Introducing WALKER – Safeguarding Cultural Heritage through Evacuation Run Maps

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ABSTRACT

The crisis management cycle contains the step *Preparedness*, in which the development of disaster plans takes place. Run plans for fire fighters are a well-established means for enhancing preparedness in public buildings. A wide array of plans is available, serving to aid firefighters in swiftly orienting themselves during emergency situations on-site. These plans may also include detailed information as needed, providing tactical insights into critical elements within the building. In this practitioner paper, we present the adaptation of run plans to the realm of cultural heritage preservation. We utilize the existing format for the communication of information about the safe handling of cultural heritage to the command staff and the fire fighters. These *cultural heritage escape plans* offer guidance on the safe handling, evacuation procedures, and the prioritization of cultural heritage items in the case of an emergency and can be added to the existing tactical firefighting plans in public cultural heritage institutions. The evacuation plan format has been developed by the Munich County Fire Fighters and was manually implemented for all cultural heritage objects of the Bavarian Palace Department. The format has proven beneficial. With this format, we aim to enhance the preparedness of cultural heritage sites against natural disasters. Given the inherent sensitivity of cultural heritage objects, which require careful handling, these escape plans encompass instructions for the secure dismantling and evacuation of these items to designated safe areas. Furthermore, we introduce the software WALKER, a specialized tool designed for the creation of evacuation plans tailored to cultural heritage contexts. WALKER has been deployed for test usage for cultural heritage institutions for testing and evaluation of its potential. Both evacuation maps and WALKER are part of an integrated crisis management for cultural heritage and can be classified as part of the *Preparedness* step in the crisis management cycle. Furthermore, when the plans are implemented during the response, they can also be considered part of the phase *Response.*

Keywords

Evacuation Run Maps, Cultural Heritage, Software for Cultural Heritage Protection.

INTRODUCTION

Museums and historical buildings can be hit by natural disasters, just as any other building. Yet, in various workshops of the KERES project it was found, that museums and heritage preservation authorities often fail to prepare against potential natural hazards. Research in Bavaria showed 38% of cultural heritage is in natural hazardous zones and more than 400 cultural heritage objects are endangered by more than one natural hazard. All in all 136 cultural heritages in Bavaria alone were struck by natural disasters (Japelj et al. 2019). A meta study conducted by the STORM project found that a general risk strategy for cultural heritage against natural hazards in European countries is still far from reality (STORM 2018). A low-threshold measure for the establishment of a more resilient cultural heritage landscape is the creation of evacuation run maps for firefighters: evacuation maps represent an appropriate tool to enhance the safeguarding of museums and cultural heritage against threats and are a crucial component of an effective protection plan. In this paper we present the creation of run maps for the evacuation of cultural heritage objects from buildings as well as a software to manage and create this evacuation run maps. The run maps can be addended to fire brigade operation plans and form the basis of an appropriate and efficient evacuation in the case of an emergency.

TACTICAL FIREFIGHTING PLANS

The approach of emergency responders is largely standardized when there are no indications necessitating special protective measures. If firefighting needs to be conducted differently than the trained standard procedures, this information must be conveyed to the firefighters. If they lack essential information about the incident or location, their response may be less effective. Therefore, effective communication and preparation of information play a paramount role. This information must be conveyed in a standardized manner and can complement standardized firefighting procedures.

In emergency situations, it is crucial for first responders to possess a comprehensive understanding of their surroundings. The primary means of conveying vital information to firefighters is through tactical firefighting plans. These plans are customized for specific sites and serve as a communication tool between building owners and the responding firefighting teams. Typically, a firefighting plan encompasses a general overview of the building and on-site infrastructure details, including hazardous areas and water sources for firefighting. Furthermore, it incorporates tactical information, such as the requisite extinguishing agents, with the flexibility to add supplementary details as needed.

In Europe, various standards exist that delineate and specify maps for firefighters. The German standard is documented in DIN ISO 23601, which outlines the common requirements for such plans (DIN 2020). This standard is established to create a foundation in Germany and is, when necessary, elaborated upon by the regional forces. The German standard DIN 14095 delineates operation plans for firefighting and other measures on specific sites and contains information about hazards, specific characteristics and risks (DIN 2022). If additional tactical information is given, the plan is called tactical firefighting plan. The plan contains necessary information for the head of operations, such as building information, site plans or story plans or so-called *special plans*. These special plans are predestinated to hold specific information for the evacuation of cultural heritage.

Particularly in the case of water-sensitive cultural heritage items, appropriate information about the extinguishing agent are essential. The necessary containment of fire and smoke may, in some cases, not allow for the omission of water suppression. However, in these cases targeted protective measures, such as the usage of fire blankets for the covering of cultural heritage items or their evacuation, before water usage, can be initiated. The timely and targeted evacuation of cultural heritage items holds particular significance. Depending on the urgency, required personnel, and potentially necessary protective gear, evacuation measures will mostly be achievable only by firefighting personnel. However, this process cannot succeed without the support and cooperation of the facility operator: cultural heritage might be secured by protective measures, about which the firefighters need to be informed. For the purpose of planning the systematic evacuation of art and cultural assets, an initial categorization of the artworks is necessary. In this regard, the facility operator determines the order in which the cultural heritage is to be removed from the danger zone. The operator must consider the art-historical significance and the intrinsic value of the art objects. As measure to foster preparedness, the creation of tactical firefighting plans is part of emergency management for cultural heritage and can be placed in the crisis management cycle. The cycle itself discussed in the community and several definitions exist (Moßgraber 2012), yet a common definition is the subdivision into the four parts *Preparedness, Response, Recovery, Mitigation* (FEMA 2022).

Evacuation Maps for Cultural Heritage Objects

The information named in the previous chapter must be provided to the firefighters in a standardized way, so it conveys information in the right format. To address the demand for evacuation plans for cultural heritage, the Munich County Fire Department has devised a route card format, serving as an interface between firefighters and cultural heritage managers. These maps enable managers to apprise firefighters of the specifics pertaining their cultural heritage objects, thus assisting in the prevention of collateral damages. The responsibility for creating run maps is held by the managers of cultural heritage; after creating the maps these can be added to the tactical firefighting plan, as described in the previous chapter. Especially in the context of hazards due to climate change to cultural heritage, the creation of evacuation maps fosters preparedness and prevents cultural heritage loss (Kotova et al. 2023).

The Bavarian Palace Department (Bayerische Schlösserverwaltung, BSV) is a public institution entrusted with the management and preservation of cultural heritage in Bavaria, which encompasses palaces, castles, and parks. This heritage encompasses both mobile and immobile cultural items, such as historical timepieces and Neuschwanstein Castle, which houses mobile cultural heritage items. To bolster preparedness for emergencies and safeguard mobile cultural heritage, the BSV has developed evacuation maps specifically tailored to their cultural heritage objects.

WALKER – A Novel Tool for The Creation Of Run Maps

Fraunhofer IOSB developed the concepts for WALKER during the KERES project, with a primary focus on safeguarding cultural heritage against the impacts of climate change. During the project a demonstrator for WALKER has been developed. The target users for this software are cultural heritage managers trying to foster their preparedness against potential disasters endangering their cultural heritage objects. WALKER allows the creation of run maps in the format devised by the Munich County Fire Department. It simplifies the creation and updating of run maps and includes a library of predefined icons commonly used by fire departments. This ensures that the generated evacuation maps adhere to recognized standards, making them practical for real-life applications. Furthermore, WALKER offers the evaluation of stored data, to allow the quick retrieval cultural heritage objects fitting a specific criterion, such as priority or the number of personal required for the transport.

WALKER has been developed in the context of the KERES project, which was accompanied by an expert panel. Members of the panel were cultural heritage institutions, as well as authorities and organizations with civil security tasks, such as fire fighters or the federal technical aid organizations. WALKER was developed together with the expert panel, who reviewed the application and requested or suggested new features. As the development took place during the COVID19 pandemic, the feedback sessions were held online in which the application was demonstrated. For interested users a testing environment was setup, which they could access for testing purposes. Suggestions and functions were defined in use cases, from which the most promising were chosen to be integrated into the prototype application. The development process followed the waterfall project management paradigm in four phases. Together with the experts a specification document for the software was developed. The specifications were solved with a draft, that offered (to that point hypothetical) functions, which were mapped to the requirements from the first phase. The third phase comprised the implementation of the developed functions. Quality assurance formed the last phase, in which software and end users tests were conducted.

The application allows the creation of evacuation maps through forms. Figure 1 shows the view used to create and update the evacuation maps. Information, such as position, priority or inventory numbers can be entered; images can be uploaded additionally.

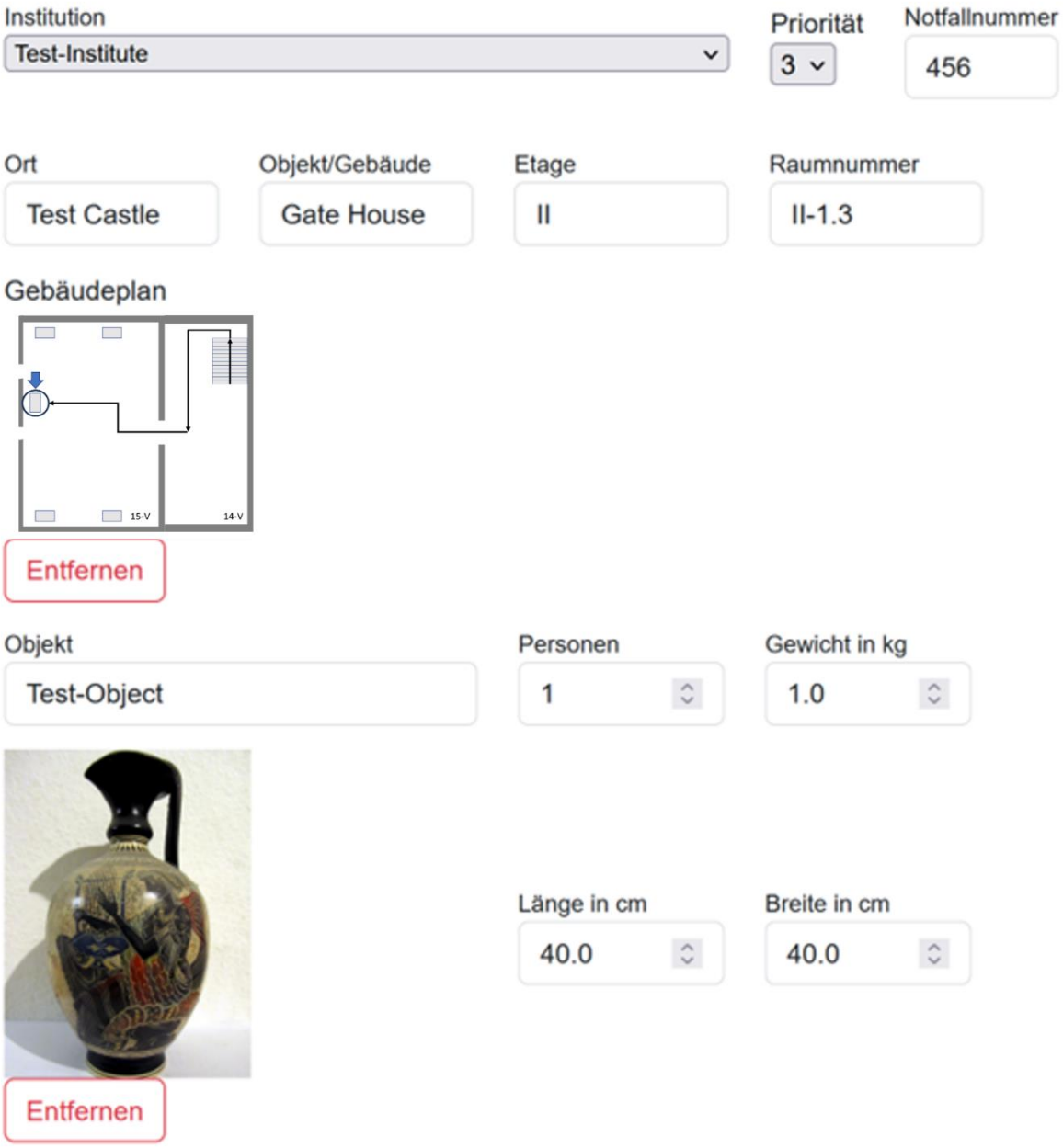

Figure 1. An excerpt from the WALKER form for data input

After entering the data, users can trigger the generation of the corresponding PDF-files which are offered as download. A created evacuation map is shown in Figure 2. It shows a hypothetical cultural heritage object managed by an institute called Test-Institute. The map was created on 09/08/2023 by a user called Walker. It has the priority level 3. The position of the object is shown in the map with an arrow; an image is shown as well. The object weighs one kilogram and measures 40 x 40 x 70 cm. A single person is required to transport the object. An image (broken vase) signalizes the object needs to be handled with care. This route card could be added to the tactical firefighting plan, thus supplementing the existing information for the firefighters.

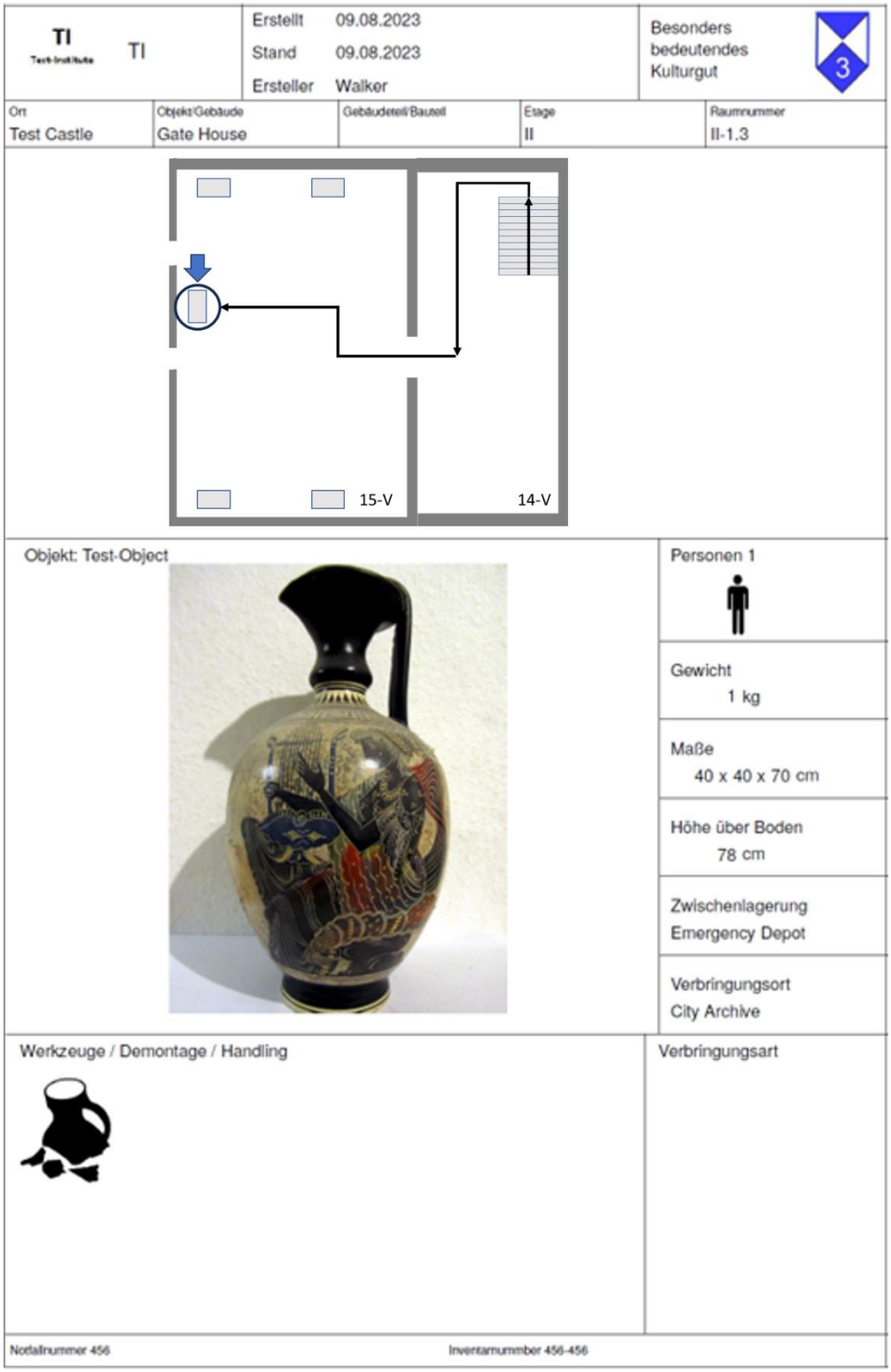

Figure 2. The WALKER generated route card

In the workshops, further beneficial features were pointed, such as the ability to filter evacuation maps by priority level and the required resources for its evacuation to be able to prioritize the evacuation of objects in case of an emergency. Yet, features like these face the contrary demand of availability of these maps in a printed form by authorities and organizations with civil security tasks. This aspect could be overcome by utilizing WALKER in the crisis operations center as application: the head of operations could, for example, request route maps with the highest priority or query objects that need only the firefighter personal he has available.

WALKER – ARCHITECTURE

WALKER is a web application built on Java 17. It is built on a backend developed on the Spring Boot framework and a front-end implemented as a Vue 3 single-page application, with Bootstrap used for layout purposes. Communication between the front-end and backend takes place through an HTTP programming interface. Structured data in WALKER is stored in a PostgreSQL database, although it can potentially work with any SQL-based database. Unstructured data, such as images, is stored within the file system. The file hierarchy is designed in a way that files from different institutions are stored in different locations if the file system. The database maintains records of file locations to ensure the unique identification of all necessary objects. Creating or updating data in WALKER can be accomplished in two ways: Users have the option to input all the necessary data for creating a route card through web forms. These forms also facilitate data updates, so the user uses the same forms for creating and updating data. The backend offers a REST-API, allowing for the (semi-)automatic creation of maps by uploading datasets. REST outlines principles for services without specifying implementation details. The first principle is the Client-Server Architecture, as seen in the World-Wide-Web, where a server provides a service that clients can request. Utilizing the widely adopted HTTP protocol (Internet Engineering Task Force 1999), REST client implementations are accessible across various programming languages. The second key characteristic is statelessness, requiring every message sent to a REST service to include all necessary information for processing. The common HTTP-methods are used to interact with the interface, whereas GET is used to retrieve entities, POST creates new entities, PUT and PATCH update entities and DELETE finally deletes entities (Roy Thomas Fielding 2000). WALKER employs LaTeX for map generation, which is triggered through the Java backend. The maps are made available as Portable Document Format files (PDF). Parameters, including required images and textual information, are stored in a configuration file. This file is then passed to as command line parameter to LaTeX, which, in turn, generates the map in PDF format. Passing the file as parameter should prevent command line injections. Assessment for potential publication on well-known open-source repository management platforms, such as GitHub, is ongoing.

EVALUATION

For further usability testing, WALKER has been deployed for BSV, as well as for Leibniz-Institut für Biodiversitätsforschung and will be deployed for Staatliche Schlösser und Gärten Baden-Württemberg. For deeper insights, we aim to evaluate both the practicability of WALKER and the user experience. An important aspect is the alignment of requirements due to different standardized operations in the federal states in Germany: differences in law and operations might have an influence on the usage of WALKER and its integration into the common workflows of a cultural heritage institution. WALKER has generated curiosity in the cultural heritage community, as it offers a low-threshold solution for the creation of evacuation maps and to enhance the preparedness of cultural heritage institutions. All test-users assess the software regarding its applicability, most importantly the question is, whether WALKER can provide benefit in a real-world context. For this, WALKER needs to undergo usability tests and most importantly expert reviews, with experts from the firefighting domain, as well as cultural heritage managers to find potential shortcomings. The created route cards could also be assessed through simulations and expert reviews, but as they are designed by fire fighters, their usability should be promising. In a dedicated upcoming project, we envisage to continue test and develop WALKER. The run maps have been evaluated during a test with fire fighters at Castle Schleißheim: before the drill, the handling and evacuation for all 400 objects within the castle have been documented with run maps in the described format (Bachhuber 2017). Feedback had been implemented in the route card format, which again was incorporated into the WALKER software.

CONCLUSION

In this paper we presented the transferal of run maps to the domain of cultural heritage for the evacuation of cultural heritage objects in the case of an emergency. By utilizing a well-known format of maps, we lower the acceptance threshold and foster practicability and the ability to integrate these maps into the common operational procedures. The format was developed by the Munich County Fire Fighters and was made publicly available for fire fighters and the managers of cultural heritage. The format has been adopted by the Bavarian Palace Department, who manually created evacuation maps for all relevant objects in their collections and assets. The maps have been tested in an evacuation drill with 400 objects in Castle Schleißheim. In the run of the KERES project, Fraunhofer IOSB developed a prototype software for the software-supported creation of maps in the named format. The software was deployed for several expert users. Further development and testing is envisaged in an upcoming project. The tests should evaluate the software and its application itself, but also its integration into the security framework of the using institutions.

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