF stands for international patent family.

Geographically, this patent landscape report finds that China has a dominant role in domestic patent filings, whereas the United States and European countries focus on a more internationalized patenting strategy. India emerges as a consistent innovator in Prediction and Detection, maintaining its specialization in this domain. The analysis also highlights the importance of key markets like Japan, the Republic of Korea, and Germany for global patent coverage.

Key players driving OHS innovations include 3M, Microsoft, Samsung and Sony, alongside large Chinese companies such as Huawei and the State Grid Corporation of China (SGCC). Emerging companies like Chengdu QinChuan IoT Technology are rapidly gaining traction, particularly in AI and IoT-based solutions. Academic institutions such as Tsinghua University and Zhejiang University have also laid a strong foundation for innovation within China, supporting industrial leaders in this field.

In conclusion, the OHS patent landscape reflects regional disparities and a dynamic shift toward AI-driven and data-centric solutions. China leads in terms of patent volume, but significant contributions are also made by the United States, Japan, the Republic of Korea, and increasingly, India. This diversity underscores the global nature of innovation in this field. Despite a slight decline in patent filings post-COVID-19, a consistently high rate of patenting activity in this domain suggests a robust commitment from industrial and academic stakeholders worldwide. This momentum presents an opportunity to foster equitable progress in addressing work-related accidents and diseases across regions. By leveraging the collective efforts of global innovators within all sectors, but especially within the construction sector, advancements can be disseminated more widely, ensuring that the benefits of these technologies reach workers in all countries, irrespective of their development status.

1 Introduction

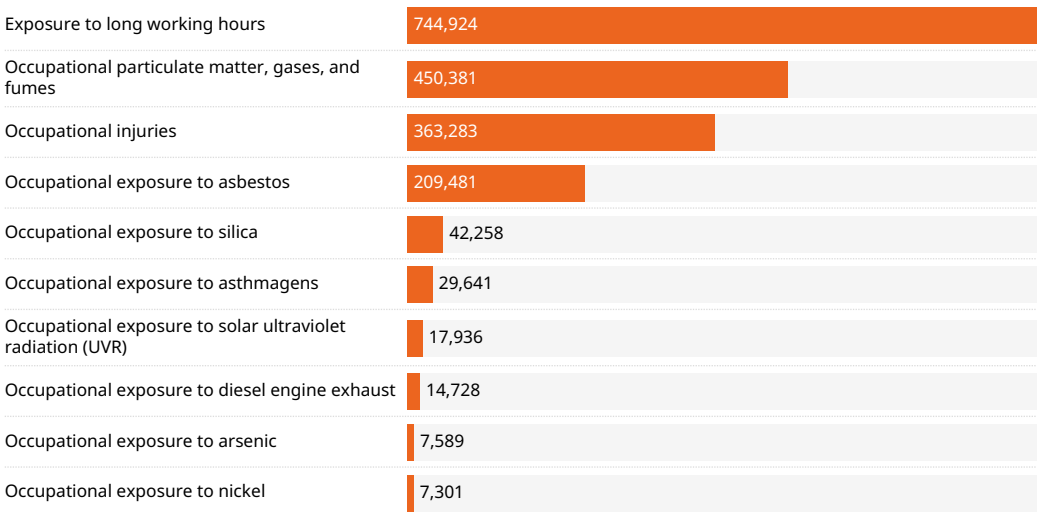
This chapter provides a background to workplace well-being within the context of occupational health and safety (OHS). It explores OHS, highlighting its role in mitigating risks and enhancing employee safety, while also outlining the research methodology adopted for this patent landscape report, detailing the scope of the patent analysis and data collection derived from global patent databases to map the trends and technological advancements in OHS solutions.

Understanding occupational health and safety (OHS)

Workplace safety remains a pressing global concern, with profound human and economic implications. According to the International Labour Organization (ILO), over 2.93 million people lose their lives annually due to occupational accidents or work-related disease. Additionally, 395 million non-fatal workplace injuries result in at least four days of absence from work every year, equating to more than one million injuries every day which are serious enough to disrupt livelihoods[1].

Exposure to long working hours remains the deadliest occupational risk, followed by particulate matter, gases and fumes, and workplace injuries.

Figure 1.1 Top 10 occupational risk factors and total number of attributable deaths, 2016



Source: A Call for Safer and Healthier Working Environments, International Labour Organization, 2023.

1 ILO (2023). A Call for Safer and Healthier Working Environments. International Labour Organization. Available at: www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_protect/%40protrav/%40safework/documents/publication/wcms_903140.pdf.

Despite advancements in OHS measures in some regions – such as the stabilization of or decline in workplace fatalities in countries like Canada[2], China[3] and the United States[4] – global progress is uneven across demographics and regions:

- Men face a significantly higher mortality rate (108.3 per 100,000 workers) compared to women (48.4 per 100,000); and
- Geographically, Asia and the Pacific accounts for 63% of global work-related fatalities, reflecting the region's vast population, and therefore substantial workforce. Work-related deaths also constitute 6.71% of global mortality, with Africa recording the highest attributable fraction (7.39%).

Among the leading occupational risk factors, exposure to long working hours (≥55 hours per week) is the deadliest, claiming nearly 745,000 lives in 2016. Other critical risks include exposure to particulate matter, gases and fumes (450,000 deaths) and occupational injuries (363,000 deaths). While progress has been made in mitigating such risks, emerging challenges – such as evolving work patterns, remote work, and mental health concerns – necessitate a shift toward proactive risk management and adaptation to new work environments.

At the economic level, poor OHS practices are a burden for companies and compromise efficiency. Accidents and occupational illnesses incur significant costs for employers, from medical expenses and lost productivity to legal liabilities. Such cost represents nearly 4% of global gross domestic product (GDP) annually. The ILO estimates that USD 361 billion could be saved globally by implementing improved health and safety measures to prevent injuries from excessive heat in the workplace[5].

In this context, technological innovation is vital to improving workplace safety. However, many countries, particularly developing ones, face challenges such as limited access to suitable technologies, a lack of awareness among potential users and insufficient collaboration between key stakeholders. Intellectual property (IP) has a crucial role to play in addressing these gaps by facilitating access to existing solutions and helping the development of new technologies tailored to specific industries and risks. Enhanced collaboration among researchers, manufacturers and users of tools, machinery, and personal protective equipment (PPE) can help ensure the availability and accessibility of effective safety measures, ultimately reducing accidents and enhancing competitiveness.

This report examines patent data to explore how technological innovation is addressing these challenges. It highlights the key players and their contribution to creating safer work environments, with the ultimate goal of reducing work-related injuries and fatalities globally.

2 Shantz, J. (2024). A comparative analysis of workplace safety trends in the USA and Canada. 1st Reporting. Available at: https://1streporting.com/articles/a-comparative-analysis-of-workplace-safety-trends-in-the-usa-and-canada/.
3 ILO (2023). Government and social partners unite to promote occupational safety and health at work for everyone in China. International Labour Organization. Available at: www.ilo.org/resource/news/government-and-social-partners-unite-promote-occupational-safety-and-health.
4 Howard, J. and F. Hearl (2012). Occupational safety and health in the USA: Now and the future. Industrial Health, 50(2), 80–83. DOI: 10.2486/indhealth.ms1356. PMID: 22498727.
5 ILO. Safety and health at work. International Labour Organization. Available at: www.ilo.org/topics-and-sectors/safety-and-health-work.

Research methodology and scope

The aim of this report is to analyze technological evolution in the field of occupational health and safety through the lens of patents filed across the world. Patents offer a unique vantage point to observe the key players in this field, highlighting those countries patenting most heavily in new technologies, as well as companies and research institutions driving innovation within the sector.

For each major technological area – Prediction, Detection, and Protection – we conducted a global patent landscape analysis, followed by a focused examination of international patent families (IPFs) to extract key trends with greater precision.

Analyzing the global patent landscape provides a broad overview of the level of investment and innovation within a chosen field. Such an analysis captures a wide array of patents, including those filed for more localized or exploratory innovations. It gives insight into the diversity of research and development efforts, ranging from foundational technologies to the novel, speculative ideas with which companies and inventors are experimenting.

To ensure a reliable and unbiased measure of inventive activity, our analysis also focuses on International Patent Families (IPFs) - representing those inventions that applicants consider important enough to seek international protection for them. This serves to highlight innovations with a universal application, control for the difference in the propensity to file multiple patent applications for a single invention between patent offices and exclude singletons of possible low value.[6]

6 Dechezleprêtre, A., Y. Ménière and M. Mohnen (2017). International patent families: From application strategies to statistical indicators. Scientometrics, 111, 793–828. DOI: https://doi.org/10.1007/s11192-017-2311-4.

2 Overview of occupational health and safety (OHS) technologies

This chapter provides an overview of OHS technologies, segmented into Prediction, Detection and Protection solutions. It explores their impact across the main industrial sectors: construction, manufacturing, healthcare, agriculture, service, logistics, and mining. Analyzing patents highlights how OHS technologies address workplace risks, enhancing safety and efficiency within diverse sectors through innovative OHS advancements.

Categorizing occupational health and safety

The International Labour Organization (ILO) guide on managing occupational health and safety (OHS)[1] emphasizes creating safe workplaces through structured frameworks, collaboration and accountability. The ILO guide emphasizes three categories of intervention in OHS:

Prediction: Identifying potential hazards through risk assessment to prevent accidents before they occur.

Detection: Ongoing surveillance of workplace conditions, using inspections and real-time data to identify unsafe practices or environmental risks.

Protection: Implementing measures to shield workers from identified risks, including safety equipment, training and emergency response plans.

This report focuses exclusively on Prediction, Detection, and Protection technologies within the context of occupational health and safety. All references to these technologies will be presented in their simple forms for the sake of clarity and ease of use. Readers are encouraged to consider the specific applications and limitations of these technologies in their respective contexts.

Each category includes a diverse set of technologies and methodologies, all aimed at enhancing safety across a variety of workplace environments. To conduct the patent analysis contained in this report, relevant technologies within each OHS category were identified and cataloged. Using these categorizations, specialized patent search strategies were developed to identify patents aligned with each technology, thereby constructing a patent dataset for in-depth analysis. This structured approach allowed a clear picture of the innovation landscape within each OHS category to be captured and to track technological advancements in OHS. Search strategies were based on patent classifications (International Patent Classification[2] and Cooperative Patent Classification[3]) and keywords relating to the technologies listed.

1 ILO. How can occupational safety and health be managed? International Labour Organization. Available at: www.ilo.org/topics/labour-administration-and-inspection/resources-library/occupational-safety-and-health-guide-labour-inspectors-and-other/how-can-occupational-safety-and-health-be-managed.
2 See, International Patent Classification (IPC). WIPO. Available at: www.wipo.int/classifications/ipc/en/.
3 See, Cooperative Patent Classification (CPC) system. European Patent Office (EPO) and United States Patent and Trademark Office (USPTO). Available at: www.cooperativepatentclassification.org/home.

Figure 2.1 illustrates the main technologies associated with each of three OHS categories used to create the patent datasets for analysis.

There are 19 different technology areas under each of the three main OHS categories.

Figure 2.1 OHS categories and technology areas

Source: WIPO/Questel.

Prediction

The Prediction category refers to the proactive identification and assessment of potential hazards in order to prevent accidents and incidents before they occur. By anticipating risks early on, Prediction technologies and methodologies aim to inform preventive measures, enhance decision-making and, ultimately, create a safer work environment.

Figure 2.2 Examples of Prediction technologies

Source: WIPO.

The Prediction category has been segmented as follows:

Statistics-based analysis: This approach uses historical data and statistical methods to identify trends and patterns that may indicate potential safety risks. By analyzing this information, organizations can make informed decisions to mitigate hazards before they occur.

Machine learning: This approach uses algorithms to analyze large datasets and predict safety incidents. By learning from past incidents, these systems provide insights and recommendations to improve safety protocols.

Behavior-based safety: This approach uses the observation and analysis of employee behaviors to enhance safety. By understanding and modifying behaviors, organizations can implement training and interventions to promote a safer workplace culture.

Detection

The Detection category refers to the continuous assessment and oversight of workplace conditions in order to identify potential hazards and prevent accidents. This involves using technologies and processes for real-time surveillance, periodic inspections, and environmental monitoring to detect unsafe practices, equipment malfunctions, or harmful exposure levels. Detection systems are critical in maintaining a safe work environment, as they enable the timely identification of risks such as toxic substances, high noise levels or machinery issues.

Figure 2.3 Examples of Detection technologies

Source: WIPO.

The Detection category has been segmented as follows:

Safety software solutions: Comprehensive software solutions are essential for managing safety protocols, tracking incidents, and ensuring compliance with regulations. These systems facilitate real-time monitoring and reporting.

Fire detection and prevention systems: Advanced fire detection systems utilize sensors and alarms to identify fire hazards early, enabling prompt response and prevention measures.

Gas detection equipment: Gas detection technologies monitor air quality and detect harmful gases, ensuring a safe environment for workers, especially in confined spaces.

Temperature monitoring systems: These systems continuously monitor temperature levels to prevent overheating and other temperature-related hazards.

Noise level monitoring: Monitoring noise levels is crucial in environments where excessive noise can lead to hearing loss and other health issues. Systems are in place to measure and manage noise exposure.

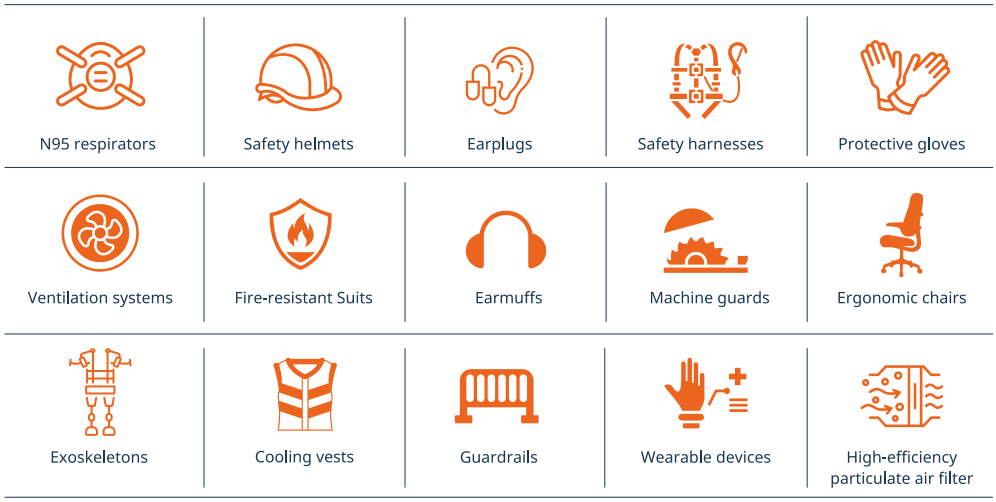
Radiation detection equipment: In industries where radiation exposure is a concern, specialized equipment is used to detect and monitor radiation levels, ensuring worker safety.

Location-based safety systems: These systems utilize global positioning system (GPS) and other technologies to enhance safety by providing real-time location data, enabling a quick response to an emergency.

Protection

The Protection category refers to measures and technologies designed to actively safeguard workers from identified risks and hazards in the workplace. This includes a broad range of solutions intended to reduce exposure to dangerous conditions, prevent injury and minimize health risks. Protection methods can include the provision of PPE such as helmets, gloves, masks, and protective clothing, as well as engineered controls such as safety barriers, ventilation systems and ergonomic equipment.

Figure 2.4 Examples of Protection technologies



Source: WIPO.

The Protection category has been segmented as follows:

Respiratory protection technologies: Respiratory protection equipment, such as masks and respirators, is vital in environments with airborne contaminants, ensuring workers' respiratory health.

Hearing protection technologies: Hearing protection devices, including earplugs and earmuffs, are essential in noisy environments to prevent hearing loss.

Personal protection equipment: PPE, such as helmets, gloves or safety glasses provide physical protection against various hazards.

Thermal protection equipment: Thermal protection gear is designed to safeguard workers from extreme temperatures, whether hot or cold.

Mechanical safeguards: Mechanical safeguards, such as guards and barriers, are implemented to prevent accidents and injury when operating machinery.

Ventilation and filtration systems: Effective ventilation and filtration systems help maintain air quality and reduce exposure to harmful substances in the workplace.

Ergonomic workspaces: Designing ergonomic workspaces minimizes the risk of musculoskeletal disorders and enhances overall worker comfort and productivity.

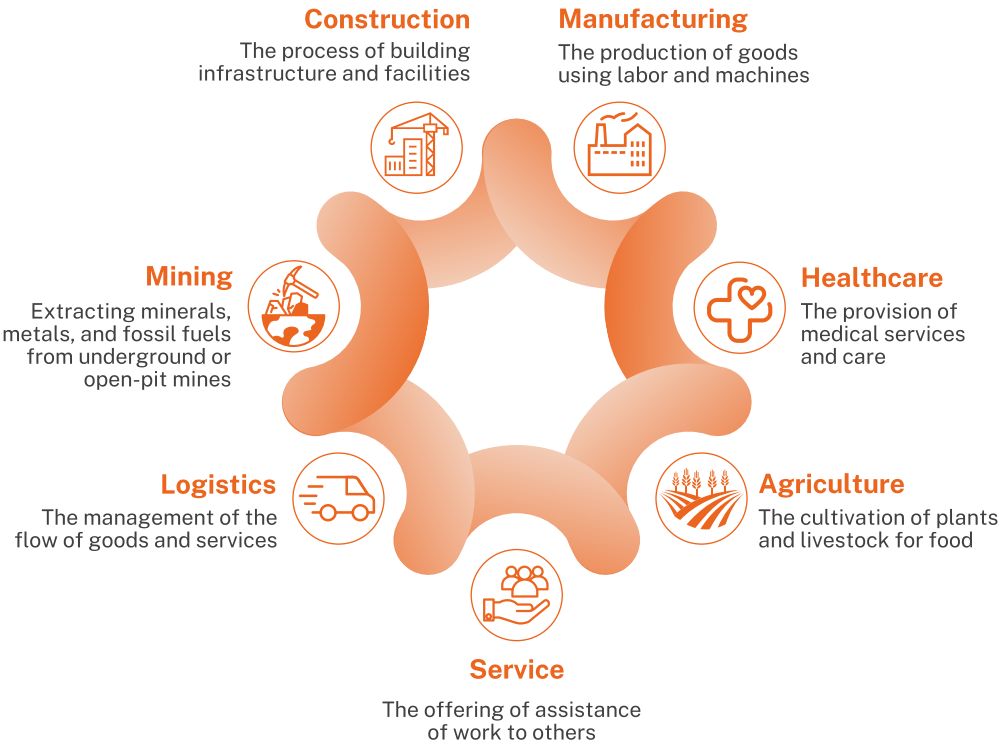
Fall protection: Fall protection systems, including harnesses and guardrails, are critical in preventing falls in construction and other high-risk environments.

Wearable devices: Wearable safety devices monitor workers' health and environmental conditions, providing real-time data to enhance safety measures.

Main industries in occupational health and safety

Occupational health and safety is a crucial aspect of every industry, ensuring the well-being of workers by minimizing risks and preventing accidents in the workplace. Different sectors present unique hazards, requiring tailored safety measures to protect employees from injury, illness and long-term health problems. The following section explores seven critical industries for OHS, giving a brief overview of each and highlighting the specific OHS challenges and solutions they face.

Figure 2.5 Industrial sectors of importance for OHS



Source: WIPO/Questel.

These industrial sectors play a vital role in economic development and employment but also present significant safety risks. From hazardous machinery and toxic exposures to ergonomic strain and psychological stress, each industry demands a focused approach to workplace safety. Understanding these risks and implementing appropriate OHS measures is essential for protecting workers and ensuring sustainable industrial growth.

Construction

The construction industry encompasses the building of infrastructure, commercial, and residential structures, as well as civil engineering projects. It involves multiple trades, including masonry, carpentry, electrical work, and heavy equipment operation. Due to the physically demanding nature of the work, OHS is critical in preventing hazards such as falls, exposure to hazardous materials, machinery-related accidents, and structural failure. Regulations focus on PPE, proper scaffolding and training to ensure worker safety.

Manufacturing

Manufacturing involves the production of goods through industrial processes, including assembly lines, machining and chemical processing. Factories operate using complex machinery, high-speed production lines and hazardous substances, making workplace safety a priority. OHS measures address risks such as machine-related injuries, exposure to toxic chemicals, repetitive strain injuries and noise pollution. Implementing safety protocols, ergonomic workstations and training programs helps mitigate such dangers.

Healthcare

The healthcare sector includes hospitals, clinics, laboratories and long-term care facilities, where professionals provide medical services and patient care. Occupational risks include exposure to infectious diseases, needlestick injuries, ergonomic strain and psychological stress due to high workloads. OHS regulations emphasize proper hygiene protocols, PPE usage and mental health support for health care workers, so as to maintain a safe working environment.

Agriculture

Agriculture covers crop production, livestock farming and agribusiness operations. Workers are exposed to risks, including pesticide exposure, machinery-related accidents, extreme weather conditions and zoonotic diseases. OHS strategies focus on safe pesticide handling, the use of protective gear, machinery safety training and ergonomic practices that prevent musculoskeletal disorders.

Service

The service sector includes industries such as retail, hospitality, finance, and customer support. Although such jobs might seem less hazardous than others, workers still face risks such repetitive strain injury, workplace violence, stress and fire hazards. OHS measures involve ergonomic workplace design, emergency preparedness and policies to address poor mental health and workplace harassment.

Logistics

Logistics covers transportation, warehousing and supply chain management, ensuring the movement of goods and materials. Workers in this industry face risks from vehicle-related accidents, lifting injuries and exposure to hazardous goods. OHS guidelines focus on proper load handling, driver fatigue management and warehouse safety measures, including clear pathways and emergency response planning.

Mining

The mining industry involves extracting minerals, metals and fossil fuels from the earth, often in hazardous underground or open-pit environments. Workers face dangers such as cave-ins, toxic gas exposure, equipment malfunction and dust-related lung disease. OHS protocols include ventilation systems, regular equipment maintenance, PPE and strict emergency response procedures to reduce risks.

3 Patent trends shaping the OHS industry

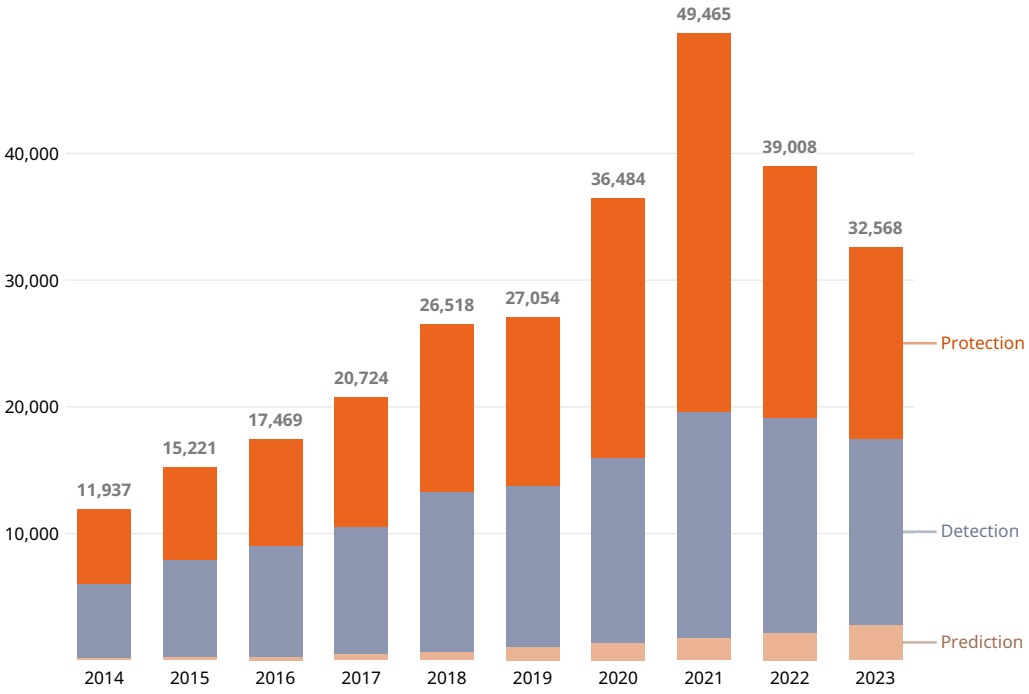
Technology trends covering global patenting activity, patent growth and development are explored in this chapter within the context of OHS technologies across Prediction, Detection and Protection. It identifies the top offices of first filing and leading patent owners, whilst also looking beyond patents to provide insights into the market dynamics, regulatory frameworks, and economic landscapes influencing OHS innovation.

Global patenting activity

Patenting activity measures how many patent families are published every year in a specific field, offering a glimpse into innovation trends. Since patents typically get published about 18 months after filing, this metric provides a delayed but nonetheless valuable perspective on technological progress. Comparing the patent growth of an industry and its respective technology areas to global trends helps to reveal whether it's rapidly evolving, holding steady or losing momentum.

OHS patents surged from 2014–2021, peaking in 2021 with a 21.5% annual growth rate; Protection patents spiked during COVID-19, while Prediction and Detection patents now rise.

Figure 3.1 OHS categories patenting trend by earliest publication year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The patent publication trends in OHS-related technologies have experienced significant growth over the past decade, reflecting an increasing focus on workplace safety and innovation. From 2014 to 2021, the number of patent families steadily rose, peaking in 2021 with a substantial surge, most likely due to new Protection patents filed during the COVID-19 pandemic. The number of patent filings increased at a compound annual growth rate (CAGR)[1] of 21.5%. This upward trend suggests heightened research and development (R&D) efforts, possibly driven by regulatory changes and advancements in occupational health solutions. However, after reaching its peak, the number of filings began to decline in 2022 and 2023, which may have been caused by the impact of the COVID-19 pandemic. Filings over this period decreased at a CAGR of 12.3%, reflecting a slowdown in patenting activity. Despite this recent decrease, the overall number of patent families remains high, underscoring the continued importance of OHS technologies in industrial and workplace safety advancements.

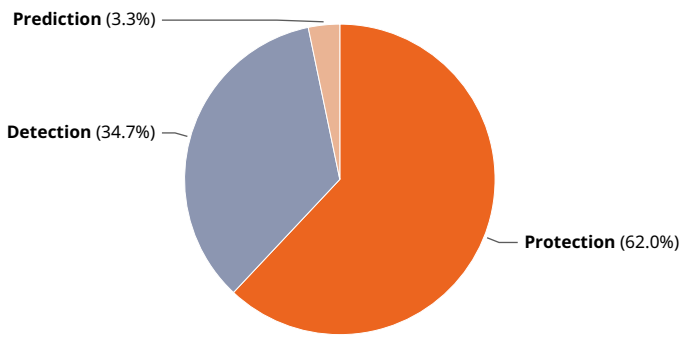
The field of Prediction has exhibited significant growth in patent filings in the last five years, between 2018 and 2023. The compound annual growth rate (CAGR) for this period stands at 26.4%, markedly higher than the global CAGR of 2.7% across all technology fields. This disparity reflects a heightened interest in and commitment to innovation within this domain. The trend culminated in 2023, with the publication of 2,823 patent families, indicating a peak in patenting activity.

Patent filings related to Detection have demonstrated a steady upward trajectory in the last five years, reaching their highest point in 2021 with 17,825 patent families. This increase underscores a growing emphasis on innovation and workplace safety. The primary drivers behind this trend include advancements in technology and the broader digital transformation of workplaces. Notable developments in sensors, automation, the Internet of Things (IoT), artificial intelligence (AI), and wearable devices have spurred numerous innovations during this period. These technologies enhance workplace safety by enabling real-time detection and monitoring capabilities, likely contributing to the sustained interest in this field.

In the domain of Protection technology, patent filing trends between 2018 and 2023 have been characterized by fluctuations, with a peak of 43,060 patent families published in 2020. However, the CAGR for this period is approximately -1.3%, indicating a slight overall decline in filing activity despite periods of strong interest. This data suggests that while the overall growth rate has decreased marginally, the field remains dynamic. The peak filing years highlight continued investment and innovation aimed at improving workplace safety through advancements in Protection technologies.

Protection solutions lead the field with 280,686 patent families, making up 62% of the total, highlighting worker safety priorities.

Figure 3.2 Patent share by number of published patents across the three OHS categories, 2004-2023



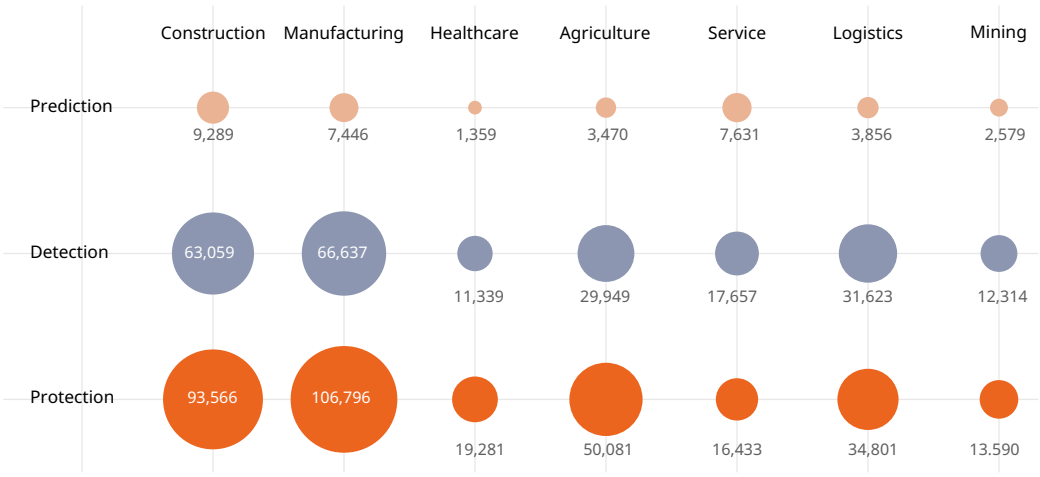
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

1 Compound annual growth rate (CAGR), initially used to calculate and determine the rate of investment return, it represents the average annual growth rate between two dates in the study.

In respect to the breakdown of the OHS patent portfolio across the three technology categories (Prediction, Detection, and Protection), Figure 3.2 illustrates the share of patent families in each category in total. Protection solutions dominate the portfolio with 280,686 patent families, or 62% of the total, reflecting the importance attached to technologies designed to protect workers against occupational hazards. Detection technologies account for 157,183 patent families, or 35% of the portfolio, reflecting significant investment in systems that identify and monitor workplace risks. Prediction systems, on the other hand, account for just 14,777 patent families, which is barely 3% of the total.

A cross-section of occupational health and safety technology areas shows notable variations in patent activity across different industrial sectors.

Figure 3.3 Share of OHS patents by industrial sector, 2004–2023



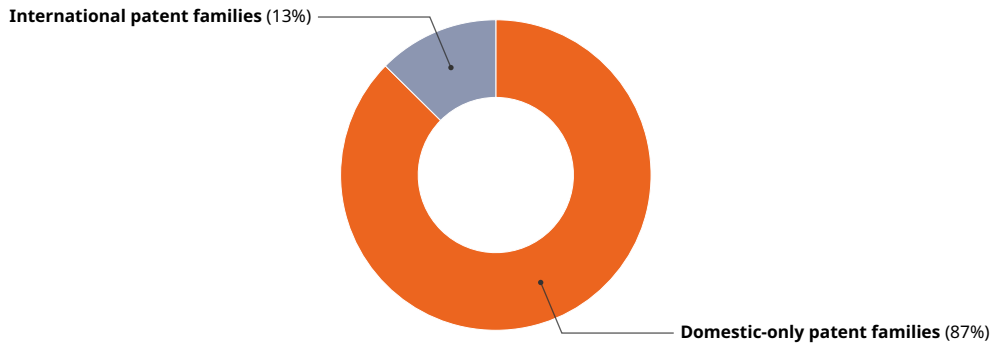
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

A cross-section of the OHS technology categories by industrial sector (Figure 3.3) reveals significant variations in patenting activity. The Protection category has the highest number of patent families, particularly in manufacturing (106,796) and construction (93,566), indicating a strong focus on workplace safety measures in these two industries. Similarly, the Detection category is quite active, with manufacturing (66,637) and construction (63,059) leading the way in terms of patent filings, indicating the growing importance of real-time safety monitoring systems. The Prediction category, while having lower overall patenting activity, shows notable contributions across various industries, with services (7,631) and construction (9,289) leading the way. This data shows that those industries with higher occupational risks, namely manufacturing, construction and agriculture, are investing more in occupational health and safety innovations, particularly in Protection and Detection technologies.

A comparative overview of the global OHS patent portfolio shown in Figure 3.4, reveals a significant disparity between domestic-only and international patent families. While there are 452,646 domestic-only patent families, representing patents filed and protected within individual jurisdictions, only 65,235 of these are also designated as international patent families. This indicates that only 13% of OHS patents are strategically represented across multiple jurisdictions (countries/regions).

The global OHS patent portfolio shows only 13% are internationalized, indicating a significant disparity between foreign-oriented IPFs and "singletons" filed in just one jurisdiction.

Figure 3.4 OHS international and domestic-only patent families shares by number of published patents, 2004–2023

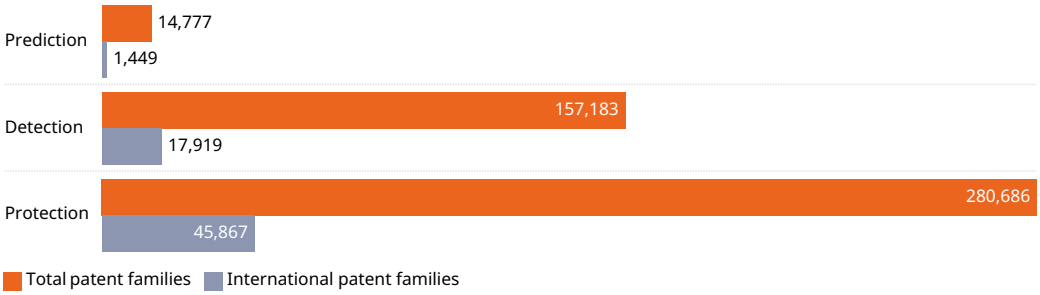


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Figure 3.5 illustrates the distribution of patents across the three OHS categories – Protection, Detection, and Prediction – differentiating between international patent families (IPFs) and domestic-only patent families. For example, in the Protection category, domestic-only patent families significantly outnumber IPF, with 280,686 compared to 45,867, indicating a strong focus on localized patent protection.

In all three OHS categories, domestic-only patent families dominate, indicating a preference for national or regional protection rather than broader international coverage.

Figure 3.5 OHS international and domestic-only patent families counts in each category by number of published patents, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Similarly, the Detection category shows a similar pattern, with 157,183 domestic-only patent families and 17,919 IPF. The Prediction category, while smaller overall, also follows this trend, with 14,777 domestic-only patent families and 1,449 IPF. In all three technology area, domestic-only patent families dominate, suggesting a preference for national or regional patent protection over broader international coverage within the OHS field.

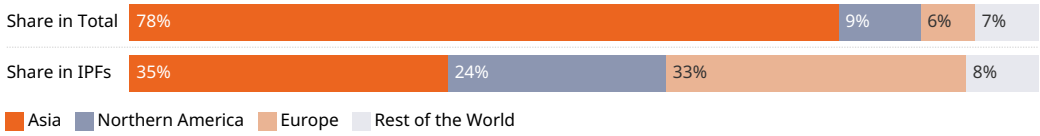
Top jurisdictions

Patent family analysis offers valuable insights into the regions driving innovation in a specific field. Typically, the first filing in a patent family, known as the priority filing, is made in the applicant's country of origin. This choice is often influenced by legal frameworks and cost considerations, making the location of the priority filing (the office of first filing) a key indicator of where active R&D and innovation is most likely to have taken place.

Figure 3.6 illustrates the distribution of OHS global patent families according to R&D location. Asia leads the way with 79% of the global patent families, indicating that most of the R&D activities relating to OHS are carried out in this region. With relatively lower shares, Northern America stands at 9% and Europe at just 6% of the total. The rest of the world contributes 7%, reflecting a smaller presence.

Asia dominates OHS research with nearly 80% of global patent families, leading innovation; IPFs show a balanced distribution with Asia at 35%, Northern America 33%, and Europe 24%.

Figure 3.6 OHS global and IPF distribution by R&D Regions, 2004–2023

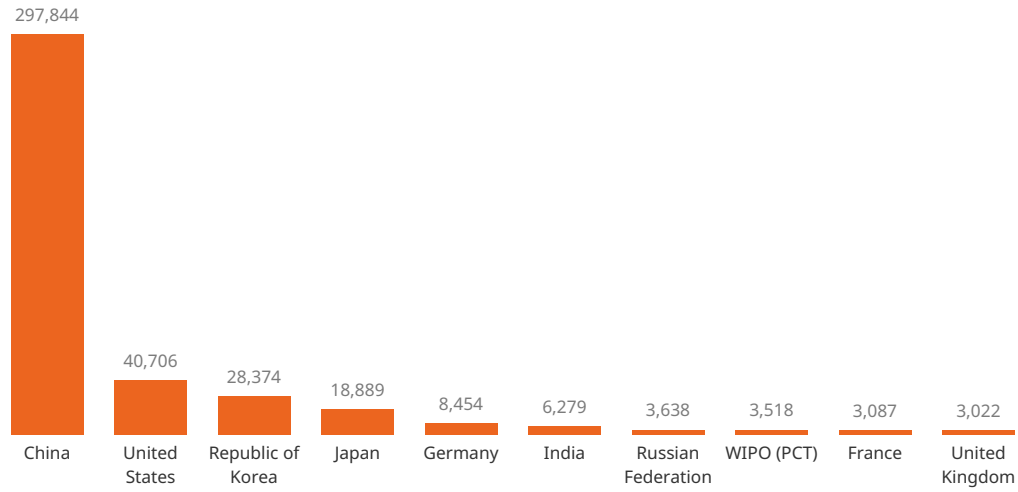


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

In terms of priority authorities (offices of first filing) for patent families, China comes out on top, with 297,841 patent families, making it the dominant force in OHS innovation. The United States follows with 40,709 filings, maintaining a strong but much smaller patent portfolio in the field. The Republic of Korea ranks third with 28,376 patent families, while Japan is fourth with 18,889 filings. These four countries collectively account for nearly 90% of worldwide OHS patenting activity (Figure 3.7).

The top four countries collectively account for vast majority of the world's occupational health and safety patent activity.

Figure 3.7 OHS top priority jurisdictions by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

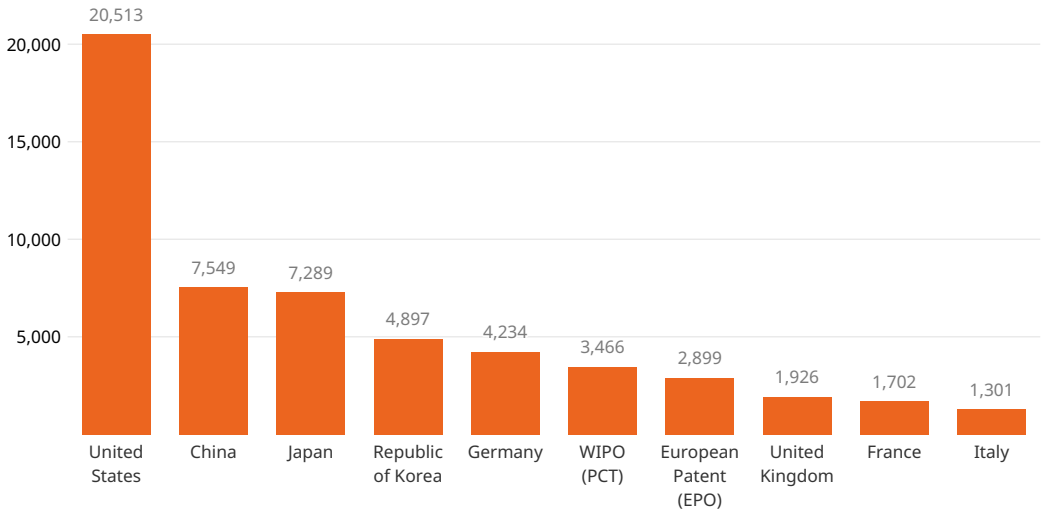
In terms of priority authorities for international patent families (IPF), Figure 3.8 reveals the predominance of the USA, with over 20,500 patent families, followed by China, with 7,549 and Japan, with 7,289. The Republic of Korea, and Germany, with 4,897 and 4,234 patent families

respectively, also made significant contributions, further reinforcing the global nature of OHS development.

As regards the regional breakdown of international patent families (IPFs), as shown previously in Figure 3.6, Asia holds the largest proportion with 35%, indicating a strong international patent strategy. Northern America follows closely at 33%, reflecting significant cross-border protection efforts. Europe accounts for 24%, showing a considerable presence in international patent filings.

The United States leads with over 20,000 IPFs, followed by China, Japan, the Republic of Korea, and Germany, underscoring the global scope of OHS innovation.

Figure 3.8 OHS top priority jurisdictions by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

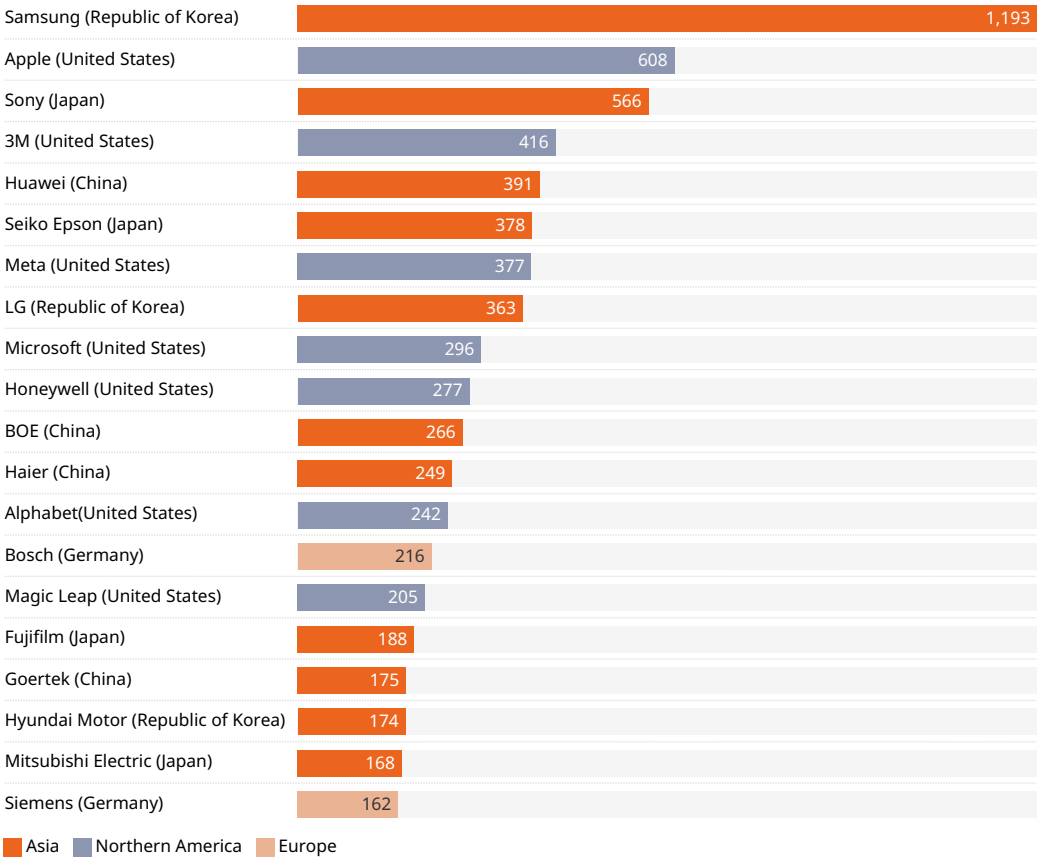
Top patent owners

Analyzing worldwide OHS patenting activity reveals the strategic importance attached to the protection of IP rights. Leading technology companies and manufacturers are committed to protecting their OHS innovations. This ongoing quest for patent protection underscores the recognized value of advances in OHS and their potential impact on a wide range of industries.

In terms of the OHS patent applicants, and more specifically among IPFs, Figure 3.9 shows that electronics manufacturer Samsung Electronics leads the ranking with a total of 1,193 IPFs filed. Technology companies Apple (608 IPFs), Sony (566) and 3M (416) follow behind. Huawei (391), Seiko Epson (378), Meta (377) and LG (363) also demonstrate a strong commitment to OHS. These data underline the growing importance of OHS and its integration into a wide range of products and services.

Among OHS patent applicants for IPFs, Samsung clearly leads with 1,193 patents filed, topping the rankings.

Figure 3.9 OHS top applicants by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

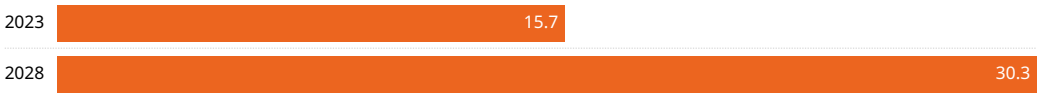
Beyond patents – insights into market, regulatory, and economic landscapes

In this part of the report, a selection of related market reports have been reviewed, analyzing the market trends and market forecast evolution of the workplace safety market.

The global workplace safety market is experiencing significant growth, driven by increasing concerns over employee well-being and stringent industrial health and safety regulations. In 2023, according to a MarketsandMarkets report[2], the market was valued at approximately USD 15.7 billion and is projected to reach USD 30.3 billion by 2028, with a CAGR of 14% during this period.

The global workplace safety market is projected to reach USD 30.3 billion by 2028 at an annual growth rate of 14%.

Figure 3.10 Projected growth in the global workplace safety market (in billion size), 2023–2028



Source: WIPO, based on market data from MarketsandMarkets report, 2023.

This expansion is largely attributed to a rising number of workplace injuries and fatalities, which has heightened the emphasis on implementing comprehensive safety measures across various industries. For instance, based on a Zion Market Research study[3] in the United States, private industry employers reported 2.8 million non-fatal workplace injuries and illnesses in 2022, marking a 7.5% increase on the previous year.

On the another hand, according to an IndustryARC report[4] technological advancements are playing a pivotal role in enhancing workplace safety. The integration of augmented reality (AR), virtual reality (VR) and AI into safety protocols is providing organizations with innovative tools with which to monitor and mitigate potential hazards effectively.

However, the market faces challenges, particularly in respect to high initial costs of implementing safety systems. The MarketsandMarkets report[5] highlights that expenses related to safety components, installation, and maintenance can be substantial, posing financial burdens, especially for small enterprises and organizations in low-income regions. Despite these challenges, the market is poised for continued growth. Zion Market Research emphasizes the increasing adoption of workplace safety solutions across various industries, including chemicals, healthcare, construction, energy, and utilities. A growing focus on employee safety and well-being is expected to further propel the market forward in coming years.

Regionally, according to Fortune Business Insights[6], Northern America is expected to be a major contributor to workplace safety market revenue, driven by global innovative technology providers and stringent safety regulations.

In summary, the workplace safety market is on a robust growth trajectory, driven by increasing safety concerns, regulatory pressures, and technological innovations. However, addressing cost-related challenges will be crucial to ensuring the widespread adoption of these essential safety measures across all sizes of organization.

2 MarketsandMarkets (2024). Workplace Safety Market. Available at: www.marketsandmarkets.com/Market-Reports/workplace-safety-market-247399116.html.
3 Zion Market Research. Occupational Health and Safety (OHS) Market. Available at: www.zionmarketresearch.com/report/occupational-health-and-safety-ohs-market.
4 IndustryARC. Workplace Safety Market - Forecast (2025 - 2031). Available at: www.industryarc.com/Research/workplace-safety-market-research-800430.
5 MarketsandMarkets (2024). Workplace Safety Market. Available at: www.marketsandmarkets.com/Market-Reports/workplace-safety-market-247399116.html.
6 Fortune Business Insights (2024). Workplace Safety Market. Available at: www.fortunebusinessinsights.com/workplace-safety-market-104923.

Correlating insights gathered from these reports with the key findings of the patent analysis shows that the global workplace safety market is set to undergo transformative growth, driven by advancements at the three intervention levels: Prediction, Detection, and Protection solutions.

Prediction solutions have become a focal point, with AI and machine learning enabling predictive analytics to identify potential hazards before they materialize. According to IndustryARC, such technologies are being integrated with historical data and real-time inputs so as to forecast risks and thereby, minimize workplace injury and fatality.

Detection solutions are at the forefront of workplace safety strategies. Zion Market Research highlights the adoption of drones, AR and VR as tools for real-time hazard monitoring, workforce training and emergency response simulation. Such innovations are empowering organizations to maintain continual vigilance and rapidly address safety concerns.

Protection solutions remain a cornerstone of occupational safety, with MarketsandMarkets emphasizing the growing investment in PPE, advanced safety systems, and automated shutdown mechanisms. Such measures not only shield employees from harm, but also ensure compliance with stringent safety regulations across industries.

The synergy of these three OHS categories, based on predictive, proactive and protective approaches, reflects a paradigm shift in workplace safety. By integrating cutting-edge technologies and addressing diverse safety needs, the workplace safety market is set to exceed USD 30 billion by 2028, creating safer, more resilient workplaces worldwide.

4 Prediction technologies: anticipating workplace hazards

This chapter overviews Prediction technologies anticipating workplace hazards in the occupational health and safety (OHS) patent landscape. It analyzes global patenting activity, patent growth, and development, highlighting top offices of first filing and leading patent owners. Additionally, it showcases benchmark inventions in Prediction technologies, illustrating innovative advancements that enhance proactive risk mitigation in workplaces worldwide.

This section examines OHS technologies associated with Prediction through the lens of patents. Innovations focus on the proactive identification and assessment of potential hazards in order to prevent accidents and incidents before they occur. By anticipating risks early, Prediction technologies and methodologies enable the implementation of preventive measures, improve decision-making processes, and contribute to creating safer work environments.

To build this analysis and create the patent dataset, the Prediction category has been segmented into three key technology areas:

- **Statistics-based analysis:** This approach leverages historical data and statistical methods to identify trends and patterns that could signal potential safety risks. By analyzing past incidents and correlating them with workplace conditions, organizations are able to make data-driven decisions designed to mitigate hazards before they materialize.
- **Machine learning:** Machine learning algorithms process vast amounts of data in order to predict safety incidents. Such systems learn from historical events and near misses, generating insights and actionable recommendations to enhance safety protocols. This approach is particularly effective in identifying complex, non-linear relationships that traditional statistical methods might overlook.
- **Behavior-based safety:** This methodology focuses on observing, analyzing and influencing worker behavior, so as to improve safety outcomes. By identifying unsafe practices and encouraging positive behavior through training, feedback and intervention, organizations can foster a culture of safety and reduce risks related to the human-factor.

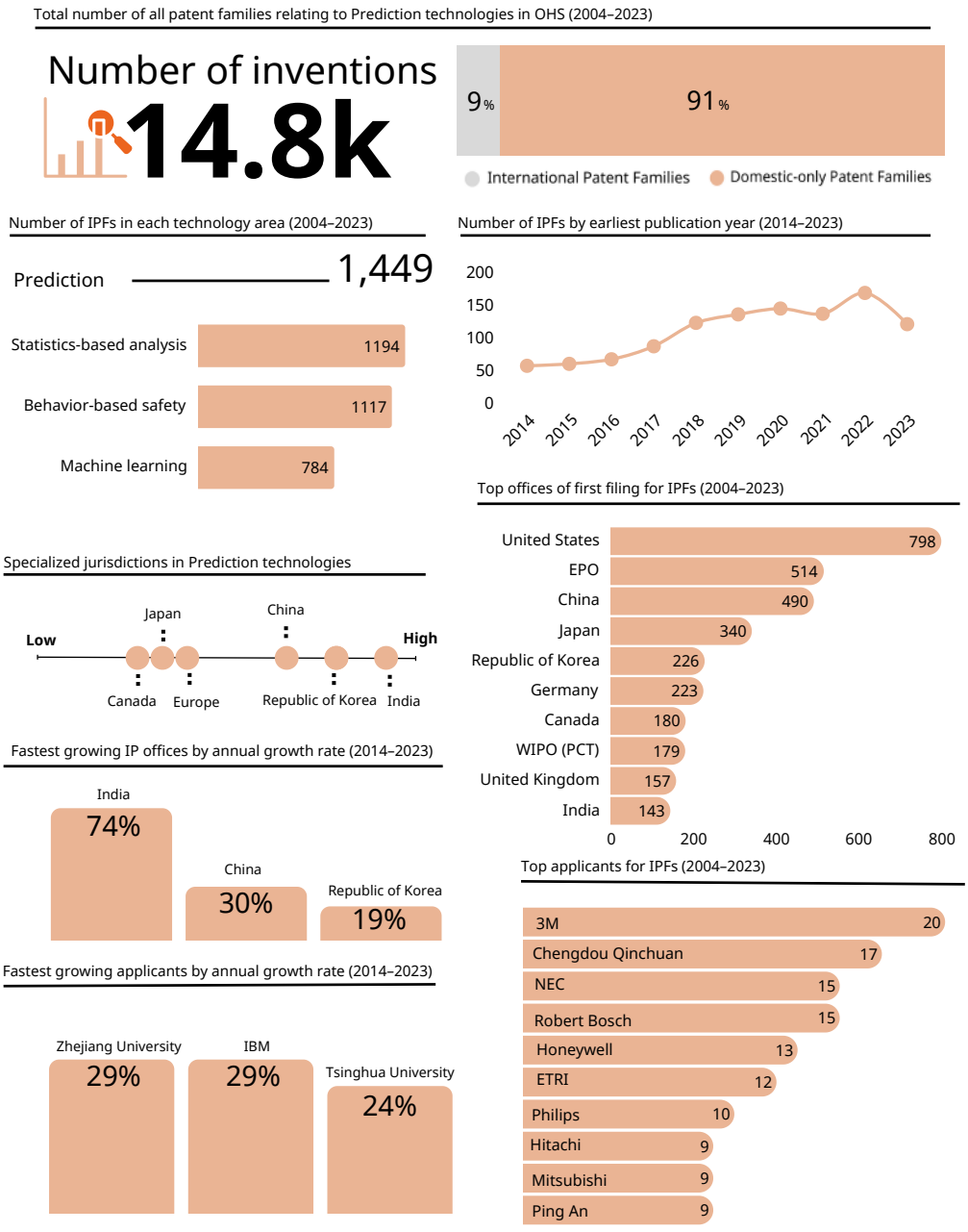
This chapter is structured into three main parts:

1. **Global patent landscape:** A broad analysis of the global Prediction patent landscape is conducted, publication trends examined, the most innovative regions or countries identified, and the key players driving advancements in the field of Prediction technologies profiled.
2. **Focus on international patent families (IPFs):** Focusing on IPFs allows the detection of the technology trends that companies consider valuable enough to internationalize and seek protection in overseas markets. Such a focus emphasizes those areas in which significant investments are being made, indicating promising channels for innovation and potential market returns.
3. **Benchmark inventions:** Lastly, specific patents that illustrate the field particularly well are highlighted. These examples showcase the cutting-edge innovations shaping the future of Prediction.

This multi-faceted approach ensures a comprehensive understanding of how Prediction technologies are evolving within the OHS domain and provides actionable insights into the technological strategies shaping workplace safety.

Global patenting landscape

Figure 4.1 Overview of the prediction technologies related to OHS

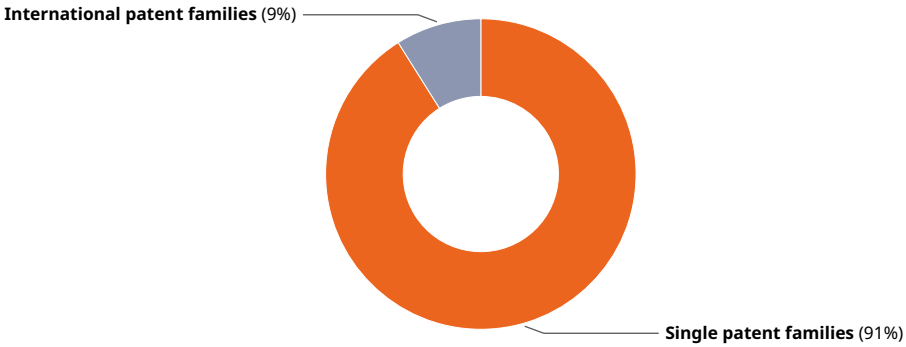


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.
Note: IPF stands for international patent family.

Based on the data collected in this study, the Prediction technologies category comprises a total of 14,777 patent families, representing 3% of the global patent portfolio in this domain. 1,449 of these are classified as international patent families (Figure 4.2).

Prediction technologies consist of a total of 1,449 IPF patent families, accounting for 9% of the global patent portfolio.

Figure 4.2 International and domestic-only patent families share in Prediction technologies by number of published patents, 2004–2023

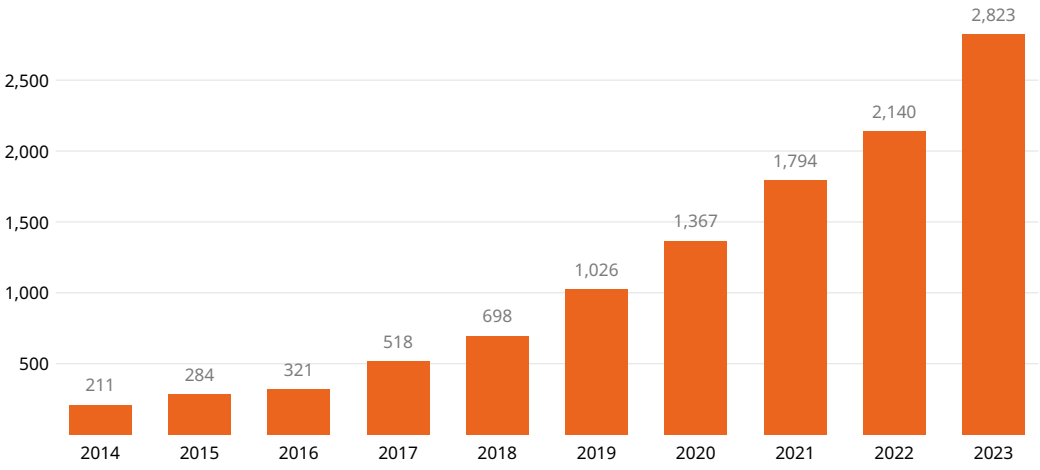


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Patenting activity refers to the number of patent families published annually within a specific field. This metric is based on the first publication date of each patent family, which typically occurs approximately 18 months after the filing date. Analyzing patenting activity provides valuable information on innovation trends in a particular field. Comparing the evolution of patent filings in a specific field to the overall growth in global patent filings enables an assessment of the dynamism and innovation intensity of that field. Such a comparison serves to determine whether a field is experiencing rapid development, stagnation or decline relative to overall technological progress.

The annual growth for 2018–2023 is 26.4%, significantly higher than the global CAGR of 2.7%, indicating increased interest and innovation.

Figure 4.3 Patent publication trends in Prediction technologies by earliest publication year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The database analyzed contained nearly 15,000 patent families. As shown in Figure 4.3, in the five years between 2018 and 2023, the field of Prediction underwent a significant upward trajectory in terms of patent filings. The compound annual growth rate (CAGR) for this period was 26.4%, compared to a global CAGR of 2.7% across all technology fields[1], reflecting a

1 This information has been calculated using the Orbit Intelligence database and other statistics on patent filings available in WIPO's World Intellectual Property Indicators 2023. Available from: www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2024-en-world-intellectual-property-indicators-2024.pdf.

heightened interest and innovation in this domain. The trend peaked in 2023, with 2,823 patent families published.

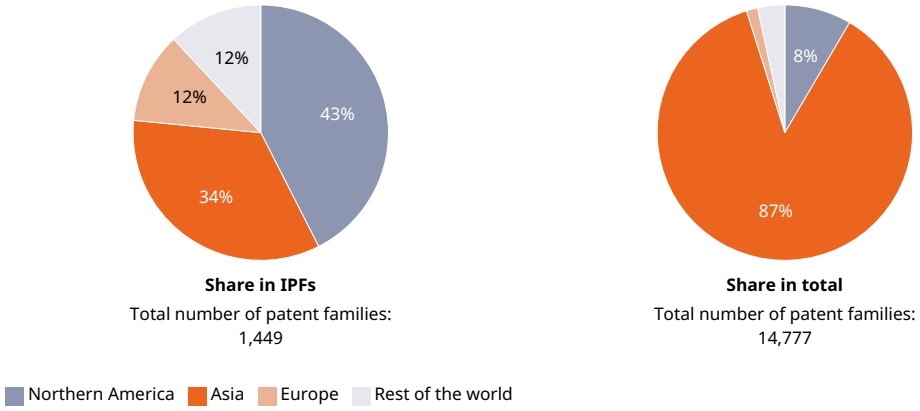
Top jurisdictions

Analyzing patent families provides valuable insights into which countries are driving innovation in a particular field. Typically, the first filing of a patent family (known as the priority filing) is made in the applicant's country of origin. This is influenced by legal frameworks and cost considerations, making the location of the priority filing (office of first filing) a strong indicator of where innovation is actively taking place.

In the field of Prediction, Asia emerges as the leading region for innovation (Figure 4.4). China plays a dominant role, accounting for an impressive 11,404 patent families, followed by Republic of Korea with 958 patent families. Northern America, driven primarily by the United States, with approximately 1,231 patent families, rank next. European countries trails behind, contributing around 209 patent families to the field.

Asia significantly dominates the Prediction-related patent landscape by representing the almost 90% of the filings, whereas Northern America leads the IPFs.

Figure 4.4 Patent distribution in Prediction technologies by R&D regions, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

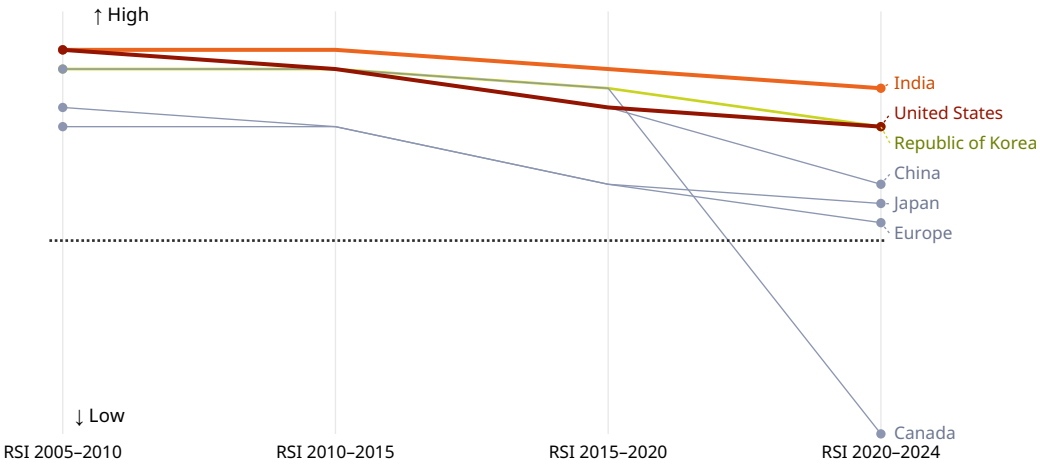
This geographic distribution highlights the significant role Asia, particularly China, plays in advancing OHS technologies related to Prediction. The dominance of Chinese innovations underscores the region's strategic focus on workplace safety technologies, while contributions from other regions, such as Northern America and Europe, reflect more modest levels of activity in comparison.

The Relative Specialization Index (RSI) is used to compare the published patenting activity of different countries within the same technology area. RSI is a measure of a country's share of patent families in a particular field of technology as a fraction of that country's share of patent families in all fields of technology. In other words, RSI has the advantage of providing a comparison between the patenting activity of two countries relative to the overall patenting activity of those same two countries. When analyzing patent data, normalized RSI is used[2].

2 See Appendix 1 for more information.

India, the United States, and the Republic of Korea demonstrate a high degree of specialization in Prediction technologies.

Figure 4.5 Relative specialization index (RSI) change in Prediction technologies across countries by year, 2005–2024



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

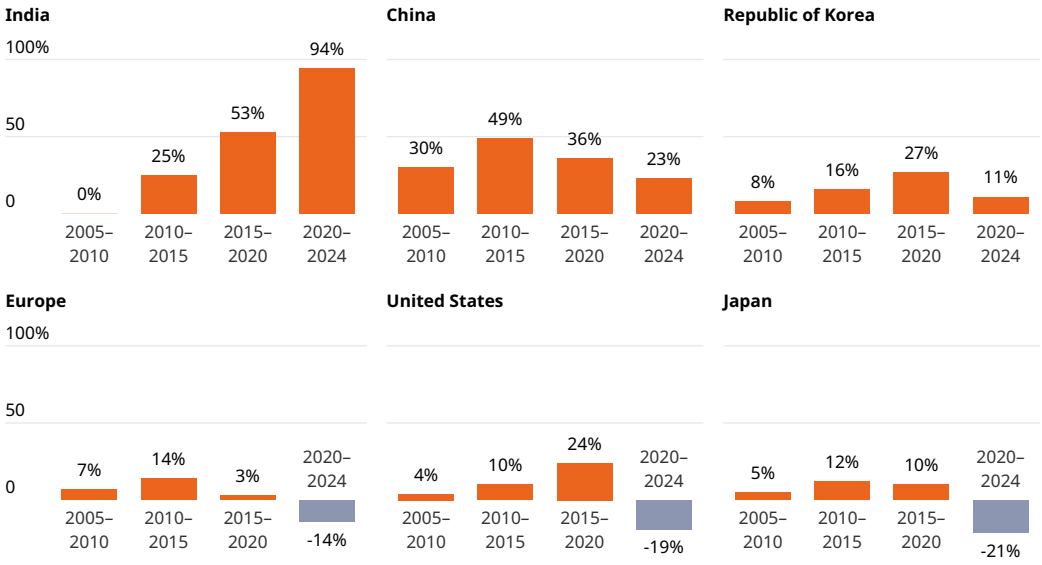
Figure 4.5 shows that India demonstrates consistently high specialization (RSI = 1 in early years, declining slightly to 0.8 by 2020–2024), reflecting sustained innovation in this domain. Similarly, the Republic of Korea maintains above-average RSI values but show gradual declines, indicating reduced emphasis in recent years. Conversely, Canada has undergone a notable decline over the past five years.

The United States and China initially exhibit strong specialization (RSI = 1) but each has experienced a steady decline over time, with an RSI values falling to 0.6 and 0.3, respectively, by 2020–2024. This trend suggests either a shift in research priorities or a diversification into other technological areas. In contrast, European countries and Japan have consistently recorded a low RSI values, reflecting a limited focus on Prediction technologies, with Europe's RSI dropping to 0.1 and Japan's to 0.2 by the final period.

Overall, most regions show a declining RSI values over time, signaling a global decrease in patenting activity in this domain relative to others. Despite this, India, Canada, and Republic of Korea remain notable contributors, while regions like Europe and Japan lag behind.

India has experienced an accelerating rise on Prediction-related patent filings in recent years.

Figure 4.6 Periodic patent growth in Prediction-related filings by priority jurisdiction, 2005-2024



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Patent growth in Prediction technologies by priority country shows that China experienced strong growth initially but slowed down in later years (Figure 4.6). The United States grew slowly at first and then underwent a significant decline. The Republic of Korea has shown steady growth, while India has seen a sharp rise over recent years. Japan and the region covered by the European Patent Office (EPO) show early growth but then experienced a declines. Overall, most regions have shown a decrease in growth, with India being a notable exception.

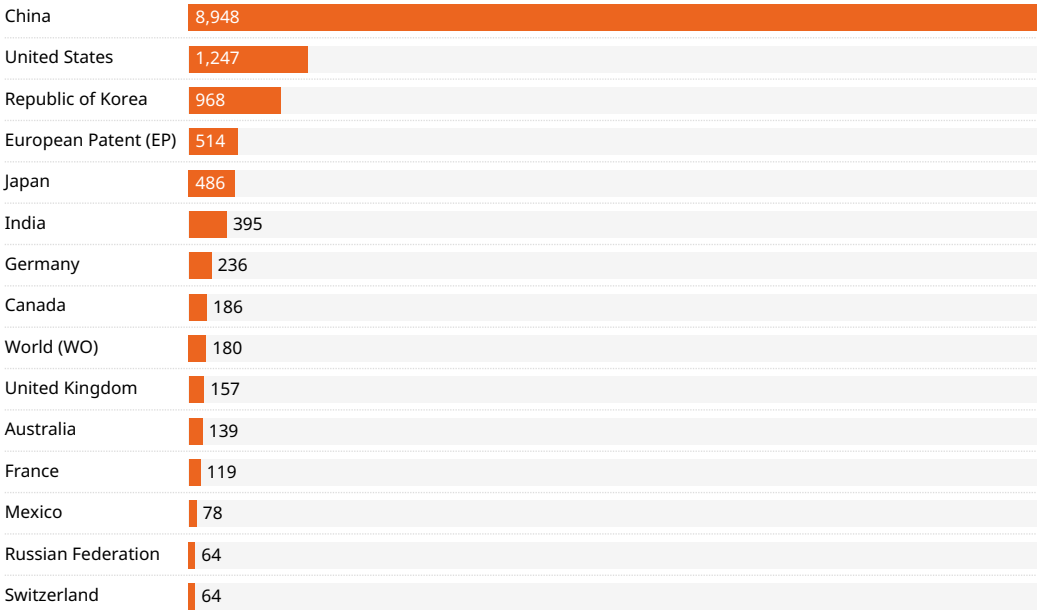
Analyzing the global coverage of patent families provides valuable insight into the key markets that manufacturers target for their innovations. Companies naturally prioritize patent protection in those countries they deem essential for securing market share and ensuring a competitive advantage.

China stands out as a dominant force in the field of Prediction in Figure 4.7, with 8,948 patent families protected within its borders, making it the most attractive market for these technologies. The United States follows with 1,247 protected patent families, highlighting the prominence of Prediction innovations in two of the world's foremost technological and economic hubs.

Other countries and regions also demonstrate significant engagement in this field. The Republic of Korea has 968 patent families, while the EPO (514), to which must be added national protections, at least – Germany (236), United Kingdom (157) and France (119) – Japan (486), and India (395) serve to further illustrate the global reach and adoption of Prediction solutions.

China emerges as a leading player in Prediction, boasting 8,948 patent families within its territory.

Figure 4.7 Top priority jurisdictions in Prediction by number of patents published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

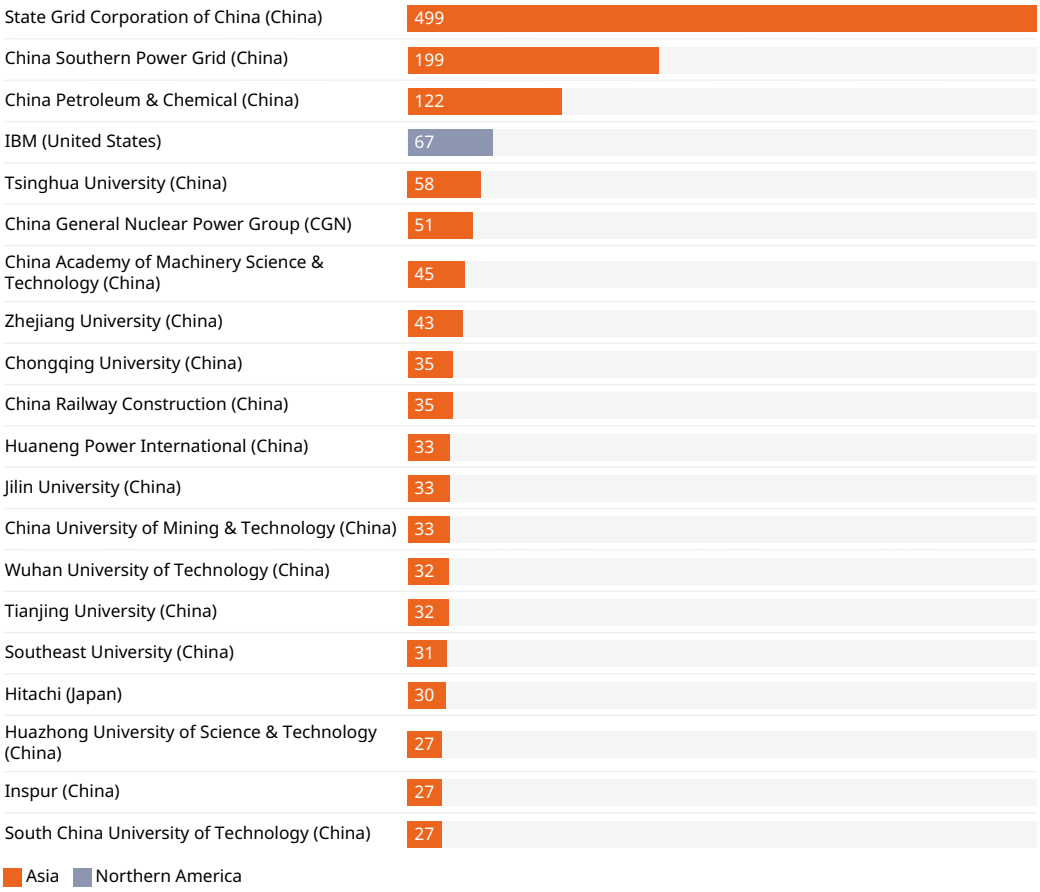
In conclusion, these figures reflect the strategic focus of innovators on key global markets, with China and the United States leading as major hubs of innovation and market activity. Substantial protection efforts across other regions and countries, such as the Republic of Korea, Europe and Japan, underline the growing international demand for and development of technologies aimed at enhancing workplace safety.

Top patent applicants

Examining the patent applicants in this area affords a comprehensive overview of those companies and organizations driving innovation and actively seeking to protect their technological advancements. This analysis identifies the key players contributing to the development of Prediction solutions and highlights their commitment to securing IP rights for their innovations.

The overwhelming presence of Chinese entities is clear in Prediction-related patent filings.

Figure 4.8 Top applicants in Prediction technologies by number of patents published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Among the top 20 patent applicants in the field, the State Grid Corporation of China (SGCC) leads with an impressive 499 patent families (Figure 4.8). It is followed by other notable entities China Southern Power Grid (199 patent families), China Petroleum and Chemical (111) and IBM (67). This dominance highlights a significant focus on Prediction technologies both by corporate and academic/research organizations, particularly within China.

The activity of top applicants reveals the surge in patent filings observed since 2015 to have been driven primarily by Chinese applicants. Interestingly, this wave of corporate filings in China was preceded by earlier contributions from Chinese universities, such as Tsinghua University, Zhejiang University, and Wuhan University of Technology, which laid the groundwork for innovation in this domain.

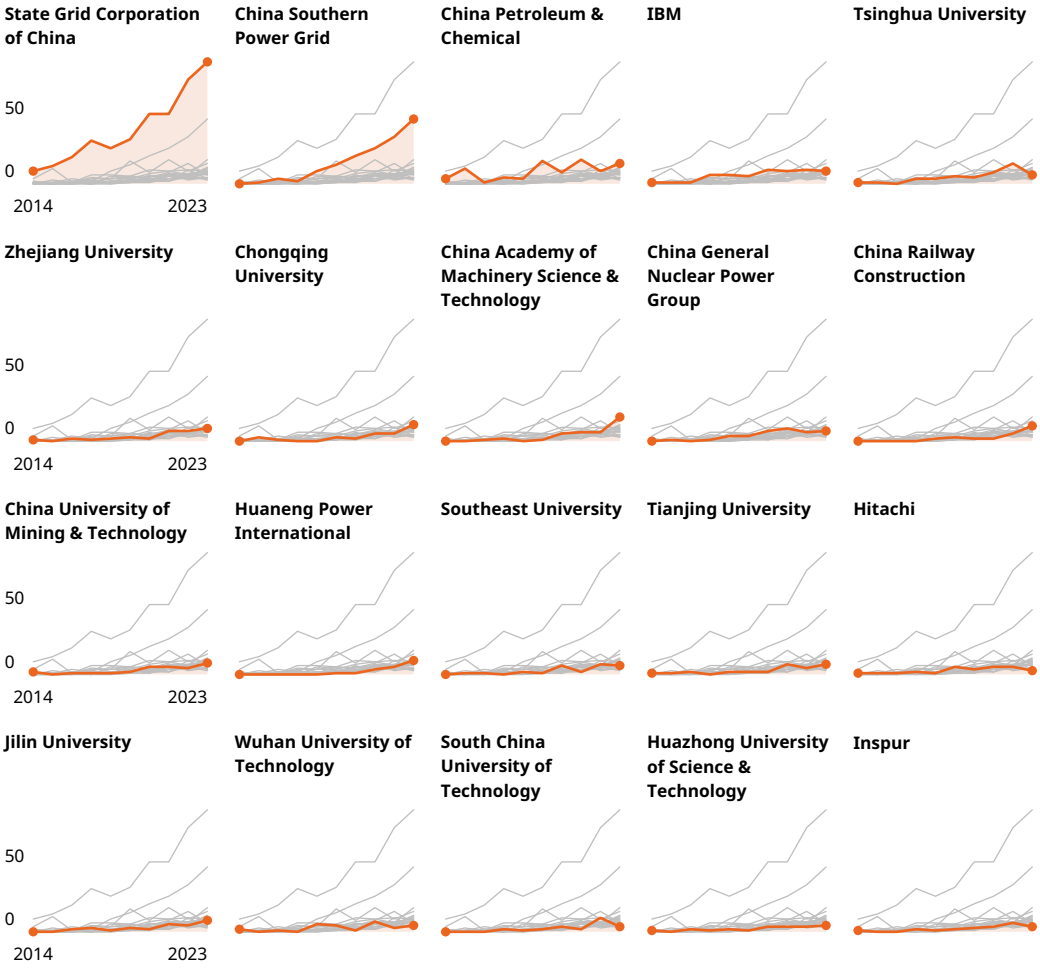
Between 2014 and 2023, IBM and Zhejiang University tied for the highest CAGR in OHS prediction patents at 29.2%, followed by State Grid Corporation of China at 28.6%. Tsinghua University achieved a 24.1% CAGR, and China University of Mining & Technology posted 18.2%. At the lower end, Wuhan University of Technology recorded the slowest growth, at 10.7%.

These figures highlight the varying levels of patenting activity in OHS prediction technology across organizations.

Notably, IBM emerges as a key non-Chinese player, distinguishing itself by being an early innovator in the sector and continuing to make substantial investments in Prediction technologies. This highlights IBM's strategic commitment to advancing safety-focused solutions on a global scale.

The robust and steady trend of State Grid Corporation of China is evident in Prediction-related patent filings.

Figure 4.9 Top patent applicants filing trend in Prediction-related technologies, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

In conclusion, Chinese players are the primary drivers behind the growth in patent filings within the OHS Prediction category. While Chinese companies dominate innovation in this domain, their success seems to be closely tied to the strong foundation and contributions provided by leading Chinese universities. This synergy between academia and industry highlights a robust innovation ecosystem in China, fueling advancements and shaping the global landscape of Prediction technologies.

International patenting landscape

This section emphasizes the value of analyzing International Patent Families (IPFs) to uncover meaningful insights into technological trends.

Analyzing IPFs helps to filter out less impactful or localized inventions, leaving a dataset that reflects substantial investments and a focus on long-term technological and commercial viability. As a result, this approach provides a clearer view of the key trends shaping innovation and reveals the areas where companies are placing their strategic bets for the future.

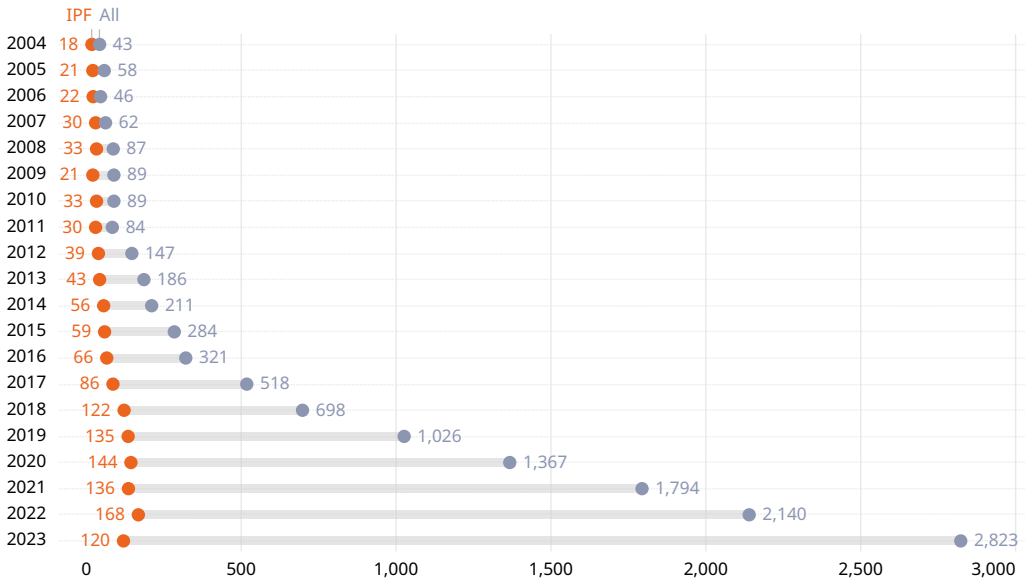
IPF development and growth

An analysis of patent filing trends in Prediction technologies reveals two key observations:

1. Explosive growth driven by China: While the number of patents in this field has surged over the past decade, growth has been primarily concentrated in China. However, a significant proportion of the patent families are China-only filings and therefore do not qualify as an IPF, as they do not extend beyond China's borders.
2. Stagnant growth in internationally significant innovation: The growth rate of IPF filings in this sector is almost flat, showing a 0% growth rate compared to a 26% growth rate for total patents in this field and 2.7% across all sectors globally. This stagnation tempers the overall growth narrative, indicating that innovations of global significance have remained steady, with approximately 120 IPFs filed annually over recent years.

Internationally significant innovations show limited growth, with a stagnant rate in IPF filings compared to 26% for all patents.

Figure 4.10 IPF and domestic-only patent trend in Prediction technologies by year, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

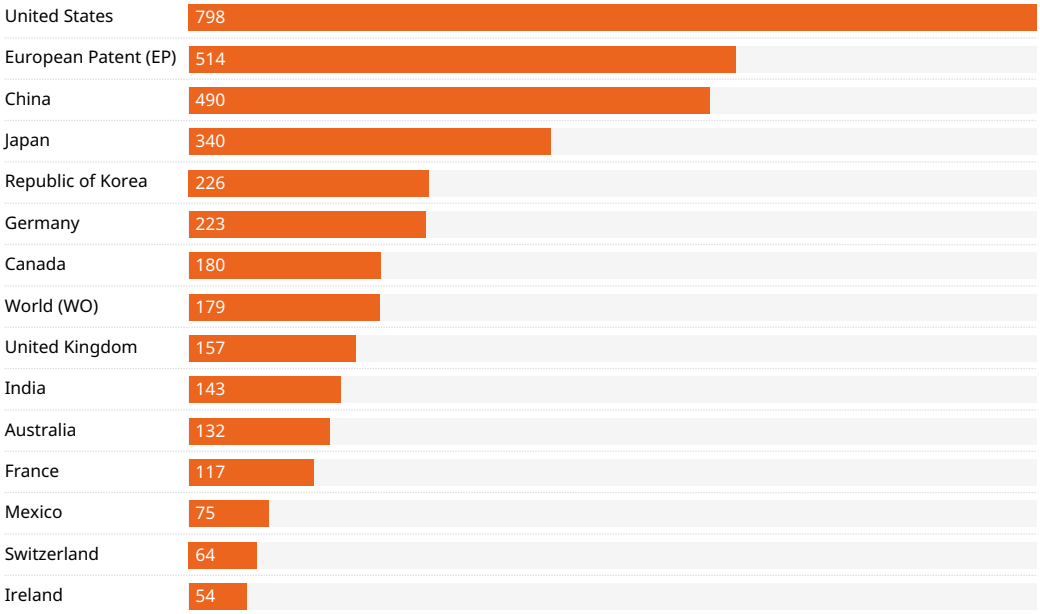
In conclusion, these findings highlight a dual dynamic – while the field is experiencing significant local growth in China (mostly non-extended patent families), the pace of globally impactful innovation remains stable.

IPF top jurisdictions

Top jurisdiction ranking underscores a deliberate strategy by innovators to secure their IP in major global markets, prioritizing regions with strong technological ecosystems and significant commercial potential.

The United States is the leading destination for patent families, with 798 filings, highlighting its importance in Prediction technologies.

Figure 4.11 Top priority jurisdictions in Prediction technologies by number of IPFs published, 2004–2013



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The United States stands out as the leading destination, with 798 patent families, reflecting its central role as a key market for Prediction technologies (Figure 4.11). The EPO follows, with 514 patent families, while China ranks third with 490. Japan and the Republic of Korea complete the top five, with 340 and 226 patent families, respectively.

In China, the total number of patent families filed domestically (8,948) far exceeds the number of internationally extended IPFs (490). This disparity highlights the predominance of local filings in China, where many patents remain focused on the domestic market without international extension. This could indicate that while China is a hub of innovation, a significant portion of its inventions are tailored to local market needs rather than having a more global reach.

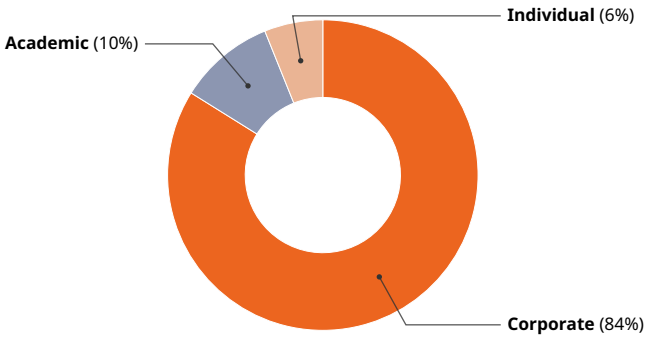
The IPF data highlights the patent strategy used by applicants in targeting the key regions for IP protection, namely the United States, Europe, China, Japan and the Republic of Korea. It also reflects the dual dynamics of innovation in China, where a strong domestic focus contrasts with a more selective approach to international patenting.

IPF top patent applicants

The OHS category of Prediction technologies has the standard characteristics of emerging technology sectors, with Figure 4.12 showing that 81% of applicants are from industry and hold 84% of the IPFs (which indicates fairly small portfolios) and a relatively large number of academic players (11% of applicants) hold 10% of the IPFs in the field.

The Prediction field is predominantly led by companies in international filings.

Figure 4.12 Applicant type shares in Prediction technologies by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Key players in Prediction technologies (Figure 4.13) include:

3M Innovative Properties leads the field, with 20 patent families, showcasing the largest and most established portfolio. The size of its portfolio and broad protection suggests a diverse and well-rooted presence in this domain. Furthermore, 3M Innovative Properties demonstrated significant activity in 2019, filing seven patent families. However, its activity has since declined, with no filings recorded in 2023, suggesting a slowdown in innovation efforts.

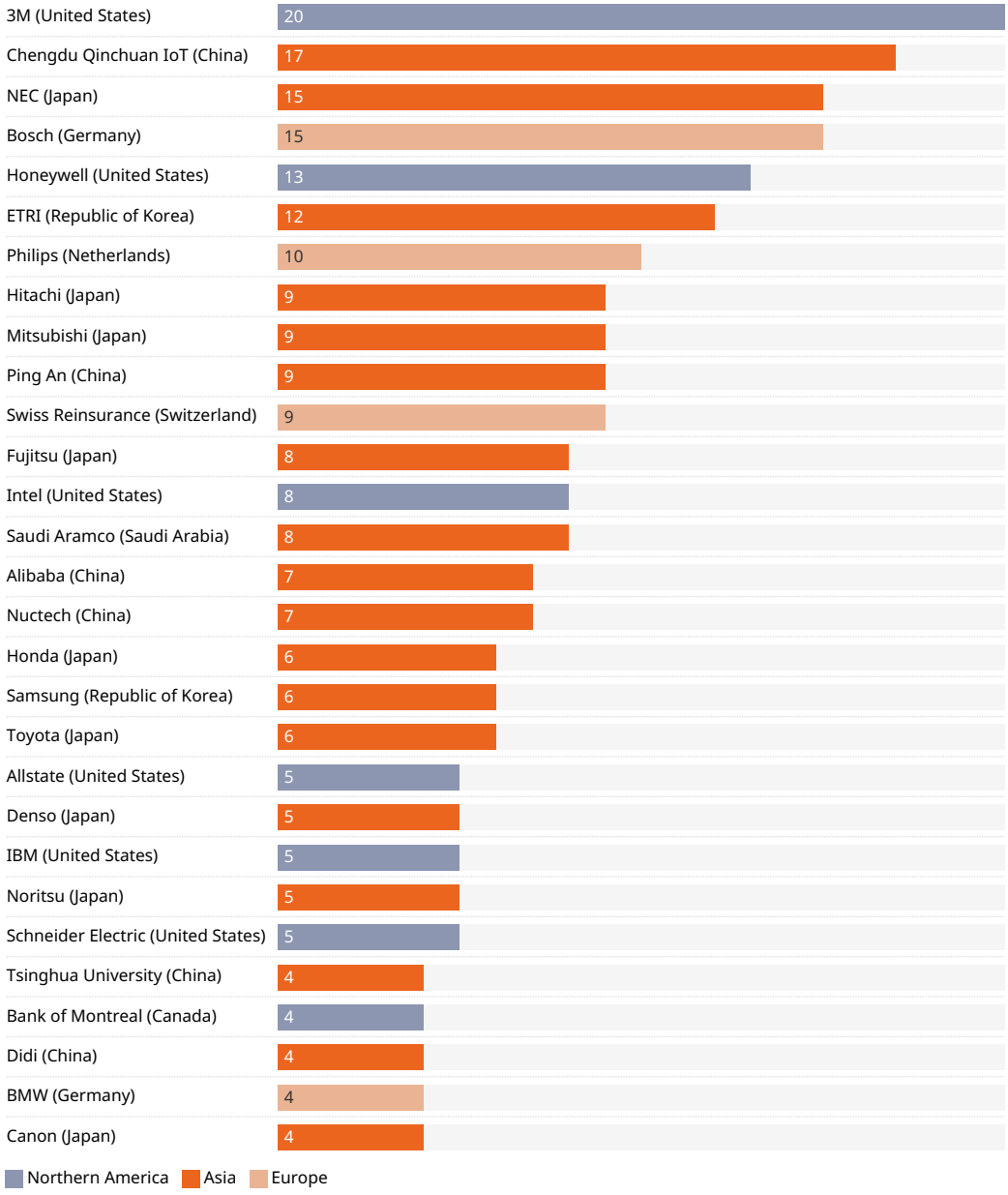
Chengdu QinChuan IoT Technology follows closely, with 17 patent families. Chengdu QinChuan IoT Technology emerged as a notable player, entering the field in 2022 and experiencing a sharp spike in filings in 2023, signaling a focused and aggressive push into this sector.

NEC Corporation holds 15 patent families, reflecting steady and consistent filing activity, with 1–3 filings per year. This indicates a deliberate, ongoing commitment to innovation in workplace safety technologies.

Robert Bosch, **Honeywell International**, and **Philips** are prominent industrial players with 15, 13 and 10 patent families, respectively. These companies leverage their expertise in automation and safety systems to develop predictive safety solutions.

The Prediction IPFs show a non-concentrated distribution among players, with 3M leading the list with 20 patent families.

Figure 4.13 OHS Prediction top applicants by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Prediction technologies feature a diverse range of players, from industrial giants to emerging innovators. While 3M Innovative Properties holds the largest portfolio and broadest protection, Chengdu QinChuan IoT Technology is quickly establishing itself with a focused and rapidly growing presence. Companies like NEC, Robert Bosch, and Honeywell International have made a steady contribution, each with distinct strategies tailored to their strengths. This dynamic landscape highlights both the maturity of the established players and the fresh momentum brought by emerging innovators.

IPF main technologies

Study of international patent families (IPFs) reinforces the insights from the broader portfolio analysis: that is, the Prediction sector has evolved significantly, transitioning from traditional statistical and behavioral methodologies to more advanced AI-based approaches.

Figure 4.14 highlights the trajectory taken by IPF growth across three major technological approaches:

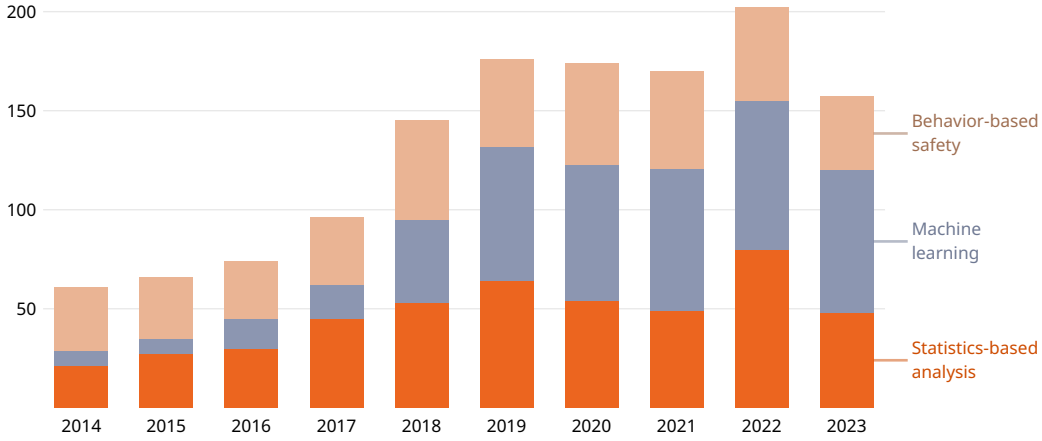
Statistics-based analysis (626 IPFs): This technology area experienced consistent growth between 2018 and 2023, peaking in 2022 with 80 patent families. However, there has been a notable decline over recent years, with filings dropping to 48 in 2023 and further to 17 in 2024, indicating a diminishing focus on this established technique.

Behavior-based safety (570 IPFs): Growth in this technology area has been steady, peaking in 2018 with 50 patent families. From 2019 onward, a gradual decline is observed, with filings reducing to 47 in 2022 and continuing to fall to 37 in 2023.

Machine learning (517 IPFs): This technology area has shown robust and sustained growth, beginning its significant rise in 2016. Filings peaked at 75 in 2022 and remained strong in 2023, with 72 patent families, highlighting an increasing reliance on AI-driven solutions for accident prediction.

There is consistent and significant growth in innovations related to machine learning.

Figure 4.14 IPF filings trend in Prediction technologies by technology area, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The IPF analysis underscores a clear technological shift within the Prediction sector. While traditional approaches like statistics-based and behavior-based methodologies are declining, AI continues to drive innovation and attract investment. Key players such as IBM and Chengdu QinChuan IoT Technology are shaping the future of this field, paving the way for more sophisticated, data-driven safety solutions.

Benchmark inventions in Prediction technologies

Main technologies and application fields

To gain a deep understanding of the technological approaches in the OHS Prediction category, the dataset of related simple patent families has been segmented into three main distinct technology areas listed below in descending order according to the number of patents:

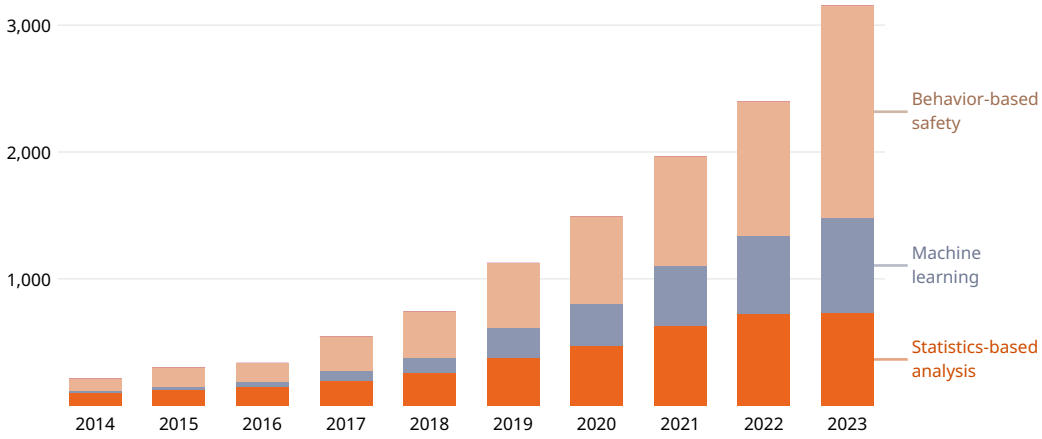
Statistics-based analysis: This technology area, with 7,941 patent families, represents technologies that leverage historical data and statistical methods in order to predict risks and improve safety outcomes.

Behavior-based safety: A total of 4,808 patent families focusses on solutions designed to analyze and influence worker behavior, so as to enhance safety.

Machine learning: AI-driven approaches account for 4,325 patent families, emphasizing the use of advanced algorithms to predict s more effectively.

Behavior-based safety inventions are increasingly on the rise in Prediction technology.

Figure 4.15 Patent filings in Prediction technologies by technology area, 2014–2023



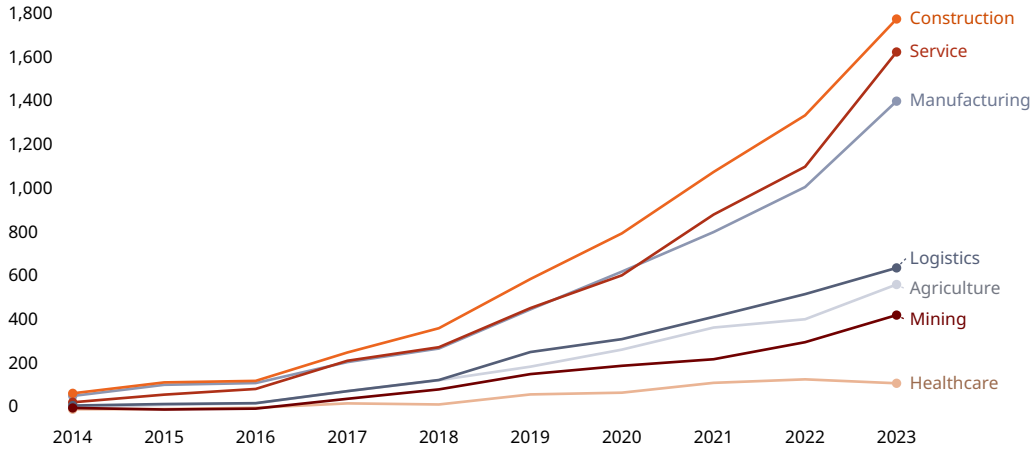
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Analysis of patent filings over time reveals the emergence of a new trend beginning in 2021. Since the data are based on publication dates and there is typically an 18-month delay between a patent's filing and its publication, the actual shift in filing activity can be traced back to the period between 2018 and 2019.

Statistics-based analysis remains the largest technology area in terms of patent volume. However, growth has stagnated over recent years, with filings having leveled off by 2021 and showing a decline since then. In contrast, behavior-based safety and machine learning are gaining momentum, with their patent filing volumes increasing steadily year-on-year, particularly in 2023.

Construction, service, and manufacturing sectors are by far the top contributors to Prediction-related filings.

Figure 4.16 Patent filings trend in Prediction technologies by industrial sectors, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Figure 4.16 reveals a strong overall increase in patent filings for Prediction technologies across various industrial sectors between 2014 and 2023:

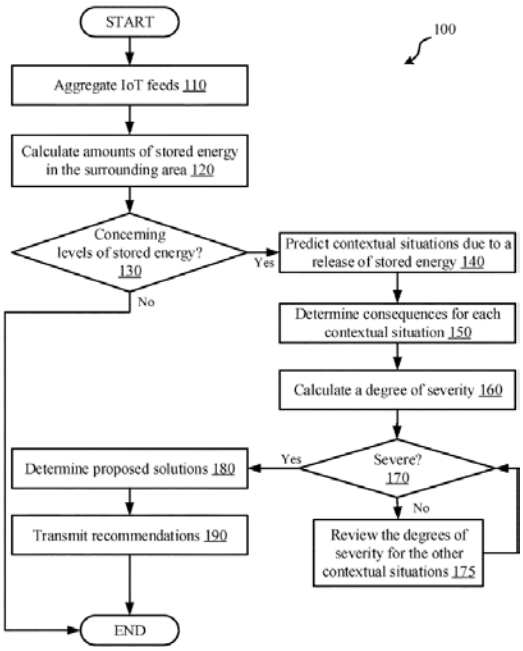
- Construction, services, and manufacturing sectors lead in patenting activity, reflecting a significant focus on solutions to enhance safety in these industries.
- Logistics, agriculture and mining sectors have likewise experienced notable growth in workplace safety innovations.
- The health care sector, while not seeing rapid growth, has maintained a steady and consistent increase in patenting activity, highlighting its ongoing commitment to safety technologies.

The analysis highlights a clear shift in technological focus within Prediction since 2019. While statistics-based approaches have historically dominated the field, newer and more dynamic approaches such as behavior-based safety and especially machine learning have driven innovation over recent years. The steady rise in patent filings across diverse industrial sectors underscores a growing recognition of workplace safety as a critical area for technological advancement.

Example patents

The examples that follow have been chosen because considered particularly example of the field.

CN115812301: Predict solutions for potential hazards of stored energy



Source: CN115812301

Patent CN115812301 describes an innovative system, owned by American multinational computer hardware, software and services company International Business Machines Corporation (IBM), that aims to predict and mitigate the effects of stored energy release by combining AR and IoT technologies. The system uses sophisticated machine learning algorithms to improve safety and preparedness in situations where stored energy can present risks.

The invention presents a comprehensive method and system designed to predict and mitigate the consequences of stored energy release in diverse environments. By aggregating data from IoT sensors and employing sophisticated machine learning algorithms, the system is capable of calculating energy levels and forecasting potential hazardous situations. The use of AR allows for the simulation of energy release effects, providing users with visual representations of potential hazards and recommending actionable solutions to minimize risks.

US10572493: Computerized process safety management system

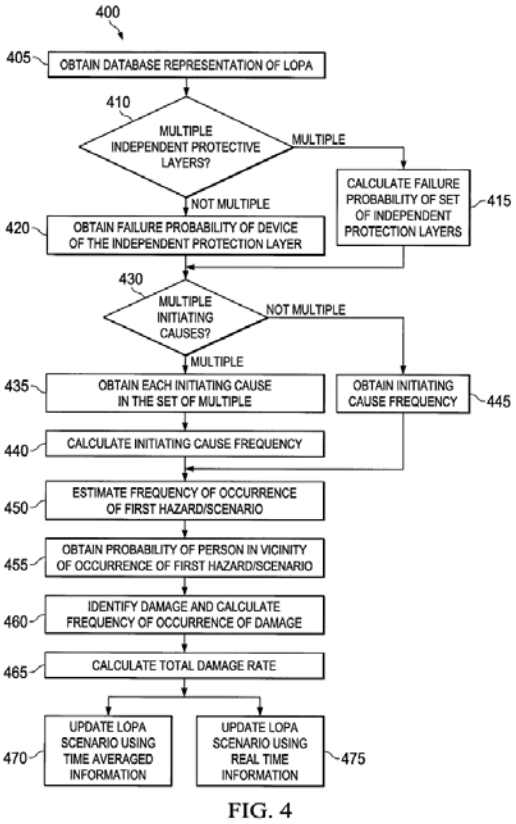


FIG. 4

Source: US10572493

Patent US10572493 filed by Honeywell International outlines an innovative method for dynamically estimating and visualizing hazard frequencies in industrial processes. The method leverages real-time data to enhance safety management and operational efficiency, making it applicable across various industrial settings.

The invention introduces a systematic approach to estimating hazard occurrence frequencies in industrial environments. By identifying initiating causes and their respective frequencies, along with evaluating the effectiveness of independent protection layers, the method provides a comprehensive safety management tool.

EP4285303: Predictive safety system for workplace risk management

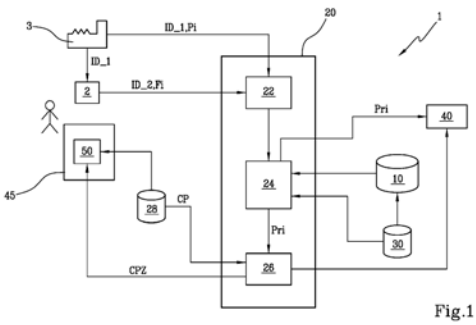


Fig.1

Source: EP4285303

The invention outlined in patent EP4285303, developed by Adam AI Solutions, focuses on enhancing workplace safety through real-time monitoring and risk assessment. This document outlines the features and advantages of a predictive system and method. Utilizing wearable

devices and IoT sensors, the system aims to significantly reduce workplace incidents and foster a culture of safety by enabling proactive decision-making based on real-time data.

The invention utilizes wearable devices and IoT sensors to monitor vital signs and environmental conditions. The system processes this data through an AI-driven risk calculation module to generate real-time accident risk profiles, enabling proactive safety measures and decision-making. This approach significantly reduces workplace incidents and fosters a culture of safety.

Summary of Prediction technologies

The domain of Prediction is undergoing significant evolution by analyzing the global patent filing evolution. It is important to note that the surge in patenting activity is primarily driven by Chinese applicants, who predominantly focus on securing local protection rather than pursuing extensive international coverage. In contrast, the evolution of IPFs suggests a more stable rate of filings and a steady level of innovation, rather than a dramatic surge. This indicates a consistent, sustained effort in advancing technologies, without the rapid expansion observed in local Chinese filings.

The key centers driving innovation in this field are:

- China: A dominant force, with contributions from universities (e.g., Tsinghua University, Zhejiang University) and established players like State Grid Corporation of China (SGCC). Emerging innovators such as Chengdu QinChuan IoT Technology are also making significant strides in future-oriented technologies like IoT and AI.
- United States: Leading industrial players, including IBM, 3M, and Honeywell International, are advancing cutting-edge solutions in this space.
- Europe and Japan: European companies like Robert Bosch and Japanese firms such as NEC also play a pivotal role as key innovators.

The principal markets targeted for patent protection are the United States, Europe, China, Japan, and the Republic of Korea. Chinese players predominantly focus on domestic protection, with exceptions among emerging industrial innovators seeking broader international reach.

Analysis reveals there has been a distinct shift in technological focus within the sector since 2019. The historical dominance of statistics-based approaches is waning, and newer, dynamic methodologies like behavior-based safety and especially machine learning are now driving innovation, reflecting an increasing adoption of data-driven and predictive technologies.

5 Detection technologies: identifying and monitoring risks

This chapter overviews Detection technologies for identifying and monitoring risks in the occupational health and safety (OHS) patent landscape. It examines global patenting activity, periodic patent growth, and development, spotlighting top offices of first filing and leading patent owners. It also highlights benchmark inventions in Detection technologies, showcasing innovations that improve real-time risk assessment in workplaces globally.

Detection systems have become essential technologies for ensuring workplace safety within all sectors. These systems rely on a combination of hardware and software to identify, prevent and respond to workplace accidents, thereby minimizing risks to workers and improving operational efficiency.

Patents provide an overview of technological developments, industry priorities and potential future directions. To this end, this section focuses on technologies associated with Detection, as seen from the perspective of patents.

Analysis and the development of a patent dataset involved segmenting the Detection category into seven key technology areas:

- **Safety software solutions**: Comprehensive platforms designed to manage safety protocols, track incidents, and ensure regulatory compliance. These systems enable real-time monitoring and detailed reporting.
- **Fire detection and prevention systems**: Advanced technologies using sensors and alarms to identify fire hazards early, facilitating prompt responses and prevention measures.
- **Gas detection equipment**: Devices that monitor air quality in order to detect hazardous gases, ensuring worker safety, particularly in confined or high-risk areas.
- **Temperature monitoring systems**: Continuous temperature-monitoring solutions to prevent overheating and mitigate risks associated with extreme temperatures.
- **Noise level monitoring**: Systems that measure and manage noise exposure in environments where excessive noise poses health risks such as hearing loss.
- **Radiation detection equipment**: Specialized tools for detecting and monitoring radiation in industries where exposure is a concern, thereby safeguarding worker health.
- **Location-based safety systems**: Technologies leveraging GPS and other location-tracking methods to provide real-time data for quick emergency response and enhanced situational awareness.

This chapter is structured into three main parts:

1. **Global patent landscape**: A broad analysis of the global Detection patent landscape is conducted, the dynamics of publication examined, the most innovative regions or countries identified, and the key players driving advancements in the field of Detection technologies profiled.
2. **Focus on international patent families (IPF)**: Focusing on IPFs allows the detection of the technology trends that companies consider valuable enough to internationalize and seek protection in overseas markets. Such a focus emphasizes those areas in which significant

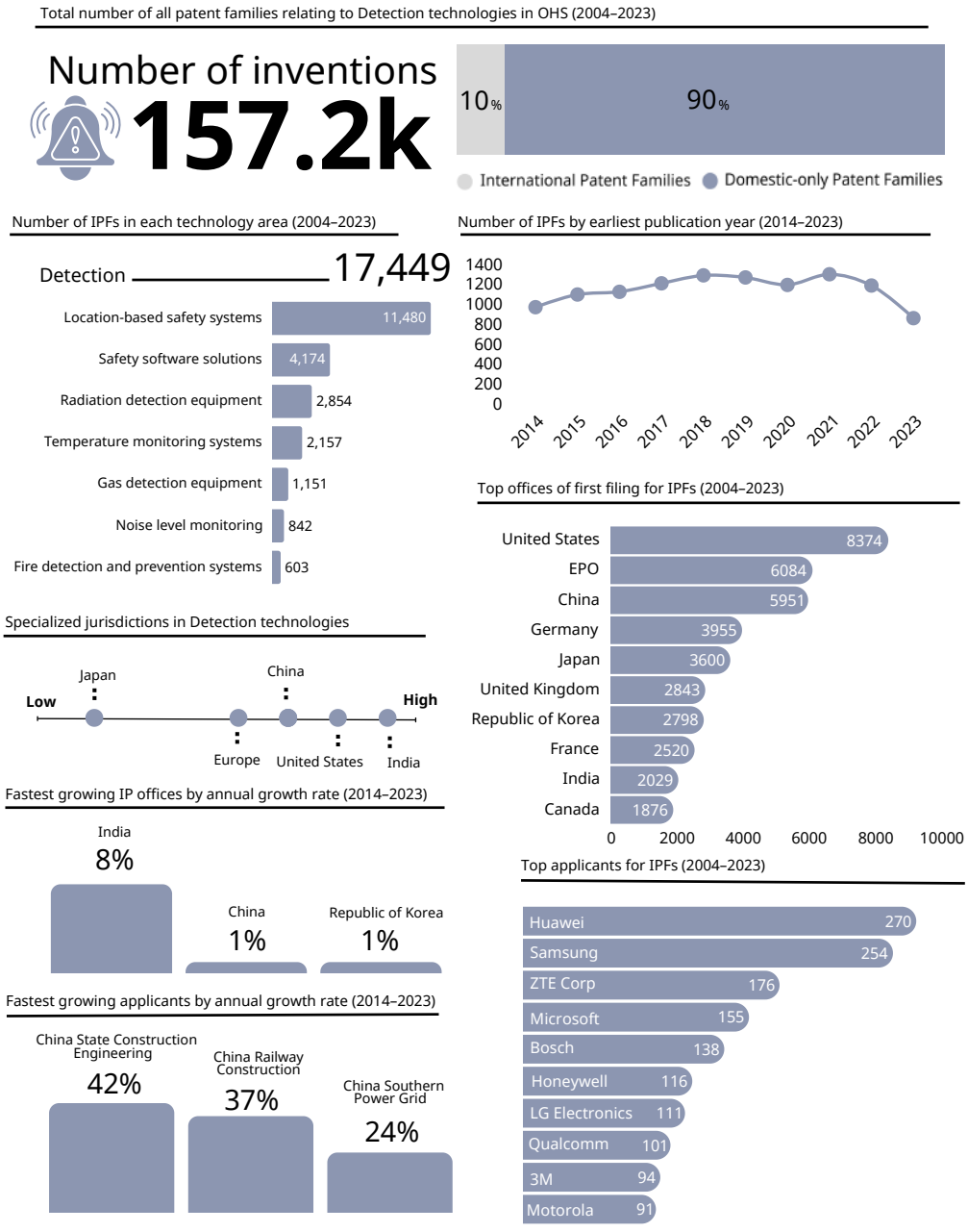
investments are being made, indicating promising channels for innovation and potential market returns.

3. **Benchmark inventions**: Lastly, specific patents that illustrate the field particularly well are highlighted. These examples showcase the cutting-edge innovations shaping the future of Detection technologies.

This multi-faceted approach ensures a comprehensive understanding of how Detection technologies are evolving within the OHS domain and provides actionable insights into the technological strategies shaping workplace safety.

Global patenting landscape

Figure 5.1 Overview of the Detection technologies related to OHS

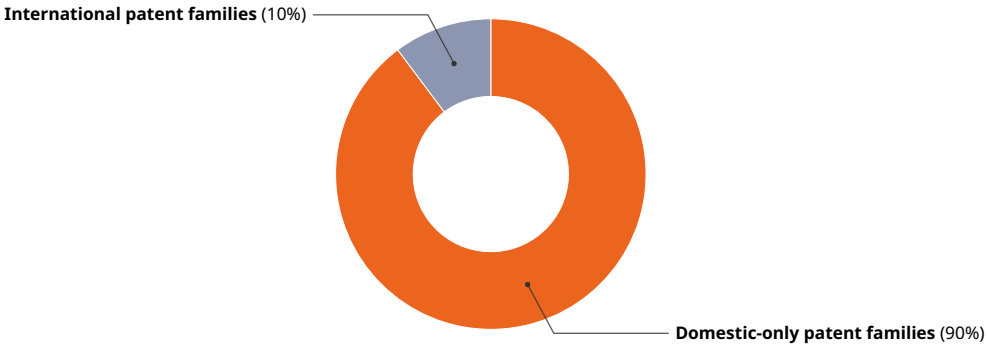


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.
Note: IPF stands for international patent family.

Based on the data collected in this study, Detection technologies accounts for a total of 157,183 patent families, equivalent to 35% of the global patent portfolio for OHS technologies. 17,919 of these are classified as international patent families (Figure 5.2).

The Detection technologies consists of a total of 17,919 IPF patent families, accounting for 10% of the global patent portfolio.

Figure 5.2 International and domestic-only patent families share in Detection technologies by number of published patents, 2004–2023



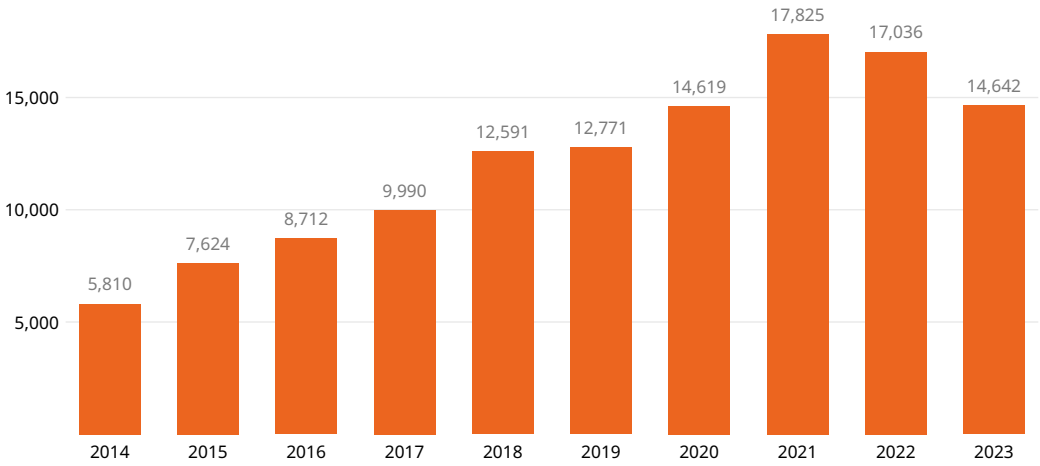
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Patenting activity corresponds to the number of patent families published annually within a specific field. This metric is based on the date of first publication of each patent family, which typically occurs around 18 months after the filing date. Analyzing patenting activity provides valuable information on innovation trends in a particular field. Comparing the evolution of patent filings in a specific field to the overall growth in global patent filings worldwide enables us to assess the dynamism and innovation intensity of innovation in that field. Such a comparison serves to determine whether a field is experiencing rapid development, stagnation or decline, relative to overall technological progress.

According to Figure 5.3, the number of patents in relation to Detection increased steadily from 2014 to 2023 which represents a CAGR of 10.8%. It peaked in 2021 with a significant 17,825 patent families. This rise shows an increased focus on innovation and safety within the sector. The main reasons for this are improvements in technology and an overall digital change in workplaces. New developments in sensors, automation, the IoT, AI, and wearable devices led to many new inventions during this period. These technologies make workplaces safer and provide real-time detection and monitoring abilities, which probably heightened interest. Also, government regulations and more stringent work safety rules may have contributed to this trend impelling the companies to invest in new solutions that adhere to the rules and keep workers safe.

From 2014 to 2023, patents for OHS Detection grew steadily, with an annual growth of nearly 11%.

Figure 5.3 Patent publication trend in Detection technologies by earliest publication year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

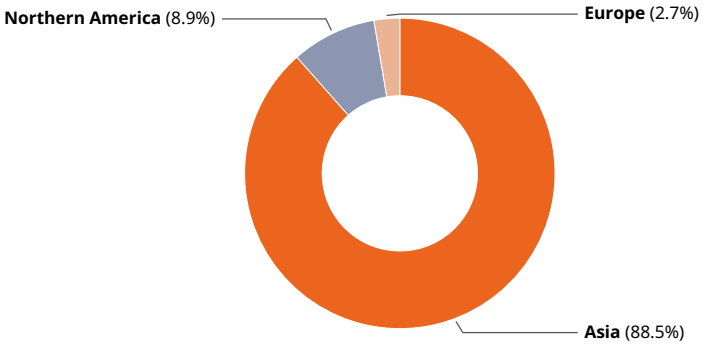
Top jurisdictions

A look into patent families allows us to identify which countries are driving innovation in certain fields. The first filing in a patent family (known as the priority filing), usually called the priority filing, is mostly done in the applicant's home country. This decision is largely driven by legal frameworks and economic reasons; hence, the location of the priority filing (office of first filing) is a strong indicator of active innovation dynamics.

In the OHS Detection category, the filing trend is clearly reflected in the geographical distribution of patent filings, with Asia in the lead (Figure 5.4). China dominates the region, with 115,975 patent families, followed by the Republic of Korea with 8,227 and Japan with 5,476. The Americas, mainly driven by the United States, take second place with 12,900 patent families, or almost 96% of total filings in the region. Europe ranks third, with 4,064 patent families.

Asia significantly dominates the Detection-related patent landscape.

Figure 5.4 Detection patent distribution by R&D regions, 2004–2023



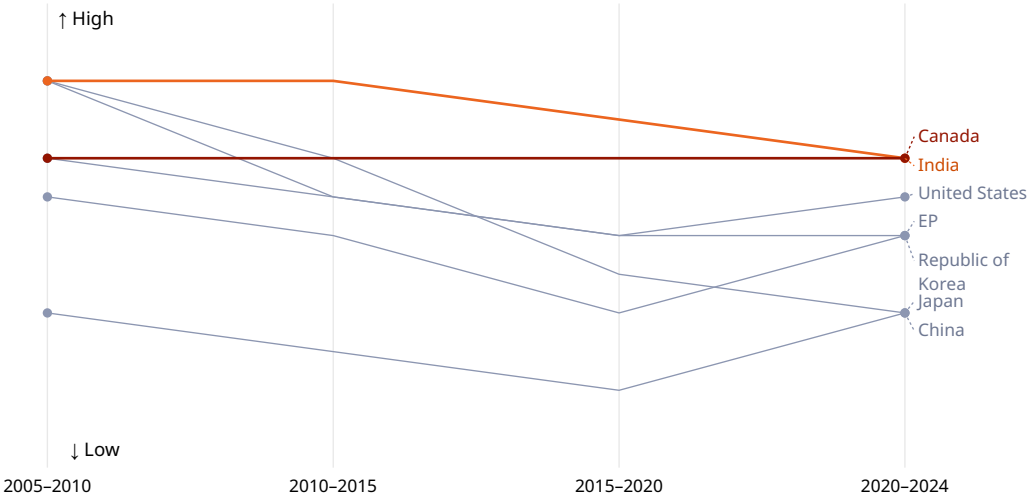
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The geographical distribution underlines Asia's central role in shaping the landscape of Detection technologies, with China emerging as an undisputed leader in driving technological advances. The rise in Chinese patent filings not only reflects the country's strategic focus on innovation but also consolidates its position as a global hub for cutting-edge development. In contrast, the United States and Europe exhibit a slower patenting activity rate.

The Relative Specialization Index (RSI) is used to compare the published patenting activity of different countries within the same technology area. RSI is a measure of a country's share of patent families in a particular field of technology as a fraction of that country's share of patent families in all fields of technology. In other words, RSI has the advantage of providing a comparison between the patenting activity of two countries' relative to the overall patenting activity of those same two countries. When analyzing patent data, normalized RSI is used[1].

India and Canada remain committed, but global RSI values show a decline, indicating reduced focus on Detection technologies.

Figure 5.5 Relative Specialization Index (RSI) change in Detection technologies across countries by year, 2005–2024



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

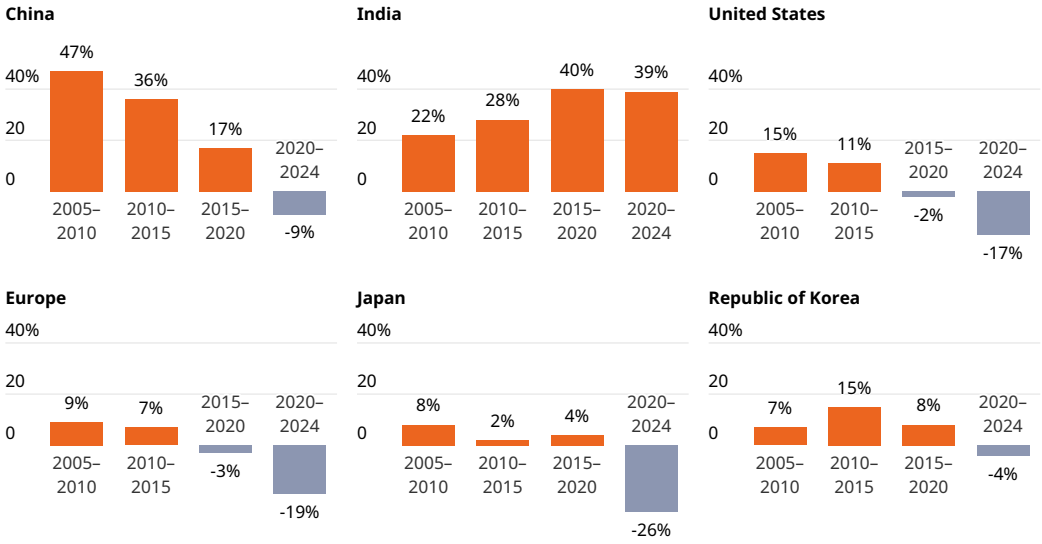
Figure 5.5 shows that India and Canada show the strongest and most sustained specialization in Detection technologies, with consistently high focus. China and the United States demonstrate an initially strong engagement, but China's specialization has declined significantly over time, whereas that of the United States has stabilized after some fluctuation. The Republic of Korea has also undergone a gradual decline, reflecting a reduced emphasis. Europe has maintained a moderate focus, whereas Japan has consistently showed minimal specialization, despite a slight recovery in recent times.

Overall, while some countries like India and Canada lead in sustained commitment, the general trend shows a global decline in RSI values, indicating a reduced focus on Detection technologies. This may indicate either that the field is maturing or there has been a shift in innovation priorities toward other emerging technological domains.

1 See Appendix 1 for more information.

India has experienced a consistent rise of Detection-related patent filings in last 20 years.

Figure 5.6 Periodic patent growth in Detection-related filings by origin jurisdiction, 2005-2024



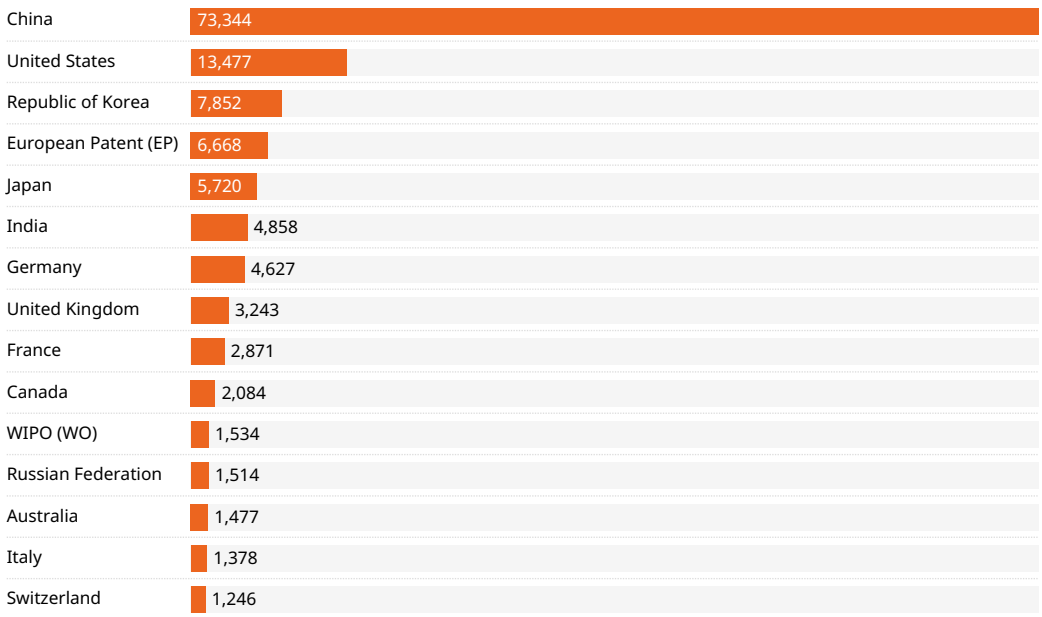
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Periodic patent growth in this field has varied widely by country. China and India underwent strong early growth, with India maintaining momentum while China's activity declined after 2020. The United States, European countries, and Japan saw a modest increase initially, followed by a decline over recent years. The Republic of Korea has shown moderate steady growth. Overall, the data highlight India's sustained leadership, contrasting with a declining trend in a traditionally strong Europe, Japan, and the United States.

Analysis of global patent family coverage provides strategic clues as to which regions and markets manufacturers consider essential targets for their innovations. Such data highlights where companies see the greatest potential for commercial success and the importance of securing IP rights to maintain a competitive edge in these markets.

China has emerged as a dominant force with nearly 75,000 patent families in Detection technologies.

Figure 5.7 Top priority jurisdictions in Detection by number of patents published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

In the realm of Detection technologies, China has emerged as a dominant force, boasting an impressive 73,344 patent families (Figure 5.7). This figure underscores China's leading role in both innovation and market share in this field. Meanwhile the United States, with 13,477 patent families, occupies second spot, reflecting its robust but relatively focused innovation landscape. The Republic of Korea is third, with 7,852 patent families, clearly demonstrating its role as a technological giant in this field. Other regions and countries also play their part in the global innovation landscape, with the EPO playing a significant role, protecting 6,668 patent families, reflecting Europe's collective focus on occupational safety technologies. In terms of number of patent families, Japan (5,720), India (4,858) and Germany (4,627) are also key players, each contributing to the global innovation landscape in a distinct way. These figures not only highlight the geographical distribution of innovation but also underline the global competition and collaboration behind advances in this crucial domain.

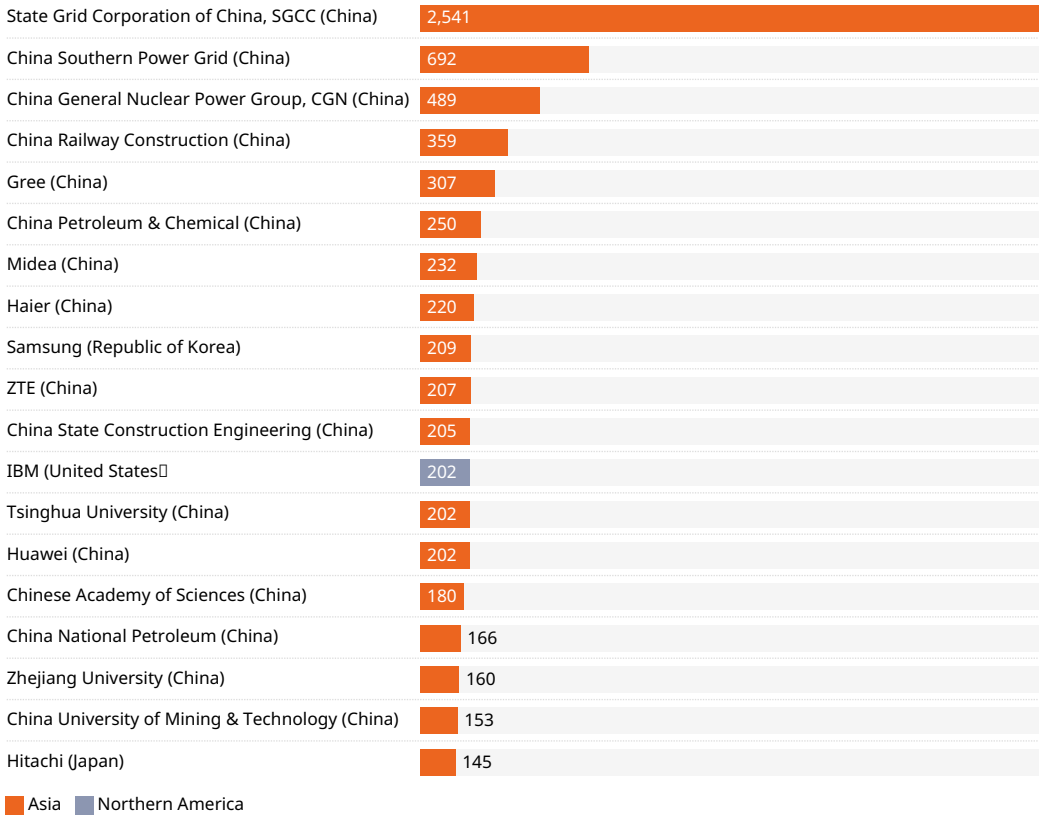
These results and numbers reflect the strategic focus of innovators on key global markets, with China asserting itself as the main hub of innovation and commercial activity in the field of workplace safety technologies. The United States follows as a major player, demonstrating its role in promoting high-value advances. Strong patenting activity in regions and countries, such as the Republic of Korea, Europe and Japan highlights the growing international commitment to workplace safety innovation, driven by the increasing importance of industrial safety standards.

Top patent applicants

Examining patent applicants in this area affords a comprehensive overview of those companies and organizations driving innovation and actively seeking to protect their technological advancements. This analysis identifies the key players contributing to the development of Detection solutions and spotlights their commitment to securing IP rights for their inventions.

Chinese companies, led by State Grid Corporation of China, dominate the Detection technologies patent landscape.

Figure 5.8 Top applicants in Detection technologies by number of patents published, 2004–2023

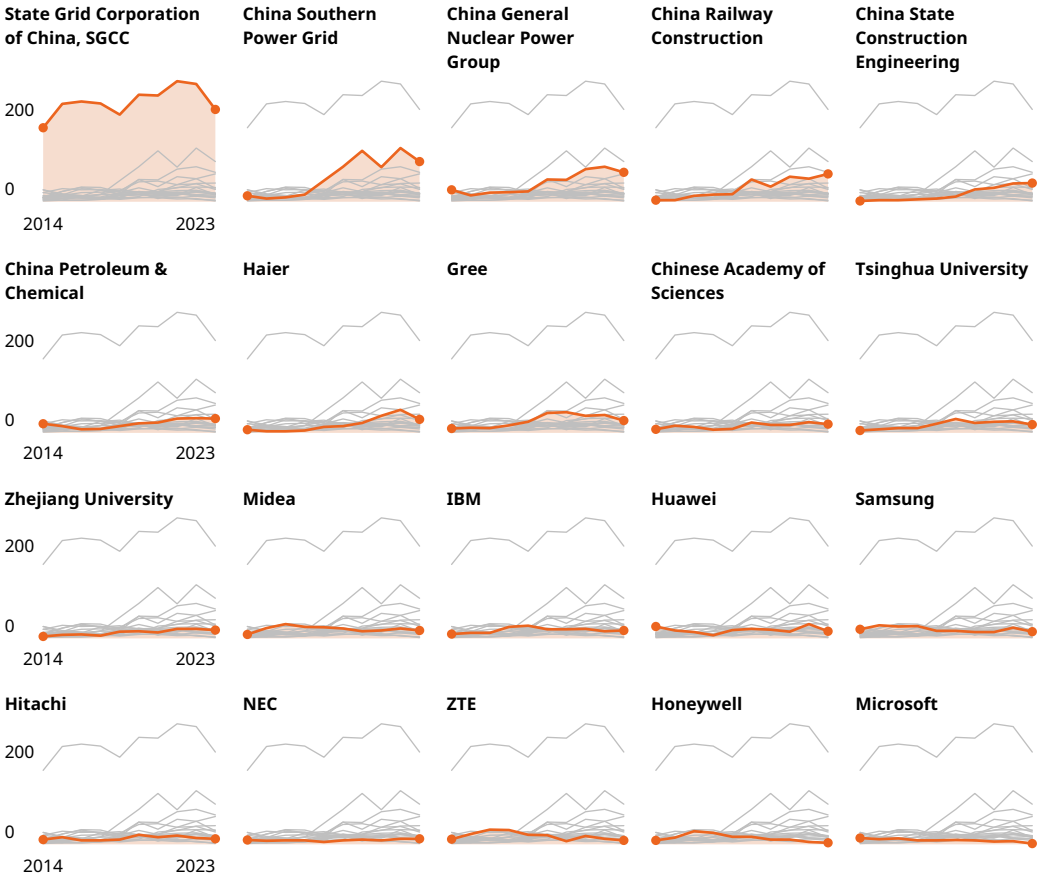


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Among the top 20 patent applicants in the field of OHS Detection technologies (Figure 5.8), SGCC (State Grid Corporation of China) leads with over 2,500 patent families, well ahead of China Southern Power Grid, which comes second with 692 patent families, while well- known multinationals such as Hauwei, Samsung and IBM hold between 200 and 300 patent families each. These applicants cover various sectors, including energy, technology and academia. This distribution underlines the predominance of Chinese entities, particularly within the energy and technology sectors, in the growth of patenting activity in this field.

State Grid Corporation of China has consistently filed the most patents by far over the last 10 years.

Figure 5.9 Top applicants breakdown in Detection-related patent filings by year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Analyzing the dynamics of the top applicants' patent publications, Figure 5.9 shows that there have generally been a high level of innovation activity that peaked between 2010 and 2022 and was followed by a potential recent decline in filings.

Between 2014 and 2023, China State Construction Engineering topped the list with a 42.0% CAGR, followed by China Railway Construction at 37.4% and China Southern Power Grid at 23.6%, reflecting robust advancements in Detection technologies. On the other hand, Microsoft experienced the largest decline at –18.7%, followed by Honeywell at –10.2% and Huawei at –5.5%, indicating a reduction in activity in the Detection category. These figures underscore the diverse organizational priorities in Detection technologies over the period.

Major applicants' activity reveals that the increase in patent filings observed since 2005 has mainly been driven by applicants within the electronics and technology sectors, such as Samsung, IBM, Huawei, LG and Robert Bosch. Energy-sector Chinese players appeared after 2007, with an increasingly high filing rate. Interestingly, this wave of company filings in China was preceded by earlier contributions from Chinese universities, such as Beijing University of Technology, Tsinghua University, Zhejiang University and the China University of Mining and Technology, which probably laid the groundwork for innovation in this field.

International patenting landscape

This section emphasizes the value of analyzing International Patent Families (IPFs) to uncover meaningful insights into technological trends.

Analyzing IPFs helps to filter out less impactful or localized inventions, leaving a dataset that reflects substantial investments and a focus on long-term technological and commercial viability. As a result, this approach provides a clearer view of the key trends shaping innovation and reveals the areas where companies are placing their strategic bets for the future.

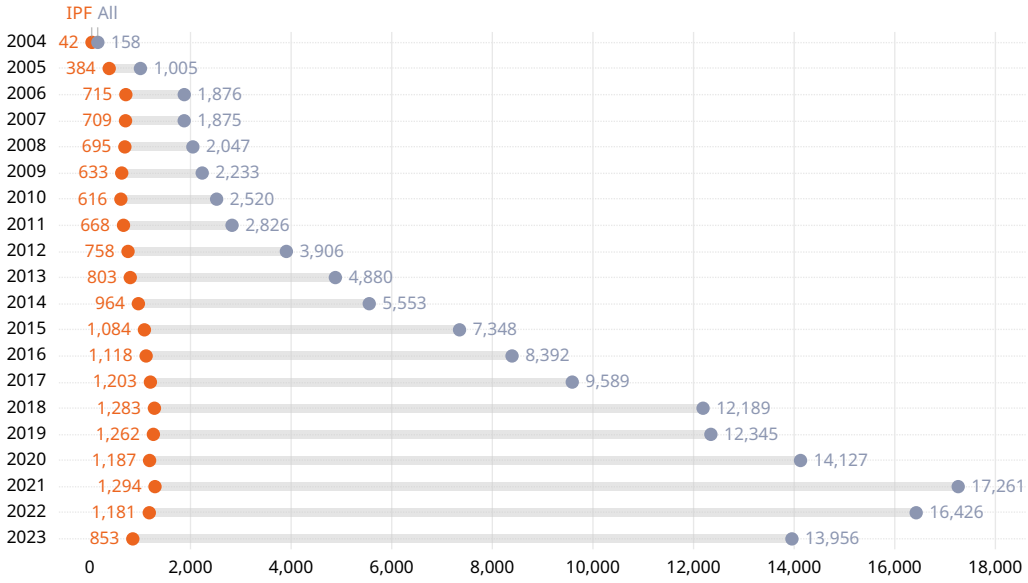
IPF growth and development

A review of IPF trends in the field of Detection technologies reveals several key trends. Over the last decade, the total number of patents in this field has increased significantly, mainly due to activity in China. However, many such patents are limited to filings in China and do not extend internationally, resulting in their exclusion from the IPF counts.

As a result, the proportion of IPFs representing patents filed in multiple jurisdictions, has remained consistently low. While the IPF ratio was relatively high in the early years of the period studied (e.g. 38% in 2005 and 2006), it has fallen over time, dropping to just 6% in 2023.

The proportion of international patent families has consistently remained low.

Figure 5.10 International and domestic-only patent trend in Detection technologies by earliest publication year, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

This trend reflects the growing gap between total patenting activity and innovations with global impact. Overall, the IPF ratio for all patents in the Detection segment over the last 20 years until 2023 has averaged 12%, underlining the limited international reach of patent filings in this field.

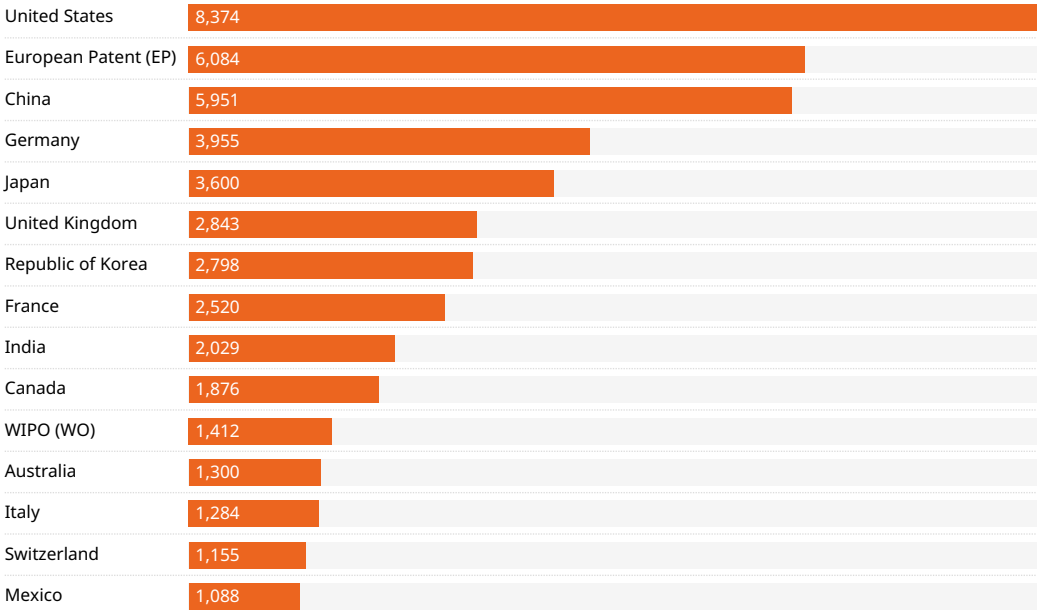
Furthermore, with regards to IPF growth, the figures suggest that while the total number of patents has increased considerably, the growth of IPFs has remained relatively modest. This indicates there there is less emphasis on global patent protection. The stagnation or slower growth of IPFs could be due to several factors, such the costs associated with international filings, which could deter small companies or individual inventors from pursuing IPFs. In addition, many innovations in the Detection category could be specific to regional needs or regulatory environments, thus reducing the perceived need for international coverage.

IPF top jurisdictions

A closer analysis of the countries in which applicants pursue protection through international patent families (IPFs) helps to illustrate the deliberate strategy of innovators to secure IP in the world's major markets, giving priority to those regions with robust technology ecosystems and considerable business potential.

The United States holds a dominant position in internationally represented patent families for Detection technologies.

Figure 5.11 Top priority jurisdictions in Detection technologies by number of IPFs published, 2004–2013



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

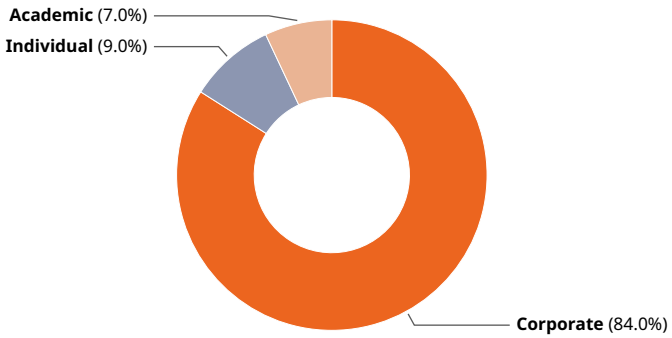
Figure 5.11 shows that the United States holds a dominant position in globally protected patent families for Detection technologies, with a total of 8,374 patent families. The EPO follows closely behind, with 6,084 patent families, reflecting its reach across multiple European jurisdictions. China also has a significant presence in this field, with 5,951 patent families, underlining its important position as an attractive market for these technologies. Germany (3,955), Japan (3,600) and the United Kingdom (2,843) are other notable countries, representing important centers of interest in this sector.

IPF top patent applicants

The OHS category of Detection technologies has the standard characteristics of emerging technology sectors, with Figure 5.12 showing that 79% of applicants are from industry and hold 84% of the IPFs (which indicates that portfolios are fairly small) and a relatively high number of independent inventors (14% of applicants) hold 9% of the IPFs in the field.

The Detection technologies are predominantly led by companies in international filings.

Figure 5.12 Applicant type shares in Detection technologies by number of IPFs published, 2004–2023

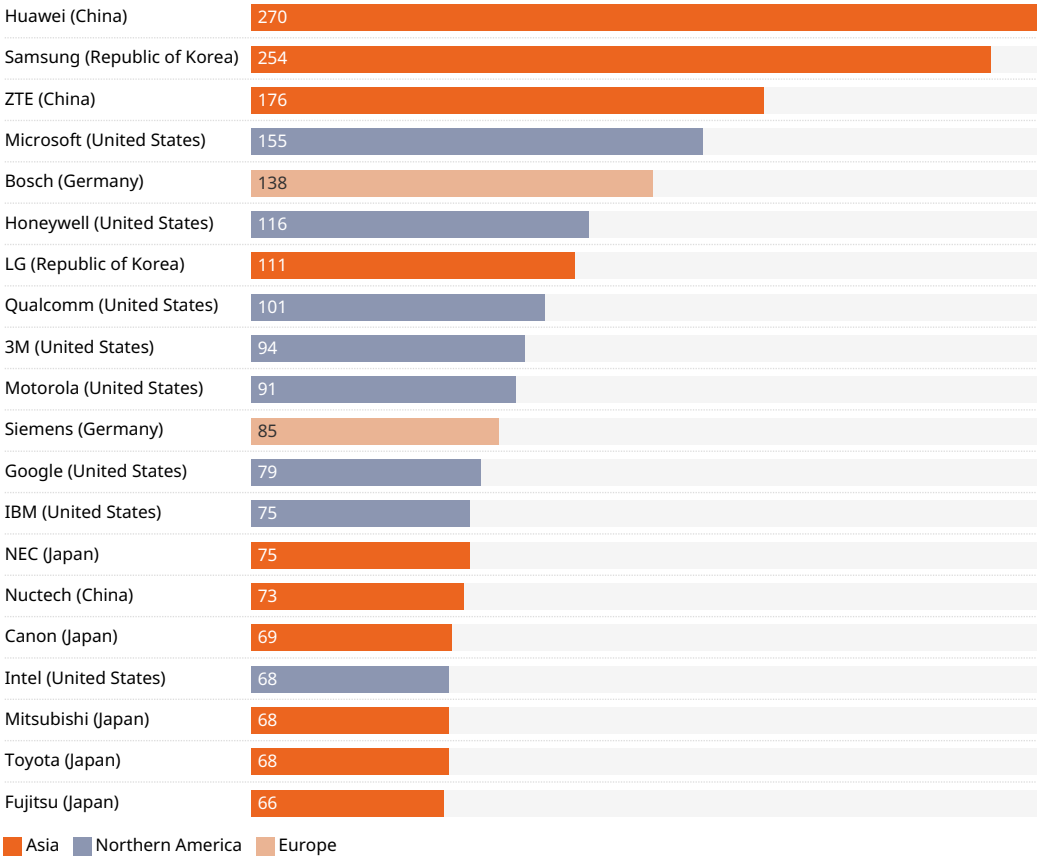


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Key players in Detection technologies are shown in Figure 5.13. Huawei holds the largest number of patent families (270), followed by Samsung Electronics (254), ZTE (176) and Microsoft (155). Among the top 20 patent applicants, Asian companies are the most represented, with 12 entities from countries such as Japan, China, and the Republic of Korea. Northern America follows with seven applicants, while Europe is represented by Bosch and Siemens. Japan stands out with seven companies listed, indicating a strong national presence. The data reflects a geographically diverse distribution of patent activity, with leading contributions from both corporate and multinational entities.

In Detection technologies, half of the top 10 patent applicants are based in the United States.

Figure 5.13 OHS Detection top applicants by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The dominance of technology giants shows major technology companies leading the way in innovation and holding most of the Detection patents. This suggests that big firms, with their greater resources and strategic focus, are the primary drivers of new advancements in workplace Detection technologies.

IPF main technologies

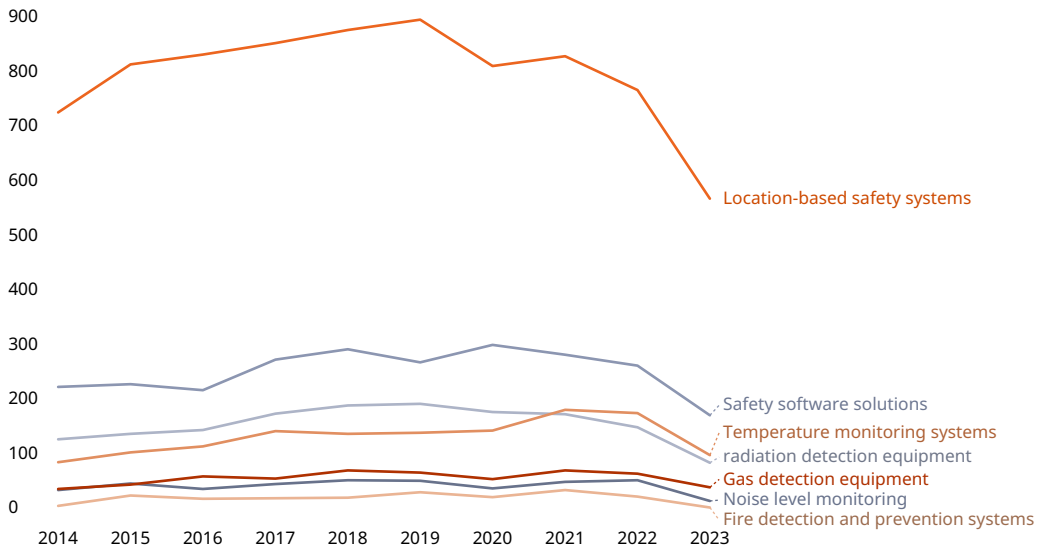
As shown in Figure 5.14, observations from 2018 to 2023 reveal steady growth in IPF filings, peaking around 2021 for various Detection technologies. Key technology areas gas detection, fire detection, location-based safety systems, and noise level monitoring experienced significant increases during this period, particularly in 2021.

Following the peak, there is a notable decline in patent filings across most technology areas, especially in the technologies location-based systems, noise monitoring and safety software solutions. This is most evident in 2023.

Location-based safety systems emerge as the most prominent areas for patent filings, with the highest number of inventions recorded between 2018 and 2023, accounting 4,505 patent families. Despite the overall drop, certain technology areas, namely temperature monitoring systems and radiation detection equipment, show relatively less fluctuation, maintaining a moderate level of patenting activity even in 2023.

There are a significant number of patents in the area of location-based and software systems in the field.

Figure 5.14 IPF filings trend in Detection technologies by technology area, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Benchmark inventions in Detection technologies

Main technologies and application fields

To gain a deep understanding of the technological approaches in the OHS Detection category, the dataset of related simple patent families has been segmented into seven main distinct technology areas listed below in descending order according to the number of patents:

Location-based security systems: With a total of 61,872 patents, this technology area boasts the highest number of patent families.

Safety software solutions: Follows closely behind, with 54,239 patents, indicating significant innovation in security-enhancing software solutions.

Temperature monitoring systems: A total of 34,693 patents reflects the importance of temperature monitoring for safety in a variety of applications.

Radiation detection equipment: This technology area includes 16,533 patents, reflecting efforts to develop technologies for detecting harmful levels of radiation.

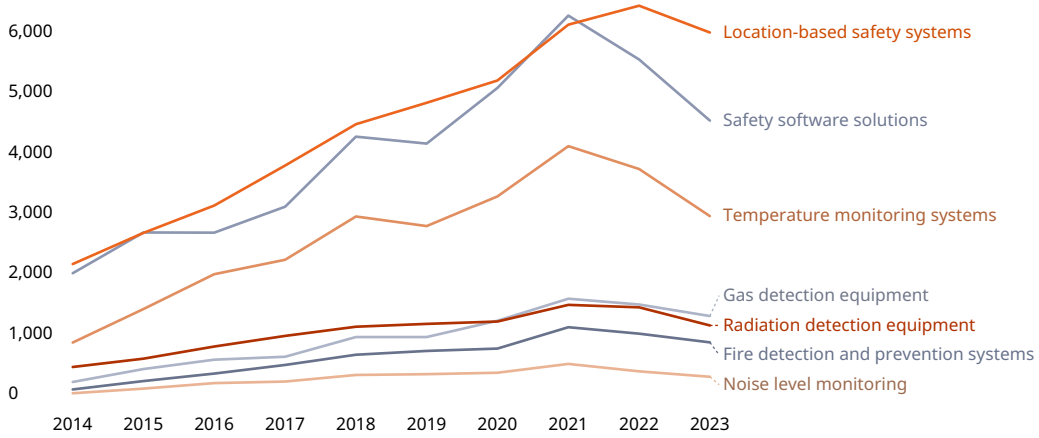
Gas detection equipment: With 14,116 patents, this technology area focuses on gas detection for safety purposes, for example to prevent exposure to toxic substances or explosions.

Fire detection and prevention systems: Progress in the field of fire safety is reflected in the 10,140 patents published.

Noise-level monitoring: This is the smallest technology area, with 5,935 patents, indicating a niche specializing in noise level monitoring for safety and regulatory compliance purposes.

There is a significant rising trend in location-based system related patents.

Figure 5.15 Patent filings in Detection technologies by technology area, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

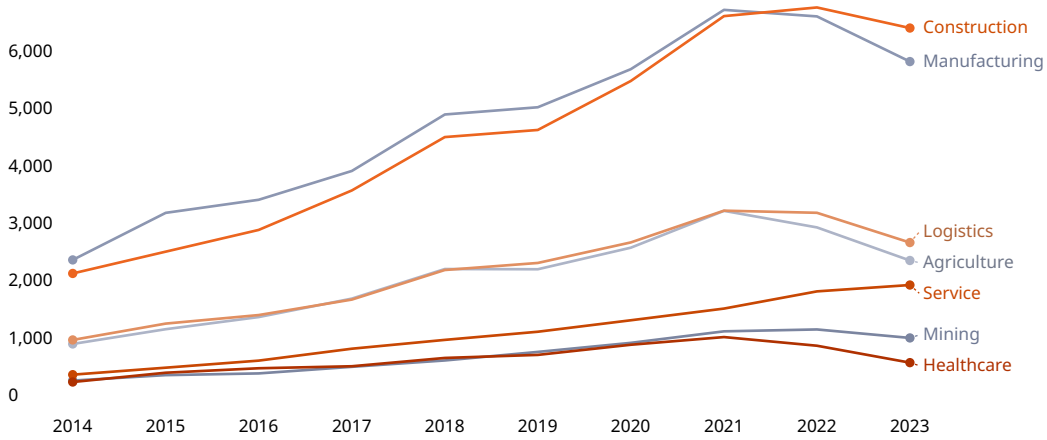
Figure 5.15 highlights key trends in patent filings from 2014 to 2023 in Detection technologies. A significant growth trajectory is observed across most technology areas, culminating in a peak around 2021. This peak reflects a heightened emphasis on safety-related innovations, potentially driven by regulatory changes, technological advancements, or a heightened awareness of workplace hazards. However, following this surge, a notable decline in patent filings is observable in most technology areas, suggesting market saturation, shifting priorities, or reduced research and development activities post-2021.

Among the technology areas, safety software solutions and location-based safety systems emerge as dominant fields of innovation. Together, these areas account for the highest number of patent filings, with 34,506 and 38,705 patent families respectively between 2014 and 2023.

This prominence underscores a growing reliance on digital solutions and real-time tracking technologies for workplace safety enhancement.

Manufacturing and construction is leading the field while the service sector is fastest growing.

Figure 5.16 Patent filings trend in Detection technologies by industrial sectors, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Figure 5.16 provides a comprehensive overview of patent filing trends for Detection technologies in different industrial sectors between 2014 and 2023. The findings reveal that the construction and manufacturing sectors remain the main contributors to patent filings, a key indicator of the significant investment in safety technologies within these industries.

The construction sector stands out as the leader in patent filings, with steady growth observed over time period in question. A steady increase in filings could be attributable to the ongoing progress of safety technologies in construction, stimulated by strong industry demand and strict regulations concerning worker safety.

In contrast, the healthcare and agriculture sectors show a more moderate growth in patent filings, with a marked decrease from 2021 onward. The healthcare sector has seen a sharp decline, with filings falling from 1,230 in 2021 to 784 in 2023.

Example patents

The examples that follow have been chosen because considered particularly representative of the field.

Patent WO2021/220108 outlines the innovative features and benefits of the Smart PPE Respirator System, assigned to 3M Innovative Properties. This invention introduces a novel approach to PPE by integrating a breath temperature sensor that monitors exhalation breath temperature, thereby facilitating the calculation of a core body temperature metric. This advancement is designed to enhance worker safety through real-time monitoring and alerts for potential core temperature issues, ultimately improving comfort and minimizing the need for invasive temperature measurement techniques.

WO2021/220108: Smart PPE respirator system (core body temperature)

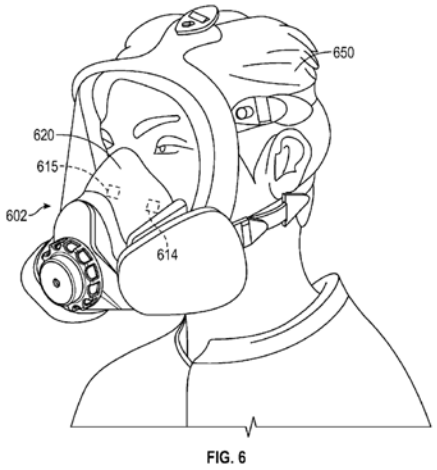


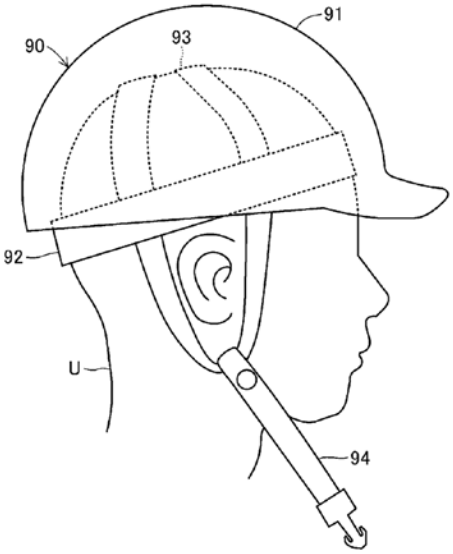
FIG. 6

Source: WO2021/220108

This system is particularly beneficial in various environments where PPE is crucial, including construction sites, healthcare settings, and hazardous work environments. By ensuring the safety and well-being of users, the invention addresses a significant need for effective temperature monitoring in challenging conditions.

Patent JP7573824, assigned to Herutu Electronics, focuses on an innovative apparatus designed to detect the wearing state of PPE, particularly helmets, through the use of contact detection sensors. By enhancing safety measures in hazardous environments, this technology aims to prevent accidents caused by improper equipment usage.

JP7573824: Apparatus for detecting wearing of body protection gear

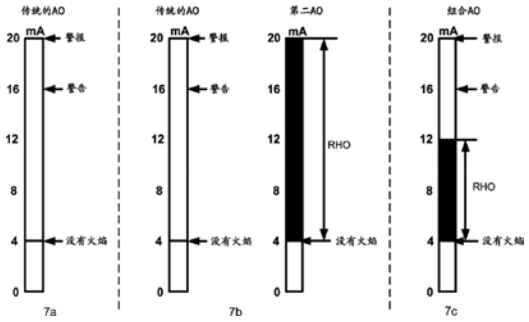


Source: JP7573824

The primary objective of this invention is to establish a dependable method for detecting the wearing state of personal protective equipment, particularly in high-risk environments such as construction sites or factories. The apparatus is designed to ensure that workers are adequately equipped, thereby promoting safety and adherence to safety regulations.

Patent CN105683729 provides an overview of the multi-spectral flame detector developed by MSA Technology. The invention is designed specifically for industrial safety applications in hazardous environments, focusing on the detection of flames and the quantification of radiant energy. The system's advanced features aim to enhance safety measures and response capabilities in industrial settings.

CN105683729: Multi-spectral flame detector with radiant energy estimation



Source: CN105683729

The system is designed to monitor radiant energy, detect flames, quantify radiant heat output, and relay information to utilization devices. This ensures timely alerts and bolsters safety measures in environments where fire risks are prevalent.

Summary of Detection technologies

The analysis of patents related to Detection underscores the dynamic and evolving nature of this crucial OHS category. Over the past decade, there has been a steady increase in innovation, driven by technological advancements in areas such as the IoT, AI, wearable devices, and sensor technologies. These innovations have not only enhanced workplace safety, but also opened avenues for better real-time detection and monitoring.

From a global perspective, the Detection patent landscape reveals strong regional dynamics. China emerges as the dominant player, both in terms of patent volume and innovation intensity, reflecting its strategic focus on workplace safety technologies. The United States, while a significant contributor, displays a relatively more focused and less expansive patenting activity. The Republic of Korea, Japan, and Germany also hold notable positions, contributing to the global ecosystem with their technological strengths.

The segmentation of workplace safety technologies into technology areas such as safety software solutions, location-based safety systems, and advanced detection equipment highlights the diversity of innovation in this category. Location-based systems and safety software have emerged as dominant areas, underlining a growing reliance on digital and real-time solutions to ensure workplace safety. Other technology areas, such as noise and radiation monitoring, although smaller, address critical niche applications and continue to show steady innovation.

The dominance of major technology players, such as Samsung, IBM and Huawei, alongside contributions from academia and smaller innovators, reflects a diverse ecosystem. While large corporations drive broad-based advancements using their substantial resources, universities and independent inventors contribute valuable niche innovations.

6 Protection technologies: mitigating workplace risks

This chapter overviews Protection technologies mitigating workplace risks in the occupational health and safety (OHS) patent landscape. It assesses global patenting activity, periodic patent growth, and development, identifying top offices of first filing and leading patent owners. It also highlights benchmark inventions in Protection technologies, demonstrating innovative solutions that enhance workplace safety and risk reduction worldwide.

Protection encompasses various measures and technologies aimed at actively ensuring worker safety by addressing identified workplace risks and hazards. Such solutions are designed to limit exposure to harmful conditions, prevent injury, and mitigate health risks. Examples include PPE such as helmets, gloves, masks, and protective clothing, as well as engineered systems like safety barriers, ventilation setups, and ergonomic tools that enhance workplace safety.

To build this analysis and create the patent dataset, we have divided the Protection category into nine main technology areas:

- **Respiratory protection technologies**: Respiratory protection equipment, such as masks and respirators, is vital in environments with airborne contaminants, ensuring workers' respiratory health.
- **Hearing protection technologies**: Hearing protection devices, including earplugs and earmuffs, are essential in noisy environments to prevent hearing loss.
- **Personal protection equipment**: PPE such as helmets, gloves, and safety glasses provide physical protection against a variety of hazards.
- **Thermal protection equipment**: Thermal protection gear is designed to safeguard workers from extreme temperatures, whether hot or cold.
- **Mechanical safeguards**: Mechanical safeguards, such as guards and barriers, are implemented to prevent accidents and injury when operating machinery.
- **Ventilation and filtration systems**: Effective ventilation and filtration systems help maintain air quality and reduce exposure to harmful substances in the workplace.
- **Ergonomic workspaces**: Designing ergonomic workspaces minimizes the risk of musculoskeletal disorders and enhances overall worker comfort and productivity.
- **Fall protection**: Fall protection systems, including harnesses and guardrails, are critical in preventing falls in construction and other high-risk environments.
- **Wearable devices**: Wearable safety devices monitor workers' health and environmental conditions, providing real-time data to enhance safety measures.

This chapter is structured into three main parts:

1. **Global patent landscape:** A broad analysis of the global Protection patent landscape is conducted, publication trends examined, the most innovative regions or countries identified, and key players driving advancements in the field of Protection technologies profiled.
2. **Focus on international patent families (IPFs):** Focusing on IPFs allows the detection of the technology trends that companies consider valuable enough to internationalize and seek protection in overseas markets. Such a focus emphasizes those areas in which significant

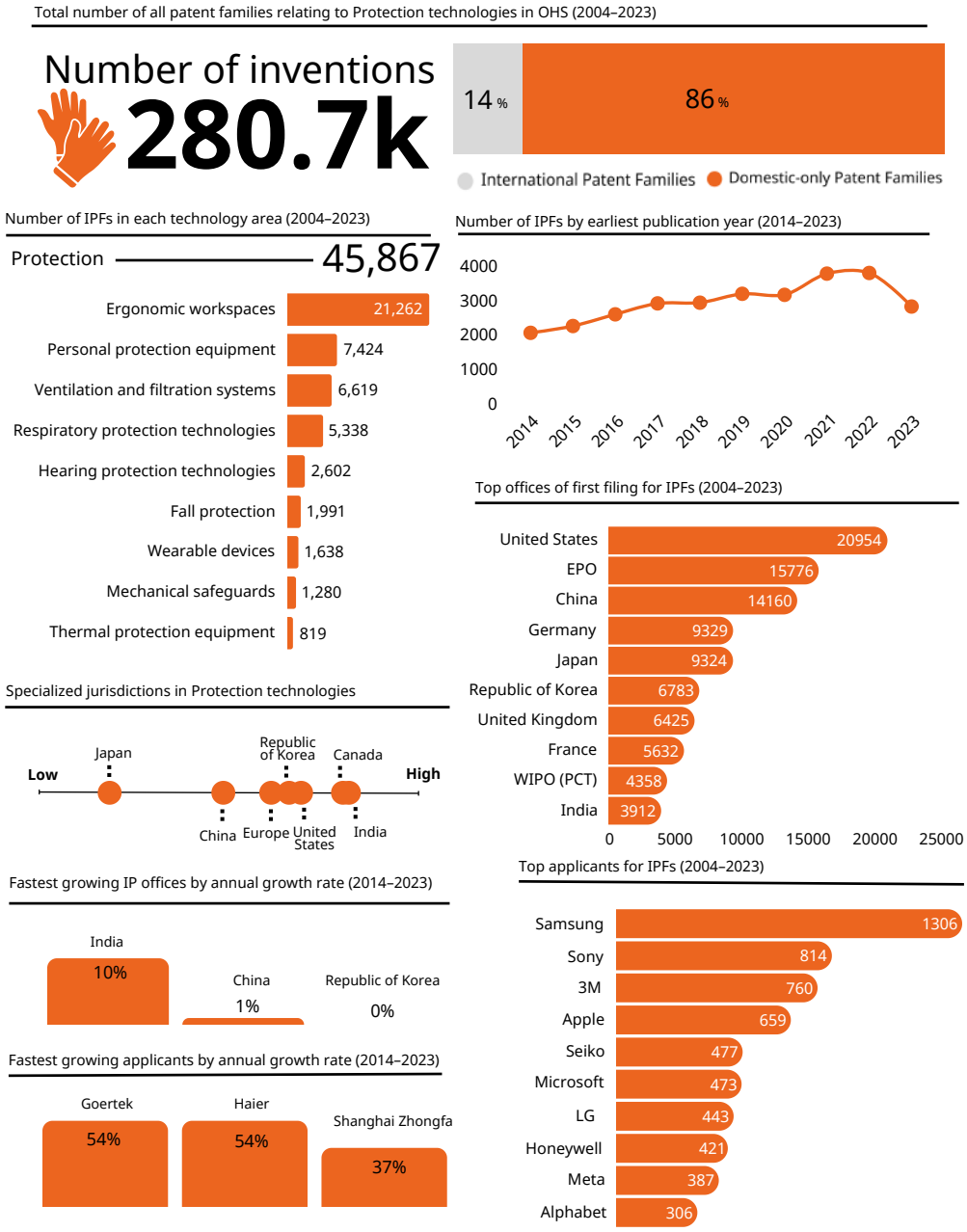
investments are being made, indicating promising channels for innovation and potential market returns.

3. **Benchmark inventions**: Lastly, specific patents that illustrate the field particularly well are highlighted. These examples showcase the cutting-edge innovations shaping the future of Protection.

This multi-faceted approach ensures a comprehensive understanding of how Protection technologies are evolving within the OHS domain and provides actionable insights into the technological strategies shaping workplace safety.

Global patenting landscape

Figure 6.1 Overview of the Protection technologies related to OHS

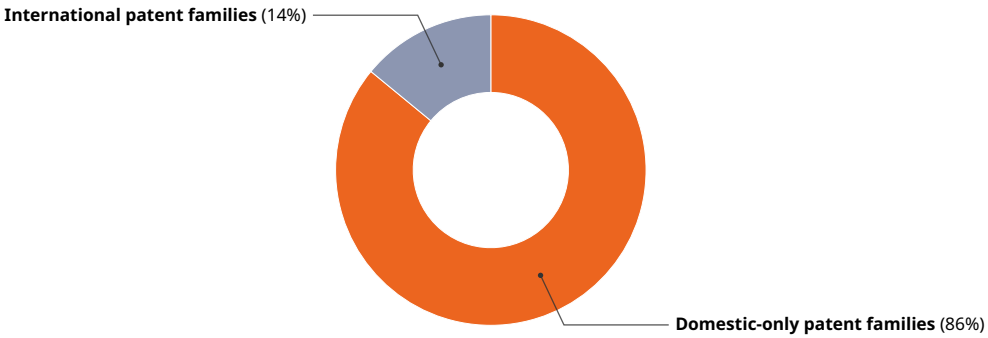


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.
Note: IPF stands for international patent family.

The Protection technologies category is the largest OHS category, with 280,686 patent families, representing around 62% of the all OHS-related inventions. 45,867 of these are classified as international patent families (Figure 6.2).

International patent families in Protection technologies accounts for 10% of the global patent portfolio.

Figure 6.2 International and domestic-only patent families share in Protection technologies by number of published patents, 2004–2023

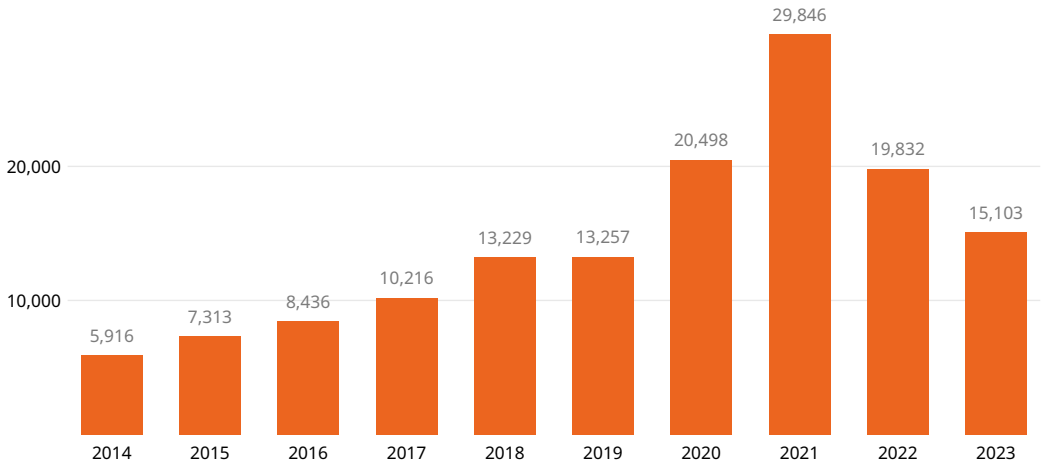


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Patenting activity measures the annual number of patent families published within a specific sector, based on the first publication date, which generally occurs about 18 months after the filing date. Examining patenting activity offers key insights into the innovation trends within a particular field.

From 2014 to 2023, patents for OHS Protection grew steadily, with an annual growth of 11%.

Figure 6.3 Patent publication trends in Protection technologies by earliest publication year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The dataset analyzed comprises 280,686 patent families related to Protection technologies. Figure 6.3 shows that between 2018 and 2023, this field has experienced fluctuating annual patent publication trends, with a peak of 29,846 families published in 2021 corresponding to the COVID-19 pandemic. However, the compound annual growth rate (CAGR) for this period is approximately -1.3%, reflecting a slight overall decline in filing activity over time , despite strong interest at certain periods.

The data highlights that, while the overall growth rate has declined slightly, the field remains dynamic. The peak publication years underscore ongoing investment and innovation aimed at enhancing workplace safety through Protection technologies.

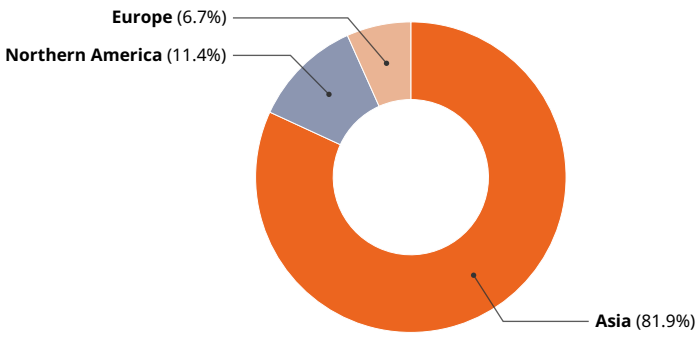
Top jurisdictions

Analyzing patent families provides valuable insights into which countries are driving innovation in a particular field. Typically, the first filing of a patent family (known as the priority filing) is made in the applicant's country of origin. This is influenced by legal frameworks and cost considerations, making the location of the priority filing (office of first filing) a strong indicator of where innovation is actively taking place.

In the field of Protection, Asia is again the main region (Figure 6.4) accounting for almost 82% of all patents. The United States accounts for almost 95% of the filings from the Americas (11.4% of all Protection patents), followed by Europe.

Asia significantly dominates the Protection technologies patent landscape.

Figure 6.4 Protection-related patent distribution by R&D regions, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

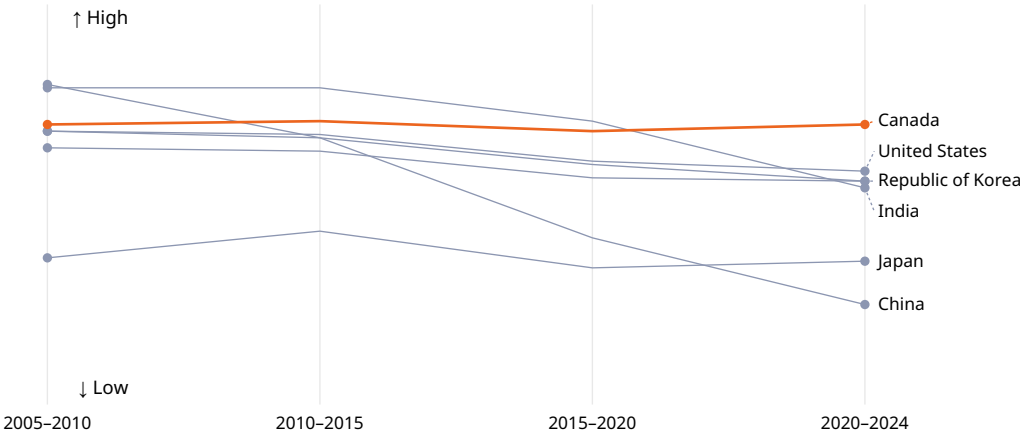
This geographical distribution emphasizes the key role that Asia, and especially China, plays in the development of technologies for Protection technologies. The leading presence of Chinese innovations highlights the region's strong commitment to advancing workplace safety technologies, while contributions from other areas, such as the United States and Europe, show comparatively lower levels of activity.

The Relative Specialization Index (RSI) is used to compare the published patenting activity of different countries within the same technology area. RSI is a measure of a country's share of patent families in a particular field of technology as a fraction of that country's share of patent families in all fields of technology. In other words, RSI has the advantage of providing a comparison between the patenting activity of two countries relative to overall patenting activity of this same two countries. When analyzing patent data, normalized RSI is used[1].

1 See Appendix 1 for more information.

Canada remains committed, but global RSI values show a decline, indicating reduced focus on Protection technologies.

Figure 6.5 Relative Specialization Index (RSI) change in Protection technologies across countries by year, 2005–2024

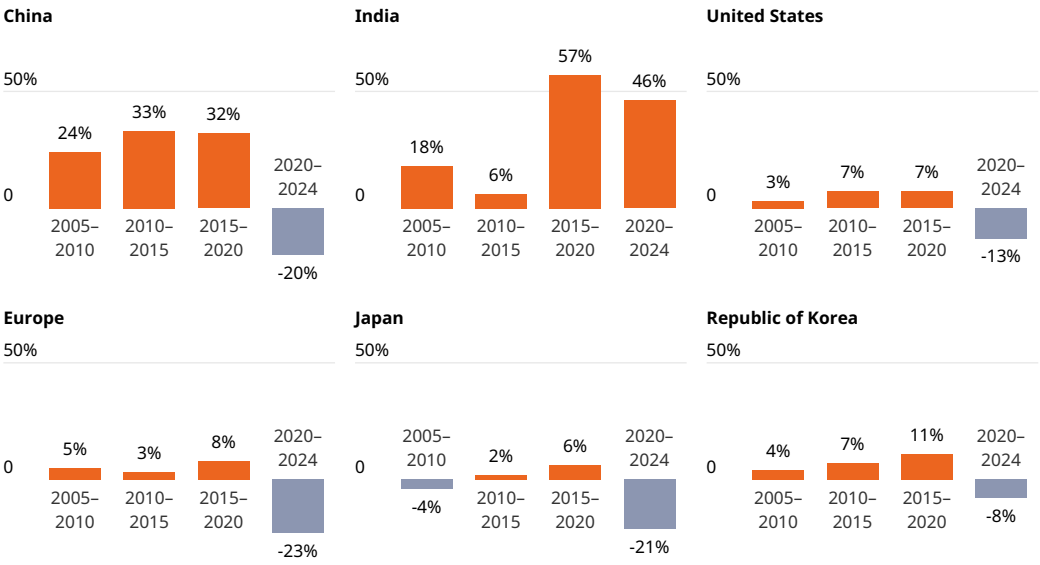


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Initially India showed strong specialization but experienced a gradual decline over recent years. China, despite early prominence, has seen its RSI value decrease significantly after 2015. In contrast, Canada, the United States and the Republic of Korea have maintained a steady RSI value, indicating consistent relative specialization in this field. Japan shows the lowest and most stable RSI value, reflecting a limited focus on this domain. Overall, the data suggest a weakening specialization for leading countries like China and India, while other regions are maintaining a steadily moderate focus.

India has experienced a consistent rise of Protection-related patent filings in last 20 years.

Figure 6.6 Periodic patent growth in Protection technology filings by priority jurisdiction, 2005–2024



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Periodic patent growth in Protection technologies reveals varied trends across countries. China and India lead with strong growth, particularly during the mid-period, but whereas India has sustained a high momentum, China experienced a decline after 2020. Northern America, Europe, and Japan showed slow, incremental growth before facing a noticeable downturn over recent years. The Republic of Korea has maintained moderate growth but has also seen a slight

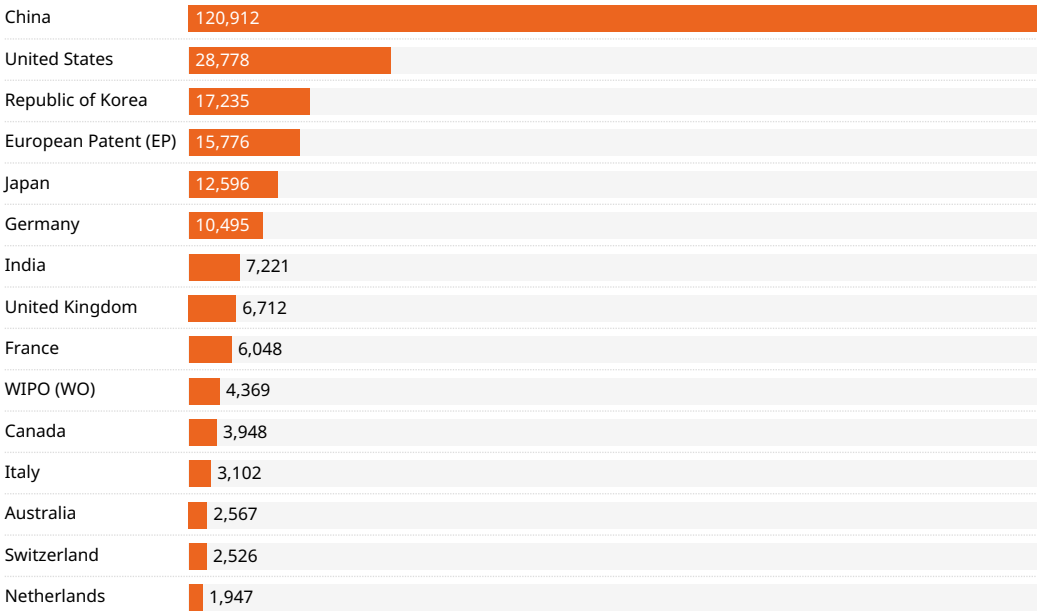
decline more recently. Overall, India stands out as a consistent driver of innovation, while other regions, including historically strong players like China and the United States, show activity decreasing over recent years.

Analyzing the global coverage of patent families provides important insights into the key markets that companies target for their innovations. Companies typically focus on obtaining patent protection in regions they consider vital for securing market presence and maintaining a competitive edge.

In the field of Protection, China dominates the global market landscape with an impressive 120,912 patent families, far outstripping the second largest market, the United States, which protects 28,778 patent families. The Republic of Korea follows with 17,235 patent families, and the EPO accounts for 15,776 protected patent families. Other important market countries include Japan with 12,596 patent families, Germany accounting for 10,495 inventions, and India with 7,221.

China has emerged as a dominant force with 120,000 patent families in Protection technologies.

Figure 6.7 Top priority jurisdictions in Protection technologies by number of patents published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

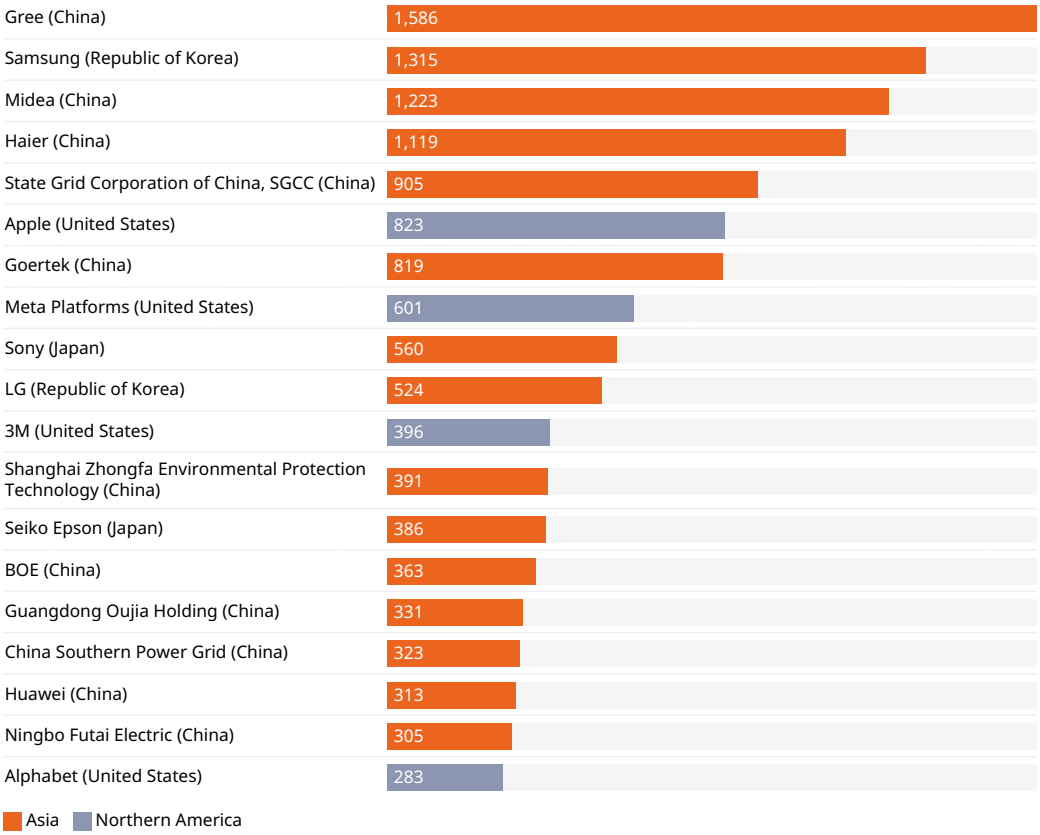
Figure 6.7 highlights the dominant position of China in terms of attractiveness, accounting for a significant share of global activity. The United States ranks second, while the Republic of Korea, Japan and Europe represent important but comparatively lower protection jurisdictions.

Top patent applicants

Examining the patent applicants in this area affords a comprehensive overview of those companies and organizations driving innovation and actively seeking to protect their technological advancements. This analysis identifies the key players contributing to the development of Protection solutions and spotlights their commitment to securing IP rights for their inventions. Figure 6.8 highlights Asia's dominant positionwith many of the top patent applicants in Protection technologies coming from the region.

Chinese companies, led by Gree, dominate Protection-related patent landscape.

Figure 6.8 Top applicants in Protection technologies by number of patents published, 2004–2023



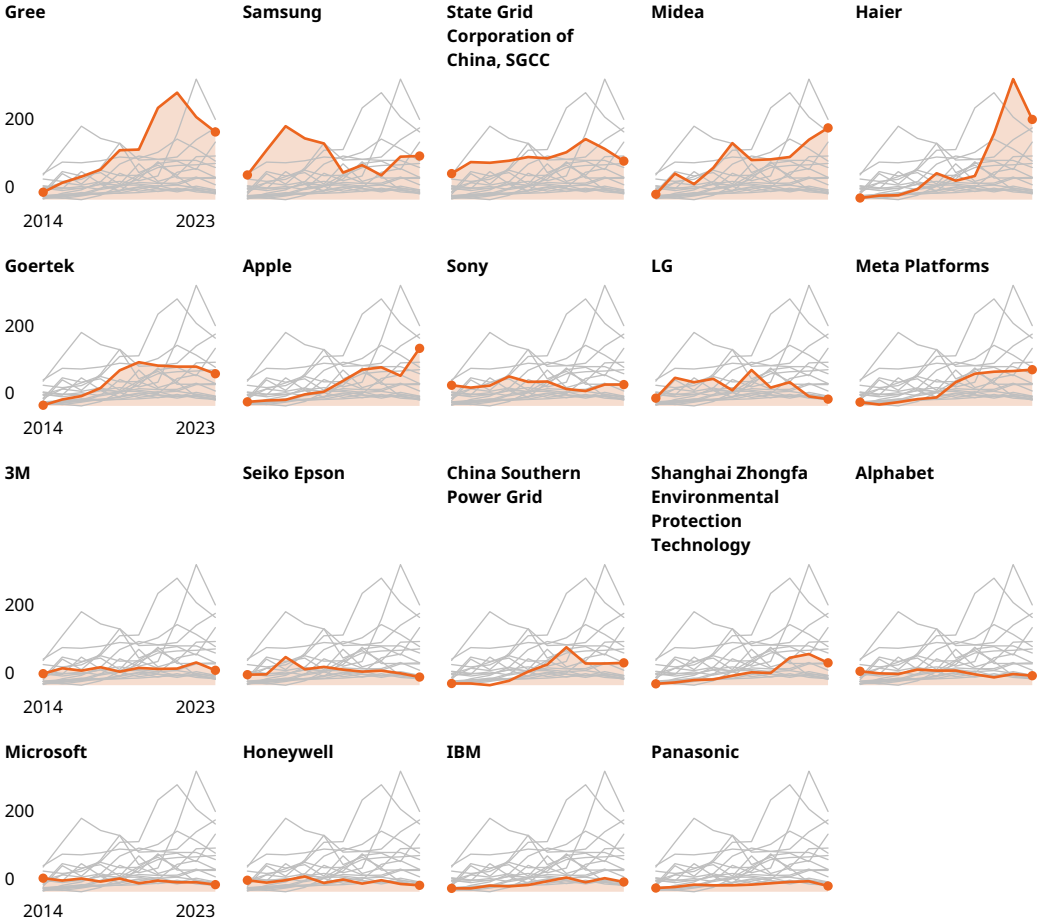
Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Gree tops the ranking with 1,586 patent families, closely followed by Samsung Electronics, with 1,315 patents. Midea (1,223), Haier (1,119), State Grid Corporation of China (SGCC) (905) and Apple (823) are also notable contributors.

Technology companies including Sony, LG, Huawei and Alphabet (Google) also feature in the list of top patent applicants and have shown solid patenting activity, contributing to innovation in Protection technologies, but not to the same extent as the top filers.

Gree has consistently filed the most patents by far over the last 10 years whereas Haier is the leader of last 5 years.

Figure 6.9 Top patent applicants breakdown in Protection technologies by year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

In OHS Protection technologies, several companies exhibited notable growth from 2014 to 2023. Goertek led the field with a CAGR of 53.6%, closely followed by Haier at 53.5% and Shanghai Zhongfa Environmental Protection Technology at 36.6%. In contrast, Microsoft saw the steepest decline at –6.9%, with Honeywell down –6.3% and Alphabet falling –4.1%, underscoring the divergent trajectories in patenting in Protection technoloiges over this period.

In conclusion, Chinese entities are the primary drivers of innovation in the field of Protection, as evidenced by the significant patent contributions from industrial leaders like the Gree and State Grid Corporation of China (SGCC). This increasing patenting activity highlights a thriving collaboration within China's innovation ecosystem. This strong foundation has positioned China as a global leader in advancing technologies aimed at enhancing workplace safety and accident protection.

International patenting landscape

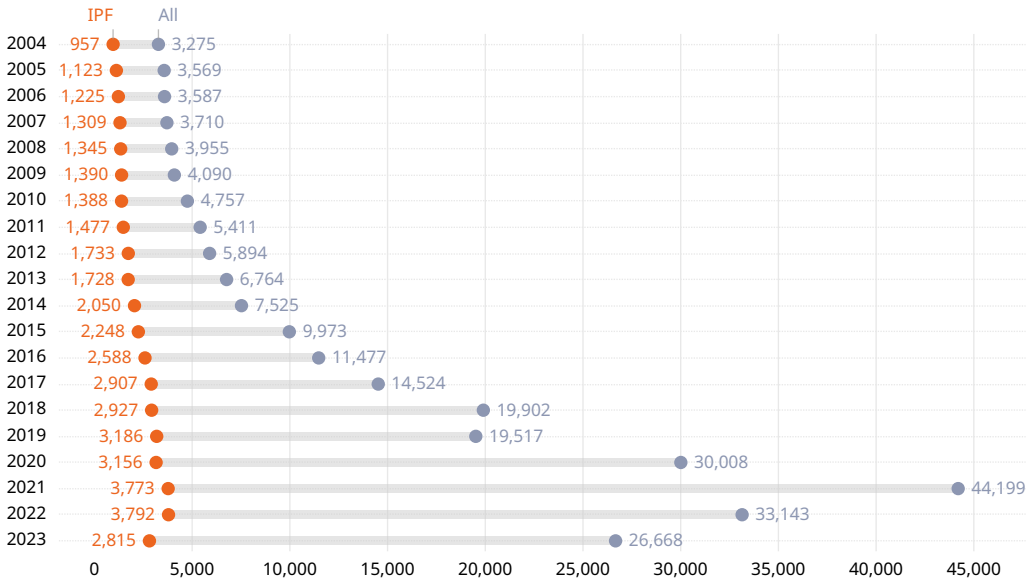
This section highlights the importance of examining International Patent Families (IPFs) to gain valuable insights into technological developments. IPFs hold particular significance as they represent inventions for which applicants have pursued patent protection in multiple countries. This action reflects both the perceived value of the invention and the applicant's intention to deploy the technology on a global scale.

IPF growth and development

Figure 6.3 highlights a clear divergence between domestic-only patent filings and IPFs in the field of Protection technologies. While the total number of patents has shown consistent growth, particularly after 2018, the share of IPFs as a percentage of total patents has steadily declined from 29% in 2004 to 11% in 2023, as shown in Figure 6.10. This indicates that the majority of recent patenting activity is concentrated in local filings, with fewer inventions being pursued for international patent protection.

The proportion of international patent families has consistently remained low in Protection technologies.

Figure 6.10 International and domestic-only patent trend in Protection technologies by earliest publication year, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Meanwhile, the number of IPFs has remained relatively stable. This stagnation suggests a plateau in globally impactful innovations within OHS Protection, because companies may be prioritizing localized solutions over global expansion. The limited growth in IPFs contrasts sharply with the surge in total patent filings, underscoring a focus on meeting regional demands rather than driving internationally significant technological advancements.

While China's explosive patenting activity bolsters the total numbers, fewer inventions are being pursued for international protection. This suggests a focus on addressing domestic challenges and markets, with limited emphasis on extending these technologies to a broader global scale.

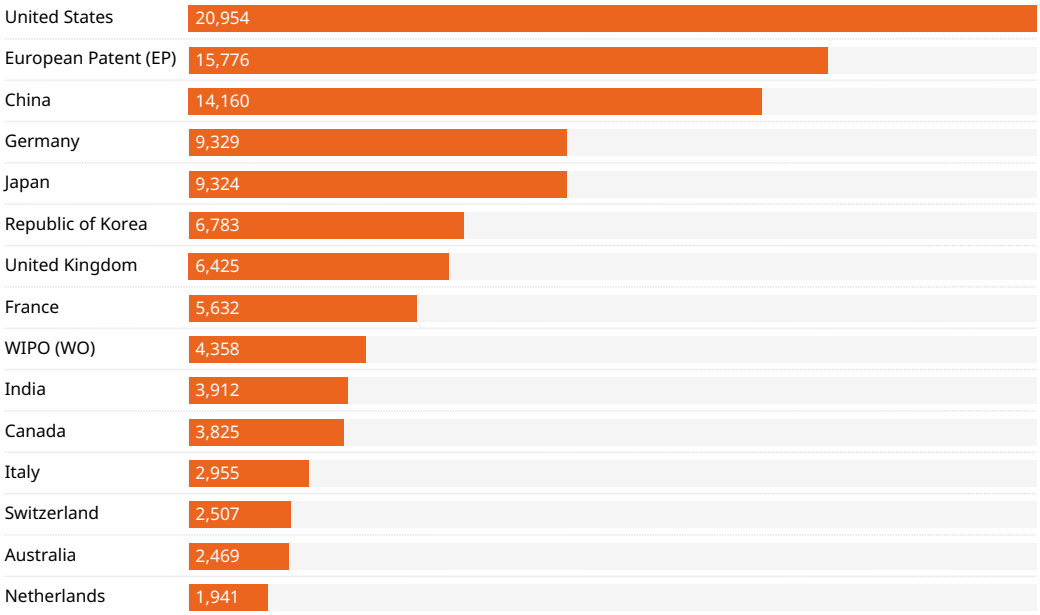
Despite a decline in the ratio of IPFs, a stable absolute numbers indicates a continued emphasis on high-value inventions with a global potential.

IPF top jurisdictions

Figure 6.11 shows the geographic distribution of patent families in the domain of Protection technologies, revealing definite regional priorities.

The United States holds leading position in internationally represented patent families for Protection technologies.

Figure 6.11 Top priority jurisdictions in Protection technologies by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The United States leads by a significant margin, with 20,954 patent families, followed by followed by the EPO at 15,776 and China, with 14,160 filings.

Other notable regions include Germany and Japan, with 9,329 and 9,324 filings respectively, further emphasizing their role as key players in advancing workplace safety technologies. In the mid-range, countries like the Republic of Korea, the United Kingdom, and France show a substantial contribution, with patent filings ranging from 5,632 to 6,783.

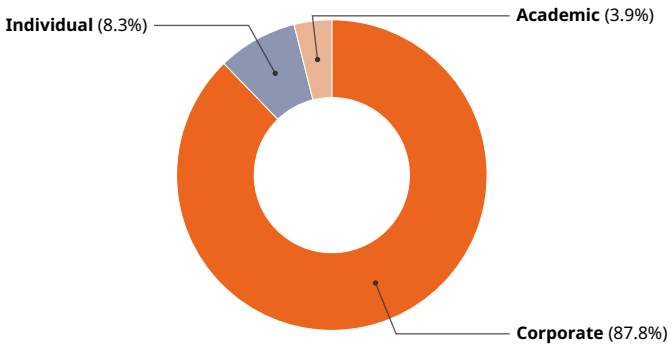
The IPF data underscores the strategic efforts of patent applicants in targeting leading markets for IP protection, with the United States, Europe, China, Germany, Japan and the Republic of Korea standing out as key destinations. These regions and countries are prioritized for having a strong technological ecosystems and significant commercial opportunities. Germany, in particular, plays a prominent role within Europe. Additionally, the data highlights China's dual approach, wherein a strong emphasis on domestic patent filings contrasts with a more selective strategy for international extensions, balancing local market needs with global aspirations.

IPF top patent applicants

The OHS category of Protection technologies is dominated by corporate entitites, with Figure 6.12 showing that 88% of IPFs come from the corporate sector. Conversely, academic applicants account for only 5% of all patents applicants, contributing to just 4% of IPFs, indicating limited involvement from the academic sector in this domain.

Protection technologies are predominantly led by companies in international filings.

Figure 6.12 Applicant type shares in Protection technologies by number of IPFs published, 2004–2023

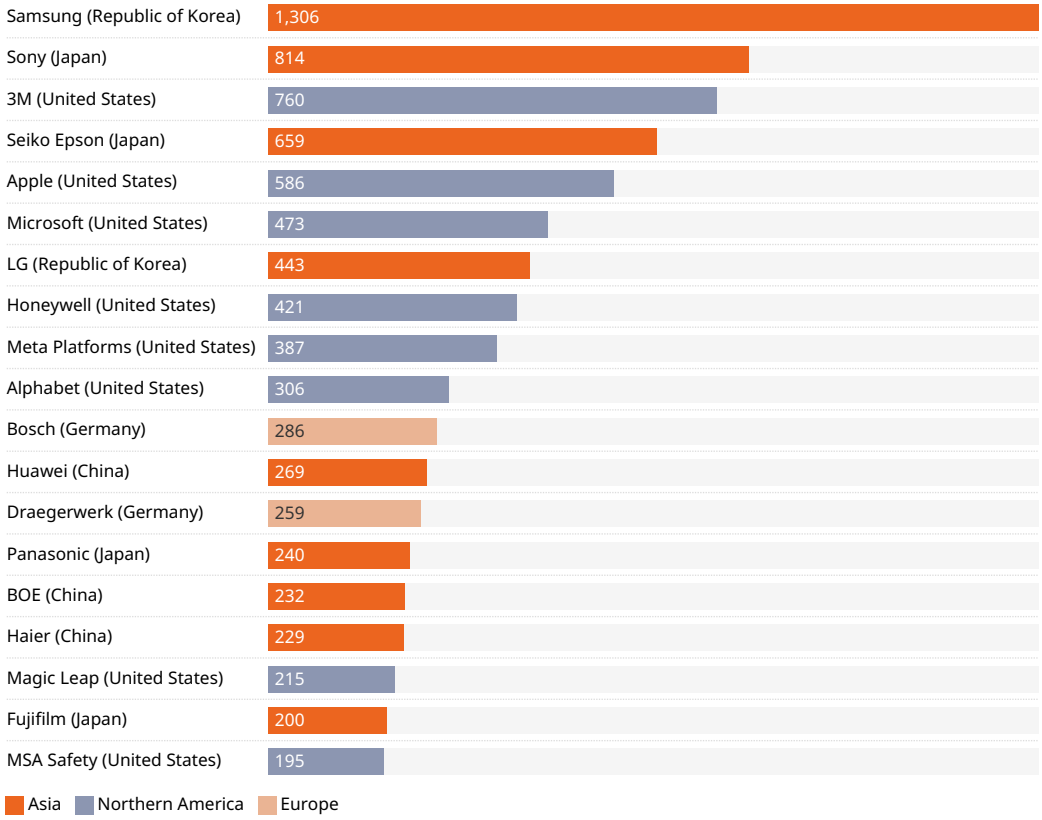


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Among the key patent applicants, Figure 6.13 shows that Samsung Electronics holds the largest portfolio, indicating a broad scope of protection and a strong presence in the field. Apple also maintains a prominent position, reflecting a significant investment in relevant technologies. Other major contributors include Sony, 3M, and Meta Platforms, each showing considerable patenting activity.Companies such as Seiko Epson, LG, and Huawei hold substantial portfolios as well, suggesting focused efforts in specific technological areas. Microsoft and Honeywell also appear among the leading applicants, pointing to consistent engagement and potential strategic interest in the domain.

Although Samsung shows clear leadership in the field of Protection-related IPFs, half of the top 10 are US-based companies.

Figure 6.13 OHS Protection top applicants by number of IPFs published, 2004–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

The Protection sector is marked by a diverse array of players, with established giants like Apple, Samsung Electronics, and Honeywell International leading with extensive patent portfolios and broad protection strategies. These companies demonstrate a strong commitment to innovation in the field. Meanwhile, players like Google, Microsoft, Seiko Epson and 3M Innovative Properties show varied approaches, ranging from diversified technological reach to a more focused, specialized effort. This mix of established leaders and niche innovators reflects the sector's maturity and the evolving strategies that different companies are employing in order to address the complex challenges of occupational safety.

IPF main technologies

Segmentation by technology area highlights several key cross-cutting trends between 2018 and 2023:

Ergonomic workspaces (21,241 IPFs): The filings in this technology area remained stable between 2018 and 2020, but there was a significant peak in 2022, followed by a sharp decline in 2023. This suggests a strong burst of innovation in 2022, which then tapered off.

Personal protection equipment (7,422 IPFs): This technology area exhibited a stable trend over time, with filings consistent without any large fluctuation, indicating steady innovation in this area.

Ventilation and filtration systems (6,611 IPFs): This technology area experienced a sharp increase in patent filings between 2020 and 2021, followed by a noticeable decline starting in 2022. This trend suggests a surge in innovation during the pandemic, followed by a reduction in filings post-2021.

Respiratory protection technologies (5,334 IPFs): Similar to ventilation and filtration systems, these technologies saw a sharp increase in filings between 2020 and 2021, followed by a decline in 2022 and 2023, reflecting the COVID-19 pandemic's initial impact and subsequent reduction in filings.

Hearing protection technologies (2,596 IPFs): There was moderate growth in this area over time, suggesting ongoing but slower innovation relative to more dynamic technology areas.

Fall protection (1,990 IPFs): This technology area showed minimal variation, indicating steady but limited innovation in comparison to other technology areas.

Wearable devices (1,639 IPFs): Similar to hearing protection technologies, wearable devices experienced moderate growth, indicating a consistent focus on innovation but at a slower pace than other technology area.

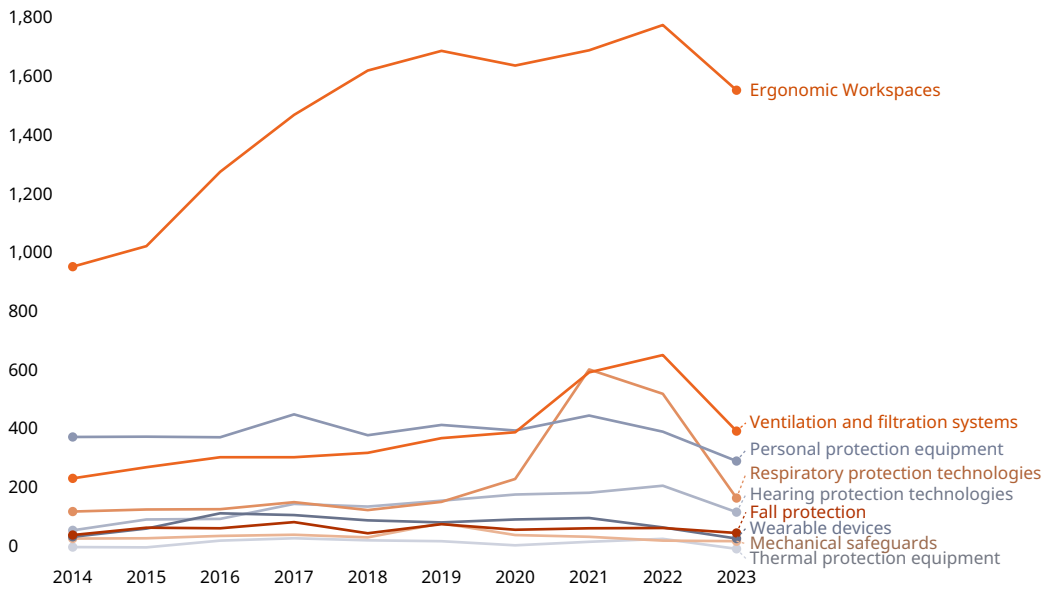
Mechanical safeguards (1,279 IPFs): This technology area displayed a stable trend with no significant fluctuations in patent filings, reflecting steady innovation in the field.

Thermal protection equipment (819 IPFs): This technology area showed minimal variation, suggesting a relatively low level of innovation compared to others in the field.

Overall trends reveal a mix of sharp increases in filings, particularly in 2021 due to external factors such as the COVID-19 pandemic, followed by a decline over recent years. Some technology areas, such as PPE and mechanical safeguards, have demonstrated steady, ongoing innovation with little fluctuation in filings over time.

Certain technology areas, like personal protective equipment and mechanical safeguards, show consistent and continuous innovation, with publications remaining relatively stable over time.

Figure 6.14 IPF publication trend in Protection technologies by technology area, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Benchmark inventions in Protection technologies

Main technologies and application fields

To gain a deeper understanding of the technological approaches in the OHS Protection category, the dataset of related simple patent families has been segmented into the nine distinct technology areas listed below in descending order according to number of patents:

Ventilation and filtration systems: Dominating the field with 87,042 patent families, these technologies focus on maintaining air quality and reducing exposure to harmful airborne substances in the workplace.

Ergonomic workspaces: With 62,618 patent families, this technology area emphasizes designing workspaces that minimize the risk of musculoskeletal disorders and enhance overall worker comfort and productivity.

Personal protection equipment: Encompassing 55,517 patent families, this technology area includes PPE such as helmets, gloves and safety glasses, designed to shield workers from physical injury and hazards.

Respiratory protection technologies: Featuring 35,586 patent families, this technology area focuses on equipment like masks and respirators, which play a crucial role in safeguarding workers' respiratory health in environments with airborne contaminants.

Fall protection: Representing 19,552 patent families, this technology area includes systems such as harnesses and guardrails, which are vital in preventing injury caused by falls in high-risk environments like construction.

Hearing protection technologies: With 16,614 patent families, this technology area provides solutions such as earplugs and earmuffs to protect workers' hearing and prevent damage in noisy work environments.

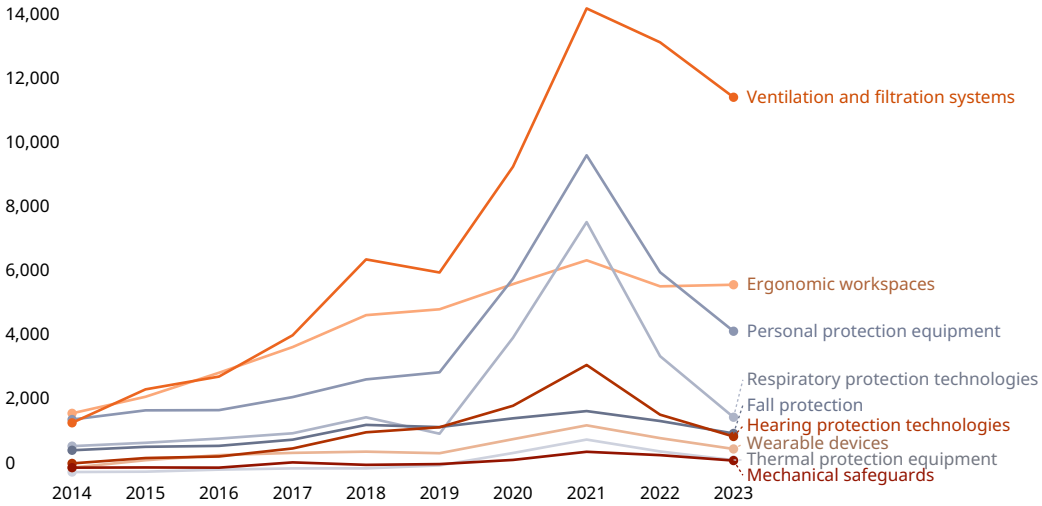
Wearable devices: Totaling 9,855 patent families, this emerging technology area features wearable safety devices that monitor workers' health and environmental conditions in real time, enhancing workplace safety measures.

Mechanical safeguards: Accounting for 5,754 patent families, these innovations include guards and barriers designed to prevent machinery-related accidents and injuries.

Thermal protection equipment: The smallest technology area, with 5,015 patent families, focuses on protective gear that shields workers from extreme temperatures, whether hot or cold.

Ventilation and filtration systems emerge as dominant technology area of Protection-related innovation.

Figure 6.15 publication trend in Protection technologies by technology area, 2014–2023

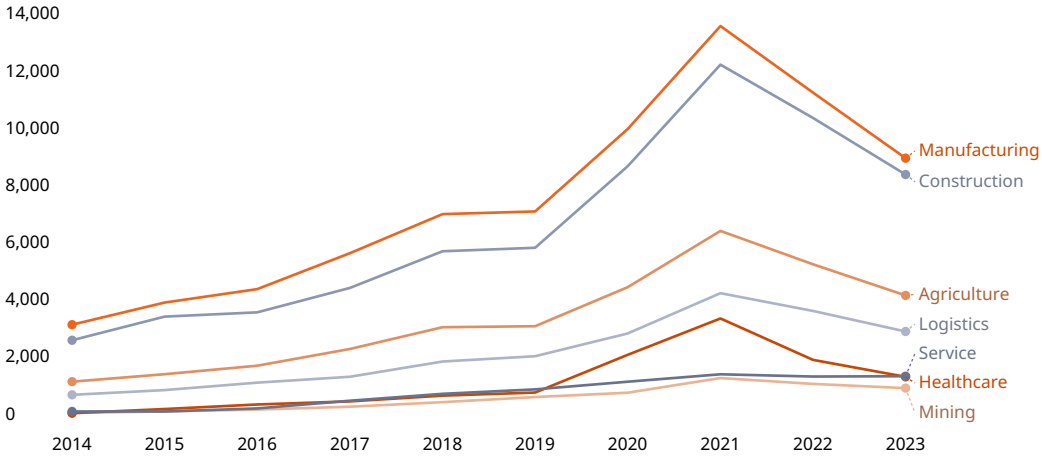


Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Patent filings in the OHS Protection category demonstrate a clear peak in 2021 across most technology areas, likely driven by increased focus on health and safety during the COVID-19 pandemic. Technologies such as ventilation and filtration systems, respiratory protection technologies, and PPE underwent dramatic growth during the period in question, reflecting the urgent need for innovative solutions to address workplace hazards. However, from 2022 onward, a noticeable decline in patent filings occurred across most technology areas, suggesting either a shift in priorities, a reduced urgency or market saturation in certain areas. Despite this decline, some technology areas, such as mechanical safeguards and wearable devices, maintained a relatively steady filing rate, indicating an ongoing interest in these areas. This trend highlights the dynamic nature of innovation in workplace safety, heavily influenced by external factors and changing priorities over time.

The manufacturing and construction industries lead in Protection technologies, while the service industry is the fastest growing.

Figure 6.16 filings trend in Protection technologies by industrial sectors, 2014–2023



Source: WIPO, based on patent data from Orbit Intelligence (Questel), December 2024.

Patent filings in the OHS Protection category reveal significant sectoral differences in terms of innovation trend between 2018 and 2023. The construction and manufacturing sectors dominated in terms of volume, peaking in 2021, likely driven by heightened safety concerns

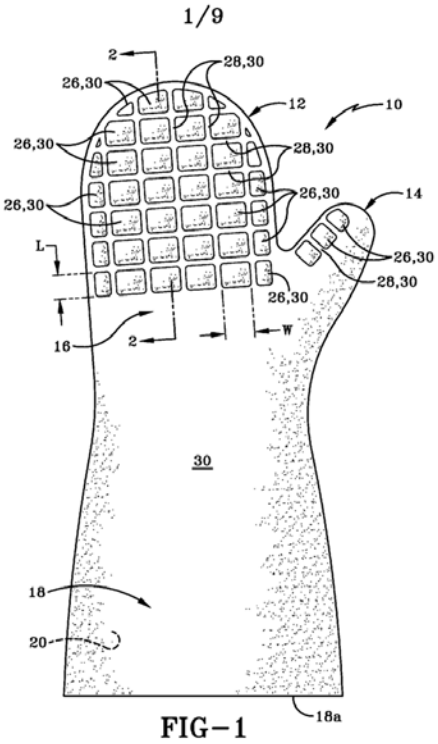
during the COVID-19 pandemic, followed by a noticeable decline by 2023. Agriculture, logistics, and services sectors showed steady but moderate growth, with a slight drop post-2021, indicating sustained yet less dynamic innovation. Meanwhile, healthcare exhibited volatility, with a sharp rise to 2021, but a significant decline reflecting fluctuating priorities. The mining sector maintained relatively steady growth throughout, reflecting its consistent focus on safety improvements. These trends highlight the varied impact of external factors and sector-specific needs on occupational safety innovation.

Example patents

The examples that follow have been chosen because considered particularly representative of the field.

Patent WO2016/022351, assigned to Summit Glove, focuses on a protective article designed to enhance safety for various body parts through innovative design features. It highlights the claims made regarding the article's structure, applications, advantages, and the specific materials utilized in its construction.

WO2016/022351: Three-dimensional protective article for enhanced body part safety



FIG−1

Source: WO2016/022351.

The primary objective of this invention is to create a protective article that enhances user safety across multiple applications, such as gloves, knee pads, and elbow pads. It aims to protect against heat and impacts, while ensuring comfort and usability, making it ideal for industrial, sporting, and everyday use.

Patent EP3058264, filed by Robert Bosch, outlines the features and advantages of a novel injury protection device designed for operators of power tools, particularly focusing on its integration within clothing to enhance safety. The device employs advanced sensor technology to monitor personal parameters and automatically deactivate power tools when predefined safety thresholds are breached, thereby reducing the risk of accidents and injuries in industrial and construction environments.

EP3058264: Injury protection device for operators of power tools

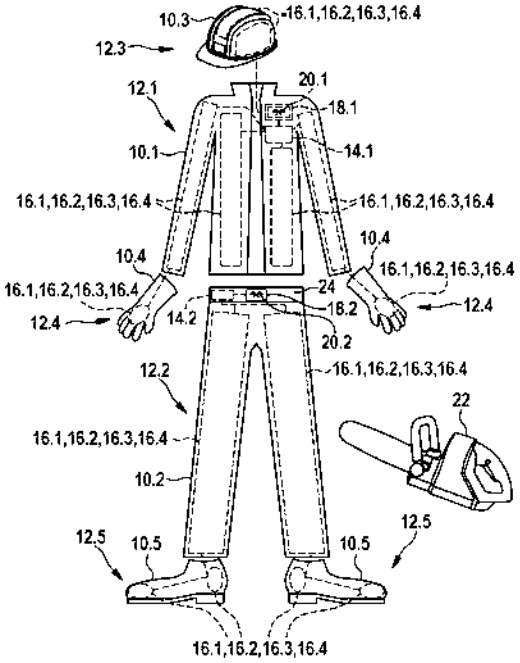


Fig.

Source: EP3058264.

The object of the invention is to provide a safety mechanism for operators of power tools, particularly in industrial or construction settings. It aims to monitor the operator's physical state and environmental conditions to prevent injuries through automatic tool deactivation. The device is applicable in various scenarios where power tools are used, enhancing operator safety and reducing the risk of accidents.

Summary of Protection technologies

The Protection category reflects a mix of dynamic growth and steady innovation across its technologies, influenced by factors such as the COVID-19 pandemic and sector-specific needs. Key technology areas like ventilation and filtration systems, and respiratory protection technologies experienced sharp increases during the pandemic, while technology areas such as personal protection equipment (PPE) and mechanical safeguards displayed consistent, ongoing innovation. China leads global patent filings, driven by localized solutions, while global leaders like Apple, Samsung, and Honeywell emphasize diverse and expansive portfolios. This patent landscape highlights the interplay between immediate safety demands, regional priorities, and sustained investment in technologies to enhance workplace safety worldwide.

7 Tomorrow's occupational health and safety

This chapter explores how evolving technologies like AI-driven prediction – with significant growth over recent years – connected wearables, and advanced analytics are transforming workplace safety. It highlights trends in key industries, for example construction and manufacturing, alongside innovations in biocompatible PPE, exoskeletons, IoT monitoring, and VR training that are shaping a proactive, data-driven future for risk management.

Report at a glance

As technology continues to evolve, several innovations are set to transform workplace health and safety. This patent landscape report highlights the evolution of key innovation areas within this field. Although most OHS patents relate to Detection technologies, in recent years Prediction technologies have emerged as the most dynamic OHS category in terms of innovation, with a compound annual growth rate (CAGR) of 26.4% between 2018 and 2023. In contrast, Detection technologies, as well as Protection solutions, have experienced a slower pace of innovation.

High-growth is seen in Prediction systems, which leverage advanced data analysis, combining historical records with real-time information to anticipate risks and propose mitigation strategies. This focus addresses growing safety concerns, regulatory pressures, and the financial challenges faced by businesses of all sizes, which is cited as a major problem by the ILO[1].

Looking at OHS innovations more generally, connected safety wearables stand out and are likely to play a pivotal role going forward. Equipped with real-time monitoring capabilities, such devices proactively detect risks, alert users, and prevent incidents before they happen. Artificial intelligence enhances these capabilities by improving analytical precision and identifying hazards, which are often overlooked by traditional methods. These technological advancements are largely driven by global technology leaders such as IBM, Huawei, Samsung, Alphabet (Google), and Apple.

1 ILO (2024). World Employment and Social Outlook Trends 2023. Chapter 3. International Labour Organization. Available at: www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@inst/documents/publication/wcms_865332.pdf

The path forward in workplace safety

The current boom in AI usage is likely a key driver behind the increase in patent filings seen in Prediction technologies. AI represents a major leap forward, rendering obsolete previous technologies based on predefined rules and static statistical models. Its adaptive capabilities allow for a more effective responses to situations and improved communication with workers[2] .

The rise in patent filings in the Prediction category may in due course be seen as a pivotal moment in the history of OHS technologies. This trend aligns with the public adoption of AI and the promising opportunities it offers. While transformative, AI alone may not be sufficient to address all current challenges. The data in this report highlights the continued focus on innovation in key industries such as construction and manufacturing, where Protection technologies remain critical and are currently being enhanced by AI.

To anticipate the future, it is important to revisit the basics and examine real key risk factors contributing to workplace accidents. These include exposure to long working hours (≥55 hours per week), particles, gases and fumes (responsible for 450,000 deaths annually), as well as extreme heat conditions[3].

Advancements in biocompatible materials for PPE are also set to reshape workplace safety in the future. These materials offer improved comfort and usability, encouraging higher adoption rates among workers. For example, lighter safety shoes and ergonomic tools not only enhance safety and well-being but also boost worker efficiency. Improving the ergonomics of work tools is already a driver of innovation, and will continue to be essential to improving working conditions.

Exoskeleton technologies, which are long anticipated, are expected to become more affordable, providing significant relief to workers performing physically demanding tasks, such as in construction or manual handling. Beyond improving productivity, such innovations could enhance economic conditions for workers – a factor often linked to risks, according to the ILO[4]. More broadly, robotics will be likely to play an increasing role in replacing humans in high-risk environments, thereby reducing injury and fatalities. IoT-based monitoring systems will increasingly be integrated directly into tools, offering continuous data on working conditions, thereby ensuring compliance, and enabling a quick response to anomalies while keeping costs low.

The integration of virtual reality (VR) into safety training programs will most likely revolutionize workforce preparedness. Immersive VR simulations can recreate high-risk scenarios in a controlled environment, thereby significantly enhancing learning outcomes at low cost, which is essential for a broad acceptance of a solution.

2 ILO (2025). Revolutionizing health and safety: The role of AI and digitalization at work. International Labour Organization. Available at: www.ilo.org/publications/revolutionizing-health-and-safety-role-ai-and-digitalization-work .
3 ILO (2023). A Call for Safer and Healthier Working Environments. International Labour Organization. Available at: www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_protect/%40protrav/%40safework/documents/publication/wcms_903140.pdf.
4 ILO (2023). A Call for Safer and Healthier Working Environments. International Labour Organization. Available at: www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_protect/%40protrav/%40safework/documents/publication/wcms_903140.pdf.

Next decade: technology in risk control

The future of OHS technologies promises to transform workplaces through a strategic focus on Prediction, Detection, and Protection, leveraging cutting-edge innovations to enhance worker safety.

In Prediction, artificial intelligence (AI) and wearable technologies are set to revolutionize risk assessment by analyzing data patterns to anticipate hazards before they materialize. A study from the University of Queensland[5] emphasizes AI's role in processing workplace injury data to forecast risks, enabling proactive interventions that address accident root causes.

For Detection, Internet of Things (IoT) sensors and real-time monitoring systems will continuously assess workplace conditions, such as air quality and equipment status. The ILO[6] highlights IoT's potential to provide real-time alerts for unsafe practices, fostering safer environments through improved data sharing.

In Protection, virtual reality (VR) training, robotics, and advanced materials like biocompatible textiles will safeguard workers by simulating hazards, automating high-risk tasks, and enhancing personal protective equipment (PPE). Research from the Massachusetts Institute of Technology (MIT)[7] underscores robotics' ability to reduce human exposure in dangerous settings, while ergonomic exoskeletons support physical safety, contributing to reduced injury rates.

Despite these advancements, challenges like data privacy, high costs, and persistent risks from hazardous environments demand ongoing innovation, as noted by the ILO's call for inclusive OHS policies[8]. The growing number of OHS-related patents reflects a commitment by the industry to address these issues. By integrating predictive intelligence, real-time monitoring, and advanced protective measures, OHS technologies are paving the way for safer, smarter, and more equitable workplaces, fostering a proactive safety culture across industries.

5 Winge, S., Albrechtsen, E., & Mostue, B. A. (2019). "Causal factors and connections in construction accidents." Safety Science, 112, 130-141.
6 International Labour Organization. (2021). Anticipating and managing the impact of technological change on occupational safety and health. Available at www.ilo.org.
7 Massachusetts Institute of Technology. (2020). Technology and the Future of Work: Robotics and Automation. Available at https://workofthefuture.mit.edu.
8 International Labour Organization. (2023). World Day for Safety and Health at Work 2023: A safe and healthy working environment as a fundamental principle. Available at: www.ilo.org/topics/safety-and-health-work/events-training/safe-and-healthy-working-environment-fundamental-principle-and-right-work

Appendices

Appendix 1: Patent indicators

Patent application

To obtain a patent, an application must be filed at the appropriate patent office together with all the necessary documents and payment of fees. The patent office will conduct an examination to decide whether to grant or reject the application. Patent applications are generally published 18 months after the earliest priority date of the application. Prior to publication, the application remains confidential. Only published patent applications have been studied in this report.

Patent applicant/assignee

When a person is applying for a patent, the word "applicant" refers to the assignee, that is, the person to whom the inventor is under an obligation to assign the invention, or the person who otherwise shows sufficient proprietary interest in the matter. Also called a patent owner or patent assignee; typically, it is the inventor's employer.

Patent classification

Patent classification is a system for examiners of IP offices or other people to code documents, such as published patent applications, according to the technical features of their content. The International Patent Classification (IPC) is agreed internationally. The European Patent Office (EPO) and United States Patent and Trademark Office (USPTO) launched a joint project to create the Cooperative Patent Classification (CPC) in order to harmonize the patent classifications systems between the two offices.

Patent family (Fampat)

Defined as an "invention-based family," this family definition from Questel incorporates the EPO's strict family rule (same priority application(s)) with additional rules (applications falling outside the 12 months filing limit; links between EP and PCT publications, etc.). This is a reasonable compromise between strict family and extended family.

PCT (WIPO)

The Patent Cooperation Treaty (PCT) is an international patent law treaty concluded in 1970, administered by the World Intellectual Property Organization (WIPO), between more than 140 Paris Convention countries. The PCT makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing a single "international" patent application instead of filing several separate national or regional patent applications. The granting of patents remains under the control of the national or regional patent offices in which is called the "national phase."

European patent (EP)

A European patent can be obtained for all the EPC countries by filling a single application at the EPO in one of three official languages (English, French or German). European patents granted by the EPO have the same legal rights and are subject to the same conditions as national patents (granted by the national patent office). A granted European patent is a “bundle” of national patents, which must be validated at the national patent office to be effective in member countries. The validation process could include submission of a translation of the specification, payment of fees and other formalities at the national patent office. Once a European patent is granted, competence is transferred to the national patent offices. Other regional patents or procedures also exist: the Eurasian patent (EA), ARIPO patent (AP) for English-speaking Africa and OAPI patent (OA) for French-speaking Africa.

International patent family (IPF)

An international patent family is defined as a patent family that has been filed and published in two or more jurisdictions (sometimes also known as foreign-oriented patent families or extended patent families). This contrasts with a domestic-only patent family or a non-international patent family, which consists of a patent family filed in only a single jurisdiction (often known as a “singleton”). Analysis by IPFs serves to highlight innovations with a universal application, control for the difference in the propensity to file multiple patent applications for a single invention between patent offices, and exclude singletons.

Priority filing

The first location in which a particular invention has a patent application filed, also known as the office of first filing.

Compound annual growth rate (CAGR)

Compound annual growth rate (CAGR), initially used to calculate and determine the rate of investment return, it represents the average annual growth rate between two dates in the report.

Relative Specialization Index (RSI)

Relative Specialization Index (RSI), as defined by the World Intellectual Property Organization (WIPO), is an analytical tool used to assess the specialization of a country's research profile. It compares the share of a specific field or technology within a country's overall research output to the global average in that field. This index helps in identifying the degree to which a country is specialized in a certain area of research and innovation relative to others.

Appendix 2: Search strategy

All patent searches for this report were conducted using the Questel Orbit Intelligence database.

A.2.1 Prediction technology area

Statistics-based analysis

In occupational health and safety, statistics-based analysis uses statistical modeling, predictive analytics, data trend analysis, and risk assessment tools to identify potential workplace hazards before they occur.

S.No	Search string
1	(G06N-007 OR G06Q-010/0639 OR G06Q-010/0637 OR G08B-031+ OR G06F-017/18)/IPC/CPC
2	((HISTORIC+ 2D (DATA OR INFORMATION OR EVENT?)) OR ((LINEAR OR LOGISTIC OR POISSON OR POLYNOMIAL OR MULTIVARIATE) 2D REGRESSION) OR ((STATISTIC+ OR TIME SERIES OR TREND) 2D ANALYSIS) OR (EXPONENTIAL SMOOTHING) OR (AUTOREGRESSIVE INTEGRATED MOVING AVERAGE) OR (MOVING AVERAGE) OR (COX PROPORTIONAL HAZARDS MODEL) OR (SEASONAL DECOMPOSITION) OR (WEIGHTED LEAST SQUARES) OR (AUTOREGRESSIVE MODEL?)))/TI/AB/CLMS
3	G06Q-010/0635/CPC/IPC
4	(((RISK+ OR HAZARD? OR DANGER+ OR SAFE+ OR THREAT+ OR VULNERABILITY OR SECURIT+) 3D (EVALUAT+ OR ANALYS+ OR MANAG+ OR ESTIMAT+ OR PREDICT+ OR PREVENT+ OR PROBABILIT+ OR CALCULAT+ OR ASSESSMENT+ OR APPRAISAL+ OR REVIEW+))/TI/AB/CLMS
5	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 4D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS/DESC
6	(1 OR 2) AND (3 OR 4) AND 5

Machine learning

Machine learning, in the context of occupational health and safety, leverages artificial neural networks, decision trees, deep learning algorithms, and pattern recognition systems to predict and prevent workplace injuries or illnesses.

S.No	Search string
1	((MACHINE 2W LEARN+) OR (NEURAL+ 2W NETWORK+) OR (DEEP+ 2W LEARN+) OR (DEEP+_LEARN+) OR (SUPPORT VECTOR MACHINE?) OR SVM OR (REINFORCEMENT 2W LEARN+) OR (DECISION D TREE?) OR (DEEP+_BELIEF+_NETWORK+) OR (DEEP+ 1W BELIEF+ 1W NETWORK+) OR "DBN" OR DEEP+_BOLTZMANN+_MACHINE+ OR (DEEP+ 1W BOLTZMANN+ 1W MACHINE?) OR (RESTRICT+_BOLTZMANN+_MACHINE?) OR (RESTRICT+ 1W BOLTZMANN+ 1W MACHINE?) OR DEEP+_REINFORCEMENT+_LEARN+ OR (RECURRENT+ 2D (NEURAL+ 2W NETWORK+)) OR "RNN" OR (CONVOLUTION+ 2D (NEURAL+ 2W NETWORK+)) OR "CNN" OR DEEP+_NEURAL+_NETWORK+ OR "DNN" OR (DEEP+ 2D (NEURAL+ 2W NETWORK+)) OR CONVOLUTION+_NEURAL+_NETWORK+)/TI/AB/CLMS
2	(G06N-020 OR G06N-003/02 OR G06F-2216/03 OR G06F-016/2465)/IPC/CPC
3	((RISK+ OR HAZARD? OR DANGER+ OR SAFE+ OR THREAT+ OR VULNERABILITY OR SECURIT+) 3D (EVALUAT+ OR ANALYS+ OR MANAG+ OR ESTIMAT+ OR PREDICT+ OR PREVENT+ OR PROBABILIT+ OR CALCULAT+ OR ASSESSMENT+ OR APPRAISAL+ OR REVIEW+))/TI/AB/CLMS/DESC
4	G06Q-010/0635/CPC/IPC
5	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
6	EPD>=2004-01-01
7	(1 OR 2) AND (3 OR 4) AND 5 AND 6

Behavior-based analysis

Behavior-based analysis enhances occupational health and safety by employing user behavior analytics, activity monitoring systems, anomaly detection, and predictive behavioral modeling to anticipate unsafe worker actions.

S.No	Search string
1	((BEHAVIOR+ OR ((HUMAN? OR WORKER? OR OPERATOR? OR USER? OR PERSON?L??? OR EMPLOYEE?) D (ACT? OR PERFORM+ OR ACTION?)) OR FATIGUE) 3D (MONITOR+ OR DETECT+ OR TACK+ OR PREDICT+ OR EVALUAT+ OR ASSESS+ OR ANALYS+ OR MODEL+ OR ESTIMAT+ OR CONTROL+ OR PREDICT+))/TI/AB/CLMS
2	(G06Q-010/06398 OR G06Q-010/063114)/IPC/CPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPD>=2004-01-01
5	(1 OR 2) AND 3 AND 4

General filter

S.No	Search string
1	(CYBER_SECURIT+ OR CYBER DEFENS+ OR MALWARE ATTACK+ OR PHISHING OR RANSOMWARE OR (DATA W BREACH) OR FIREWALL OR ENCRYPTION OR DENIAL OF SERVICE OR DISTRIBUTED DENIAL OF SERVICE OR SOCIAL ENGINEERING OR PENETRATION TESTING OR INTRUSION DETECTION OR INTRUSION PREVENTION OR MULTI_FACTOR AUTHENTICATION OR VULNERABILITY SCANNING OR ADVANCED PERSISTENT THREAT OR ENDPOINT SECURITY OR (CYBER 2W THREAT+) OR PATCH MANAGEMENT OR (IDENTITY W ACCESS MANAGEMENT) OR (NETWORK W SECURITY) OR BOTNET OR ADWARE OR SPYWARE OR ROOTKIT OR CRYPTOGRAPHY OR PUBLIC KEY INFRASTRUCTURE OR VIRTUAL PRIVATE NETWORK OR (CYBER W HYGIENE) OR (CYBER 2W ESPION+) OR (ETHICAL HACK+) OR RED TEAMING OR BLUE TEAMING OR (CYBER W FORENSIC?))/TI/DESC/CLMS/AB

A.2.2 Detection technology area

Safety software solutions

In occupational health and safety, safety software solutions include incident management software, real-time monitoring platforms, compliance tracking systems, and hazard identification tools to proactively manage workplace risks.

S.No	Search string
1	(((SOFTWARE OR DIGITAL OR "IT" OR PROGRAM+) 4D (APPLICATION? OR PLATFORM? OR SOLUTION? OR SYSTEM? OR TOOL? OR PRODUCT? OR PACKAGE OR SERVICE? OR FRAMEWORK?)) OR ("IOT" OR (INTERNET OF THINGS) OR ((CONNECTED OR INTERNET_CONNECTED OR NETWORKED) 2D (DEVICE? OR SENSOR+))))/TI/AB/CLMS
2	(G06F-008 OR G06F-003 OR G06F-009 OR G06F-015 OR G06F-017 OR G06F-018 OR H04W-004/70 OR G16Y-030)/IPC/CPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

Fire detection and prevention systems

Fire detection and prevention systems, within occupational health and safety, consist of smoke detectors, heat sensors, flame detectors, and automatic sprinkler systems to protect workers from fire-related incidents.

S.No	Search string
1	((FIRE OR BLAZE OR FLAM+ OR FUME? OR SMOKE?) 2D (DETECT+ OR SENSING+ OR DETERMIN+ OR INSPECT+ OR INVESTIGAT+ OR SCAN+ OR SENSOR+ OR RECOGNI+ OR DISCOVER+))/TI/AB/CLMS
2	(G08B-017 OR A62C-002 OR A62C-035)/CPC/IPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

Gas detection equipment

Gas Detection Equipment supports occupational health and safety with portable gas detectors, fixed gas monitoring systems, multi-gas analyzers, and leak detection sensors to safeguard workers from hazardous gas exposure.

S.No	Search string
1	(GAS 2D (DETECT+ OR SENSING+ OR DETERMIN+ OR INSPECT+ OR INVESTIGAT+ OR SCAN+ OR SENSOR+ OR RECOGNI+ OR DISCOVER+))/TI/AB/CLMS
2	(G01N-033 OR G01N-027/16 OR G01N-2027/222)/IPC/CPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

Temperature monitoring system

Temperature monitoring systems in occupational health and safety use infrared thermometers, thermal imaging cameras, temperature sensors, and overheat detection systems to prevent heat-related illnesses in the workplace.

S.No	Search string
1	((TEMPERATURE OR HEAT OR WARMTH OR THERMAL OR THERMALITY) 4D (DETECT+ OR SENSING+ OR DETERMIN+ OR INSPECT+ OR INVESTIGAT+ OR SCAN+ OR SENSOR+ OR RECOGNI+ OR DISCOVER+))/TI/AB/CLMS
2	(G01K-001 OR G01K-003 OR G01K-005 OR G01K-007 OR G01K-009 OR G01K-011)/CPC/IPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

Noise level monitoring

Noise level monitoring, in the context of occupational health and safety, employs sound level meters, noise dosimeters, acoustic sensors, and real-time noise tracking devices to protect workers from hearing loss.

S.No	Search string
1	((NOISE OR LOUD OR SOUND) 4D (DETECT+ OR SENSING+ OR DETERMIN+ OR INSPECT+ OR INVESTIGAT+ OR SCAN+ OR SENSOR+ OR RECOGNI+ OR DISCOVER+))/TI/AB/CLMS
2	(G01H OR G01R-029/26)/CPC/IPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

Radiation detection equipment

Radiation detection equipment enhances occupational health and safety with Geiger counters, dosimeters, scintillation detectors, and ionization chambers to monitor and mitigate radiation exposure risks for workers.

S.No	Search string
1	((RADIATION OR (RADIANT D (HEAT? OR ENERG+)) OR IRRADIATION OR RADIOACTIVIT??? OR (PARTICLE? 2D EMISSION) OR NUCLEAR OR RAY?) AND (ANALY+ OR DETERMIN+ OR EVALUAT+ OR INSPECT+ OR INVESTIGAT+ OR SCAN+ OR DETECT+ OR SENSOR+ OR RECOGNI+ OR DISCOVER+ OR FIND+ OR IDENTIFY+ OR CHECK+ OR PERCEPT+))/TI/AB/CLMS
2	G01T/CPC/IPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

Location-based safety systems

Location-based safety systems in occupational health and safety feature GPS tracking devices, proximity sensors, geofencing systems, and worker location monitors to ensure employee safety in hazardous zones.

S.No	Search string
1	(((POSITIONING D SYSTEM?) OR (MAPPING D POSITIONING) OR LOCATION? OR LOCALIZ+ OR GEO_LOCAL+ OR GEO_LOCAT+ OR POSITIONING OR GEO_POSITION+ OR GEO_FENC+) AND (DETERMIN+ OR INVESTIGAT+ OR SCAN+ OR DETECT+ OR SENSOR+ OR RECOGNI+ OR IDENTIFY+ OR PERCEPT+))/TI/AB/CLMS
2	(G01S-001/02 OR G01S-005/02 OR G01S-013/87 OR G01S-011/14 OR G01S-005/18 OR G01S-001/72 OR G01S-015/02 OR G01S-015/04 OR G01S-015/06 OR G01S-005/16 OR H04B-010/116 OR G01V-003 OR G01R-033 OR H04W-004/02 OR H04W-064)/IPC/CPC
3	(((INDUSTR+ OR FACTORY OR FACTORIES OR MANUFACTUR+) 4D (INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+)))/TI/AB/CLMS
4	EPRD>=2004
5	(1 OR 2) AND 3 AND 4

A.2.3 Protection technology area

Respiratory protection technologies

Respiratory protection technologies, in occupational health and safety, consist of N95 respirators, self-contained breathing apparatus (SCBA), powered air-purifying respirators (PAPRs), and gas masks with filters to protect workers from airborne contaminants.

S.No	Search string
1	(A62B-007:A62B-015 OR A62B-018:A62B-033 OR A41D-013/11)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>2004
4	1 AND 2 AND 3

Hearing protection technologies

Hearing protection technologies support occupational health and safety with earplugs, earmuffs, custom-molded ear protection, and acoustic filters to prevent noise-induced hearing loss in noisy work environments.

S.No	Search string
1	(A61F-011/06 OR G10K-011/16 OR H04R-001/10 OR A45D-044/12 OR A42B-003/16)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>=2004
4	1 AND 2 AND 3

Personal protection equipment

Personal protection equipment, in the context of occupational health and safety, includes safety helmets, protective gloves, body armor, and high-visibility clothing to shield workers from physical workplace injuries.

S.No	Search string
1	(A41D-013/04 OR A41D-013/05 OR F41H-001 OR A61F-009/04 OR A61F-009/02 OR F16P-001 OR A41D-013/015 OR A42B-001/018 OR A42B-003 OR A41D-013/008 OR Y10S-002/902 OR H05F-001 OR H05F-003 OR A62D-005 OR A62B-017/006 OR A62B-029 OR A62D-2101 OR A62D-2203 OR A62B-017/04 OR A62D-003 OR A41D-031/04)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>=2004
4	1 AND 2 AND 3

Thermal protection equipment

Thermal protection equipment enhances occupational health and safety with fire-resistant suits, insulated clothing, heat shields, and cooling vests to protect workers from burns or heat stress.

S.No	Search string
1	(A62B-017/003 OR A62B-017/005 OR A41D-031/06 OR A41D-031/08 OR D03D-015/513 OR B32B-2307/30 OR D03D-015/52 OR A41D-019/01529)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>=2004
4	1 AND 2 AND 3

Mechanical safeguards

Mechanical safeguards in occupational health and safety feature machine guards, lockout-tagout systems, safety interlocks, and barrier shields to reduce the risk of machinery-related accidents.

S.No	Search string
1	(F16P-001 OR F16P-003/001 OR F16P-003/02 OR F16P-003/08 OR F16P-003/008 OR F16P-003/12 OR F16P-003/18 OR F16P-005 OR F16P-007)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>=2004
4	1 AND 2 AND 3

Ventilation and filtration systems

Ventilation and filtration systems, applied to occupational health and safety, include air purifiers, exhaust fans, HEPA filtration systems, and dust collection units to ensure clean air and reduce respiratory hazards for workers.

S.No	Search string
1	(A62B-013 OR F24F-007 OR F24F-011/0001 OR F24F-003 OR F24F-2120 OR E06B-007/02 OR Y02B-030 OR F24F-008 OR F24F-011/33 OR F24F-013/28 OR F24F-013/22 OR B08B-015/00 OR B08B-2215/00 OR D01H-011/005 OR B01L-001/04 OR B60H-003/06 OR B60H-003/0085 OR Y02A-050/20)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>=2004
4	1 AND 2 AND 3

Ergonomic workspaces

Ergonomic workspace solutions in occupational health and safety encompass adjustable desks, ergonomic chairs, anti-fatigue mats, and wrist supports to minimize musculoskeletal disorders among employees.

S.No	Search string
1	(A61B-005/22 OR G06F-003/048 OR A47C-007/029 OR A47C-003 OR A47C-009/002 OR B25G-001/102 OR A61M-2205/586 OR G06F-2203/0333)/IPC/CPC OR (ERGONOM+ OR USABIL+ OR USER_FRIENDLY)/TI/CLMS
2	(G06T-019 OR G02B-027/01 OR G06F-003/011 OR H04N-013/344)/IPC/CPC OR (((AUGMENTED REALITY) OR (VIRTUAL REALITY) OR (MIXED REALITY)))/TI/CLMS
3	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
4	EPD>=2004
5	(1 OR 2) AND 3 AND 4

Fall protection

Fall protection, within occupational health and safety, involves safety harnesses, guardrails, lanyards, and fall arrest systems to prevent worker injuries from falls at height.

S.No	Search string
1	(A62B-035/0006 OR A62B-035/0043 OR A62B-035/0081 OR A62B-035/04 OR E04G-021/3204 OR A62B-001 OR E06C-007/18)/IPC/CPC
2	(A62B-035 OR A61B-005/1117 OR G08B-021/043 OR G08B-021/0446 OR B66B-005/008)/IPC/CPC AND ((FALL+ 4D (RESTRAINT+ OR PROTECT+)) AND (+ACTIVE OR REAL_TIME OR LIVE))/TI/AB/CLMS/DESC
3	(A62B-035/0093 OR B66D-005 OR E04G-021/3261 OR A62B-035/04)/IPC/CPC AND (FALL+ 4D (ARREST+ OR STOP+))/TI/AB/CLMS/DESC
4	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
5	EPD>=2004
6	(1:3) AND 4 AND 5

Wearable devices

Wearable devices in occupational health and safety include smart helmets, fitness trackers, exoskeletons, and vital signs monitors to enhance worker safety and monitor health conditions in real time.

S.No	Search string
1	(A41D-001/002 OR A41D-013/01 OR A41D-013/002 OR G08B-021/0446 OR F21V-033/0008 OR A63B-2220/836 OR A42B-003/0433 OR A44C-005/0015)/IPC/CPC
2	((INCIDENT? OR ACCIDENT+ OR HAZARD+ OR DANGER+ OR SAFE+)) OR ((OCCUPATION+ OR WORK_SPACE? OR WORKPLACE? OR ON_THE_JOB OR EMPLOYMENT_RELATED OR WORKING OR WORK OR WORKSITE OR JOB+ OR LABOR OR EMPLOYEE? OR WORKER? OR HUMAN? OR USER? OR PERSON+ OR OPERATOR?) 5D (INCIDENT? OR ACCIDENT+ OR INJUR+ OR HAZARD+ OR DANGER+ OR SAFE+ OR SECURIT+ OR PROTECT+))/TI/AB/CLMS/DESC
3	EPD>=2004
4	1 AND 2 AND 3

A.2.4 Industrial sectors

Industrial sectors include various activities:

- Construction: Building and maintaining structures and infrastructure.
- Manufacturing: Producing goods from raw materials
- Healthcare: Providing medical services and products
- Agriculture: Cultivating plants and rearing animals for food and resources
- Services: Offering intangible value and expertise
- Logistics: Managing the movement and flow of goods
- Mining: Extracting minerals and geological materials.

Construction

This sector encompasses activities related to the building, modification, and maintenance of structures and infrastructure like roads, bridges, and utility systems.

S.No	Search String
1	(G06Q-050/08)/IPC/CPC OR (CONSTRUCTION OR ARCHITECT??? OR (CIVIL D ENGINEER) OR ROAD? OR BRIDGE? OR (STRUCTURAL D ENGINEER) OR ELECTRICIAN? OR PLUMBER??? OR CARPENTER? OR MASON?? OR CRANE? OR BULLDOZER? OR EXCAVATOR? OR WELDER? OR ROOFER? OR PAINTER? OR DECORATOR? OR PAINTING OR WALLPAPERING)/TI/AB/TX

Manufacturing

Manufacturing is an industrial sector that involves the production of goods from raw materials through various processes, including design, assembly, and finishing.

S.No	Search String
1	(G06Q-050/04 OR G06Q-050/06 OR Y02P-010)/IPC/CPC OR (POWERPLANT? OR POWER_PLANT? OR PLANT OR MANUFACTUR??? OR (MACHINE D OPERATOR?) OR FACTORY OR INDUSTRIAL OR ASSEMBLER? OR (MAINTENANCE 2D (TECHNICIAN? OR MACHINERY OR EQUIPMENT OR SYSTEM?)))/TI/AB/TX

Healthcare

This sector encompasses a broad range of companies and organizations that provide medical services, manufacture medical equipment or drugs, offer health insurance, or otherwise facilitate the provision of healthcare to individuals.

S.No	Search String
1	(HOSPITAL OR PHARMAC???? OR CLINIC OR INFIRMARY OR HOSPICE OR INPATIENT OR NURSING OR ASYLUM OR NURSE OR SICKBAY OR DISPENSARY OR SICKROOM OR CLINICIAN OR SANITARIUM OR (MEDICAL 3D (SERVICE? OR MANUFACTUR??? OR EQUIPMENT)) OR DRUGS OR (HEALTH D INSURANCE))/TI/AB/TX

Agriculture

The agriculture sector encompasses a broad range of activities related to the cultivation of plants and the rearing of animals for food, fiber, medicinal plants, and other products used to sustain and enhance human life.

S.No	Search String
1	(G06Q-050/02 OR G06Q-050/165)/IPC/CPC OR (AGRICULTUR??? OR FARM??? OR AGRONOM??? OR CULTIVATION OR HUSBANDRY OR CULTURE OR CROP OR TILLAGE OR BREEDING OR CATTLE OR STOCK OR ANIMAL OR SHEEP OR HERD??? OR RANCHING OR STOCKBREEDING OR REARING OR GRAZING OR PASTORAL OR (CHICKEN D COOP) OR POULTRY OR OVINE? OR GOAT? OR BOVINE? OR RANCHER? OR FRUIT? OR VEGETABLE? OR NUT? OR GOAT? OR PIG? OR MEAT OR DAIRY OR PEST OR HORTICULTURIST? OR LANDSCAPING OR GREENHOUSE OR VETERINARIAN? OR IRRIGATION OR ENTOMOLOGIST? OR FORESTER? OR FOREST? OR WOOD OR BIODIVERSITY OR FISHER??? OR AQUACULTURE OR FISH?? OR HATCHER???)/TI/AB/TX

Service

The services sector, also known as the tertiary sector, is characterized by activities that do not produce tangible goods but instead provide intangible value such as expertise, convenience, access, or entertainment.

S.No	Search String
1	(G06Q-010 OR G06Q-050/01 OR G06Q-050/10 OR G06Q-050/12 OR G06Q-050/14 OR G06Q-050/16 OR G06Q-050/163 OR G06Q-050/167 OR G06Q-050/18 OR G06Q-050/182 OR G06Q-050/184 OR G06Q-050/186 OR G06Q-050/188 OR G06Q-050/20 OR G06Q-050/205 OR G06Q-050/2053 OR G06Q-050/2057 OR G06Q-050/22 OR G06Q-050/26 OR G06Q-050/265 OR G06Q-050/34 OR G06Q-050/43 OR G06Q-050/50 OR G06Q-050/60)/IPC/CPC OR (TEACHER? OR PROFESSOR? OR EDUCATIONAL OR LIBRARIAN? OR BANKER? OR (SOFTWARE W DEVELOPER?) OR LAWYER? OR HOTEL? OR HAIRDRESSER? OR BAKER? OR ARTISAN?)/TI/AB/TX

Logistics

The logistics sector refers to the industry that deals with the planning, implementation, and management of the movement, storage, and flow of goods, services, and information throughout the supply chain—from the point of origin to the point of consumption. It encompasses various activities, including transportation, warehousing, inventory management, packaging, materials handling, and distribution.

S.No	Search String
1	(G06Q-010/083 OR G06Q-050/40 OR G06Q-050/47 OR G06Q-010/083)/IPC/CPC OR (LOGISTIC? OR TRUCKING OR SHIPPING OR (AIR D FREIGHT) OR TRANSPORT OR TRANSPORTATION OR SHIPPER? OR SHIPMENT)/TI/AB/TX

Mining

This sector focus on the extraction of minerals, metals, and other geological materials from the Earth's crust. These resources include ores, coal, precious metals, stones, oil shale, gemstones, limestone, and other materials essential for manufacturing and energy production.

S.No	Search String
1	(E02F-009/00 OR E21D-021 OR E02D-05/74 OR E21D-020 OR E02D-029/045 OR E02D-029/063 OR E21D-011 OR E21D-009 OR C22B-015 OR E21C-025 OR E21C-033 OR E21C-037 OR E21C-039 OR E21C-035 OR E21B-007)/IPC/CPC OR (MINING OR MINE? OR ((EXTRACTING OR REFINING) 2D METAL?) OR MINERAL)/TI/AB/TX

The WIPO *Patent Landscape Report on Occupational Health and Safety* provides an in-depth analysis of global patent trends in this field, with a focus on three key areas: accident prediction, detection and protection technologies. These innovations leverage advanced methods such as statistical analysis, machine learning, and real-time monitoring to improve workplace safety. The report highlights a rapidly evolving landscape shaped by technological progress, regulatory frameworks, and growing awareness of occupational hazards.

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