Safety Management and Human Factors, Vol. 105, 2023, 94–101
https://doi.org/10.54941/ahfe1003074

Prevention Ecosystem Integrated Into Digitalized Manufacturing

Malisa Viktorijo and Effenberger Georg

AUVA Allgemeine Unfallversicherungsanstalt, AT-1100, Vienna, Austria

ABSTRACT

The increasing integration of information technology across all industries affects the entire production systems, both each individual machine and entire process chains, and impacts occupational health and safety. The globalization of the economy has been largely implemented, so that disruptions at any point in the supply chains have a worldwide impact. In particular, the production locations of individual components for machines are distributed internationally. However, national legal and normative regulations differ from country to country and influence production processes and workplace design. Machine manufacturers with production sites in different countries must comply with different regulations and also take occupational health and safety into consideration. To facilitate access to global OSH regulations, compare and analyze differences, a prevention platform will be built as an ecosystem and initially made available to the manufacturing industry. The prevention ecosystem will bring together relevant occupational safety and health data from national institutions and provide manufacturing companies with the required, always up-to-date information and tools. After all, digitization and global production also need globally usable digital prevention of hazards.

Keywords: Global manufacturing, Cybersecurity and occupational safety, Occupational safety and health, Prevention ecosystem

INTRODUCTION

Predominantly large and medium-sized production companies have their own production facilities or partner companies in various countries. The productions are set up according to the nationally applicable legal and normative provisions. However, the national legal framework can change, which can lead to changes in the industrial production processes and systems.

National normative and legal regulations affect production systems by setting minimum standards for working conditions, health protection, emission control and waste management. The design of workplaces depends on sector-specific national standards, which can have both positive (occupational safety and environmental protection) and negative effects (higher acquisition costs). The national education system and the education level of workers have a direct impact on production: Well-developed education systems ensure a well-trained workforce, but can also lead to a shortage of skilled workers in some sectors. Available local infrastructure, such as the availability of energy and raw materials, transport links and internet, also influences production processes.

The proportion of electronic components and software in production systems is steadily increasing, making **cyber security** ever more important. The globalisation of the economy means internationally distributed production sites whose processes and machines comply with different standards and whose workplaces are designed according to different norms. The vertical networking of plants, machines, databases, departments within the company as well as the horizontal networking of raw material suppliers, logistics and customers is progressing. Increased interconnectedness also means that cybersecurity is increasingly impacting workplace safety and requires continued investment in the latest tools, hardware and innovative strategies to protect their networks and overall production.

Since the Industry 4.0 initiative, many new technologies have developed in parallel. Recent years have been characterized by a focus on environmental and climate protection. Thus, large investments have been and will be made in renewable energies, e-cars and sustainability of products in the coming years. This has created many jobs in the field of electronics and digital technology, so that prevention services are increasingly concerned with **"digital" jobs**. The share of electronics and software in machines and workplaces is constantly increasing. It has become accepted that software must be constantly updated. On the whole, the trend in equipment and machines is towards more functionalities and, at the same time, shorter and **shorter life cycles**.

The shorter lifespan of work equipment leads to **frequent changes at workplaces**, which requires adaptation or the development of new prevention measures. Prevention as a service is becoming more intensive and increasingly complex. Figure 1 shows an internally conducted forecast of how the tasks of the prevention department are likely to change in connection with the new technologies. New technologies (Industry 4.0) lead to **more digital prevention services**.

When workshops are located in different countries and are subject to national normative and legal regulations, machines have to be manufactured according to different standards and workplaces have to be designed differently. In addition to language barriers, national regulations lead to differences in setting up the same production.

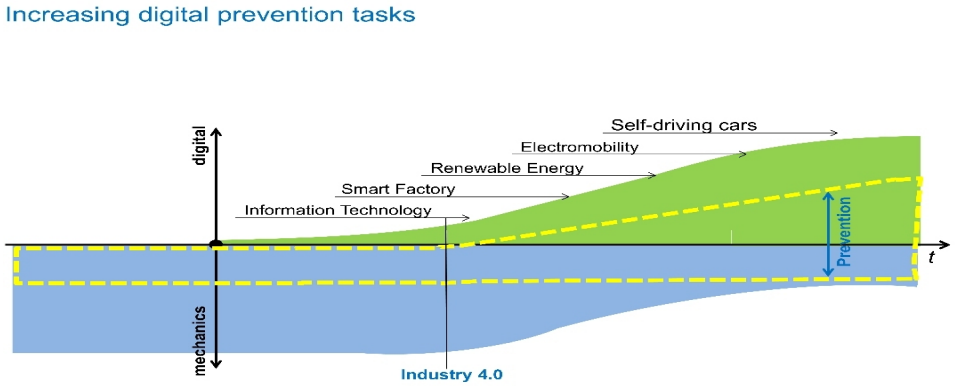

Figure 1: New technologies (Industry 4.0) lead to more digital prevention services (adapted from Malisa, 2022).

In this environment, prevention services must continuously monitor technological developments and help to safely integrate technologies, develop new models and quickly provide targeted **health and safety information** to manufacturing companies in all workplaces. From an occupational health and safety perspective, it is important that no hazards arise for people in the new workplaces. By connecting work equipment to the internet, connecting external devices or manually entering data, targeted cyber-attacks are possible in the workplace, so these threats must also be included in a risk analysis and a workplace assessment that is carried out regularly. In Fig. 2, new technologies have been grouped according to the threats posed by cyberattacks on machines and devices, according to (Malisa, 2018) and (Malisa, 2019).

From the perspective of machinery safety and occupational health and safety, as well as the impact of cyberattacks, technologies can be divided into five groups, as shown in Figure 2: (Malisa, Effenberger, 2022)

1. *Smart Human*
   Devices, measuring instruments or displays that are attached and worn directly on the human body. (Figure 2, Pos. 1)
2. *Digital Connectivity*
   Machines, controls, simulations, databases dislocated from each other but connected via the Internet for data exchange. (Figure 3, Pos. 2)
3. *Artificial Intelligence*
   Artificial intelligence, machine learning and other intelligent algorithms for production systems. (Figure 3, Pos. 3)
4. *Digital factory*
   Models of individual real machines or entire production systems integrated with simulations and interacting with real machines. (Figure 3, Pos. 4)

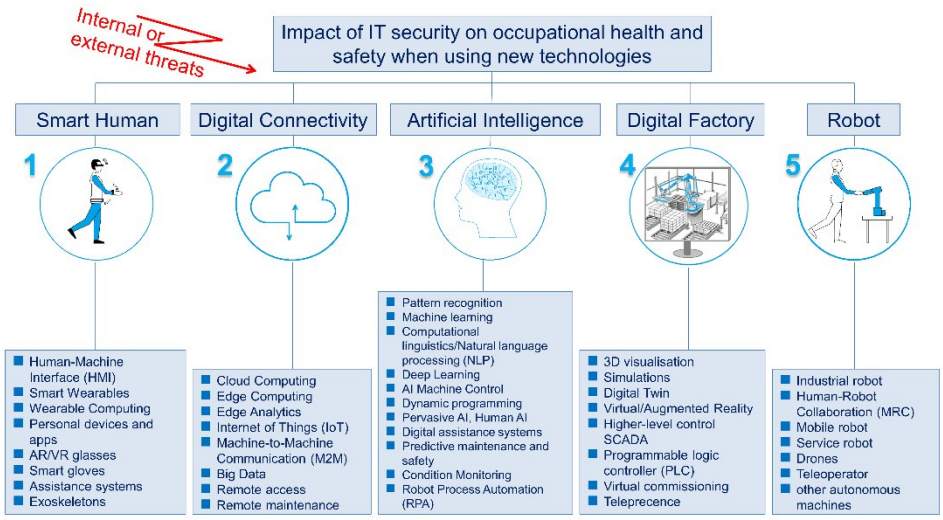

Figure 2: Grouping new technologies based on the impact of IT-security on occupational health and safety (Malisa, 2018, 2019).

5. *Robots*
   Industrial robots, mobile platforms or multicopters, used for the automation of production systems. (Figure 3, Pos. 5)

This grouping helps on the one hand to bundle the necessary prevention measures and other information, and on the other hand to facilitate communication between the departments of the company, in particular between occupational safety and OT/IT. Digitalization is changing all areas of industry, and technological developments are advancing very quickly, so prevention must be adapted in step. Technological change requires prevention to be flexible and dynamic. For each new digital technology in the workplace, safety has to be assessed with regard to cyberattacks and, if necessary, measures for secure use have to be developed.

The prevention service needs a platform that covers new technologies, including cyber security with information, rendering a sound and clear presentation. In addition, communication with industry must take place using all conventional and digital communication channels in order to be able to communicate technology-adequate updates efficiently and promptly.

This paper is the basis for an ongoing project that invites all readers - companies, institutes and large enterprises from different countries - to participate in the subprojects.

DEVELOPMENT OF AN ECOSYSTEM FOR PREVENTION

Challenges are manufacturing systems in which many new technologies are integrated. One possible system is shown in Figure 3, where remote maintenance is performed on a human-robot collaboration system in such a way that the maintenance person is in front of the robot wearing AR glasses and the remote expert is connected to the robot controller via simulation and the process is monitored via condition monitoring.

To perform a risk assessment of such **complex systems**, teamwork with different experts is required.

The prevention service needs a platform that covers the new technologies, including cyber security, with information and presents it in a sound and clear manner. In addition, communication with the industry needs to take place through all conventional and digital communication channels in order

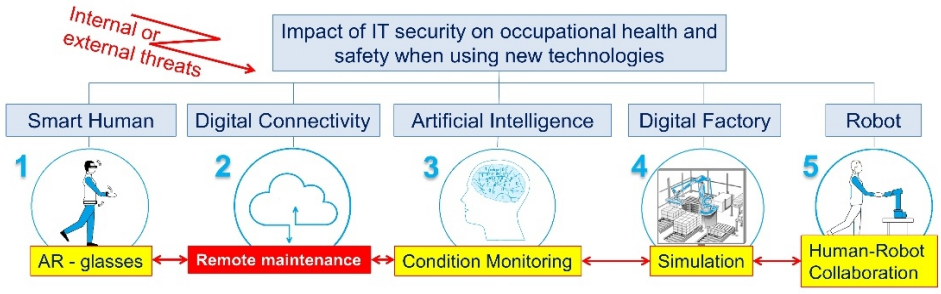

Figure 3: Example "remote maintenance" – on a complex system for risk assessment.

to communicate technology-appropriate updates in an efficient and timely manner. (Leah, 2022)

The prevention platform must adapt to the rapid changes in the manufacturing industry and globally and include the following features:

- keep pace with new technologies
- shorter life cycles of machines
- rapid changes in workplaces
- influence of IT security on occupational safety
- different national normative and legal regulations
- sending information about health and safety in the workplace via all information channels
- helping to create the risk assessment for complex systems.

Due to the many requirements for the platform, it is possible to build a platform as an ecosystem with a database in the background and the possibility of integrating different interfaces, modules and further modules in the future.

According to (Fraunhofer, 2022) an ecosystem is defined by the following characteristics:

a) it satisfies the actual needs of potential consumers,
b) it delivers added value that was previously unattainable without the ecosystem service,
c) it is attractive to both providers and demanders of services, and
d) it provides added value for all partners involved in the ecosystem service.

Consequently, the general structure of the ecosystem under this project "prevention ecosystem" will have the following characteristics:

ad a) The user can create an account in the "Prevention ecoSystem" for himself, for a company or a workshop. Depending on his professional interest, the user can enter specific topics, a production plant, the individual machine or a specific workplace. On this basis, he automatically receives all information on the subject of health and safety at work, including standards and legal texts, publications and regular updates in the future.

ad b) The "Prevention ecosystem" provides the user with targeted and up-to-date information, assessment templates, dates for recurring inspections and storage space for their own documents. All information is distributed via different communication channels.

ad c) The "Prevention ecoSystem" is open to companies from the health and safety sector. Machinery manufacturers can deposit digital documents including declarations of conformity for their machinery on the platform. Selected service providers can integrate their services into the ecosystem. These can be: Personal Protective Equipment (PPE) certification bodies, service providers for various workplace measurements (e.g. dust and gas, noise, lighting), but also other OSH related topics such as research funding, books and journals, events, seminars, trade exhibitions.

ad d) It is important for all service providers integrated in "Prevention ecoSystem" to be in direct contact with users via the platform in order to

strengthen their profile in the sector and to be able to pass on new information directly to users at any time. Users have all the information they need stored in one place. All information is accessible at all times, comes from secure sources and is constantly updated. It is important for every prevention service provider to increase the level of information on occupational safety and health in all workplaces, to keep it constantly up to date and to make the information available securely and up-to-date through all communication channels.at work in all companies, to keep them constantly up to date and to make the information available via all communication channels.

OPERATING PRINCIPLE OF THE ECOSYSTEM

Figure 4 shows the basic components of the national "Prevention ecosystem", which also serves as a coordination point for other subsystems such as countries and sectors. Support monitors the system, integrates modules into the system, maintains the database, installs new languages, manages role permissions, updates frontend and backend, takes care of backup, etc.

It is planned to store the historical data separately and use it to train the AI. The aim is to use the AI to improve health and occupational safety at specific workplaces.

It is conceivable that the AI will also be used for chat bots, live chats, semantic analysis of reports from operational systems, etc.

Figure 5 shows a schematic overview of the main information flow from users, occupational safety and health component manufacturers and national hazard prevention institutes. The structure of ecoSystem will be modular, so that modules can be easily extended or new modules can be added. Modules can be technical in nature, but also assessment modules, etc. Support and data will all be entered in English. However, multiple languages will be available to users for communication.

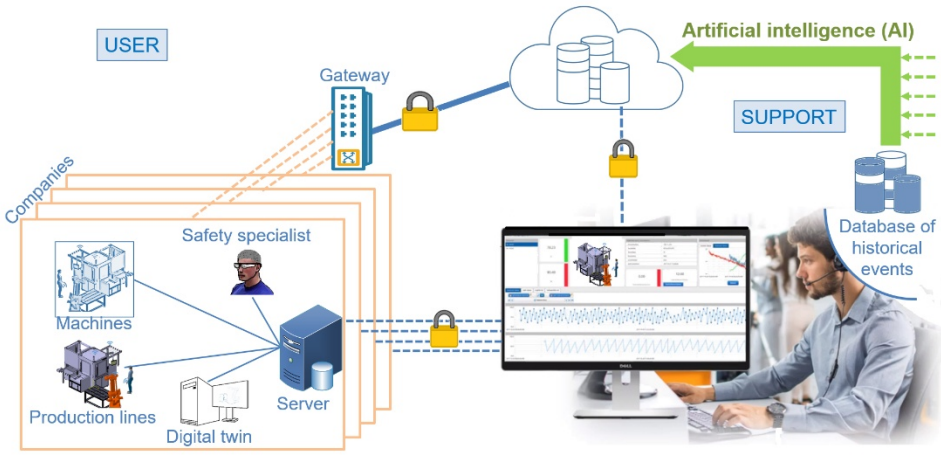

Figure 4: National "prevention ecosystem" for Austria and coordinating body for international subsystems (Malisa, Effenberger and Wittig, 2022).

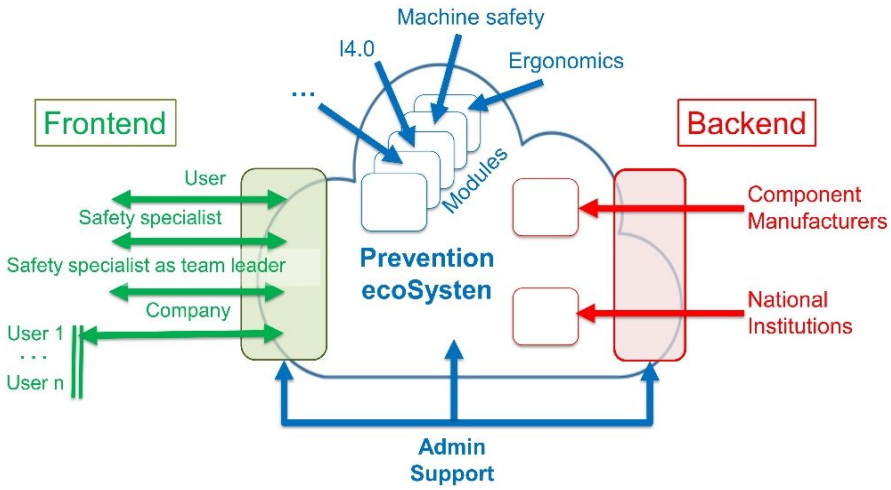

Figure 5: Schematic representation of the flow of information in/out of the ecosystem.

Cross-country prevention means rapid cross-border dissemination of information, so that in the event of accidents at a particular machine or workplace, prevention measures can be developed immediately and information can be passed on to all other users of the same type of machine.

It is also possible to compare country-specific differences at the same or similar workplaces in terms of standardisation or applicable laws, evaluate safety measures and make workplaces safer overall.

The prevention platform is designed to provide users with information through both traditional and all digital media channels. New information channels will also be developed, e.g. Presentation of prevention measures for a specific machine directly on the display or on a monitor at the workplace. For being able to address all sectors, company sizes and employees evenhandedly, the information should be prepared in a scalable way.

CONCLUSION

The integration of information technology in production companies is changing work equipment, processes and, at the same time, workplace safety. To ensure safety and health in the workplace, up-to-date information must be transmitted to workplaces in a preventive manner, e.g. via various information channels to the users of the prevention platform, an ecosystem. If an accident or near-accident occurs on a particular machine, users with the same type of machine are informed worldwide and the necessary preventive measures are communicated. Corporate safety professionals, employers, operators and other service providers have online access to the information they need via a "Prevention ecoSystem" platform built on ecosystem principles. Information is disseminated through multiple communication channels to quickly share publications and updates with registered users. This is especially important when it comes to cyberattacks and their impact on machines, production systems and workplaces.

In order for the prevention service to keep pace with changes in production, an expansion of the "Prevention ecoSystem" platform is underway. To this end, agreements are currently being drawn up with cooperation partners, various models are being tested and research projects are being defined. It is also being examined whether the latest results of artificial intelligence can be used for prevention and how they can be integrated into the ecosystem.

REFERENCES

Fraunhofer. (2022) "Digitale Ökosysteme und Plattformökonomie - Fraunhofer IESE", Fraunhofer-Institut für Experimentelles Software Engineering IESE". Webseite: https://www.iese.fraunhofer.de/de/leistungen/digitale-oekosysteme.html#Was-sind-Digitale-oekosysteme.

Leah. (2022) "Die 9 wichtigsten Kommunikationskanäle für Kunden – Vorteile und Nachteile", Userlike. Retrieved May 12, 2022, from https://www.userlike.com/de/blog/kommunikationskanaele 2022.

Malisa, Viktorijo. (2018) "Safety Relevance of New Technology", Forum News, N° 49 – 12. European Forum.

Malisa, Viktorijo. (2019) "Digitization of production: safety & security groups of new technologies for prevention", Conference NES 2019 - Nordic Ergonomics Society, Elsinore, Denmark.

Malisa, Viktorijo and Effenberger, Georg. (2022) "Prevention on the path of digitization", 11th international conference of WorkingOnSafety.net – Focus on Humans in a Technological World (WOS2022), Olhao, Portugal.

Malisa, Viktorijo. Effenberger, Georg and Wittig, Klaus. (2022) "AI-enabled Prevention ecoSystem". 7th European Conference, EUROSHNET, Paris, France.