FIRE **WISE**

Project duration: 01.01.2024-31.12.2025 **Project coordination**: Software Competence Center Hagenberg GmbH The project is financed under the Austrian Federal Ministry of Finance's programme KIRAS.

Knowledge management for fire brigades: Processing information for humans and machines

In an area where applying knowledge can make a difference of life and death and with many players involved, knowledge management is key. Firefighting is a prime example: Technical innovations in firefighting lead to additional resources and processes for hazard prevention, and to the increased use of machines. Consequently, it becomes increasingly demanding for firefighters to process available data from various resources (e.g., drones and robots) and select appropriate tactics in a short time and under pressure. In addition, large parts of relevant knowledge (e.g., operational experience) are personal, not systematically documented and are often only passed on informally. This knowledge is often not directly available in the field which can drastically reduce the performance of the emergency organizations.

Accordingly, systematic documentation and, based on this, efficient search and access options for relevant knowledge by humans and – more and more – also machines are indispensable.

Approaching a solution to Al-supported knowledge management

In the light of these challenges, the Austrian research project FireWISE seeks to develop a proof of function for a novel knowledge management system addressing the dynamics and complexity of knowledge in hazard prevention and representing it in human- and machine-readable form.

Concepts and technologies from the areas of data catalogs, machine learning and generative artificial intelligence (GenAI) are used for the automated categorization and integration of knowledge (organized by metadata). FireWISE uses AI for categorization and integration itself but can also serve as a source of information for other AI-based systems.

FireWISE is an assistance system that can be easily integrated in external systems, such as emergency management systems. To optimally map the content in a humanand machine-readable form, it is processed in a domain data model using semantic technologies.

Understanding user acceptance is key

Since the success of knowledge management systems largely depends on their pracitcal integration, the technology acceptance of firefighters is analyzed parallel to the technical implementation. Taking the example of selected reference technologies, an online survey collects data on the technology acceptance and acceptance factors of Austrian firefigthers.



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International examples

Current European UCP projects such as COLLARIS or COVALEX are dedicated to connecting experts and knowledge across borders. The Horizon Europe project CREXDATA deals with developing a generic platform for real-time critical situation management, flexible action planning and agile decision using extreme scale and complex data. These projects contribute to knowledge management in mitigating risks and fighting disasters on an international scale but do not go into the individual firefighter's needs.

On a national level, firefighting associations have their own approaches to knowledge management:

Austria: Traditionally, Austria relies on volunteers. There are currently about 300,000 volunteers serving in the Austrian fire brigades, providing day-to-day emergency assistance as well as disaster response if needed. To ensure consistent quality, information is shared on a knowledge management platform – currently a file sharing platform that allows access to different PDFs - in training and exercises. Missions are documented on different digital platforms (e.g., sybos, FDISK) to allow for learning from experiences of others.

Germany: Germany also relies on volunteers, with more than 1 million citizens currently volunteering. A formalized system of standardization and certification, elearning and digital mission documentation serve as the basis for knowledge management. Knowledge is transferred both inter-organisationally (e.g., with medical emergency services, police) but also intra-organisationally with knowledge exchange across federal state borders.

USA: In the USA, knowledge management is focused on technology with data analysis, GIS, and real-time communication and dedicated incident command systems (ICS). These ICS are also the basis for similar systems in other countries (e.g., Germany).

United Kingdom: With the National Operational Guidance Programme, the UK ensures that standardized knowledge is available for all fire brigades.

Japan: Especially in the light of the prevalence of earthquakes and tsunamis, Japan's fire brigades employ advanced systems for collecting and analysing data, supporting knowledge management on various levels of operation.



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Way forward

FireWISE is currently halfway through its project duration, and progress is promising (see below for some of the first results). The domain data model is finalized. The transition from a spreadsheet to a data catalogue with taxonomies, and ultimately to a knowledge graph and knowledge network illustrating connections and correlations, has been highly insightful. Additionally, a UI prototype based on technical requirements analysis has been developed, providing a foundation for further development and testing. Talking about testing: The above-mentioned survey among Austrian firefighters, has recently started and its results are highly anticipated.

Detailed insights are provided on the next pages which are an excerpt of the results from the first year of the FireWISE project.

Overall, an AI-based knowledge management system designed for both humans and machines contributes to the optimization of structures and deployment strategies in fire brigades. With the data and knowledge base prepared in this way, FireWISE creates the basis for a low-threshold and efficient transfer of knowledge, a successful and effective use of firefighting technology and the assessment of the cost-benefit ratio when purchasing cost-intensive resources.

Are you interested in discussing this topic? The FireWISE team would love to exchange ideas and experiences.

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Project partners





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FireWISE mid-term results

Domain data model and data catalog

Due to the ongoing changes in fire service knowledge, the **domain data model** is designed in such a way that both the content and the structure are **adaptable**. The current milestone therefore only shows a snapshot of the constantly evolving model.

Data sources have been collected based on the knowledge of the project employees and desktop interviews with experts from the LOI partners (Austrian Fire Brigade Association, Federal State Fire Brigade Associations) and forest fire experts from volunteer and professional fire departments nationally and internationally. Textual sources were searched for additional data sources using a snowball system. After removing duplicates, **83 relevant data sources** were identified and entered into the data catalog in parallel per manual entry.

In addition to the **taxonomic recording** of data soures in the data catalog,, terminologies and organizational processes emerged as important modelling elements. The use of the terminologies supports human communication among vegetation fire experts, but also developers and researchers, e.g. within the FireWISE project team.

Using the example of the **wildfire use case**, specific requirements, people involved and stored processes were played through in order to create the basis for the development of the knowledge management system. The "simple tactical forest fire forecast" and "water supply management" were specified as consistent example processes for the project. The tasks (roles) and the associated processes in the context of vegetation firefighting were played through for the people.

The detailed process analysis for the wildfire use case revealed the integral importance of the **management processes** and their **inherent networking** with the external fire service stakeholders (roles) that are important for forest fires.

Technical implementation knowledge management system

Based on five personas that define the target groups of FireWISE and two scenarios, the range of functions was defined in the form of **27 specific requirements**.



The planned system architecture of FireWISE, which is also described during requirement analysis, consists of three components:

1. FireWISE Core: This part provides FireWISE's key functionality, which includes storing and indexing of various data sources, extracting metadata, managing the domain data model, and answering user queries. The FireWISE core is built based upon various technologies including database systems, data catalogs, large language models (LLMs), and LLM orchestration frameworks.

2. FireWISE API: To facilitate the usage of FireWISE, the core functionality is accessible via RestAPI for third-party systems. For example, to integrate the system into an existing emergency management system.

3. FireWISE Dashboard: The aim of the dashboard (see screenshot below) is to simplify the usage of FireWISE for firefighters. Leveraging the FireWISE API, the dashboard gives access to FireWISE's functionality based on an intuitive user interface. Key aspects include references to relevant data sources, a graphical visualization of the technical data model, and an interactive chatbot.

Datenquellen	Fachdatenmodell	Chat Box	
GeoSphere Fachempfehlung	Ressourcen Szenario Ort		Enter
	Ergebnisse		Zeit
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Figure 1: Screenshot of FireWISE dashboard.

In parallel to the requirements analysis, a **survey and analysis of existing data catalogs** was carried out. The aim of the evaluation was to identify a data catalog system based on the identified requirements that can be used by subject matter experts in a simple and efficient manner as part of the FireWISE knowledge management system.

As part of a pre-selection, six systems were considered. **OpenMetadata** showed the greatest overlap with the required requirements and was selected as the data catalog for the current prototype.

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Nevertheless, OpenMetadata only covers a small part of the functionality required for the FireWISE knowledge management system (for example, the use of unstructured data is not supported), which is why the FireWISE architecture concept to be developed places particular focus on providing the missing functionality.

Based on the domain data model and the technical requirements, the development of a concept for implementing a knowledge management system for wildfires was started. The concept includes a number of technical approaches that are used to solve the specific problems derived from the requirements:

- 1. The developed domain data model is transformed into a **knowledge graph** and thus represents the structured knowledge of the experts.
- 2.An integration of knowledge from the doctrine, internal documents, technical literature and other unstructured data is not feasible by hand due to the high effort and ongoing expansion. Therefore, FireWISE follows the **AI-based approach** of using large language models to automatically extract relevant concepts and entities and their relationships and make them available for the technical data model.
- 3. The resulting extended domain data model is used together with the extracted technical metadata of the data sources to categorize and integrate the available data sources according to the current questions. In order to enable interaction with the FireWISE knowledge management system to be as simple as possible, questions should be able to be asked in natural language form, i.e. similar to a **chatbot**.

The **functional proof** of the FireWISE knowledge management system has already started. The focus here is on the prototypical implementation of several aspects of the system in order to verify technical feasibility.

Social Science Technology Acceptance Analysis

After a review of the state of the art research on various **technology acceptance models**, the quantitative survey was planned. The consortium selected reference technologies for the survey for the purpose of identifying general and specific acceptance factors. UAVs, UGVs and digital emergency management systems were selected.

Building on the identified technology acceptance models, technology acceptance factors were operationalized and the **online questionnaire** was designed. After pretesting, the online questionnaire was distributed.. Collecting responses is still ongoing.

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Would you like to learn more or stay up to date? Reach out to the FireWISE team.

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