

Article

Qualitative Fire Vulnerability Assessments for Museums and Their Collections: A Case Study from Kosovo

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Abstract: Fires are among the most frequently recurring hazards affecting museums and cultural heritage sites. The fires of the National Museum of Brazil in 2018 and of Notre Dame de Paris in 2019 showed that the consequences of such events can be heavy and lead to irreversible heritage losses. In Kosovo, few studies were made about the risks that can affect cultural heritage sites. A project led by the NGO Kosovo Foundation for Cultural Heritage without Borders (CHwB Kosova) in 2018 explored the most prevalent risks for the cultural heritage sites of the country and highlighted fire as a predominant risk in Kosovo. In order to better understand it, vulnerability assessments were conducted in several museums in Kosovo. Data were collected through field visits in the different museums, in which interviews with staff members as well as observations were conducted. The aim of this paper is to present the main results of the fire vulnerability assessments conducted in Kosovo's museums in 2018. An important aspect of this project is the approach to collect information in data-scarce environments. It is believed that the questionnaires used to lead interviews with museums' staff members could help other practitioners to collect data in such contexts and evaluate more easily the risk of fire for the museums and their collections. In the context of Kosovo, one of the main findings is the identification and prioritisation of measures to ensure better protection of Kosovar museums. Structural mitigation measures such as alarm and fire suppression systems are not the only elements necessary to improve the resilience of Kosovar museums to fire. Indeed, the promotion of risk awareness, the training of staff members and the realisation of crisis simulation exercises are just as important in order to prevent and detect a fire, and above all, to respond quickly and accurately if a fire occurs.

Keywords: risk mitigation; fire risk; heritage protection; vulnerability; resilience; museums; Kosovo



Citation: Fafet, C.; Mulolli Zajmi, E. Qualitative Fire Vulnerability Assessments for Museums and Their Collections: A Case Study from Kosovo. *Fire* **2021**, *4*, 11. <https://doi.org/10.3390/fire4010011>

Received: 13 February 2021

Accepted: 5 March 2021

Published: 10 March 2021

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1. Introduction

On 2 September 2018, a fire that lasted more than five hours destroyed almost 90% of the collections in the National Museum of Brazil. The damages were huge: the last remaining audio records of some languages that are no longer spoken were lost among other priceless artefacts. According to the New York Times, the museum was not equipped with a fire suppression system and it contained a lot of inflammable materials [1].

The National Museum of Brazil is not an isolated case: even though neither uniform European nor International fire statistics exist, a lot of cultural institutions are particularly prone to fire risk [2–4]. For instance, 180 fires in historic buildings were reported in Czech Republic between 1992 and 2001, and among the 193 fires that took place in heritage places of United Kingdom in 2020, 29 led to the total destruction of the building [5,6].

Kosovo is a landlocked and partially-recognised State situated in the centre of the Balkans, which declared unilaterally its independence from Serbia on the 17 February 2008. The 2011 Kosovo Law on Fire Protection provides “*protective mechanisms to prevent the causes and spread of fire*” and stipulates, for instance, that public buildings should have fire prevention plans as well as conditions for the “*unimpeded evacuation of people in case*”

of outbreak of fire by building evacuation stairs as well with related equipment for alarm and firefighting" [7]. However, fires remain a key concern as building regulations are often violated and a great number of buildings in Prishtina and in other cities are built too close to each other. It accentuates the risk of fire propagation and impedes fire services from easily accessing some buildings. Added to that, access is often hindered by obstructive parking and narrow entrances, and buildings lack basic fire equipment such as hydrants, ladders, and fire extinguishing equipment [8].

In 2018, a project led by the Kosovo Foundation for Cultural Heritage without Borders (CHwB Kosova) explored the most prevailing risks for the cultural heritage sites of Kosovo and highlighted fire as a predominant risk for the museums [9]. In order to better understand this risk, assessments with a focus on vulnerability were conducted in 13 museums of Kosovo. While operational fire risk assessment tools for heritage sites have not yet been developed so far in the academic literature, this work was conducted in concert with recent considerations in the Disaster Risk Reduction field, such as an evolution *"from a culture of merely responding to natural disasters to a more comprehensive framework with ex ante planning, actions, and investments"* [10].

The aim of this paper is to present the main results of the fire vulnerability assessments conducted in Kosovo's museums in 2018. Therefore, the objective is twofold:

- Establish a method to collect information in data-scarce contexts regarding fire vulnerability aspects for museums and their collections
- Identify and prioritise fire safety measures that ensure a better protection of Kosovar museums.

2. Conceptual Framework

The following subsections briefly discuss the relevant concepts that underpin this research, that being: "museum" and "risk, vulnerability and resilience".

2.1. Museum

Museums are subject to a myriad of definitions. One of the first modern museologists, George Brown Goode, defined a museum in 1896 as *"an institution for the preservation of those objects which best illustrate the phenomena of nature and the works of man, and the utilization of these for the increase of knowledge and for the culture and enlightenment of the people"* [11]. This definition is similar to the one given by Britannica Encyclopaedia (Museum is defined in Britannica Encyclopaedia as *"an institution dedicated to preserving and interpreting the primary tangible evidence of humankind and the environment"*) and highlights key characteristics of museums: the presence of collections with objects having outstanding cultural values, the realisation of preservation work and the production of knowledge around those objects [12]. For Dillenburger, the core of a museum is its exhibition, where objects or information are not only displayed, but embedded [13].

The concept of a museum is not static and has been constantly evolving [14]. It is notably demonstrated by the multiple changes in the definition given by the International Council of Museums (ICOM), which works toward a shared definition among museum professionals [14–16]. While a first definition in 1946 was primarily focused on the collections being the key criteria of museums, ICOM aimed at finding a more inclusive definition, which *"recognises the dissimilar conditions and practices of museums in diverse and rapidly changing societies, and supports museums in developing and adopting new scientific paradigms and addressing more adequately the complexities of the 21st century"* [15]. In the 2001 Cultural Heritage Law in Kosovo, the 1974 definition given by ICOM is stipulated: *"a museum is non-profit making, permanent institution in the service of the society and its development, and open to the public, which acquires, conserves, researches, communicates, and exhibits, for purposes of study, education and enjoyment, material evidence of man and his environment"* [17].

As those multiple definitions presuppose, there is a great diversity of museums' forms, contents, functions, and purposes. Museums are often classified by types of collections ranging from general museums to natural science, science and technology, art, history,

and even virtual museums [12,13,18]. Pavoni also distinguished house museums, whose characteristic is the indissoluble and complementary link between the building and its collections [19]. Gurian offers another classification by creating five categories of museums: *object-centred*, focusing on collections and the exhibition of objects with a great cultural value; *narrative centred*, specialised in contextualisation, and giving explanations through stories; *client-centred* putting their audience as a priority by granting importance to “*promoting learning among their targeted visitors*”; *community-centred*, often arising “*from a community’s desire for self-expression*” [20] by displaying for instance work crafts or information known only through the elders; and finally, *the national museums* created by a nation to offer a “*representation of nationhood*” and often proponents of tourism [16]. According to him, a museum can fall into one, several, or all of those categories [16].

This diversity in what the notion “museum” encompasses is reflected as well in Kosovo, and this aspect was thus taken into consideration when selecting the museums for this study. Indeed, the assessed museums range from the National Museum of Kosovo to museums assimilated to community-based museums. Moreover, general, archaeological, ethnographic, historic as well as science-related museums were selected in this research.

2.2. Risk, Vulnerability, and Resilience

Risk is commonly defined as the likelihood of a hazard multiplied by its consequences [21–25]. A lot of methodologies including ISO 31010 Guidelines exist in order to assess risks, although only few of them focus specifically on heritage sites [25–28]. Risk assessments can be conducted by adopting either a quantitative approach or a qualitative approach. Even though qualitative approaches have often been described as rather less objective than quantitative assessments, they present a real advantage in a data-scarce context [21,29,30].

Some researchers insist on the vulnerability dimension of risks [21,24,31]. Vulnerability is defined by Coppola as “*a measure of the propensity to incur the consequences of a hazard*” [21]. While exposure only takes into consideration the potential experience of a hazard, vulnerability includes physical, social, economic, and environmental factors that can influence the likelihood and consequences of a hazard [21,31]. Thus, it incorporates the uncertainties as well as the complexities inherent to our world, including its dynamic nature [31–33]. Assessing vulnerability is rather complex due to its multiple facets that are often interconnected. Nonetheless, reducing vulnerability inherently increases resilience, defined by Holling in 1973 as “*the ability of systems to absorb changes of state variables and parameters, and still persist*”, and more recently by The United Nation Office for Disaster Risk Reduction as “*the ability of a system, a community or a society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner including through the perseverance and restoration of its essential basic structures and functions*” [34,35].

In this study, vulnerability was understood as the possibility of being damaged by fire following the aforementioned definitions. Nonetheless, exposition to fire, factors contributing to the likelihood and consequences of fire, but also lack of mitigation and risk reduction measures, were incorporated into vulnerability assessments.

3. Methods

3.1. Desk Review

In order to meet the first objective of this study, which is to establish a methodology to assess fire vulnerability of museums in data scarce contexts, a thorough desk review was conducted in order to build on relevant contributions from the existing body of literature, as well as to identify the theoretical foundation for the research and the best practices to increase the resilience of museums to fire. The matter has not yet been thoroughly delved into by the scientific community. Only Tétreault assessed fire risk specifically for collections in the Museums [36]. Nevertheless, several studies deal with either general fire risk and vulnerability aspects, or with issues regarding museums’ vulnerability to risks. Both were

considered in this desk review, along with reports made by organisations working on museum conservation, heritage protection, and fire safety.

A fire assessment guideline was created based on the results of the desk review. It gathered a range of questions about the most important aspects contributing to either the resilience or the vulnerability to fire. This guideline was used during the field visits to assess the current situation in an exhaustive and comprehensive manner.

3.2. Field Visits: Face to Face Interviews and Observations

In order to assess the vulnerability of Kosovo museums, field visits were organised in 13 museums across Kosovo (These museums were chosen to conduct the field visits because of time limitation, and as staff members answered to our request) (Figure 1). All museums are owned either by the state or by the municipality, apart from the Museum of the Querkezi Family, which is owned by Ferdonije Querkezi who is the founder as well as the caretaker of this museum, which she created in her own house. The Ethnographic Museum of Prishtina was unfortunately not taken into account in this study due to its closure for renovation works.

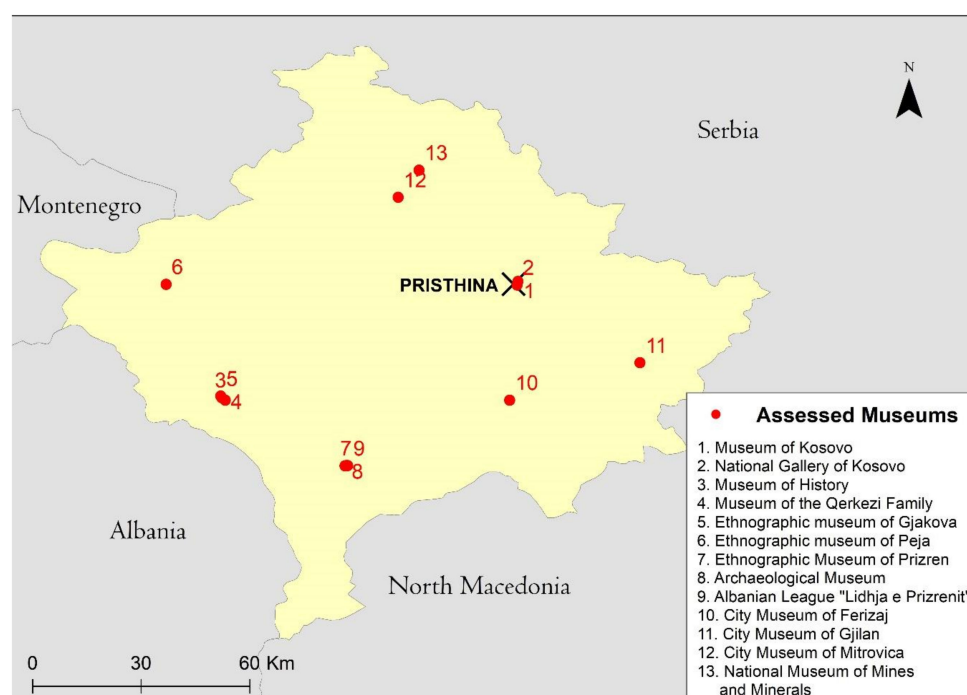


Figure 1. Map of the Assessed Museums in Kosovo.

During these field visits, observations, as well as 13 face-to-face interviews, were conducted with staff members of the museums. The museums counted between 0 and 33 dedicated staff members (Table 1). In the case of the City Museum of Gjilan, where there is no dedicated staff member, a city officer was interviewed instead since the museum is situated in the city hall. Due to the small number of staff members in most of the assessed museums, interviewees did not have particular positions in the museum. Instead, they had interchangeable roles that encompass various tasks and missions.

The questionnaire that resulted from the desk review was used to orient the observations as well as the interviews. Interviews allowed some flexibility to collect unforeseen data and to address further information or themes that seemed relevant to the interviewee. It also allowed the researchers to verify whether the questions were correctly understood by the stakeholders. All field visits were conducted in October and November 2018. Thus, this study reflects the state of the museums at this date.

Table 1. Number of staff members in the assessed museums.

Assessed Museums	Number of Staff Members
National Museum	33
National Gallery	12
Ethnographic Museum of Gjakova	3
Historic Museum (Gjakova)	1
Ethnographic Museum of Peja	6
Archeological Museum (Prizren)	2
Ethnographic Museum of Prizren	7
Albanian League	10
City Museum of Ferizaj	1
City Museum of Gjilan	0
City Museum of Mitrovica	11
National Museum of Mines and Minerals	8

One limitation of the method is that the questions were often asked to only one or two staff members in the different museums, because of time limitation and/or lack of availability. Therefore, the answers can sometimes reflect the interviewee's own knowledge, his/her point of view or opinion. Indeed, the interviewees might have been unaware of some of the museum's fire protection measures, or their answers might follow some risk perception biases (Risk perception biases include for instance psychological and cognitive biases, such as available heuristics (Tendency to get stuck to what happened recently, of seeing the future as an extrapolation of the present), positive illusions (Underestimating our likelihood of being affected by a risk), risk ambiguity aversion (tendency to overestimate unknown risks) and familiarity principle (Being used to something and so not being careful anymore about it) [21,37,38]) they may have. Moreover, common limitations of interviews include the potential lack of motivation or availability of the respondents [39] and the fact that interviewees often try to show a better image of themselves and are thus inclined towards deliberately omitting some information [40]. Those common limitations did not seem to impede the research as interviewees were collaborative and seemed interested and motivated to answer the questions and saw a clear interest in contributing with honesty in the study given their desire to protect the museums and their collections. Finally, another limitation concerns the difficulty to analyse qualitative data as researchers are prone to biased interpretations of data [41]. To counter that, the findings for each museum were still discussed between the two researchers.

3.3. Data Analysis: Qualitative Approach

A qualitative approach was adopted to analyse the data collected through interviews and observations. Qualitative research allowed us to better understand and explain the context of vulnerabilities, which can often be overlooked by quantitative methods. Moreover, this approach was preferable considering the lack of available quantitative data on the subject for Kosovo. One drawback of choosing a qualitative approach is that it provides fewer points of reference for readers and it offers a rather subjective comparison of the museums' level of vulnerability [42].

To identify critical vulnerabilities, a ranking approach was used using a verbal description of the vulnerability. For each museum, several categories of vulnerability were identified based on the questionnaire presented in Appendix A. For each of these categories, the vulnerability of each museum was assessed as "low", "medium", or "high" following the analysis and the counterbalance of several criteria, specific to each category of vulnerability. In order to further reflect on uncertainties due to a lack of evidence or

available information, “in between categories” were created, named “low to medium” and “medium to high” (Figure 2).

Low	Low to Medium	Medium	Medium to High	High
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Figure 2. Vulnerability ranking.

4. Results

Results are divided into two subsections, which were derived from the desk review and from the analysis of the field visits’ observations and key informant interviews. First, the best practices and recommendations for fire resilience of museums are outlined in order to establish a method of collecting information in data-scarce contexts regarding fire vulnerability aspects for the museums and their collections. The resulting questionnaire is then shortly introduced. The second subsection focuses on the fire assessment results and identifies some fire safety measures that ensure better protection of Kosovar museums.

4.1. Desk Review Results: Best Practices and Recommendations for Fire Resilience of Museums and Their Collections

The results of the desk review were used to build an appropriate questionnaire that supported the fire risk assessment in the museums of Kosovo. The following subsections introduce the findings regarding the best practices and recommendations for fire resilience of museums, as well as a quick description of the different sections of the resulting questionnaire.

4.1.1. Sources of Fires and Consequences in the Context of Museums

Identifying the potential sources of fire in a building is primordial in order to implement suitable measures to counter it. Main causes of fire include [2,3,10,36,43–46]:

- Presence of ignition source such as candles or waste on the ground inside and around the property;
- Unsafe uses and practices, such as an absence of fire-safe practices, non-banned smoking, and unsafe renovation involving hot work;
- Poor maintenance of fire suppression equipment and neglect of installations;
- Building system incidents such as electric fault and malfunction of heating system;
- Severe weather events such as lightning strikes;
- Malicious acts including arson and vandalism. According to Tetreault and UN-ESCO [36,43] the risk of arson may be higher in the case of controversial exhibition or collection, or immediately before, during and after an armed conflict, which is the case of Kosovo. In the context of Kosovo, acts of vandalism are a main concern even though almost only religious sites have been targeted by theft of money and valuable materials, and rarely by arson [45,46]. However, it cannot be excluded that museums are targeted too given the regional geopolitical context.

Potential sources of fire need to be assessed considering different levels of enclosure, such as the support and the fitting of the collection, the different rooms but also site and region, in order to consider all potential dangers [43]. Indeed, external sources of risks can also affect a museum and its collection. Urbanisation, development pressure, socio-economic transformations and unsustainable tourism have been identified as the main factors threatening cultural heritage sites by Jigyasu, et al. [4]. In the context of fire risk, increased urban density surges the probability of fires as well as the exposure of heritage sites to fire [10,47]. This is notably the case in Kosovo, where an uncontrolled construction boom occurred at the end of the conflict in 1999. It led to the construction of intrusive buildings and illegal constructions where most of them failed to adhere to building codes [48] and to “problems in integrating heritage in spatial planning” [44].

Consequences vary greatly depending on the area of origin of the fire, its spread, the time of ignition, and the total response time, including detection and extinguishing [2,10,36].

Nevertheless, fires can cause irreversible losses and thus have tremendous consequences. Indeed, a collection or a building can be fully or partially burnt. The smoke, as well as the soot depositions, can also create direct damage to a building or its content. Moreover, temperatures increase during a fire and this can cause the melting, deformation, or discoloration of some objects. The physical forces that go with a fire can also cause the fall of objects or some structural damages that can eventually lead to some parts of the building collapsing [36,45,47,49]. Fires also have indirect consequences: for instance, water damage may result from the intervention of firefighters or the use of sprinklers can cause high humidity, mould, and corrosion. Also, fires may lead to losses of information about a collection, if documentation is burnt or if labels are destroyed, lost, or displaced [36,45,49].

4.1.2. Assets to Protect in Museum Contexts

Thinking about the assets to protect is necessary in order to identify appropriate fire safety measures [21]. In general, the most valuable assets to protect in museums are human life as well as collections [46]. Some museums were implemented in historic buildings, and, in this case, the contents of the building as well as the building itself are both important to protect [3]. It is often the case in Kosovo, especially with the numerous ethnographic museums that were implemented in traditional houses [9]. If creating a museum in a historical building is relevant (especially in the case of ethnographic museums) and aesthetic, it also poses certain challenges: *“as building codes evolved and became more sophisticated, it became more of a challenge for historic buildings to meet modern fire safety standards”* [46]. Historic buildings are often made of inflammable materials such as wood, they have old and thus hazardous electric systems, and they present a lack of compartmentalisation [2,3]. For those reasons, it is necessary to be particularly vigilant in museums established in heritage buildings, with the intention of determining *“which measures are essential and appropriate to risks while keeping sensitivity to aesthetics and choosing options with minimal invasive criteria and physical impact on the fabric and décor of the building”* [2]. Since collections cannot be replaced, a safer option is to place them in more modern and purposely made buildings [2]. In any case, fire protection systems need to be chosen accordingly to the building structure, the environment conditions, and to the specific features of the collections [3].

4.1.3. Risk Reduction Measures: Preventing a Fire from Happening

Different measures can be implemented to reduce the risk of fire. We can distinguish between measures that can prevent a fire happening and those that can reduce the consequences of it, along with some preparation measures that will ease the response in the event of a fire [31]. First, it is possible to implement measures that will help prevent a fire from happening. For instance, ignition sources should be identified in order to be removed or to raise awareness of the risks connected to them in the case they cannot be removed [3,49]. Moreover, a non-smoking policy should be established. Staff should also make sure that fabric and inflammable materials are kept at a suitable distance from sources of heat such as lamps [3,49,50].

Good housekeeping is also crucial for fire prevention [4,49]. Apart from cleaning and removing waste in and around the building, which could be a potential source of ignition, it plays an important role in making sure that *“all escape routes are clear and the floor is in a good state”* and that fire exits can easily be opened [50]. Furthermore, housekeeping has a building checking and inspection dimension, allowing staff members to notice any problems related to building installations and to detect early any potential electrical default [49]. In order to prevent fires, such inspections are important, for instance, to check that electrics have been switched off or unplugged but also to prevent arson as anything unusual could be noticed [3]. Arson can also be prevented by implementing security measures and having an efficient surveillance system (guards, security cameras, and alarms) [46]. Inspections are particularly important when renovation works are ongoing in historical buildings [49], because *“repair or restoration of older buildings often increases*

the risk of fire, by exposing their combustible spaces during the process and generating flammable debris” [46]. It is recommended to require a Hot Work Permit and to *“protect collections or move to a secure location during hot work”* [3,36].

Regarding fires happening due to external sources of ignition (from surrounding buildings), measures to avoid a fire include efforts to *“ensure legislation deals with the surroundings or buffer spaces around heritage”* and to make sure that *“land use plans that protect heritage places and their surroundings”* are in place and respected [47]. Therefore, it requires cooperation with authorities as well as enough political enforcement.

4.1.4. Mitigating Risks: Reducing the Potential Consequences of Fire

A fire cannot always be avoided, that is why measures that reduce the potential consequences of fires also need to be considered. A first measure is to have a good detection system with alarm systems such as smoke or heat sensors [3,46,49]. Detection systems are considered one of the *“most cost-effective fire technologies”* and are key to saving human lives as they warn people and help evacuate the building quickly and at the right time [46]. They also limit important destruction as they permit an early response. Apart from evacuation alarms, evacuation processes are eased thanks to exit signs (including emergency lighting) and evacuation plans on the wall. Evacuation plans showing escape routes should be displayed in strategic positions and they should display, in a clear manner, escape routes, building exits, as well as quick information such as the rescue service contact details [46]. Establishing an evacuation strategy is therefore decisive and will be discussed in more detail in the next section (Section 4.1.5).

A fire suppression system can also be activated to limit the consequences of fire [3,46,49]. Extinguishers are the most common equipment, and they should be displayed in visible and strategic places [2]. There are other fire suppression systems such as sprinklers which automatically react to the heat generated by a fire. They reduce by 80% the probability of dying and property damages [3]. Even though sprinklers had been disregarded for a long time due to the water damages they cause, especially on books and collections, it has been acknowledged that water damages have less consequences than fire damages [50]. An alternative to sprinklers is gaseous systems, which are commonly used in computer suites and *“extinguish the fire by reducing the oxygen level of an enclosed area”*. They can be used in fittings and allow people *“to protect very rare or fragile cultural artefacts”* [50]. Fittings designed to maintain a low interior temperature are also used in museums to prevent fire from reaching some artefacts [3].

Structural fire protection also reduces the spread of fire from the room of origin to other parts of the building. This includes compartmentalisation of a building, the use of materials that prevent building collapsing or fire-resistant staircases [2,3]. Unfortunately, those measures are usually hard to implement in historic buildings since they would imply a lot of structural modifications, as discussed in Section 4.1.2. They are nonetheless proven to be very efficient: for instance, enclosed stairways will act as both a smoke and fire barrier while open stairways often act as a chimney and contribute to fire spreading from a floor to another [2].

Finally, it is also important to ensure good access for firefighters to reduce the consequences of a fire event. What is more, an easy access to water will help speed up the response considerably. Therefore, the proximity of working hydrants is decisive to mitigate fire risk [36].

4.1.5. Preparing the Response

“The key to effective protection of cultural heritage at risk is advance planning and preparation” [49]. Being prepared is important to ensure a good response in the event of a fire. It is recommended to have an up-to-date contingency plan or emergency procedure guide, which helps to ensure adequate and coordinated efforts response [10,49]. Such plans consist of summarising the measures in place to reduce the risk of fire as well as the roles of all stakeholders in the event of a fire in order to assure a coordinated response. It should also include a detailed response plan with hydrant location, means of providing immediate access, heritage documentation as well as a list of qualified people to contact [49,50]. This

document should often be reviewed and updated [3,50]. It should also contain information regarding the needs of museum collections: an up-to-date inventory is crucial, with multiple back-up databases in different formats (paper document, online database, computer database). An evacuation plan for artefacts needs to be written with indications about removal choice priorities as well as any specific direction for moving artefacts [3,49].

The contingency plan needs to be implemented and tested through training and simulation exercises, which are a key aspect to fire risk preparedness [3,49]. Training includes knowing how to react in the event of a fire, by organising or helping with the evacuation of people as well as knowing how to use fire suppression equipment [49,50]. Indeed, *“whether or not the fire safety measures to be used call for engineering expertise, it is important for owners of historic buildings and historic site administrators to understand some basic concepts”* [46]. In the case of museums, training incorporates emergency procedures connected to the moving of artefacts [49]. Training can take place through drills and simulation exercises, which are particularly helpful in identifying the strengths and weaknesses of the response in place and improving it if necessary. Exercises are a good way to test both fire reduction and mitigation measures implemented in the museum [2,50], as is conducting evaluations of exercises help to *“include and implement corrective actions to remove, reduce and or mitigate fire hazards and vulnerabilities”* in the initial plans [3]. For the same reasons, archives on past events help museums to be better prepared if experienced feedback has been made [3].

Finally, the need to include all relevant stakeholders has been stressed in the literature. Indeed, familiarity with the building and its contents will help firefighters to be more efficient and will ensure that they have the adequate material and knowledge to take appropriate actions. Therefore, establishing cooperation with the firefighting department is pertinent in the whole process of writing and implementing preparedness and contingency plans. Inviting the fire brigade to drills is recommended, as well as opening a direct phone line to the fire department or other emergency authorities [3,36,49].

4.1.6. A Continuous Process

“Because risk management is a continual process, we should keep repeating the cycle and stay alert for significant changes that may occur” [45]. Fire risk assessments need to be reviewed often, as well as other preparedness and contingency documented procedures. Annual exercises and reviews are recommended in order to keep all measures up to date, and reviews also need to be made after any fire incident, change in the installations, or organisation of the museum [2,3,50].

4.1.7. Desk Review Outcome: Questionnaire to Assess Fire Risk in Museums

Based on the aforementioned findings, the questionnaire used as an interview guideline during the field visits was divided as such:

- The first part of the questionnaire contains some basic questions about the building in order to identify it and give its main characteristics. Information about the building structure such as the presence of inflammable material were incorporated in order to evaluate its vulnerability to fire;
- The questionnaire then focuses on the description of the surrounding areas of the building (presence of intrusive buildings, proximity of infrastructure such as electric lines or roads as well as the cleanness of the surroundings), whose answers could be given through observations;
- The third part of the questionnaire deals with past events as it is believed that they can constitute an important source of information regarding any potential weaknesses towards fire events;
- The fourth part of the questionnaire explores the management of the museum in order to identify any potential barrier to implement fire safety measures (lack of interest, human resources, money or time)
- The next section aims at assessing the level of maintenance of the museum;

- The sixth part focuses on the physical aspects of the building such as the construction materials, or the identification of potential sources of ignition within the building;
- The accessibility of the building was assessed in the seventh part of the questionnaire;
- Fire safety systems and equipment are indexed and identified in the eighth section;
- The next section explores preparedness aspects to face a fire event (trainings and emergency procedures);
- Security aspects, in order to assess the risk of arson, were then tackled;
- Finally, specific information regarding the collections, such as their documentation and labelling, were collected thanks to the last section of the questionnaire.

The full questionnaire is available in Appendix A.

4.2. Fire Assessments Results in the Museums of Kosovo

This section describes the key fire assessments results for Kosovo's museums based on the field visits. Results for each category of vulnerability are presented in different subsections, before being summarised. Recommendations arising from these assessments are then presented in the last subsection.

4.2.1. Surrounding Environment Assessment

Museums in Kosovo are under “temporary protection”. Yet, interviewees informed us that no buffer zones were created to protect those sites from intrusive buildings and from the proximity of infrastructures such as electric lines. Based on the researchers' observations during field visits, half of the museums did not often suffer from the lack of buffer zones, thanks to big courtyards surrounding them. However, the Qerkezi Family Museum, the Ethnographic Museum of Prizren, the Archaeological museum of Prizren, and the City Museum of Gjiilan seem more vulnerable to fire as they are situated in very dense urban areas. In Peja, the surrounding areas of the ethnographic museum pose a more serious threat not only because of the urban density but also because a gas station was built next to the museum. Regarding the City Museum of Mitrovica, the building accommodates both the Museum and the School of Music, which can potentially increase the risk of fire. In Ferizaj, the presence of a residential apartment just above the museum is increasing its vulnerability to fire, as a domestic accident could easily affect the museum. While no fire incidents happened in the past, water damage caused by this apartment was reported.

Sites were clean during the field visits, but it was not rare to find waste on the ground in the streets of the different cities of Kosovo and in nature. Therefore, this risk needs to be kept in mind in the context of Kosovo. Based on these findings, the vulnerability result regarding the surrounding environment for each museum can be found in Table 2.

Table 2. Vulnerability results related to the surrounding environment.

Museums	VULNERABILITY RESULTS
Museum of Kosovo	Low
National gallery	Low
Ethnographic museum of Gjakova	Low
Qerkezi Family museum	Low to Medium
Historic Museum	N/A
Ethnographic Museum of Peja	Medium
Archaeological museum of Prizren	Low to Medium
Ethnographic Museum of Prizren	Low to Medium
Albanian League of Prizren	Low
City Museum of Ferizaj	Medium
City Museum of Gjiilan	Low to medium
City Museum of Mitrovica	Medium
National Museum of Mines and Minerals	Low

4.2.2. Past Events

No past events related to fire were identified by any staff members. However, none of the interviewees mentioned the existence of a database where past events were inventoried or described. Therefore, their answers reflected their personal knowledge, and some information might have been lost throughout the years and due to staff turnover.

4.2.3. Management Related Vulnerability

Most museums in Kosovo (11 out of 13) are funded by municipalities and by the Ministry of Culture. Only the National Museum of Mines and Minerals was funded by a different stakeholder (the Ministry of Economic Development) and the Querkezi family—historical museum of 1999 which is mostly funded by the owner, Ferdonije Querkezi. In all assessed museums, insufficient financial resources to ensure a good management and maintenance of the museums and of their collections were pointed out by interviewees. Most interviewed staff members (9 out of 13) pointed out the lack of human resources. It was for instance the case in the Museum of Kosovo where a biologist was needed in order to ensure a better conservation of the collections. Some museums such as the History museum of Gjakova and the City Museum of Ferizaj operate with very limited staff members, and the City Museum of Gjilan has no dedicated staff members.

4.2.4. Structural Vulnerability Assessment and Maintenance

Ten out of thirteen museums in Kosovo contain inflammable materials, notably because a lot of traditional artefacts which constitute ethnographic museums' collections are made of wood or fabrics. Moreover, the three ethnographic museums are situated in old traditional houses with wood as one of the main material constructions, and are thus highly vulnerable to fire (Figure 3). Added to that, two museums still have old electrical systems which can be a potential source of fire and thus increase the probability of a fire to occur. It is notably the case of the Ethnographic Museum of Peja (Figure 4). Smoking was banned in every museum apart from the Querkezi's family house.



Figure 3. Like other Ethnographic Museums in the region the ethnographic Museum of Gjakova is hosted in a traditional house made in wood, which made it particularly vulnerable to fire risk.



Figure 4. Old electrical system used in the Ethnographic Museum of Peja.

The museums were all well maintained with housekeeping often being conducted. Nevertheless, electrical equipment was rarely subject to regular inspections. For instance, the National Museum of Kosovo seemed well maintained with housekeeping often being conducted but electrical installations and equipment were only checked if the staff was requiring it, and a default could be missed because of that. Moreover, interviewees reported that electrical devices were not always switched off when not being used. This shows that a certain lack of awareness of electrical systems is a potential source of fire.

Only the Albanian League of Prizren was concerned by construction works during the visits, and further safety measures were taken during this time in order to prevent the risk of fire.

Based on these findings, the vulnerability result regarding structural vulnerability and maintenance for each museum can be found in Table 3.

Table 3. Structural and Physical vulnerability results.

	Smoke Ban	Sources of Ignitions	Electric and Heating System	Housekeeping	VULNERABILITY RESULTS
Museum of Kosovo	Yes	-	Modern	Good	Low
National gallery	Yes	-	Modern but no generator Using electric heating instead of central heating	Good	Low to Medium
Ethnographic museum of Gjakova	Yes	+++	Modern	Good	Medium
Qerkezi Family museum	No	+++	Old (porcelain use box)	Good	High
Historic Museum	Yes	++	N/A	Good	Medium
Ethnographic Museum of Peja	Yes	+++	Old electric system No generator	Good	Medium to high
Archaeological museum of Prizren	Yes	+	Modern	Good	Low
Ethnographic Museum of Prizren	Yes	+++	N/A	Good	Medium to high
Albanian League of Prizren	Yes	++	Modern	Good	Low to medium
City Museum of Ferizaj	Yes	+	Modern	Good	Low
City Museum of Gjilan	Yes	+	Modern	Good	Low
City Museum of Mitrovica	Yes	+	Modern	Good	Low
National Museum of Mines and Minerals	Yes	-	Modern	Good	Low

4.2.5. Accessibility for Firefighters

All assessed museums had easy access for firefighters. However, accessibility could sometimes be complicated due to the heavy traffic in most of Kosovar cities (especially in the capital city, Prishtina). Moreover, parked cars sometimes impede the access to buildings. For instance, the National Museum of Kosovo has easy access from the road and a large courtyard in front of the building which facilitates access to firefighters. Nevertheless, the road traffic is often congested in Prishtina and could impact the good accessibility to the building.

Based on these findings, the vulnerability result regarding the accessibility for each museum can be found in Table 4.

Table 4. Results of accessibility-related vulnerability.

Museums	Building Accessibility	Risk of Congestion	VULNERABILITY RESULTS
Museum of Kosovo	Good	High	Medium
National gallery	Good	Medium	Medium
Ethnographic museum of Gjakova	Good	Low	Low
Qerkezi Family museum	Good	Low	Low
Historic Museum	Good	Low	Low
Ethnographic Museum of Peja	Good	High	Medium
Archaeological museum of Prizren	Good	High	Medium
Ethnographic Museum of Prizren	Good	High	Medium
Albanian League of Prizren	Good	Low	Low
City Museum of Ferizaj	Good	Low	Low
City Museum of Gjilan	Good	Medium	Low to Medium
City Museum of Mitrovica	Good	Medium	Low to Medium
National Museum of Mines and Minerals	Good	Low	Low

4.2.6. Fire Safety System and Equipment

There are a lot of disparities in terms of fire equipment in the different museums. Nonetheless, a silver lining is that over half of the museums have easy access to water via fire hydrants.

Extinguishers were the most common fire equipment found in the museums of Kosovo. However, only 6 museums out of 13 had their extinguishers displayed in visible places and only 5 museums out of 13 had their extinguishers tested every six months. Smoke sensors were found in only four museums despite their excellent results as early warning systems. Regarding sprinklers, none of the museums were using this system, the most reported reason was the potential damages it could cause to collections. Five museums indicated being equipped with a lightning rod, which are particularly efficient in mountainous regions to avoid fires caused by a weather event. Some staff members were aware of the need to acquire more fire equipment. For instance, the ethnographic museum of Gjakova was planning to buy smoke sensors and a lightning rod depending on available funding. Unlike the other museums, the Qerkezi Family museum did not have any specific fire equipment. This can probably be explained by its ambiguous status, being a museum and residential housing at the same time.

Based on these findings, the vulnerability result regarding fire safety system and equipment for each museum can be found in Table 5.

Table 5. Results of fire equipment induced vulnerability.

	Smoke/Heat Sensor	Sprinklers	Extinguisher	Access to Water	Building Hydrant	Lightning Rod	Tested Items	VULNERABILITY RESULTS
Museum of Kosovo	Yes	No	Yes, but not in visible place	Yes	Yes	N/A	No	Medium
National gallery	Only in the mail exhibition area	No	Yes	Yes	Yes	N/A	Yes, every 6 months	Low
Ethnographic museum of Gjakova	No	No	Yes	Medium	No but proximity of a city hydrant	No	Yes, every year	Medium to high
Qerkezi Family museum	No	No	No	Yes	No	No	No	High
Historic Museum	No	No	Yes	N/A	No	No	N/A	High
Ethnographic Museum of Peja	No	No	Yes, but not in visible places	Yes	No	No	Yes, once a year	Medium to high
Archaeological museum of Prizren	No	No	Yes	Yes	Yes	Yes	Yes, every 6 months	Low to Medium
Ethnographic Museum of Prizren	Yes	No	Yes, but not in visible places	Yes	Yes	No	Yes, every 6 months	Low to Medium
Albanian League of Prizren	Yes	No	Yes	Yes	Yes	Yes	Yes, every 6 months	Low
City Museum of Ferizaj	No	No	Yes but not in visible places	Yes	Yes	Yes	Yes, once a year	Medium
City Museum of Gjilan	No	No	Yes but never tested and old	Yes	Yes	Yes	No	Medium
City Museum of Mitrovica	No	No	Yes	Yes	Yes	Yes	Yes, every 6 months	Low to Medium
National Museum of Mines and Minerals	No	No	No	Yes	Yes	No	No	High

4.2.7. Preparedness: Emergency Procedures and Trainings

The preparedness phase of the questionnaire highlighted a general trend of an absence of training as well as emergency procedures related to fire risk. Only one museum, the Ethnographic Museum of Peja, was displaying exit signs and none of the museums had an evacuation plan. Moreover, no museums had an emergency or contingency plan, and cooperation with fire brigade was non-existent except for the City Museum of Ferizaj, where collaboration with firefighters was initiated following a water damage event caused by the residential apartment situated above the museum.

Regarding training, 2 staff out of 33 in the Museum of Kosovo received trainings to evacuate people. Moreover, the staff at the Archaeological museum of Prizren had followed trainings for both people and artefacts emergency evacuation. At the Albanian League of Prizren, only one staff member had been trained, but he had disseminated the learning outcomes with his colleagues. The Museum of Kosovo also highlighted good communication between staff members, which could facilitate communication in case of a fire event. Nonetheless, the results for this part of the questionnaire clearly highlighted an important vulnerability and a need to fill this gap.

Based on these findings, the vulnerability result for each museum regarding preparedness measures can be found in Table 6.

Table 6. Preparedness-related vulnerability results.

	Staff Trained	Exit Signs	Evacuation Plan	Cooperation with Fire Brigade	Emergency Plan Described Roles, etc.	Defined Communication Channels in Case of Emergency	UPDATED PAN	VULNERABILITY RESULTS
Museum of Kosovo	2 out of 33 staff members trained. no specific training for artefacts evacuation	No	No	No	No	No but good communication between staff members	No	High
National gallery	No	No	No	No	No	No	No	High
Ethnographic museum of Gjakova	No	No	No	No	No	No	No	High
Qerkezi Family museum	No	No	No	No	No	No	No	High
Historic Museum	No	N/A	N/A	No	No	No	No	High
Ethnographic Museum of Peja	No	Yes	No	No	No	No	No	High
Archaeological museum of Prizren	Yes, for both people and artefacts evacuation	No	No	No	No	No	No	High
Ethnographic Museum of Prizren	No	No	No	No	No	No	No	High
Albanian League of Prizren	Only 1 staff member, 8 years ago Dissemination of learning	No	No	No	No	No	No	High
City Museum of Ferizaj	No	No	No	Yes	No	No	No	High
City Museum of Gjilan	No	No	No	No	No	No	No	High
City Museum of Mitrovica	No	No	No	No	No	No	No	High
National Museum of Mines and Minerals	No	No	No	No	No	No	No	High

4.2.8. Security Assessment

The level of security was variable from one museum to another. Indeed, security was ensured by a guard, cameras, and an alarm for only 4 museums out of 13 whereas two museums did not have any of these measures to protect the site and its collections. In general, cameras were the most used security tool, followed by guards and alarms.

The City Museum of Mitrovica was set in the same building as the School of Music, which was presenting a secondary security threat due to the potential carelessness of the students and a more complicated entrance control. The city museums of Gjilan and Ferizaj were also set-in buildings with multiple functions.

Based on these findings, the vulnerability result regarding security can be found for each museum in Table 7.

Table 7. Results of security related vulnerability.

	Gard	Cameras	Alarm	VULNERABILITY RESULTS
Museum of Kosovo	Yes	Yes	No	Low
National gallery	Yes	Yes	Yes	Low
Ethnographic museum of Gjakova	No	No	No	High
Qerkezi Family museum	No, but entrance controlled by the owner	Entrance camera	No	Medium to High
Historic Museum	No	Yes	No	Medium to High
Ethnographic Museum of Peja	No	No	No	High
Archaeological museum of Prizren	Yes	Yes	Yes	Low
Ethnographic Museum of Prizren	No	Yes	Yes	Low to Medium
Albanian League of Prizren	Yes	Yes	Yes	Low
City Museum of Ferizaj	Sometimes	Yes	No	Medium
City Museum of Gjilan	Sometimes	Yes	No	Medium
City Museum of Mitrovica	Yes	No	No	Medium to High
National Museum of Mines and Minerals	Yes	Yes	Yes	Low

4.2.9. Collections Protection to Fire Risk

All museums' collections were labelled, and only the Qerkezi Family Museum did not have an inventory and documentation of the artefacts. Nonetheless, inventories were not always updated, such as for the National Museum of Mines and Minerals. Regarding the documentation, the City Museum of Ferizaj and the Ethnographic Museum of Gjakova did not have any backup documentation nor digitalised data, which highlighted a vulnerability of losing information in the event of a fire (paper documents could be burnt).

Based on these findings, the vulnerability result regarding collections in each museum can be found in Table 8.

Table 8. Results for the vulnerability of collections.

	Inventory	Labels	Documentation	VULNERABILITY RESULTS
Museum of Kosovo	Yes	Yes	Yes (only few digitalised)	Low to Medium
National gallery	Yes	Yes	Yes	Low
Ethnographic museum of Gjakova	Yes	Yes	Yes (in paper only)	Medium
Qerkezi Family museum	No	Yes	No	High
Historic Museum	N/A	N/A	N/A	N/A
Ethnographic Museum of Peja	Yes	Yes	Yes	Low
Archaeological museum of Prizren	Yes	Yes	Yes (in the process of digitalisation)	Low to Medium
Ethnographic Museum of Prizren	Yes	Yes	Yes	Low
Albanian League of Prizren	Yes	Yes	Yes	Low
City Museum of Ferizaj	Yes	Yes	Yes (in paper only)	Medium
City Museum of Gjilan	Yes	Yes	Yes	Low
City Museum of Mitrovica	Yes, currently updated	Yes	Yes	Low to Medium
National Museum of Mines and Minerals	Yes but not updated	Yes	Yes	Low

4.2.10. Summary of Fire Risk Results in Kosovo Museums

The main findings of the assessments are summarised in Table 9 and offer a great overview of the current vulnerabilities for each museum.

Table 9. Summary of fire assessment results.

	Surroundings	Building	Accessibility	Equipment	Preparedness	Security	Collections
Museum of Kosovo	Low	Low	Medium	Medium	High	Low	Low to Medium
National gallery	Low	Low to Medium	Medium	Low	High	Low	Low
Ethnographic museum of Gjakova	Low	Medium	Low	Medium to high	High	High	Medium
Qerkezi Family museum	Low to Medium	High	Low	High	High	Medium to High	High
Historic Museum	N/A	Medium	Low	High	High	Medium to High	N/A
Ethnographic Museum of Peja	Medium	Medium to high	Medium	Medium to high	High	High	Low
Archaeological museum of Prizren	Low to Medium	Low	Medium	Low to Medium	High	Low	Low to Medium
Ethnographic Museum of Prizren	Low to Medium	Medium to high	Medium	Low to Medium	High	Low to Medium	Low
Albanian League of Prizren	Low	Low to medium	Low	Low	High	Low	Low
City Museum of Ferizaj	Medium	Low	Low	Medium	High	Medium	Medium
City Museum of Gjilan	Low to medium	Low	Low to Medium	Medium	High	Medium	Low
City Museum of Mitrovica	Medium	Low	Low to Medium	Low to Medium	High	Medium to High	Low to Medium
National Museum of Mines and Minerals	Low	Low	Low	High	High	Low	Low to Medium

The museum which seems to be the most vulnerable to fire risk is the Querkezi Family Museum. It is notably due to its dual role of museum and residential house. Following this, ethnographic museums often show the highest scores of vulnerabilities compared to other museums, partially because they are implemented in historical wooden houses but also due to a lack of fire and security related equipment.

An unforeseen and direct result of our assessments was the awareness-raising which occurred through the interview process.

4.2.11. Main Recommendations

Ensuring appropriate fire- and security-related equipment for all museums is a key recommendation, but the most important identified gap concerns preparedness. There is an urgent need to start training museum staff, as well as to plan emergency and contingency procedures and to test them to make them operational.

Based on the aforementioned findings, the following recommendations were formulated:

- Create and implement buffer zones around the different museums to ensure that there will not be construction of intrusive buildings in the future.
- Ban parking in some strategic points around the museum to be sure that no car disturbs the access to the museum for firefighters in the event of a fire.
- Organise meetings with firefighters to elaborate a joint solution ensuring a good accessibility to the building in the event of a fire.
- Replace the old electrical system when needed with more modern and secured ones.
- Make sure the lights or electrical elements are moved away from wood artefacts and fabric artefacts.
- Make sure that all of the electrical elements are switched off whenever they are not being used.
- Furnish all museums with appropriate fire and security-related equipment.
- Extinguishers should be placed in visible places in all the museums.
- Display exit signs.
- Display emergency plans showing evacuations routes, closest exits, and the location of the fire safety equipment (notable the extinguishers).
- Create an emergency procedure guide involving all the museum's staff and define roles among staff members in case of emergency, and the basic and important steps or measures to take in the event of a fire.
- Train museum staff members for both people and artefacts evacuation.
- Inform and train fire brigade staff about the specificities when it comes to handling fire with museum collections.
- Cooperate with the fire brigade in order to ensure an effective coordination in the event of a fire, with the establishment of communication channels, and by the organization of joint training exercises.
- Organise regular simulation exercises to identify eventual gaps in the emergency procedure, in order to improve coordination and direction as well as staff's reaction to emergency situations.
- Conduct regular checks, and make sure fire systems are tested every six months.
- Ensure the creation of several back-ups of the inventories and artefacts documentations (paper AND electronic formats).

5. Discussion

This study highlighted multiple museums' vulnerabilities to fire, including the presence of ignition sources outside and inside of the building, poor accessibility to the site, a lack of or a misuse of fire safety and security systems and equipment, a lack of emergency and preparedness procedures, including the training of staff, and an absence of backup for the collections inventories and documentations. It appeared through both the literature review and the case study that numerous stakeholders play a part in increasing the resilience of museums to fire, and thus, that vulnerability is sourced at different levels.

At the individual and museum level, barriers to build fire resilience in museums could be assimilated to the concept “value-action gap” which is mainly used in environment studies to point out the difference between what people say and do [51]. Blake (1999) distinguished an individuality barrier which concerns “*personal attitudes or cognitive structure*”, such as a lack of interest or motivation as well as a feeling of not being the right person to conduct an action [51]. In the context of fire safety, museum staff members are often museologists or curators who might not be familiar with fire safety, and the inherent complexity of such a process might discourage them to act. “*A lack of awareness of the need to reduce risks*”, limited knowledge as well as capacity of local officers and museum staff are often stated as key issues to implement fire safety measures [10,47]. During the interviews, numerous staff were surprised by the relevance of our questions and sometimes mentioned that “*they had never thought about such a thing before*”, highlighting their lack of awareness regarding fire risk.

Moreover, staff members might not feel legitimate to take action and thus sense themselves as not responsible for implementing fire safety measures. Practically, dedicating motivated and trained staff to fire safety questions seem to be the solution to counter those barriers. However, lack of human resources is common in the heritage sector, and this lack of expertise does not exclude Kosovo as reported by the OSCE [44] (In 2014, the OSCE reported that “*municipalities often appear to lack inspectors qualified for assessing the protection of cultural heritage sites*” and they do not have necessary resources to train the existing ones [44]) and as shown by the study results. The lack of human resources in Kosovo’s museums and elsewhere involve that staff members have limited time allocated to fire safety, which result in non-review, non-update, and sometimes non-existence of preparedness documents, as well as limited or absence of simulation exercise and coordination among stakeholders.

Poor financial resources are often the main reason for a lack of human resources, and it therefore reinforced the aforementioned constraint. Nonetheless, a lack of available funds also contributes in a more direct way to a museum’s vulnerability as it would prevent the museum from acquiring offering proper and maintained fire safety equipment, tools and methods [45,47]. Although it has strong repercussions at the museum level, a lack of funds is often due to local or national policies. Culture and heritage often suffer from a lack of political involvement and of prioritisation [47]. This seems to be the case in Kosovo, since all interviewees mentioned the lack of funding, which is also revealed by the study results regarding the scarcity in terms of fire safety as well as security equipment. On top of the political aspects, insufficient legal frameworks for heritage protection and conservation standards pose a threat to heritage and museums [47]. Indeed, legal aspects influence the integration of heritage in spatial planning [10]. In Kosovo, the low priority given to cultural heritage protection constitutes a barrier to fire safety since there are no buffer zones surrounding museums. Furthermore, “*the [Kosovar] legal framework related to cultural heritage protection in general is in line with international human rights standards*” but it does not clearly stipulate the division of responsibilities between different institution” which led to default in its implementation [44]. Regarding our study results, it shows an important gap at a broader level to implement a good direction, coordination, and cooperation for fire preparedness.

Beyond the main recommendations elaborated in Section 4.2.11, vulnerability could only be reduced by promoting fire resilience through awareness campaigns and through broadening education on fire safety at all levels. Reinforcing political commitment is also key to ensure the long-term resilience of museums to fire.

6. Conclusions

This study offers an overview of the current situation in terms of fire risk protection in the museums of Kosovo. Based on the results, the Querkezi Family museum was assessed as the most vulnerable to fire risk. Moreover, the findings offer a better picture of what the needs are to improve Kosovo museums’ fire resilience. Targeted actions to reduce the risk of fire and its potential consequences must take place in order to ensure a better protection of museums and their collections. A particular need is to strengthen preparedness aspects,

with for instance the creation of evacuation plans and the organisation of trainings that involve all staff members as well as fire brigades. One of the direct and unforeseen results of our assessments was the awareness-raising on the topic with staff members, through the interview process. Their reaction and their will to improve the situation will most likely ease the implementation of measures and is a potential opportunity for organising trainings and actions towards resilience.

Another objective of this study was to create an operational approach to collect fire vulnerability related-data for museums and their collections in data-scarce contexts. It is believed that the forms used to lead interviews with museums' staff members, and which were elaborated based on a thorough desk review, could help practitioners to collect data and evaluate more easily the risk of fire for the museums and their collections and thus help prioritise appropriate mitigation measures to implement. Therefore, this method could be applied in other contexts and especially in data-scarce contexts. Such applications would also permit museums to improve this methodology based on the learning outcomes that would arise from them.

While this study contributes to research on museum fire resilience, it focused on assessing vulnerability and on risk reduction, mitigation, and preparedness aspects. However, resilience is a larger issue than that. It involves, for instance, the definition of recovery models, as well as of a continuity planning strategy, which could notably include, in the context of museums, building recovery as well as collection restoration strategies [52]. Moreover, collections were considered as a whole in this study but more specific vulnerability assessments of objects in the collections could be conducted in order to ensure more specific, suitable, and appropriate fire safety measures.

Author Contributions: Conceptualization, C.F. and E.M.Z.; methodology, C.F.; data collection, C.F. and E.M.Z.; formal analysis, C.F. and E.M.Z.; data curation, C.F. and E.M.Z.; writing—original draft preparation, C.F.; writing—review and editing, C.F. and E.M.Z.; visualization, C.F.; supervision, E.M.Z.; project administration, E.M.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We would like to acknowledge all staff members of Cultural Heritage without Borders Kosovo office, staff members of the different museums in Kosovo consulted for this research, and the fire Brigade of Prishtina.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Questionnaire used for field visits.

Date: __/__/__; __:__

Basic information

Name: _____
Address: _____
Construction date: _____
Type of building: _____
Use: _____
Owner: _____
Type of ownership: _____
Type of protection: _____
Architecture type: _____
Size: _____
Main building material: _____

Information about the surrounding area

Information about the surrounding area are important to collect in order to evaluate the exposure of the cultural heritage site to a fire starting outside of the building.

Is there a buffer zone around the property? ☐ Yes ☐ No

Is it respected? ☐ Yes ☐ No

Size of the security perimeter (if any): _____

Is the site clean (waste on the ground, etc.)? ☐ Yes ☐ No

Is there any intrusive buildings? ☐ Yes ☐ No

Are there any construction work next to the building? ☐ Yes ☐ No

Proximity of infrastructures (electric lines, roads, etc.)? ☐ Yes ☐ No

Are the buildings in the surrounding following building codes and standards? ☐ Yes ☐ No

Are there any illegal constructions? ☐ Yes ☐ No

Description of neighbouring buildings, optional information:

Information about previous events

Has a fire occurred in the past? ☐ Yes ☐ No

Is there a record of past events that affected the museum? ☐ Yes ☐ No

Source of past fire: ☐ Accident ☐ Lack of management ☐ Vandalism/malicious act ☐ Surrounding

Other: _____

Relevant information (frequency/number of previous events, loss of value/items affected, information about the response, other details about a previous event, etc.):

Building management

How is the site funding? _____

Is there any political interest (in protecting the site) and public investment? ☐ Yes ☐ No

Are there enough human resources? ☐ Yes ☐ No

Are there enough financial resources? ☐ Yes ☐ No

How many staff members is there? _____

How does the team communicate (meetings, etc.)? _____

Are there legal instruments concerning this site? ☐ Yes ☐ No

If yes, please state them:

Other relevant information:

Physical/Structural aspects of the building

Material construction: are they particularly inflammable (e.g., wood)? ☐ Yes ☐ No Details: _____

Are there potential sources of ignition within the building? ☐ Yes ☐ No

Are there construction works within the site? ☐ Yes ☐ No

Are enough measures taken for safety and security of the renovation works? ☐ Yes ☐ No

Relevant information related to the use of the building that can be interesting regarding the risk of fire (practices that can have an impact, limit or increase the risk of fire):

Maintenance

Is there a visible lack of maintenance (grass is not cut, etc.)? ☐ Yes ☐ No

If yes, describe: _____

Is smoking banned? ☐ Yes ☐ No

Is there a natural or artificial ventilation? ☐ Yes ☐ No

Type: _____

Is there a generator? ☐ Yes ☐ No

Are electrical equipment switched off when they are not used? ☐ Yes ☐ No

Type of heating system: _____

Are there regular inspections of the building and its components)? ☐ Yes ☐ No

How often is maintenance and housekeeping conducted? _____

How often are the infrastructure (electrical installations, equipment, etc.) checked? _____

Other relevant information/observation:

Accessibility

Is the building easy to access for firefighters? ☐ Yes ☐ No

What is the condition of the road/information about why is it hard or easy to access?

Fire safety system and equipment

Are there any smoke or heat sensor? ☐ Yes ☐ No

Are fire retardant materials used? ☐ Yes ☐ No

Are there sprinklers? ☐ Yes ☐ No

Are there fire extinguisher? ☐ Yes ☐ No

Is there an easy access to water, or bucket of water or sand? ☐ Yes ☐ No

Are there building hydrants? ☐ Yes ☐ No

Is there a lightning rod? ☐ Yes ☐ No

Are fire safety items (e.g., extinguishers) tested? ☐ Yes ☐ No

How often? _____

How far is the closest hydrant? _____

Other relevant information:

Evacuation/emergency plan

Is the staff trained to deal with emergencies (such as a fire with a simulation exercise)?

☐ Yes ☐ No

Are they trained to evacuate people? ☐ Yes ☐ No

Are they trained to evacuate artefacts? ☐ Yes ☐ No

How often are trainings organised? _____

Are there defined role among staff in case of emergency? ☐ Yes ☐ No

Is there any form of cooperation with the fire brigade? ☐ Yes ☐ No

Is the fire brigade participating in simulation exercises? ☐ Yes ☐ No

Does the fire brigade have the equipment and knowledge (in order not to cause unnecessary water damage to the buildings and its contents during interventions for instance)? ☐ Yes ☐ No

Is the fire brigade trained for the specificities of historic buildings? ☐ Yes ☐ No

Are there designed areas/routes for emergency evacuation? ☐ Yes ☐ No

Are those areas clear of objects/ easy to use? ☐ Yes ☐ No

Are those routes adequately dimensioned? ☐ Yes ☐ No

Are those routes clearly indicated (e.g., is there any EXIT sign, or emergency light)? ☐ Yes ☐ No

Is there a plan showing access, evacuation/escape routes, fire hydrants, etc.? ☐ Yes ☐ No

Is there an evacuation plan? ☐ Yes ☐ No

Is there a designed person responsible of implementing the evacuation plan in case of emergency? ☐ Yes ☐ No

Does the plan specify communication channels to use in case of emergency? ☐ Yes ☐ No

Does it provide enough detail concerning the evacuation of people and significant object or collections? ☐ Yes ☐ No

Are there specification of cultural properties requiring special care in emergency? ☐ Yes ☐ No

Does it specify property access (for firefighters, etc.)? ☐ Yes ☐ No

Is the evacuation plan known by all staff members? ☐ Yes ☐ No

Is the plan updated? ☐ Yes ☐ No

How often? _____

Other relevant information:

Security

The security is an important aspect to check since lots of fires occurring in buildings are actually arsons (malicious acts).

Is the access to the building controlled? ☐ Yes ☐ No

How? _____

Are there guards? ☐ Yes ☐ No

Are there any cameras for the security of the building? ☐ Yes ☐ No

Are there any alarm for the security of the building during the closing hours? ☐ Yes ☐ No

Other details:

Collections

Information about collections is important to collect in order to have a better picture of the potential damages that could be related to the occurrence of a fire in a museum.

Is there an inventory of the different elements or of the collections? ☐ Yes ☐ No

How often do you have the need to move/transport collections? _____

How is transportation organised? Are there any existing measures to prevent bad handling?

How is storage organised? _____

On which support are the collections display? Is it stable? _____

Are the collection labelled? ☐ Yes ☐ No

Are the collection documented? ☐ Yes ☐ No

How (paper document, online database, on a computer, multiple places/back-up)?

Other details:

References

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