Design of a Smart Community Event Planning Platform

Masterarbeit

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Leonie Ackermann

Supervisor: Prof. Dr Daniela Nicklas

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Abstract

This master thesis builds upon the project idea "Raum- und Materiallotse" which is part of Bamberg's *Smart City* strategy, and makes suggestions for its implementation. It was investigated which stakeholders are interested in using a Smart Community Event Planning Platform like "Raum- und Materiallotse" and requirements from the perspective of the expected users were identified via interviews. This project was worked on with Chaudry Hamza Tariq, who was particularly involved in developing a prototype (Smart Events Web Application) based on the user stories distilled from the interviews and proposing a solution to enable access to community-shared rooms through smart locks. Each individual's contributions to the research are highlighted in the respective chapters.

This report provides an in-depth analysis of the Smart Events web app and explores its development and implementation's technical and practical aspects. It also investigates the potential limitations and challenges of developing a secure access system, including user privacy, security, and scalability issues. Additionally, this master thesis examines how a space search and event planning platform can support the development of *Smart Community* and makes specific recommendations for its implementation in Bamberg.

By exploring the requirements and limitations of such a platform, this thesis contributes to the broader field of access control and secure storage, demonstrating how smart locks and other technologies can be applied to community-based spaces and events and highlighting this approach's potential benefits and challenges. Furthermore, the research conducted in this master thesis contributes to the ongoing exploration of practices to improve the participation of citizens and non-governmental institutions in *Smart Cities* and to build sustainable *Smart Communities*, where individuals, organisations and governing agencies work in partnership to realise a common goal.

Glossary

ICT Information and Communication Technology.

Kulturamt (Cultural Office) is part of the administration of a city or a municipality. Even though the tasks of the Kulturamt vary depending on the municipality or federal state, it is always responsible for promoting cultural activities.

Ordnungsamt (Public Order Office) is part of the administration of a city or a municipality. Even though the tasks of the Ordnungsamt vary depending on the municipality or federal state, it is always responsible for public order and safety.

Wirtschaftsförderung (Economic Promotion) can be an office or a subdivision of the administration of a city or a municipality. Even though the tasks of the Wirtschaftsförderung vary depending on the municipality, it is always responsible for positively influencing the overall conditions for businesses and employers in order to maintain and strengthen the economic power of the municipality.

1. Introduction

If you type the word *Smart City* in a search engine, you will see many images of large skylines, often spanned by a network of shining dots and lines. What is usually missing are the people who live in these cities and help shape them - as if connectivity alone makes a city smart. When developing smart city technologies, the challenge is building the infrastructure for better connectivity and supporting the connections between citizens. This is important to prevent the digital divide from growing and to ensure that you develop the right product so your software does not become like a ghost city.

Citizen participation in *Smart City* projects is seen as a crucial success factor by various researchers [5] [7] [11] [15]. At the same time, a research gap concerning practices, barriers, and new ways to increase participation in *Smart Cities* exists [11]. In general, it seems that *Smart City* initiatives lack the infrastructure (or interest) to support meaningful engagement and empowerment of citizens [5] [10]. At its worst, researchers described citizen involvement in *Smart City* projects as a disciplinary instrument to improve efficiency rather than a tool to deepen democracy [10].

The city of Bamberg is part of the federal programme "Model Projects Smart Cities" and strives to advance a wide variety of digitalisation projects within this framework until 2027 [17]. Bamberg's *Smart City* concept aims to improve the city society's ability to implement digital innovations sustainably and thus further increase the high quality of life in the city. Therefore the central feature of the *Smart City* strategy development is the consistent orientation towards the needs and suggestions of the citizens. Bamberg wishes to develop the vast majority of projects from citizens' ideas. The University of Bamberg provides scientific support for this endeavour with the *Smart City Research Lab* in the context of which this thesis was written.

During the think tank "'Ideenschmiede' organised by the city of Bamberg in autumn 2021, citizens contributed the project idea "Raumlotse" [1] Their vision was to create an open-source platform supporting cultural creators in Bamberg to find suitable event spaces. Places usually unused in the evenings or vacant buildings available for temporary use should be entered on the platform. Cultural creators should be able to use the platform to book venues. To make the venues accessible to the users, the idea of implementing a *Smart Lock* system was discussed during the think tank. In March 2023, when the present work was almost complete, the City of Bamberg published a strategy paper

[1] Smart City Bamberg, "Die Ideenschmiede". https://smartcity.bamberg.de/2021/09/14/die-ideenschmiede/(accessed 2023-01-10).

listing the sub-project "Raum- und Materiallotse" as planned, pending the availability of funds [14].

This master thesis further develops this project idea and makes suggestions for its implementation. In concrete terms, this means investigating which stakeholders are interested in using a Smart Community Event Planning Platform like Raumlotse and identifying the requirements from the perspective of the expected users via interviews. This project was worked on with Chaudry Hamza Tariq, who was particularly involved in developing a prototype (Smart Events Web Application) based on the user stories distilled from the interviews and researched how access to community-shared rooms can be enabled through smart locks.

The research conducted as part of this master thesis contributes to the ongoing exploration of practices to improve the participation of citizens and non-governmental institutions in *Smart Cities* and to build sustainable *Smart Communities*, where individuals, organisations and governing agencies work in partnership to change their circumstances in significant ways. The work examines how a space search and event planning platform can support the development of *Smart Community* and makes specific recommendations for its implementation in Bamberg. There is a need for localised *Smart City* research for medium-sized cities like Bamberg, which also incorporates the institutionalised association culture specific to Germany.

A large part of the publications to date deals with the *Smart City* projects of large cities such as Barcelona, Rio de Janeiro or Incheon. At the same time, much of the literature on smart events is less about the needs of the people organising events and more about smart infrastructure - e.g. smart waste bins [13], booking and check-in systems [9]. There is also a focus on large-scale events organised by corporations or government agencies [6]. The literature thus conveys an image of citizens as passive consumers of events through which they have to be successfully guided by the organisers with the help of technology.

As the Raumlotse project idea and earlier research in the *Smart City Research Lab* [1] show, however, the citizens of Bamberg do not see themselves as passive consumers, but as active shapers of their city, and thus also frequently as (voluntary) event organisers who would like support from the Smart City Bamberg in their endeavours. This work draws on the experience of local experts in organising for-profit and not-for-profit events, as well as their approach to sharing resources and building trust. It thus implements a citizen-centred approach, which is often invoked but so far too rarely put into practice.

The remainder of this thesis is organised as follows: Chapter 2 provides definitions and background information on relevant concepts. Chapter 3 explains the methods used in this thesis, while Chapter 4 summarises the interview results. In Chapter 5, there is an overview of the user stories that were written based on the interviews, followed by the detailing of the design and implementation of the prototype in Chapter 6. Chapter 7 discusses and evaluates the gathered results and provides recommendations. The outcomes of the master thesis are summarised in Chapter 8. The thesis ends with an outlook on how community-based room-sharing systems with smart locks and the

support of cultural creators in the Smart City Bamberg can be further developed in Chapter 9.

2. Background

The following sections define the terms used in this thesis and introduce related work and projects.

2.1. Smart City

This section discusses the term *Smart City* and the difficulties of a universally valid definition of the concept. Furthermore, the significance of the *Smart Community* dimension in general and in the context of this work is elaborated on.

The term *Smart City* emerged from the "smart growth" movement of the nineties, which sought community-driven solutions to urban problems [15]. At its inception, it referred to the importance of new ICT for modern infrastructures in cities [3]. This technological focus is the key component of the *Smart City* concepts of companies such as IBM, Cisco Systems, and Siemens AG. The technocentric and often top-down (corporate) approach to *Smart Cities* has been criticised by scientists such as Robert G. Hollands, who argued in 2008 that "progressive smart cities must seriously start with people and the human capital side of the equation, rather than blindly believing that IT itself can automatically transform and improve cities" [7]. Hollands advocates adapting ICT to the needs of citizens and using it "socially in ways that empower and educate people".

The preceding paragraph offers a small glimpse into the discourse on the term *Smart City* that has been going on for over twenty years without a generally accepted definition in sight. As of 2019, Tadili and Fasly note in their survey on citizen participation in *Smart Cities*, there "is no consensus among researchers about a smart city definition, key elements, and boundaries" [15]. The researchers explain this as a result of the global use of the concept in different contexts and the similarity of *Smart City* to other terms such as intelligent city, digital city, and knowledge city [15]. Albino *et al.* have also pointed out the fuzziness of the label in their literature review "Smart Cities: Definitions, Dimensions, Performance and Initiatives" and that it is "used in ways that are not always consistent" [3]. In their paper, they suggest that this may be because the term is applied to different "domains", distinguishing between "hard domains", such as buildings, energy grids, and waste management, and "soft domains", such as education, culture, and social inclusion.

Taewoo Nam and Theresa A. Pardo explored *Smart City* definitions and a variety of conceptually related terms in their paper "Conceptualizing Smart City with Dimensions

of Technology, People and Institutions" [11]. They organised the definitions according to three dimensions based on some recurrent characteristics:

Technology dimension The use of urban ICT infrastructure to improve quality of life is the main driver for the smart city. The conceptual relatives included in this dimension are Virtual City, Digital City, Wired City, Information City, Intelligent City, and Ubiquitous City.

Human dimension includes human capital and relates smart city to education, citizenship, learning and knowledge. This dimension includes the concepts of Creative City and Knowledge City.

Institutional dimension The combination of technological and human dimensions is very important. Still, it won't be easy to develop a smart city project without cooperation between stakeholders and institutional governments. This dimension concerns the concepts of Green City, Smart Community and Sustainable City.

These dimensions encompass different visions of the *Smart City* and imply diverse strategies to achieve them. The visions and strategies a particular city chooses depends on specific municipal goals and priorities. These should be taken into account when assessing the smartness of a city [3]. Albino *et al.* have shown that many ranking systems do not do justice to the complexity that such an assessment requires.

In the context of this thesis, *Smart City* denotes **an ambition to increase the efficiency of urban processes by employing digital technology to meet the needs of citizens and support the development of a *Smart Community***. This working definition encompasses the concepts of

Information city Provides digital environments where information is collected from local communities and made available to the public via digital platforms.

Creative City Fosters a climate suitable for an emerging creative class by supporting social infrastructure, such as creative professions, knowledge networks, voluntary organisations, and the entertainment economy.

as defined by Nam & Pardo [11]. The concept of *Smart Community* is elaborated in the following section.

2.2. Citizen Participation and Smart Community

Various scholars agree that citizens and their quality of life are a key dimension of *Smart Cities* [3] [5] [7] [11]. However, as Borkowska & Osborne point out, *Smart City* infrastructure that supports citizen engagement and mutual exchange is rarely provided [5]. Or as Tadili & Fasly put it:

> "No recent studies about practices, barriers and new ways to increase civic participation in smart cities could be found, there is a lack of efficient

> information and data about cities initiatives for the citizen participation in smart cities projects." [15]

The researchers see this state of affairs as a threat to the success of *Smart City* initiatives and suggest "citizens should be involved as an integral part because they are users, decision-makers, consumers and sources of data and information" [15]. Citizen participation in decision-making has many benefits, e.g. for citizen education and a better understanding of community expectations by the administration, as well as strengthening civic engagement [8]. However, meaningful citizen involvement is difficult, costly, and time-consuming [8].

Fittingly, according to Tadili & Fasly's study, the most significant barriers to citizen participation in *Smart City* projects are *Smart City* illiteracy, the lack of a long-term vision or plan, and budget limitations. Their findings urge researchers to develop practices to enhance citizen participation and governments to update their policies and budget for meaningful citizen involvement. Following Berntzen & Johannessen [4], the forms of citizen participation in *Smart City* initiatives can be categorized as such:

Experts contribute their experience and competencies to develop better solutions and plans. Thanks to their input, problems can be avoided early, reducing the risk of failure.

Democratic participants take part in the decision-making process and build sustainable local communities.

Data collectors help collect environmental and other data by using smartphones and other technologies.

In the context of this thesis, citizens participate as experts. Although citizen participation is necessary for building a *Smart Community*, it is not the only pillar; as Nam & Pardo state, institutional preparation and community governance are essential to the success of *Smart Community* initiatives [11]. A *Smart Community* consists of individuals, organisations and governing agencies working in partnership using ICT to achieve a shared interest [11].

2.3. Smart Events

This section was written in collaboration with Chaudry Hamza Tariq [16]

A smart social event is an event that uses technology to enhance the social experience of attendees. There is no specific theoretical background for smart social events, as they can be applied to various events and can be approached from multiple angles.

One possible theoretical framework is event management. Event management is the process of planning, coordinating, and executing events, including using technology to facilitate various aspects of the event. Event management theory can help to understand

how technology can be used to streamline event planning and execution and how it can be used to improve the overall experience of attendees.

Another possible theoretical perspective is ICT. ICT studies using computers, software, and other digital technologies to transmit, process, and store information. It can help to understand how technology is used at events to disseminate information, create engaging experiences, and facilitate communication among attendees.

Another theoretical background that might be relevant for understanding smart events is media studies. Media studies study media production, distribution, and consumption, including digital media. It can help to understand how technology is used at events to disseminate information, create engaging experiences, and facilitate communication among attendees.

Ultimately, the theoretical background for smart events will depend on the event's specific goals and objectives and how technology is used to achieve those goals.

Smart events are organised and managed using technology to streamline various processes and improve the overall experience for attendees. In terms of security, there are a few key considerations that are important to keep in mind when planning and organising a smart event:

- **Cybersecurity**: With the increasing reliance on technology at events, ensuring that all systems and devices used at the event are secure and protected against cyber threats is essential, which includes securing the event's website and registration systems, as well as any devices that will be used on site such as tablets, kiosks, and RFID badge scanners.
- **Cybersecurity**: Ensuring the physical safety of attendees is an essential aspect of event security, including hiring security staff, implementing metal detector and bag checks, and having a plan in place for handling emergencies.
- **Data protection**: Collecting and storing personal data from attendees is an integral part of event planning, but it is also essential to ensure that this data is handled and stored securely to protect the privacy of attendees.
- **Network security**: With the widespread use of WiFi at events, it is vital to ensure that the event's network is secure and protected against cyber threats, which includes implementing strong passwords, regularly updating network security protocols and monitoring network activity for any unusual activity.

Overall, smart event security aims to ensure the event is a safe and enjoyable experience for attendees while protecting their privacy and personal data.

2.4. Smart Locks

This section was written in collaboration with Chaudry Hamza Tariq [16]

Electronic locks that can be remotely controlled via a smartphone, device, network, or internet connection are known as smart locks. These locks typically use Bluetooth, Wi-Fi, or a similar wireless technology to communicate with the device or network that controls them.

Smart locks offer a range of features and benefits, including the ability to lock or unlock a door remotely, grant access to specific individuals, and track who has accessed the lock and when. They can also often be integrated with other smart home systems, such as security cameras and alarm systems, to provide an added layer of security and convenience.

The theoretical background for smart locks includes a range of technologies and concepts, including:

- **Wireless communication**: Smart locks use wireless technologies such as Bluetooth and Wi-Fi to communicate with the device or network that controls them, which lets users control the lock and access its features and functions remotely.
- **Security protocols**: Smart locks typically use secure protocols, such as AES (Advanced Encryption Standard) or TLS (Transport Layer Security), to protect against unauthorised access and ensure the privacy and security of the lock and its users.
- **Access control**: Smart locks often use access control methods, such as PIN codes, biometric authentication, and RFID (radio-frequency identification) tags, to grant access to specific individuals or groups.
- **Internet of Things (IoT)**: Smart locks are often part of the Internet of Things (IoT), a network of connected devices that can communicate and exchange data, which enables smart locks to be integrated with other smart home systems and devices, such as security cameras and alarm systems, to provide a more comprehensive and integrated security solution.
- **Artificial intelligence (AI)**: Some smart locks use artificial intelligence (AI) to learn and adapt to users' behaviour and preferences, improving their convenience and security over time. For example, a smart lock might learn to unlock automatically when a user approaches the door or to only grant access to specific individuals during certain times of the day.

2.5. Similar Projects

This section was written in collaboration with Chaudry Hamza Tariq [16]

The **Raumkompass** [2] connects property owners with artists and cultural workers in Nuremberg. It facilitates short, medium, and long-term rentals of spaces to meet the high demand from the cultural scene. The service also helps to find solutions for the cultural use of empty rooms, intending to upgrade urban spaces from both urban development and economic, social, and cultural perspectives. The activities of Raumkompass also include vacancy and interim use management for the city of Nuremberg to activate and sustainably use existing resources. The organisation works with other actors to develop diverse, unusual, and unique cultural spaces throughout the city.

Citymapper [3] is a popular mobile app that provides real-time information about public transportation, bike-sharing, and other modes of transportation in over 80 cities worldwide. The app allows users to plan their trips, check schedules, and receive alerts about delays or disruptions. It also provides information about bike-sharing options, including real-time availability and pricing.

Waze [4] is a community-based traffic and navigation app that uses real-time data from users to provide up-to-date information about traffic conditions and the best routes to take. The app allows users to report accidents, hazards, and other incidents and receive alerts about road closures and disruptions.

Waze's unique feature is the utilization of its user community to crowdsource data, enabling the app to provide real-time traffic updates that are often more accurate than traditional traffic reports. The app also allows users to interact, share information, and establish virtual communities based on location or interests. Waze offers other features like a local business and attraction search engine, carpooling, and ride-sharing tools. The app is a robust urban mobility tool that taps into its user community's collective knowledge to provide real-time information and improve urban navigation.

Eventbrite [5] is an online platform that allows event organizers to promote and manage events. The platform provides various tools for creating and managing event pages, selling tickets, and promoting events through social media and email marketing.It also provides real-time event information, including schedules, locations, and descriptions. It allows users to search for events based on their interests or background and provides tools for creating and sharing event calendars. Overall, Eventbrite is a powerful tool for event organizers that allows them to promote and manage events more effectively.

[2] https://www.nuernberg.de/internet/kreativraeume/
[3] https://citymapper.com/
[4] https://www.waze.com/live-map/
[5] https://www.eventbrite.com/

While Citymapper, Waze, and Eventbrite represent important developments in smart city technologies and offer real-time information about transportation, mobility, and event schedules in cities, they need to address the needs of event organizers and attendees specifically. Our proposed Smart Events Web App aims to fill this gap by providing real-time information about events, venues, materials, and transportation options in a single, user-friendly platform and extend their contributions. By leveraging the latest technological advances, we believe we can create more connected, efficient, and sustainable cities for all.

3. Methodology

To further develop the project idea "Raumlotse" by exploring how it might contribute to the building of *Smart Community* and enable access to community-based room sharing with *Smart Locks*, several requirement elicitation techniques were employed. The following sections explain these techniques in further detail.

3.1. Interviews

The vision of "Raumlotse" points to Event Organisers, Room Providers and Material Providers in Bamberg as the main users of the potential platform. Therefore representatives of these groups were interviewed. Potential interview partners were recommended by machbar e.V. and Bamberger Kurzfilmtage e.V., whose representatives had proposed the original project idea. Additionally, interview partners were recommended because of their affiliation with the Smart City Research Lab or the Smart City project.

The sample was consciously biased towards representatives of local non-profit or small arts organisations. On the one hand, this group first voiced the need for a Community Event Planning Platform. On the other hand, non-profit organisations are usually oriented toward the public good and have experience with community building. As such, they already possess valuable expertise that can contribute to the building of *Smart Community*.

In the context of this thesis, a person is considered to be an Event Organiser if they are part of an organisation with a considerable focus on organising events. In the case of non-profit organisations, this may even be their statutory purpose. Organisations are included as Room or Material Providers if their spaces or materials are publicly advertised as available for rent or otherwise made accessible.

The aim of interviewing these stakeholders was twofold. Firstly, to determine the status quo of processes and challenges in organising events and renting spaces and equipment in Bamberg. Secondly, to collect the conscious requirements for a Smart Community Event Planning platform. Interviews facilitate detailed enquiries and allow interviewees to explain their views.

In addition to the potential users, representatives of software development agencies in Bamberg were interviewed to obtain feedback on the feasibility and potential pitfalls of developing a project like "Raumlotse". Further valuable expertise was gathered by

interviewing a representative of the "Raumkompass" project of the Stadt Nürnberg, which shares similarities with the vision of "Raumlotse".

All potential interview partners were invited via e-mail with a short introduction to the project and an explanation of why their participation would be valuable. A timeframe of 30-45 minutes was given as orientation. The participants could decide if they preferred to meet in person or online and if they wished to be interviewed in English or German. An information sheet, a consent form and an interview guide were sent to the participants beforehand [2]. The interviews were recorded and then transcribed or documented with notes and afterwards summarised.

3.2. User Stories

Based on the interview results, user stories are written to describe the discovered necessary functionalities for a Smart Community Event Planning Platform. User stories are used in most iterative processes to communicate requirements to stakeholders [12]. Their aim is not to specify the requirements but to act as a starting point or placeholder for a functionality whose details have yet to be worked out [12]. User stories are written in this form:

> **As a [role], I want [functionality] so that [reason for or use of the functionality].**

3.3. Prototype

The first two methods share an inherent weakness: they only reveal results that are limited by the ideas and experiences of the stakeholder and by their ability to describe something that does not exist for the moment. In contrast, a prototype makes the product real enough for stakeholders to bring up requirements that might otherwise be overlooked. When stakeholders see the functionality displayed by a prototype, it inspires them to bring up additional or even different requirements [12].

Therefore a high-fidelity prototype is created to visualise the gathered requirements and elicit further unconscious requirements from the stakeholders. This approach is particularly appropriate when a product has not existed before, is difficult to visualise, and the stakeholders have no experience with either the kind of product or the proposed technology [12]. High-fidelity prototypes are also helpful in discovering usability requirements [12].

3.4. Workshop

To get feedback on the prototype on selected user stories, a workshop was conducted during IGER (Intergalaktische Erfahrungsreise), an event organised by the local hacker

association backspace e.V. taking place 16-18 September 2022. The workshop titled "Designing a Smart Community Event Planning Platform" took place on 17 September 2022 as part of the *Smart City* track organised by the Smart City Research Lab [6]. Admission to the event was only open to ticket holders. Still, it was also possible to provide free tickets to individuals who had already participated in the interview process for this master thesis.

The duration of the workshop was one hour. The participants tried out the prototype in this timeframe and gave feedback. Then the participants chose the user stories they found most interesting to discuss and expand upon. The participants and a silent moderator documented the workshop with facilitation cards on a pinboard.

[6] "Designing a Smart Community Event Planning Platform - Intergalaktische Erfahrungsreise". https://web.archive.org/web/20220924160421/https://cfp.fairydust.reisen/iger-2022/talk/XFETHN/, Sept. 2022. – (accessed 2023-02-07)

4. Interviews

This chapter summarises the results of the interviews conducted between May and August 2022. The full interview transcripts and notes can be found in "Raum- und Materiallotse: Interview Materials and Transcripts" which was published separately from this master thesis [2]. Some interview partners fit into more than one category. They were asked a combination of questions from the interview guides of the respective groups.

4.1. Event Organisers

For the stakeholder group "Event Organisers" six interviews were conducted.

machbar bamberg e.V. is committed to expanding sociocultural spaces in Bamberg. In addition to cultural-political engagement, they focus on organising events in spaces open for temporary use.

Bamberger Festivals e.V. promotes a subcultural concert and music scene in the Bamberg area and supports young musicians. Their projects include planning and staging events, supporting local cooperation partners, arranging performance opportunities, offering workshops for musicians, providing advice on funding and grants, networking and representing the interests of the local music scene.

Classical music event organiser This interview partner is involved in organising various classical music events professionally and voluntarily.

contweedancecollective develops and organises dance performances which unite interdisciplinary methods and structures of dance, theatre and music with the vision of connecting people through dance.

WildWuchs Theater Bamberg promotes art and culture focusing on theatre and performative art in Bamberg and the region, regularly realises theatre projects professionally and creates space for other cultural events such as concerts, readings, festivals and exhibitions.

backspace e.V. is a local hackers' association which also organises events on technical topics and hacker culture.

The following sections summarise the interviewees' approaches to event organising in Bamberg and their visions for a *Smart Community Event Planning Platform*.

4.1.1. How do you approach event organising currently?

At the beginning of each process, there is the event idea. machbar reports that they have an interesting location in mind in some cases and then develop an event concept based on on-site possibilities, for example, in an old swimming hall. Depending on the idea, the Event Organisers have to consider and plan the following aspects:

- Room search and booking
- Publicity
- Funding
- Equipment
- Liability
- Security
- Setup and Dismantling

The aspects "Publicity" and "Funding" were not explicitly addressed by the interviewers but were brought up by some interviewees, mostly when speaking about challenges. Not all interviewees explained their process in the same detail, meaning they are not equally represented in the following subsections.

Room search and booking

After developing the event idea, the Event Organisers usually consider which rooms are suitable based on their experience. Only Bamberger Festivals reported that they consult an internal room list which is partly also an implicit "not" list because some locations have bad conditions. Their list is based on one the Kulturamt provided. The next step for the Event Organisers is to contact the Room Provider to check availability. Depending on the Provider (and how often the Organiser has used the space), the booking is completed by email or after a face-to-face meeting and room tour.

For the selection of a suitable room and the further planning of the event, the Event Organisers need a range of information:

- Space size
- Availability of storage space
- Permitted number of persons
- Availability and number of seating
- Availability of event equipment (e.g. lighting and sound system)
- Gas, water, electricity hook-ups
- Sanitary facilities

- Noise limit
- Accessibility
- Reachability by public transport
- Parking facilities
- Rent and additional costs
- Additional conditions, limitations and expectations of the Room Provider

Which of this information is needed also depends on the type of event. For theatre, dance and music performances, it is also interesting to know whether the space can be used for rehearsals and whether the stage has to be dismantled after each performance or whether set-ups can be left in place. It is also very important for the Event Organisers to have a permanent contact person.

Three interview partners (machbar, classical music, WildWuchs) described their approach to finding new spaces. There are clear differences here. According to machbar, they cycle around the city looking for free rooms or rely on word of mouth. WildWuchs is not looking for rooms in the streets, but they rely on their network to find suitable venues, even unusual ones like barns or the Eisengießerei. The classical music event organiser reports lengthy searches and enquiries to find spaces that fit the character of the music.

machbar and WildWuchs have experience with (attempting) temporary use of vacant buildings. machbar stressed that they are always looking for locations to show people the city in new ways. They want to facilitate cultural events in many different spaces or places. When they find a new vacancy, they discuss the possibility of holding an event there with the city and the Ordnungsamt. These discussions determine the conditions under which an event can take place there. If machbar does not have contact details of the owner of the vacancy, they get support from the Wirtschaftsförderung to find them out.

This process is time-consuming and labour-intensive. And with unclear prospects of success, as WildWuchs has experienced. Getting vacant rooms for theatre performances has been impossible for them so far.

Equipment, Liability and Security

Table 4.1 compares the different equipment and security needs of the Event Organisers and the way they deal with liability. The need for equipment and pre-existing inventory varies considerably, while not many security measures are generally required for events. Liability for events is usually handled by taking out insurance on behalf of an organisation.

Table 4.1: Event Equipment, Liability and Security

Interview Partners	Equipment	Liability	Security
machbar	Often use rooms with no interior. Equipment has to be borrowed or rented.	Event liability insurance of the association.	Usually no admission control. Security personnel at large events, such as festivals.
Bamb. Festivals	Equipment must be booked from rental services depending on the location.	Event liability insurance of the association.	Depending on the event an admission or age check. Partly done by volunteers and partly by professionals (e.g. at the Jahnwiese).
Classical music	Rent rare or special instruments	Insured via umbrella association Fränkischer Sängerbund.	Volunteers for admission control.
contwee dance collective	Had to rent all their equipment in the past. Recently invested in lighting equipment and dance floor. Rent sound equipment, or additional event equipment for outdoor festivals	Liability insurance as GbR.	Night security to watch equipment during the outdoor festival.
Wild Wuchs	Have a basic inventory of stage parts, lighting and sound equipment. Sometimes, equipment is borrowed within their network or from private individuals. Or booked from a rental service.	Insured via umbrella association Verband Bayerischer Amateurtheater.	Volunteers for admission control.
backspace	/	Insured via umbrella association Verbund Offener Werkstätten.	/

One area that also belongs to the subject matter of safety, but is not included in the table, is fire protection and other mandatory permits. Most interviewees mentioned fire safety compliance as an important part of organising events, which also brings challenges. Depending on the venue, the fire brigade may have to come to check the emergency exits, or some events may require firefighters to be on-site, which incurs additional costs. Another example of required permits is the liquor license to serve drinks.

Setup and Dismantling

Of the interviewees, only Bamberger Festivals reported that they prepare a set-up and dismantling plan which lists all materials and their return location. It seems that this area of event planning and implementation mostly relies on the experience of those involved. The Classical music event organiser described this as a "well-rehearsed" process in which the same people always take care of the same tasks.

machbar uses a list to keep track of the equipment they have borrowed, which they also label with stickers saying to whom they must be returned. According to WildWuchs, there is an equipment list in their storage room, but it is not used. For the most part, respondents do not seem to have a standardised procedure or digital system for planning set-up and dismantling, as well as equipment lending and return.

Returning equipment after dismantling the event may require arrangements with the Room Provider if some items are still stored at the venue. The Event Organiser needs access later to collect the items. machbar reported that they usually contact the Room Provider after the event to thank them, get their perspective and impressions, and ask if they would be willing to provide space for an event again.

4.1.2. What challenges do you face?

Table 4.2 shows that four Event Organisers described finding suitable and available event spaces as difficult. WildWuchs experienced that communication with non-commercial Room Providers is usually difficult. Sometimes spaces break away, or it turns out that they do not fit the event after all. Moreover, the more unknown the spaces are to the general public, the more difficult the promotion for the Event Organizers.

Table 4.2: Event Challenges

Interviewee	**Room search**	**Rent and additional costs**	**Funding**
machbar	Getting access is hard work, even if one already has much experience.	/	/

Continued on next page

Table 4.2: Event Challenges (Continued)

Bamb. Festivals	/	/	Applying for funding is very time-consuming. It is hard to plan long-term if one is dependent on project funding.
Classical music	Time-consuming and sometimes involves meeting very high requirements.	Costs of bookings can not be covered by an association or ticket sales alone. Events depend on additional funding,	/
contweedancecollective	Very demanding.	Small artist groups struggle to cover rent and artists' remunerations. Events depend on additional funding,	Current local cultural funding does not meet the real need. The long processing time for applications also makes planning difficult.
WildWuchs	Suitable rooms are few.	Rent is the largest fixed cost factor.	/

Three interviewees reported difficulties covering room costs, while two remarked on issues with securing funding. Concerning funding, Bamberger Festivals considers the project funding they are receiving as advantageous because it ensures flexibility. Still, it comes with the disadvantage of being unable to plan long-term. On the other hand, the Classical music event organiser and contweedancecollective explained that applying for funding requires planning one to two years in advance.

contweedancecollective also judges the current possibilities of local cultural funding as restrictive and not oriented towards the actual needs of local artists. For example, a local artist can only submit one project application, regardless of how many projects they actually carry out. This is challenging for artists and can lead to them doing one well-funded project to be able to do another one that does not generate as much money.

In addition to the challenges in Table 4.2, contweedancecollective and WildWuchs have the impression that Bamberg's culture and small arts scene lacks visibility. contweedancecollective also felt that the city of Bamberg does not support the small arts scene as effectively as possible. They feel that the city administration generally does not feel responsible for the needs of the artists and that one has to overcome many hurdles to realise projects.

4.1.3. What are the minimum functionalities that the Raumlotse would need to have to be useful for you?

Bamberger Festivals did not answer the questions about functionalities, as they do not consider a platform like Raumlotse useful for their work. Their reasoning behind this can be found in section 4.1.5. The other five interviewees agree that a catalogue of available rooms would be desirable, with as much information about the properties of the individual locations as possible (see list under "Room search and booking" in section 4.1.1). Three said that pictures of the venue are also very helpful. The Classical music event organiser also envisions a section in which users can add additional information to the description of a location after they did an event there, e.g., what is a good end time for an event so that the audience will still be able to use public transit.

The user should have an easy way to see which rooms are available. It must be possible to search the catalogue and to have an advanced search function which allows one to filter for certain characteristics of rooms, e.g., according to the time of availability and the desired size. The listings should include contact information or an easy way to contact the Room Providers via the platform. machbar posited that regarding the functionalities, less is more. The use should be as uncomplicated as possible.

Additionally, machbar proposed to think not only of Event Organisers as potential users but also of businesses. This idea is inspired by the Munich-based platform SHQUARED, which has the business model to bring companies together to share a location and rent.

Two criteria were also brought up, which were considered important for the platform's success. WildWuchs said there must be enough rooms, meaning a representative amount of rooms, from barns to garages. According to machbar, it is important to have a credible organisation run the platform, like the city of Bamberg.

4.1.4. In an ideal world, what would a platform that supports you perfectly do?

When asked to envision an ideal platform for event organising, the answers were very diverse. The ideas where there was some overlap between the interviewees were the integrated event calendar and Smart Lock system, which were suggested in the project description sent to them in advance. The Classical music event organiser and contweedancecollective could see an event calendar as useful for planning events and keeping informed about other Event Organisers' plans.

Expanding on the idea, the contweedancecollective suggested a notification system that informs other Event Organisers about the new event, e.g. via e-mail. In their opinion, this would provide a networking opportunity for Event Organisers in Bamberg that does not yet exist. They think that currently, insufficient contact is maintained and that the platform could provide a network without any obligation, which usually leads to people worrying about taking care of an additional burden.

machbar and contweedancecollective have embraced the idea of enabling access to spaces through the platform by integrating a Smart Lock system. machbar pointed out that one issue they often face is that the caretaker has no time to open the location for them, and they therefore can not use it. This problem could be addressed by implementing a Smart Lock system which could contribute to more locations being available in the Smart Community Event Planning Platform.

Additionally, contweedancecollective envisions facilitating ticket sales via the platform, while backspace would like information about catering options and restaurants that can be booked for events. machbar's vision for an ideal Raumlotse is more ambitious:

> "So you have some kind of shopping cart. And you're clicking, I have this location, and I need for this location the PA, chairs, toilet, this and this and this. And so I'm clicking this into my cart and have the contact possibilities. And yeah, so I'm clicking an event together. [...] In the future, we can click an event together with location and events and maybe artists too."

WildWuchs has a similarly grand vision. It should enable fast communication so that rooms can be booked at short notice. The payment process would also be handled via the platform. They also proposed to provide interfaces to other resources like the culturemap of Franz KAfkA e.V.

The vision of the Classical music event organiser is more about the support of the platform than about functionality. They envision a project manager or staff member who promotes the growth and positive development of the platform. They point out that networking does not happen by itself but has to be supported in a targeted way. This aligns with a comment from WildWuchs that the city needs to help build a relationship of trust so that there is confidence in the platform.

4.1.5. Additional remarks

According to Bamberger Festivals, the platform would probably not be useful for them because the knowledge is already there. For them, the city's list of rooms is sufficient. They believe the focus should be on maintaining current event spaces and creating new ones. In their experience, even strongly established spaces in Bamberg are in danger of disappearing and rehearsal rooms are also in short supply.

Given the limited space available, they questioned whether Bamberg is too small for such a platform and whether this is a sensible use of resources. They think that the mindset in Bamberg may not be ready for it, as one encounters many unnecessary barriers.

machbar expressed doubts about the idea of an event calendar and booking system. They fear that maintaining a calendar and an online booking system could overwhelm (potential) Room Providers and discourage them from placing their location on the platform. In their opinion, implementing these functionalities "might be more work than it's worth in the end."

4.2. Room Providers

Kulturfabrik KUFA, JuZ am Margaretendamm and nana theater im Club Kaulberg were interviewed between July and August 2022. The KUFA aims to promote inclusion and artistic diversity and offers spaces that people with and without disabilities can use for various events, such as dance, theatre, concerts, workshops and talks. They are open to joint projects with regional associations and institutions and wish to enrich and support the free, regional cultural scene.

The JuZ is a location for youth work operated by Innovative Sozialarbeit gGmbH on behalf of the city of Bamberg. In addition to various artistic, media-pedagogical, musical, sporting and other activities, the youth centre offers space for events such as concerts, exhibitions, readings and discussions. Club Kaulberg is an atmospheric vaulted cellar and home to the small theatre nana theater, which offers a varied programme of in-house productions and guest performances with a clear focus on literature and music.

All three room providers do not use an online booking system to process room requests. Instead, requests are received through various channels and then processed by the relevant staff. Table 4.3 summarises the different contact channels and space costs and provides information on what support providers offer in running the event, what challenges they face, how they deal with liability issues and what they expect from their users.

For the room providers, it is important that the events fit into their concept. At the JuZ, events have to be aimed at a young audience; for the KUFA, values such as inclusivity and diversity are paramount. The nana theater director relies on his gut feeling when selecting guest performances.

The respondents' approval of the project idea "Raumlotse" is mixed. While the director of the JuZ signalled that they would participate in the platform no matter which form the design takes in the end, the KUFA prefers a pure database without booking functionality. The KUFA cannot imagine a system with minimal contact between themselves and the renter, as with car-sharing platforms or Airbnb. They state that their public events calendar is not meaningful regarding whether events can occur on a vacant day because they have non-public events. Moreover, personal contact is important for them when assessing renters. JuZ also pointed out that they have internal events.

On the other hand, the director of the nana theatre sees no benefit at all in such a platform. In his opinion, the problem is not to fill the programme but to attract a sufficiently large audience. The conversations with the KUFA and the JuZ also show that the premises are so busy that demand exceeds the staff capacities of both providers.

Table 4.3.: Room Providers' Interview Results

	KUFA	**JuZ**	**nana theater**
Request via	Phone or e-mail.	Phone, e-mail, messenger, social media or in person.	E-mail or in person.
Cost	Rent between 250 and 450 euros.	Oftentimes, no rent is charged.	The entrance fee split is 70/30.
On-site equipment	Light and sound equipment. Technical assistance or a short technical briefing is offered.	Event and lighting equipment. Fixed fee for the sound system.	Stage, sound and lighting equipment.
Support during event	Full-time staff member must be present and possibly volunteers for technical support, bar and drinks.	A staff member accompanies the event from set-up to cleanup. Staff provide support as needed, e.g., with technical equipment, drinks sale, or youth protection checks at the entrance.	Staff in charge of bar and cleaning.
Challenges	Volunteers can only manage a limited number of events.	Restricted to one concert until midnight per month. Some months are very popular, and booked out long in advance.	Hard to meet expectations of artists towards venues. It is becoming more difficult to earn money professionally with culture and to attract a big enough audience, especially young people.
Access	Locking service is usually provided by KUFA.	Staff unlocks and locks facilities.	Staff unlocks and locks facilities.
Liability	Renter's risk as clarified via the contract. In some cases, KUFA's liability insurance also applies.	JuZ is liable for violations against the protection of minors. The organiser is responsible for the event, but the staff is usually liable.	The premises are insured, and liability insurance takes effect in the event of damage.
Expectations towards users	Event should run in an orderly fashion without vandalism. KUFA wants to offer culture for all, therefore, there must be reduced entrance fees for certain groups, and escorts are free of charge. The event must be inclusive; e.g., provide an introduction in easy language and use no strobe lights.	Contract communicates the expectations. The staff enforce respectful handling of the premises. Organisers should allow reduced entrance fees to ensure low-threshold access.	Leave items stored in the changing room alone. Be friendly and respectful. Treat technical equipment well. Certain boundaries must not be crossed on stage. The stage programme must be of good quality.

4.3. Material Providers

In July and August 2022, interviews were conducted with Kreisjugendring [7] Bamberg-Land (KJR), backspace e.V. and Offene Werkstatt Bamberg e.V. (OWBA). The KJR lists a selection of materials for rent on its website, including playground equipment, tents and a minibus [8]. backspace is a local hackers' association that offers, among other things, a laser cutter, several tools, an electronics lab and a small workshop on its premises. OWBA provides workstations and various tools and machines for materials such as cardboard, paper, fabric, wood or metal.

Even though backspace and OWBA do not operate a rental service, they provide materials and equipment that are not commonplace and would be difficult to use outside a workshop. In addition, they provide their knowledge and time free of charge, making other art and craft projects possible in the first place. Table 4.4 compares how and to whom the three organisations provide access to their materials and tools, what challenges they face, how they deal with liability questions and what they expect of their users.

	KJR	**backspace**	**OWBA**
Borrowers	Youths and youth organisations	Members	Use only possible on site
Booking system	Only for internal booking management	No	No
Fixed lending or opening hours	Lending during opening hours	No	Usage during opening hours
Challenges	Requires a lot of patience. Sometimes, the return is forgotten, or things are returned incompletely. Storage space is reaching its limit.	/	Pure operation by volunteers causes a lack of continuity.

[7] A city, district, regional or federal youth ring is a union of several youth associations, usually in the form of an association with legal capacity, in Bavaria as a public corporation, whose tasks are defined in the Child and Youth Welfare Act of the Social Code.

[8] "Verleih: KJR Bamberg-Land". https://www.kjr-bamberg-land.de/service/verleih – (accessed 2023-02-10)

Access	Collection of materials from the cellar or the Bauhof. Issuance by employees.	Members can enter the premises anytime using a Smart Lock system. Non-members can usually drop by in the evening.	Some team members are responsible for opening access to the premises during opening hours.
Liability	Liability of the borrower or their association. Minibus is fully insured with an own-risk excess of 300 euros.	Insured via umbrella association Verbund Offener Werkstätten.	Users must confirm the exclusion of liability and third-party liability with a signature. Volunteers are insured through the assoc.
Expectations towards users	Respect and honesty. Participation in the mandatory training for certain equipment.	Few written rules. Be careful, and ask in case of uncertainty.	Leave workspace clean and abide by the house and association rules.

Table 4.4.: Material Providers' Interview Results

During the interview with the KJR, the failed project "Bamberger Ressourcenpool" was addressed. It was an attempt in 2018 to make it easier for associations to borrow materials and equipment from each other. The aim was to create a platform where existing resources are listed and associations can borrow them. However, many associations did not take up the offer. KJR explained that their organisation did not participate because their main target groups are young people and youth organisations, not the general public. Additionally, they considered it to be too much work to maintain another platform for equipment rental.

KJR also reports that they find an online booking system for the materials too inflexible for their process, as they prefer to handle the return times flexibly, which they do not find easy to map with existing solutions. Internally, they use open-source resource planning software Rapla by erdkante to manage the bookings.

When asked under what circumstances they would be willing to have their materials and equipment included in a platform like Raumlotse, all three organisations answered very similarly. None of the organisations wants their equipment to be bookable through a platform. At the same time, they would not mind being listed with their offer on the platform and getting visibility.

KJR specified that they could imagine categories of materials listed on the platform. For example, if a user looks for playground equipment or minibuses, they would find a link to the KJR. A joint booking system for rental in Bamberg would be too complex

in their view, even though the KJR admits that the ideal would be to see everything in one tool. However, in their opinion, this is unrealistic because everyone would have to use the same system, and many already have their own systems.

Asked for further thoughts on the project, KJR suggested that many room providers might shy away from renting out their spaces because they are unfamiliar with legal aspects. It would be worth considering that the city develops a concept to address this issue or provides a model contract.

4.4. Software Providers

The interviews with Safectory and BlooZone were conducted in May 2022, so quite early in the process of this thesis. Both companies specialise in location-based services. While Safectory develops, deploys and maintains Bluetooth / BLE and Wifi hardware and designs, plans and implements network infrastructure for location-based analytics (flow tracking), Bloozone focuses on mobile content production and marketing solutions.

4.4.1. What technologies would be required to realise this product?

It was pointed out that the basic functionality of the "Raumlotse" could be realised in a completely analogous way by providing a simple list of available spaces. Assuming that the goal is to track activity in specific locations and venues, a data infrastructure would need to be built to provide a list of currently available spaces. A data infrastructure would also be required to implement a booking system.

As Safectory specialises in asset and flow tracking, the possibility of implementing a system that can determine whether the entrance to a space is open or closed was discussed. This could be implemented with beacons or tags, and the states could be tracked with standard software. Such a system would require the implementation of a customised front end.

On the other hand, implementing an event calendar would not pose much of a challenge as there are free resources that are well maintained. Therefore, it would be advisable to focus on the core value of the Smart Community Event Planning solution and then integrate the platform with other existing systems.

> "You don't need to maintain or build a service that is running thousandfold already. So let's not do it."

4.4.2. What (financial) resources would be required for the realisation?

The cost estimation depends not only on the bill attached to the initial software development project but also questions related to operation (On which server is it going to run?) and maintenance (Who is going to take care of it?). BlooZone also pointed out that, in

addition to developers and a project manager, it would also be necessary to employ staff responsible for scouting suitable locations and marketing the platform. Therefore, they estimate about 500 000 Euros for implementing a project like "Raumlotse". In their opinion, a private company would be unable to generate enough revenue to run such a platform. Thus it would have to be subsidised by the government.

4.4.3. What problems could arise? And how would you address them?

> "[Y]ou need to understand what makes [the owners] think, 'If it goes that way, then I'm confident to give my room away to somebody. And then if it doesn't work out, I'm also confident that I will get paid for cleaning or reorganising or whatever."'

In the interviewees' experience, the challenges in developing or introducing new software are often due to non-technical factors. Will the room providers trust the platform? Will enough potential users see the platform as valuable to them?

Thus, it is important to present the use case of a Smart Community Event Planning Platform in a way that not only focuses on the monetary costs but also highlights the value created.

> "What value has it if people can just meet anywhere and come together and share things? What value is that? Is there also a need for third places - or, if you would have to build it on the other hand, how much money would that cost?"

Gathering convincing arguments for the advantages of easier access to spaces and simplified event planning could help obtain public funding. Assuming that the number of potential event organisers in Bamberg is in the low three-digit range, it would not be easy to operate such a platform profitably. One possibility would be to rent advertising space on the platform, which would involve additional costs for promoting these spaces.

BlooZone's experience is that it is difficult to convince local business owners to pay for ads regularly.

> "You can convince them to do an ad for a month or a week, but sometimes it's really tough to convince them to do it constantly, and of course, we would need to have this constantly."

The potentially low traffic on the platform would also make it unattractive for advertisers. A recommendation to mitigate this would be to consider integrating the project into a larger user or media content platform. Integrating a tool into a known platform could be more successful than attracting users to a new, stand-alone platform. However, finding a suitable partner to implement such an undertaking also brings its own set of challenges.

Considering the potential business model of a Smart Community Event Planning Platform brings many challenges to light, which is why this question was directly addressed in the interviews with the software providers.

4.4.4. How could a possible business model for the product look like?

There is the option that room providers charging rent give up part of their profit for the platform's operation. Another possibility would be to charge users a small monthly fee for using the platform. However, as the user base would be relatively small, even with 500 or 1000 users per month paying 5 Euros, the revenue would only be around 5000 Euros per month. Under these circumstances, paying a whole team to set up and run a platform would not be easy. Therefore the most realistic option would be to run this whole platform with constant subsidies from the local government or the Bavarian government as part of their promotion of the *Smart City* concept.

4.4.5. Do you think it would make sense to provide only some functionalities of the platform for free and others for a fee? Which ones?

Implementing the unlocking of additional inventory or services with payment was suggested. For example, the authorisation to unlock a certain cabinet containing sound equipment or beverages.

4.5. Raumkompass

In June 2022, a representative of the "Raumkompass" project of the City of Nuremberg graciously agreed to an in-depth interview, summarised in the following sections.

4.5.1. Genesis of the "Raumkompass"

As part of the application to become the European Capital of Culture 2025, a cultural strategy was drawn up in which the City of Nuremberg undertook, among other things, to support cultural creators in finding spaces. But not only to find spaces but also to support the entire process, from brainstorming to the utilisation concept. The "Raumkompass" is, of course, only one building block within a long-term strategy.

Part of the Raumkompass project is the digital platform OffSpaces, which the Office for Culture and Leisure has realised within the framework of the European Union's Forget Heritage project. In OffSpaces, empty spaces can be publicly advertised by their owners. Since the EU project was carried out with ten partners in seven countries, the platform is available in several languages. The administrator is the City of Nuremberg.

The technical development of the platform took two years in cooperation with the Nuremberg agency Tollwerk. The biggest problem in the development was that the

platform was already commissioned from Tollwerk before the concept was ready, and the data protection issues had been clarified. Since many partners were also involved, there were always requests for changes during the development process. In retrospect, it would have been better first to create a watertight concept and then award the contract. However, the City of Nuremberg was awarded the Federal Prize for Cooperative Urban Development (Bundespreis für kooperative Stadtentwicklung) for its involvement of numerous actors in the process.

The source code belongs to the city of Nuremberg and the EU; it is not open source. However, any interested municipality can obtain admin rights for the platform and test it. Until 2024, the EU will pay the operating costs, but it remains to be seen what the future holds for "Raumkompass".

4.5.2. How is the "Raumkompass" received by the cultural creators in Nuremberg?

The cultural creators are very satisfied. In addition to the platform, it is very helpful that a cultural manager supports the cultural workers with advice on their questions. "Raumkompass" only supports non-profit projects and volunteers; everybody else is referred to the Office for Economic Development. In retrospect, it might have been better to have just one platform for Nuremberg, with the city's corporate design embedded in the city administration's website. Users are confused because they are unsure whether the platform is Europe-wide or only for Nuremberg.

4.5.3. How is the "Raumkompass" received by the room providers?

There is also a lot of positive feedback from this side, even though it is a lot of work to build trust. Many landlords have given feedback that they were very happy afterwards to have come into contact with cultural creators. This exchange, which would not have happened without the "Raumkompass", was perceived as inspiring and personally enriching.

4.5.4. Are there any legal challenges?

The current concept is safe from a data protection point of view. Rooms are only displayed if the owners agree. It is estimated that 80% of the spaces the Office for Culture and Leisure knows about are not displayed on the internet. In these cases, the contact between interested cultural creators and the owners is mediated by the cultural manager.

The city is not involved with the contracts between tenants and landlords. To obtain a permit for commercial use of space, the cultural manager refers the matter to the building authorities. The role of the Office of Culture and Leisure is that of guarantor for the interested cultural creators. The city's name gives the cultural creators the benefit of

the doubt when negotiating with the owners - on the other hand, the cultural manager inculcates the cultural creators to handle the spaces responsibly so as not to harm the "Raumkompass" and future interested parties. This relationship of trust works very well, and so far, there have been no problems.

5. User Stories

User stories were written based on the interviews with the Event Organisers (4.1), Room Providers (4.2), and Material Providers (4.3). In some cases, the interviews revealed contradictory visions for a Smart Community Event Planning Platform, which can only be pointed out in this thesis but not resolved. The user stories are grouped by functionality. Unless otherwise stated, the source of the user story is part of the user group named as the acting person at the story's beginning.

View Locations

VL1 The Event Organiser finds out about a room's relevant features to ensure the room is suitable for the planned event.

VL2 The Event Organiser searches the rooms by different event categories to ensure that the room fits the event format and target group.

The Classical music event organiser described VL2. Still, it was acknowledged that this might not be necessary as suitability for certain types of events can be inferred from the characteristics of the space. Nevertheless, the user story has been added in this section, as it may be useful if space providers are explicit about the types of events for which their spaces can be used.

Request Location

RL1 The Event Organiser contacts the provider via the platform so as not to keep track of different communication channels.

RL2 The Event Organiser completes all booking process steps, including payment, via Raumlotse to switch between platforms as little as possible.

RL3 The Event Organiser receives the necessary information to open and close the space to avoid the usual stress of handing over the keys for both the Room Provider and the Organiser.

The functionality of RL2 is not unreservedly endorsed by the Event Organisers interviewed. It was also explicitly rejected by one of the Room Providers.

Manage locations

ML The Room Provider receives support in offering the rooms legally securely and information about possible risks to offer rooms as low-threshold as possible. (Source: KJR)

As this user story does not originate from a Room Provider, it should be reviewed with someone from this user group. However, as it came up in the conversation with Raumkompass that Room Providers contact the cultural manager with questions about permits (and are then referred to another municipal department), there seems to be a need for information and support.

Edit location

EL The Event Organiser can add their own experiences using the space in the location description to help future Organisers in their planning.

View materials

VM The Event Organiser consults the available equipment and materials list to avoid researching what is available in Bamberg on their own.

Events

E1 When the Event Organiser adds a new event to the event calendar, the platform notifies other Organisers so that they can consider the new event in their planning.

E2 The Event Organiser sells the tickets via the platform to handle as many event processes as possible in one space.

The doubts about the event calendar in the interviews focused on the additional workload for Room Providers and the lack of validity regarding availability because internal events also occur on the premises. E1 addresses one of these concerns by leaving the maintenance of the event calendar to the Event Organisers.

Other

O The Event Organiser finds catering options for the event to have all the information needed for event planning quickly.

6. Design and Implementation

This chapter was written in collaboration with Chaudry Hamza Tariq [16]

This chapter presents the design and implementation of a Smart Events web application with smart locks integration to facilitate citizen participation and community building in the context of smart cities. The chapter describes the web application prototype, developed using agile software development methodologies and user-centred design principles, focusing on usability, accessibility, and security. The chapter then presents the application's control flow graph, sequence diagram, and OPM diagram, visually representing the application's functionality, interactions, and data flow.

6.1. Prototype

This chapter will delve into implementing the concepts outlined in the earlier chapters. Our prototype utilises the Vue framework, a JavaScript tool for constructing user interfaces. Firebase powers the back end. The users' needs were obtained through interviews and workshops, and the website was designed to be simple and navigate.

Smart events [9] is a web-based application representing the platform that supports Bamberg's cultural creators and business owners in finding suitable spaces. We designed the application in four roles, i.e., event organiser, location provider, material provider, and guest. An event organiser can create and manage events. Location providers can upload and manage locations. Material providers can upload and manage materials, whereas guests and all roles can join events, and a calendar displays all the events with their timings.

6.1.1. System Architecture

The system architecture of the web application is designed to ensure efficient communication between the application's front and back ends. The front end is developed using the Vue.js framework, which provides a simple and intuitive user interface for the web application. The back end of the application is developed using Firebase, a Backend as a Service (BaaS) platform, which provides a scalable and reliable cloud infrastructure for real-time data synchronization and storage [**?**]. The communication between the application's front and back ends is achieved using Firebase's API, allowing seamless data

[9] https://smart-events.netlify.app

transfer between the two components. The overall system architecture is optimized for performance, scalability, and reliability, ensuring the web application can handle large traffic volumes and provide a smooth user experience.

Figure 6.1.: System Architecture

In addition to the front and back ends, the system architecture includes a database to store and manage the application's data. Firebase provides a NoSQL database as part of its services, which allows for flexible and scalable data modeling. The database is designed to handle a large volume of data and provide fast read and write operations. Firebase also provides secure authentication and authorization features, ensuring that only authorized users can access the application's data. The combination of Vue.js and Firebase allows for rapid web application development while also providing a robust and scalable system architecture that can meet users' needs.

6.1.2. Actors

This section outlines the various stakeholders involved in the development, implementation, and maintenance of the web application, which are as follows:

Guest A guest actor is a person who attends an event organized by an event organizer. They may be invited or registered to attend the event. As a guest, they may have access to certain features such as viewing the event schedule, speaker information, and other relevant details about the event. They may also be able to provide feedback or interact with other guests. The guest plays an essential role in the event, as their satisfaction is often a measure of the event's success.

Event organizer An event organizer actor is a professional who plans and manages events such as conferences, conventions, ceremonies, and parties. They handle tasks such as selecting venues, coordinating vendors, setting budgets, and managing logistics. They may also be responsible for promoting and marketing the event to attract attendees. The event organizer ensures that the event runs smoothly and thrives.

Location provider A location provider actor is typically a person or organization that rents out or makes space available for events such as weddings, parties, conferences, and other gatherings. They may also provide additional services such as catering or event planning.

Material provider A material provider actor is a person or organization that supplies materials for events such as trade shows, conferences, and exhibitions. They may provide promotional products, signage, and display materials.

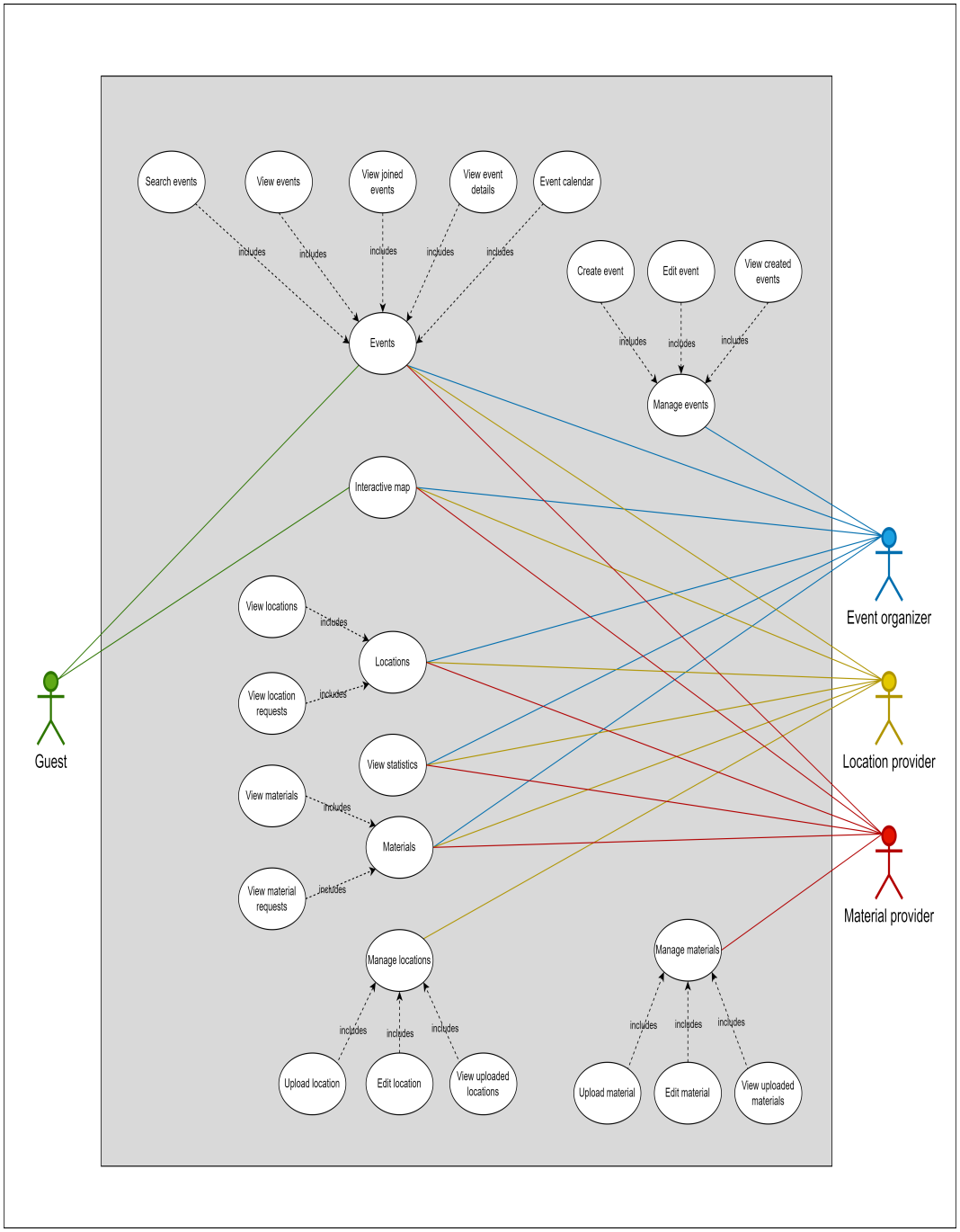


Fig. 6.2: Smart Events functionality by means of a UML use case diagram

6.1.3. Workflow

This section presents the web application's workflow, which outlines the steps users can take to achieve their desired outcomes. The workflow is designed to be user-friendly and intuitive, emphasizing minimizing the steps required to complete a task. The workflow considers the different actors involved in the system and their respective roles and responsibilities. The workflow describes a specific process or use case within the web application.

Location provider (Upload Location)

Location provider uploads locations in 5 steps which are explained below:

- In first step there is location title and selection of dates in which location is available. Dates can be selected in range or for one day only.
- In second step user needs to enter address of location then it will be set in the map automatically for user's ease.
- In third step description of location is required.
- In fourth step there are options about furnishing, catering and characteristics of location where user can select options the location is providing.
- In last step cover photo is required of location and user can also upload more photos for better responses.

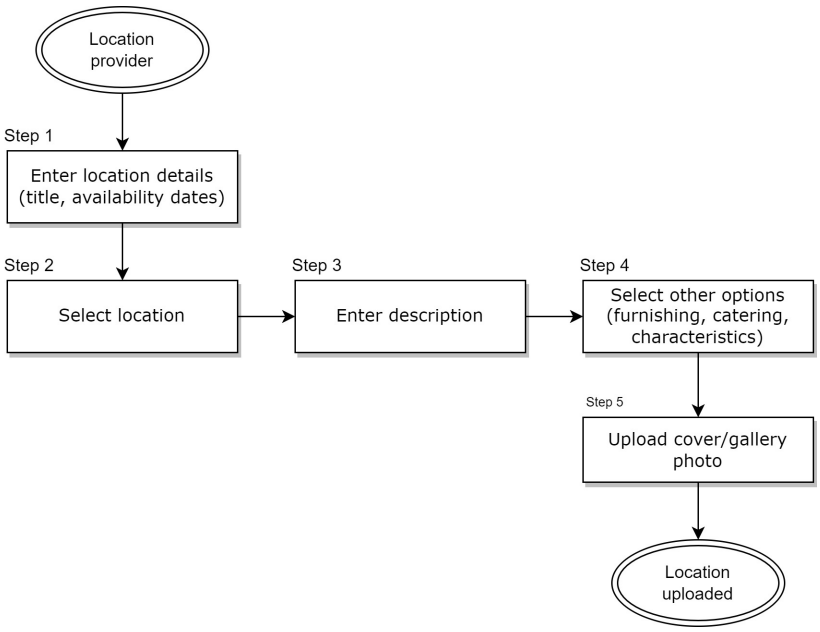


Fig. 6.3: Upload location workflow

Event Organizer (Create Event)

Event organizer creates event in 5 steps which are explained below:

- In first step there is event name, start date and start time of an event. There is also an end date and end time of an event if user wants to specify it.
- In second step user needs to have location approved for the selected date in previous step. This helps to reduce last moment cancellation of event in case óf location unavailability. Location address will be set in the map automatically for user's ease.
- In third step description of an event is required.
- In fourth step there are different options for approved materials, cleaning services, insurance services and security services which are offered by third party companies. User can select their services for an event.
- In last step cover photo is required for an event.

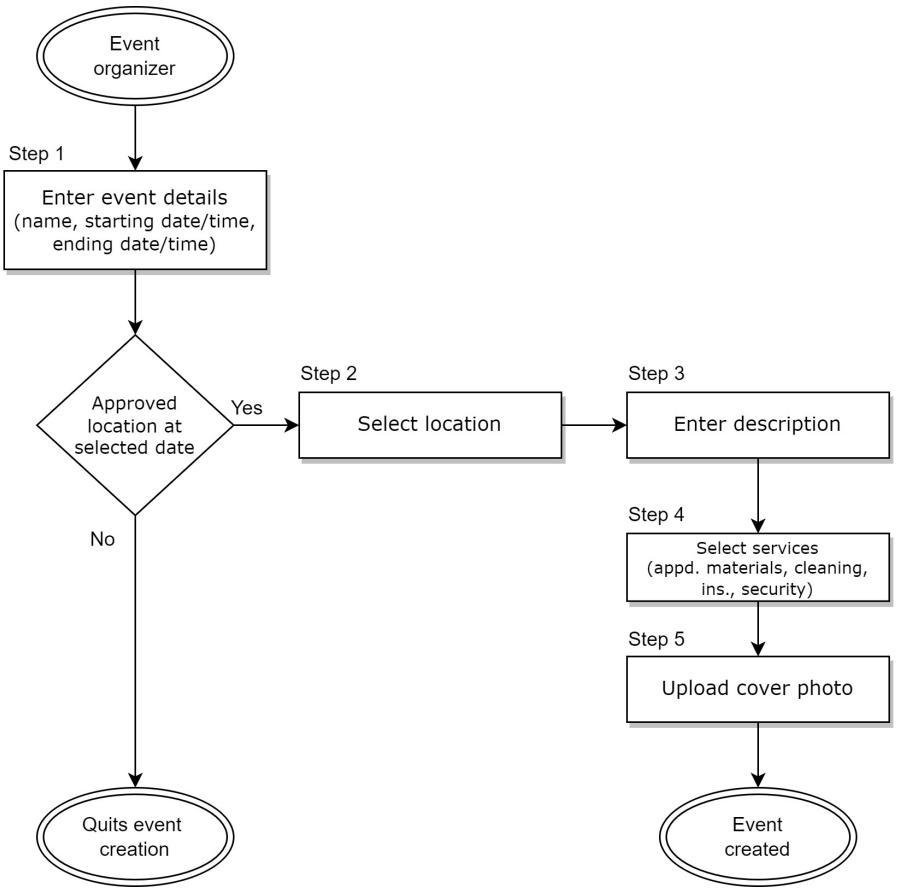


Fig. 6.4: Event organizer workflow

Material provider (Create Event)

Material provider uploads material in 2 steps which are explained below:

- In first step there is material name, description and quantity of material.
- In second and last step cover photo and gallery pictures are required of material.

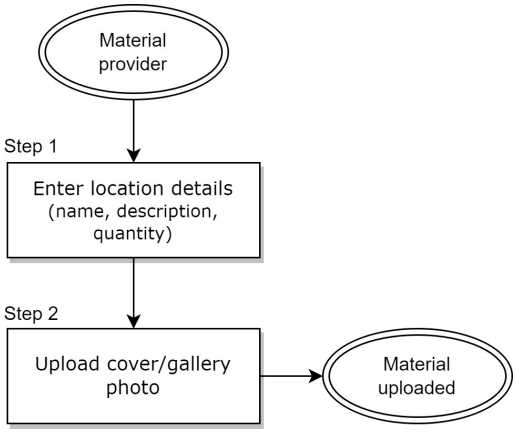


Fig. 6.5: Material provider workflow

6.2. Control Flow Graph

A control flow graph (CFG) is a visual representation of the flow of control in a computer program or algorithm. In the context of a Smart Events web app, a CFG could be used to show the different pathways a user can take when using the app, as well as the various decisions and actions that are taken along the way.

Following is the CFG for user registration. The user registration process for a Smart Events web app that is connected to Firebase Auth is a process that allows users to create a new account in the app by providing their email and password. The process ensures that only valid and secure registration attempts are successful.

When users click the "Register" button in the app, they are prompted to fill out the registration form. The registration form is then validated to ensure they meet the necessary criteria, such as a valid email format and a password of a certain length.

Once the email and password have been validated, they are sent to the Firebase Auth service for registration. Firebase Auth is a service provided by Google that allows developers to add user authentication to their apps quickly. It handles the registration process, including creating a new user account and securely storing the user's email and password.

If the registration is successful, Firebase Auth will return a response indicating that the account has been created. It also stores users in Firestore DB. Once the user is registered

in firebase, it also creates a profile in the Nuki portal. The user will then be redirected to the main page and logged in.

Firebase Auth will return an error message if the registration is unsuccessful. The app will then handle this error message, such as displaying an error message to the user indicating that the email is already in use.

In summary, by connecting to Firebase Auth for user registration, ensure that only valid and secure registration attempts are successful. Firebase Auth provides a secure and easy-to-use way to handle registration, including storing users' credentials securely.

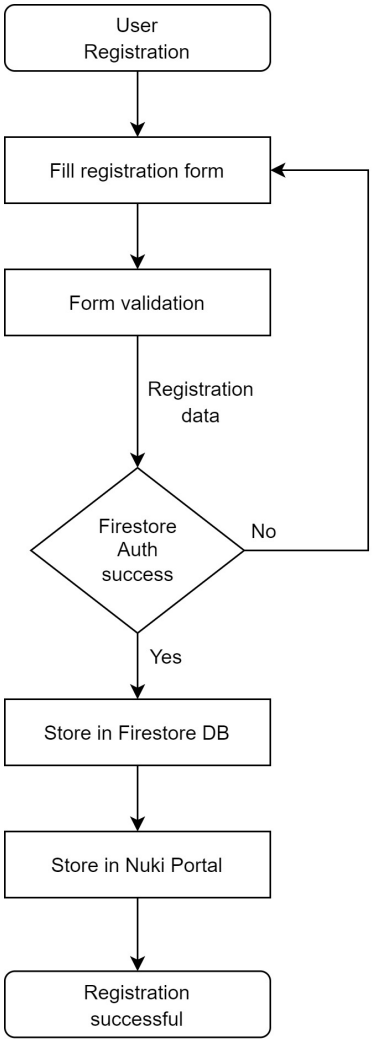


Fig. 6.6: User registration CFG

Following is the CFG for the whole Smart Events web app. After successfully logging in, the application determines a user's role based on credentials. Then, there is a whole bunch of options for each role which is self-explanatory in the figure.

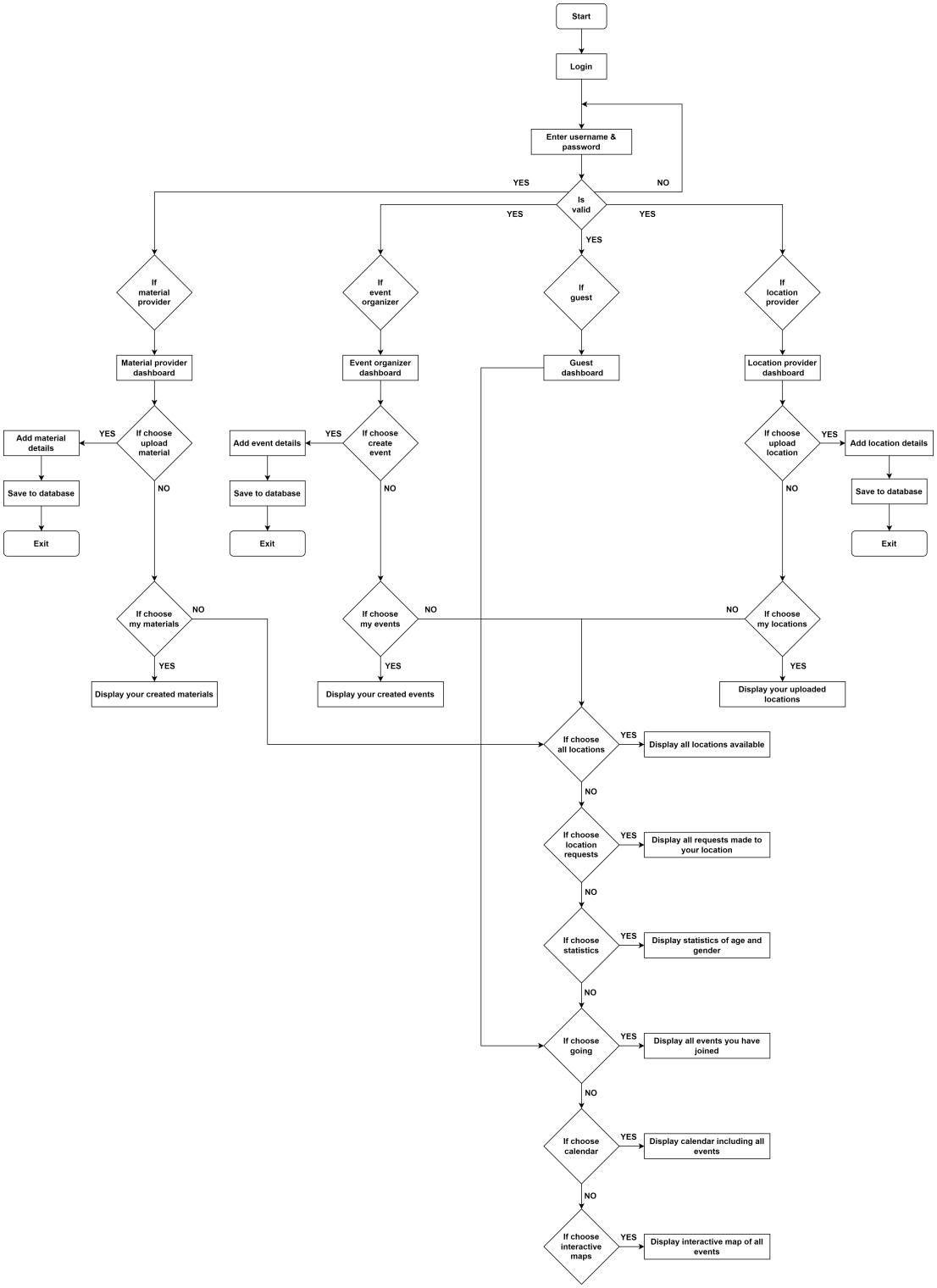


Fig. 6.7: Smart Events CFG

6.3. Sequence Diagram

A sequence diagram is a type of UML (Unified Modeling Language) diagram that shows the interactions between objects or components in a system over time. It is commonly used to design or document the behavior of a software system. In a sequence diagram, objects are represented by vertical lines (lifelines), and interactions between them are represented by horizontal arrows (messages) in chronological order. The diagram also includes activation bars to indicate the duration of an object's processing of a message. Sequence diagrams can visualize the flow of control and data in a system and help identify potential issues or bottlenecks.

The following sequence diagram shows the interactions between the guest actors' joining the event from the events web page, Firestore DB, and Nuki API. The Guest actor accesses the website, and the website shows available events on the Home page by retrieving event information from a database. The guest actor selects the event and is forwarded to the event details page, where the guest clicks on the "Going" button, which calls the joinEvent function to dispatch the payload to the Firestore DB to update the event members list. Then it brings back the response from the DB. In case of a successful response, it requests the user account Id from the Nuki portal via calling the API, which returns the user account Id (if it exists); otherwise, the user cannot join the event. After successfully getting the Id web sends the payload of the selected event date and time via API to Nuki to only authorize the user to access Nuki smart lock for this particular time.

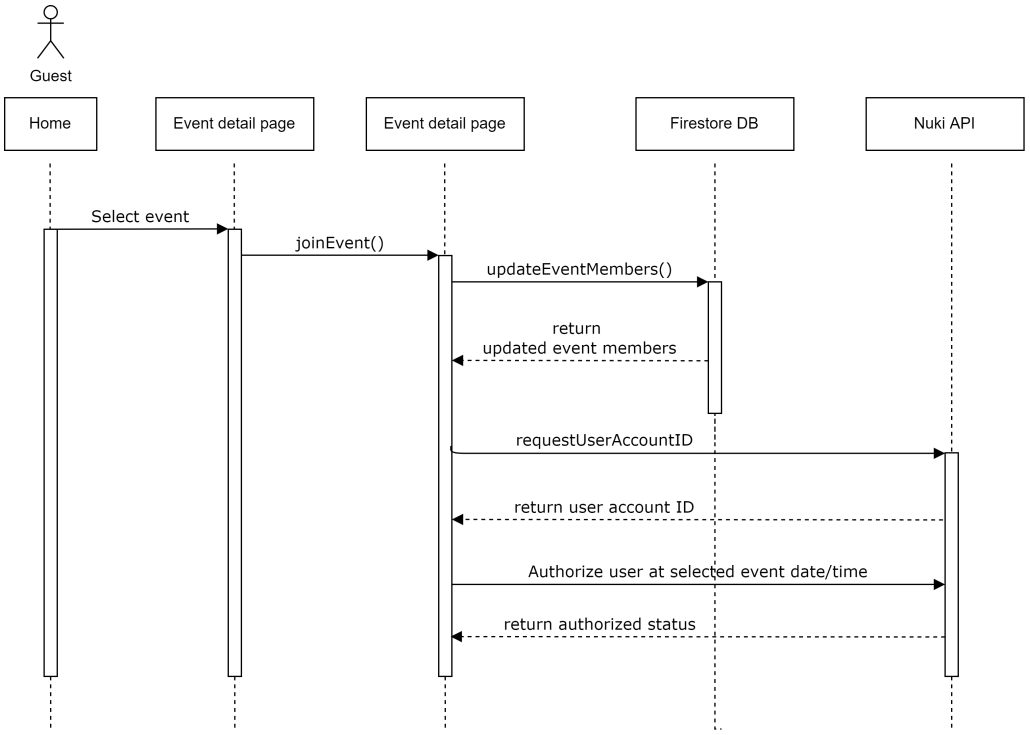


Fig. 6.8: Sequence Diagram for Guest Joing Event

After getting a successful response from the Nuki server user, the "going" button turns green, enabling the directional map for this particular event. Upon pressing the directions button, it checks the user account ID from the Nuki portal via API request, which responds with the ID if the user exists. Upon successful response, it checks the event members from Firestore DB, so if the user exists in event members, then it loads the event location on the map, which shows all the directions to the event location with distance from the user's live location. Once the user has reached the location and there is less than 0.5m to the exact location coordinates by assuming there is an entrance, the map automatically disappears and displays QR Scanner to scan the QR code the event organizer placed at the entrance. After scanning the QR, if it matches, the application sends a command to the Nuki smart lock to unlock.

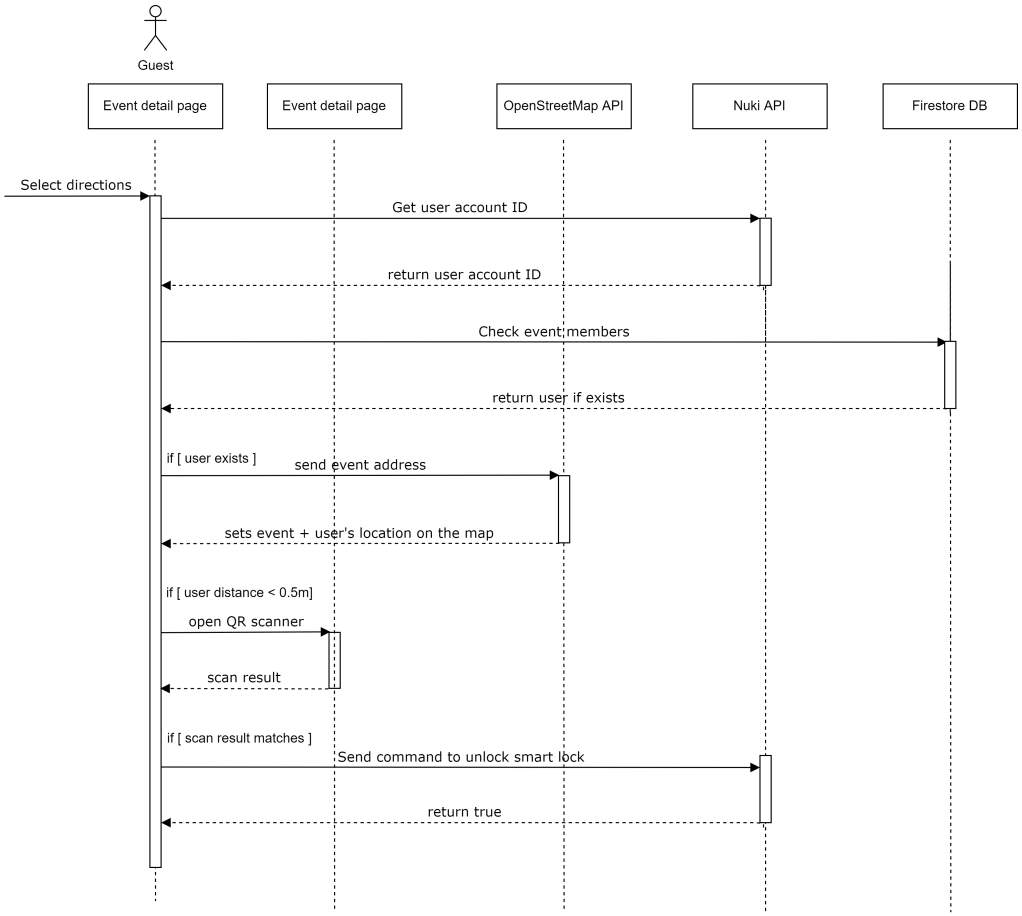


Fig. 6.9: Sequence Diagram for accessing Event

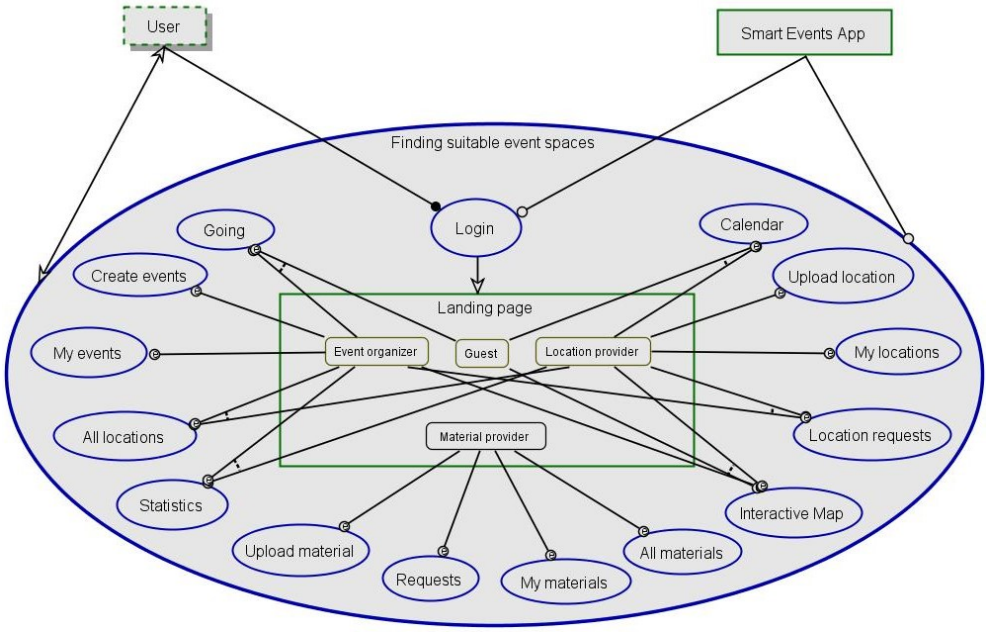
6.4. OPM Diagram

An OPM (Object-Process Methodology) diagram is a modeling tool used to describe the system's structure and behavior clearly and concisely. In the case of the Smart Events

Web App, the OPM diagram represents the system's different objects, processes, and connections between them.

At the highest level, the Smart Events Web App OPM diagram includes three main objects: Event organizer, Location provider, Material provider, and Guest. These objects represent the key entities involved in the system and are connected by processes that facilitate communication and data exchange.

It provides a clear and comprehensive overview of the system's structure and behavior and can be used to guide further development and refinement of the system. By understanding the connections between different objects and processes, designers and developers can identify areas for improvement and create a more efficient and effective system for event management.



User is environmental and physical.
User handles Login.
Finding suitable event spaces exhibits Landing page.
Finding suitable event spaces consists of Login, Create events, My events, All locations, Location requests, Going, Calendar, Upload location, My locations, Statistics, Interactive Map, Upload material, My materials, Requests, and All materials.
Finding suitable event spaces requires Smart Events App.
Finding suitable event spaces affects User.
Finding suitable event spaces zooms into Login, Calendar, Going, Upload location, Create events, My events, My locations, Location requests, All locations, Statistics, Interactive Map, Upload material, All materials, Requests, and My materials, as well as Landing page.
Landing page can be Event organizer, Location provider, Guest, or Material provider.
Landing page triggers Create events, Interactive Map, Statistics, Going, Location requests, All locations, and My events when it enters Event organizer.
Landing page triggers Interactive Map, Upload location, Calendar, Statistics, Location requests, All locations, and My locations when it enters Location provider.
Landing page triggers Interactive Map, Calendar, and Going when it enters Guest.
Landing page triggers Requests, My materials, Upload material, and All materials when it enters Material provider.
Login requires Smart Events App.
Login yields Landing page.
Calendar requires either Guest Landing page or Location provider Landing page.
Going requires either Guest Landing page or Event organizer Landing page.
Upload location requires Location provider Landing page.
Create events requires Event organizer Landing page.
My events requires Event organizer Landing page.
My locations requires Location provider Landing page.
Location requests requires either Location provider Landing page or Event organizer Landing page.
All locations requires either Location provider Landing page or Event organizer Landing page.
Statistics requires either Location provider Landing page or Event organizer Landing page.
Interactive Map requires Guest Landing page either Location provider Landing page, or Event organizer Landing page.
Upload material requires Material provider Landing page.
All materials requires Material provider Landing page.
Requests requires Material provider Landing page.
My materials requires Material provider Landing page.

Fig. 6.10: OPM (Object-Process Methodology) Diagram

6.5. Comparison with Similar Projects

To fully understand the contribution of the developed prototype, it is important to contextualise it within the existing literature. Therefore, in this section, we will provide a comparison with other similar projects that have been conducted in the field. By doing so, we highlight the relevance of similar projects and why they are interesting and identify their similarities and differences.

When comparing the Raumkompass (see Section 2.5) service to the developed prototype, which offers a variety of features such as event creation and management, location provision, material provision, and guest management, it is essential to consider the key differences and similarities between the two.

The Raumkompass and the prototype aim to provide event planning solutions and offer event organisers location options. While the Raumkompass focuses on cultural spaces in Nuremberg only, this prototype could provide a broader range of locations. However, the scope of their services differs significantly, with the prototype offering a wide range of features such as event creation, guest management, and material provision. At the same time, the Raumkompass is more focused on providing unique and diverse cultural spaces for events and helping property owners, artists, and cultural workers to connect. Additionally, the Raumkompass is a municipal contact point and part of the city of Nuremberg's vacancy and interim use management, aimed at activating and sustainably using existing resources. At the same time, this prototype may focus differently on urban development and sustainable use of resources.

In summary, while both the Raumkompass service and prototype aim to provide solutions for event planning and organisation, the Raumkompass service is more focused on providing unique and diverse cultural spaces for events and working with property owners and artists, and cultural workers. It has a focus on urban development and sustainable use of resources. On the other hand, Smart Events offers a broader range of event planning and organisation features.

When comparing the Citymapper (see Section 2.5) to the developed prototype, One of the critical features of Citymapper is its ability to integrate with other transportation providers, such as ride-sharing and taxi services, allowing users to compare different transportation options and choose the most convenient and cost-effective. Citymapper also offers a range of additional features, such as real-time information about traffic conditions and weather, and user-generated content, such as reviews and recommendations for local businesses and attractions. Overall, Citymapper is a comprehensive tool for urban mobility that provides users with a wealth of information to help them navigate cities more effectively.

Compared to Waze (see Section 2.5), this prototype will offer a comprehensive tool for event organisers and attendees that combines real-time information about events and traffic routes in a single platform. Addressing the specific needs of this user group, it will provide a valuable resource for promoting smart and sustainable events in cities.

Waze is also interesting regarding future features from which inspiration can be taken regarding user interaction, sharing information, and establishing virtual communities based on location or interests.

In contrast to Eventbrite (see Section 2.5), this prototype provides real-time information about transportation options with valuable information about events and venues that can be useful for event attendees.

When comparing the web app prototype developed for this master thesis with similar projects, several differences and similarities can be identified. One area where the prototype excels is its unique focus on integrating smart locks into event management. While other event management apps may offer access control and security features, using smart locks as a central component is relatively new and innovative. This approach provides a more secure and efficient way to manage access control, with the added benefit of real-time monitoring and remote control capabilities. Also, the interface design of the prototype is more modern and user-friendly compared to some of the older projects. The prototype also offers more features and functionalities, such as real-time collaboration and integration with external APIs such as Nuki Smart Lock, which needed improvement in other projects.

However, one area where the prototype could improve is scalability. Some other projects had been developed with scalability in mind, whereas the prototype focused on delivering a functional MVP. Additionally, some of the other projects had a larger user base and more extensive testing, making them more stable and reliable.

Overall, while the web app prototype developed for this master thesis has several strengths, there are also areas for improvement. By focusing on scalability and conducting more extensive testing, the prototype has the potential to be a competitive offering in the market of similar projects.

7. Evaluation and Discussion

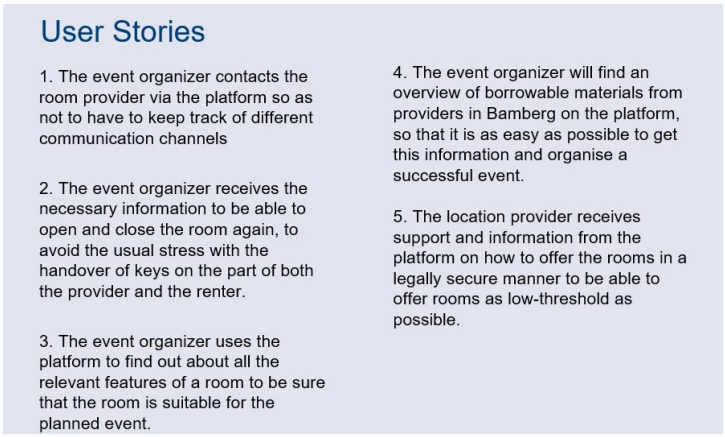
In this chapter, the evaluation of the prototype during a workshop is discussed, as well as the outcomes of citizen participation during this project. Based on these insights, recommendations are given for further developing a Smart Community Event Planning Platform in Bamberg, which could also be explored in the context of other *Smart City* projects.

7.1. Evaluation of the Workshop

This section was written in collaboration with Chaudry Hamza Tariq [16]

This workshop evaluation aims to assess the effectiveness of the Smart Events Web Application in meeting user needs and expectations. Participants were shown the application and asked to provide feedback on its usability, functionality, and effectiveness.

Method: The workshop was conducted in an IGER Smart City Track event [10] where participants were shown the Smart Events Web Application and asked to interact with it for a designated time. After the interaction, participants were asked to complete a feedback survey, which included questions about their experience using the application and their suggestions for improvement. Participants were also given some user stories from which they needed to pick a user story and then gather in groups to break down the described action into individual steps. This method helped to discuss what this process should look like and what could go wrong.



[10] https://fairydust.reisen/2022/08/smart-city/ (accessed 2023-02-07)

Fig. 7.1: User stories

Results: The workshop participants received the Smart Events Web Application well. Most participants found the application easy to use and navigate, with clear instructions and intuitive design. Participants also suggest new features and a slight UI change to make it more understandable. Apart from appreciation, the following prototype suggestions emerged from the feedback:

- There should be a search functionality.
- Credential status should be changeable.
- Improve responsiveness.
- Event creation with map or route.
- Different visibility for events, i.e., public/planned.
- Advertisement for material services
- The account type should be recognisable

From the user stories, only two were picked by the participants, i.e., 3 and 4, and after discussion, the participants gave the following suggestions and pointed out what could go wrong:

For user story 3:

- The size and technical information of the room should be mentioned.
- What kind of events can happen in the selected room should be mentioned.
- Rent should be mentioned.
- Good search filters would also be required.
- There should be an event calendar with more functions.
- It would be good to have the providers' contact information.
- The reservation is planned, and no preliminary talk is possible because there is no way to contact the room provider.

For user story 4:

- There should be a labelling system for borrowed materials.
- The materials should be sorted automatically for easy return.
- The material provider can be contacted in an emergency or to borrow more items during the event.

- There must be a solution to return items quickly in case items are from different sources.

Conclusion: The Smart Events Web Application was well received by the workshop participants, who found it an effective event planning tool. The feedback provided valuable insights into areas where the application can be improved, including adding more visual aids, customisation options, and advanced features. Based on these findings, many features were added to the current prototype, such as search functionality, responsiveness, event creation with a map, material services, and recognition of account type and room details. The future development of the Smart Events Web Application can focus on addressing these areas of improvement to enhance the user experience and increase user satisfaction.

7.2. Smart Lock Evaluation for the Smart Events Web Application

This section was written in collaboration with Chaudry Hamza Tariq [16]

The Smart Events Web Application is designed to enable community-based room sharing using smart locks. The smart lock feature is vital to the application, as it allows users to easily manage access to shared spaces and ensure security. As the designer and developer of the application, self-evaluation was conducted to gain insights into the smart lock feature's usability, effectiveness, and user satisfaction.

The following criteria were used to evaluate the smart lock feature of the Smart Events Web Application:

- Ease of integration: How effortless is integrating the smart lock with the application?
- Effectiveness: How effectively is the smart lock enabling community-based room sharing?
- User satisfaction: How satisfied is the user with the smart lock feature of the application?

The Smart Events Web Application was utilised and evaluated the smart lock feature in terms of ease of integration, effectiveness, and user satisfaction. A smart lock was installed and configured and then linked to the application. A series of room-sharing tasks were conducted using the application and smart lock to assess the integration's ease of use and effectiveness. Following the use of the application, a survey was administered to collect feedback regarding overall satisfaction with the smart lock feature.

Data was collected through observations of using the application and smart lock and their responses to the survey questions.

Evaluation of the smart lock feature of the Smart Events Web Application revealed that it is highly effective in enabling community-based room sharing. Integrating the smart lock with the application was easy to set up. Shared spaces were easily accessed using the application and smart lock, and this feature contributed significantly to the overall effectiveness of the application.

In terms of effectiveness, the smart lock is highly effective in ensuring security and managing access to shared spaces. The application's integration with the smart lock allowed accessible grants and revoked access to shared spaces as needed, which helped to ensure privacy and security for all users.

The smart lock feature is highly satisfactory regarding user satisfaction, with a range of features that meet expectations for a smart lock-enabled room-sharing application. The feature's ease of use and reliability was appreciated, contributing to a positive user experience.

The main limitation of self-evaluation is the potential for bias as a designer and developer of the Smart Events Web Application. The familiarity with the application and smart lock integration may have influenced our perceptions of its ease of integration and effectiveness. It may not accurately represent the experiences of actual users. Additionally, the sample size is limited to only the application developer and does not have the opportunity to gather feedback on smart locks from a diverse group of users.

Self-evaluation of the smart lock feature of the Smart Events Web Application has provided valuable insights into the ease of integration, effectiveness, and user satisfaction of the feature. The high ratings indicate that the smart lock integration effectively enables community-based room sharing and is user-friendly. However, further research and evaluation with actual users are needed to validate our findings and to address any limitations identified during this self-evaluation. Overall, this self-evaluation provides a starting point for future research and smart lock-based room-sharing system development.

7.3. Discussion of Citizen Participation and Smart Community building

During this project, well-tried requirements elicitation techniques like interviews and prototyping were used to involve citizens as experts in the design of a Smart Community Event Planning platform. It became clear that of the stakeholders involved, most of the Event Organisers were very interested in such a platform and in sharing their visions. Although there is a lot of overlap in the ideas regarding basic functionalities, such as having as much information about the space as possible and an easy-to-use search and filter function, the utopias are quite varied. While one person wants a networking tool

to keep up to date with the work of other event organisers, another imagines a shopping basket with which events can be clicked together. Noticeably, the visions only overlap where the project description influenced them. Interestingly, one Organiser's vision of an Airbnb for spaces, which enables short-term booking of spaces, is explicitly rejected by a Room Provider.

The interviews show that both Room and Material Providers prefer direct contact to transactions on a platform. It is also apparent that Room and Material Providers see no real need for a Smart Community Event Planning Platform. Maintaining their presence on the platform would be an additional effort without benefit, as their resources are already in demand.

This raises the question of how the platform can offer Room and Material Providers the greatest possible benefit with the least effort on their part to motivate them to participate. A possible benefit for the Room Providers could be implementing the Smart Lock system. However, the interviewees of this stakeholder group did not show much interest in granting access to their premises to external parties when no staff is present, unless in exceptional cases. Another possible solution would be to create interfaces for existing booking and rental services.

Should the vision of the Smart Community Event Planning Platform be pursued further, it would need to be clarified which stakeholder group retains the final say concerning the functionalities. In addition, the extent to which commercial space and material providers should be involved in further development would have to be examined. The interests of another group have also not been considered so far, also because they are difficult to grasp: those who could provide suitable spaces but do not know how. On this point, more could be learned from projects like Raumkompass and vacancy projects in other cities.

The interviews were very enlightening regarding building a *Smart Community* around the organisation of events in Bamberg. Event Organisers often rely on their community and networking to find new spaces and get access to materials and equipment. They also often rely on the community to provide security for their events, for example, by taking care of ticket sales and admission or age checks.

Two Event Organisers see a Smart Community Event Planning Platform as a possibility to improve their networking by informing them about the plans of others. They feel contact is not sufficiently maintained, and the platform could provide a low-threshold way to stay in touch. One of them additionally envisions a project manager or staff member who promotes the growth and positive development of the platform, as they point out that networking does not happen by itself but has to be supported in a targeted way. They also suggested maintaining information about the spaces as a community and sharing experiences of holding events in the listed spaces.

Another Event Organiser emphasised that they want to give something back to the city through their activities by showing people how vacant places can be used in new ways. In describing their process, it is clear how much influence city departments such as

the Ordnungsamt and the Wirtschaftsförderung have in enabling event organising and community building. When efforts are made to ensure that vacant spaces are used, space providers and cultural practitioners who would otherwise never have come into contact can be brought together. This exchange, already made possible in Nuremberg through the "Raumkompass", for example, can be inspiring and personally enriching.

It is, therefore, not surprising that in the interviews, the desire was often expressed for the city of Bamberg to be involved in the Smart Community Event Planning Platform. This is reminiscent of the definition of *Smart Community* presented at the beginning, which consists of individuals, organisations and governing agencies working in partnership using ICT to achieve a common interest. Two Event Organisers see the city's role as crucial in giving credibility to a potential platform so that users trust it.

However, more needs to be done than building trust in a Smart Community Event Planning Platform. Judging from the interviews, trust must also be built between the city administration and Event Organisers. From the interviews, artists feel Bamberg's cultural and small arts scene lacks visibility, funding and appreciation. They have the impression that the city administration generally does not feel responsible for the concerns of artists and that many obstacles must be overcome to realise projects.

In summary, there is a community built by the Event Organisers to make events possible in Bamberg. Building a Smart Community Event Planning Platform could strengthen the community between Event Organisers. To succeed, ways must be found to unite Room and Material Providers and the relevant city departments behind a shared interest to build a true *Smart Community*. While the question of how to involve Room and Material Providers can be further explored as part of a software development process, the city of Bamberg needs to find ways to create space for culture as part of its cultural policy. It, therefore, needs to weigh how much money it would cost to build cultural spaces instead of investing resources in making them available and sharing what is already there.

7.4. Further Recommendations

The interviews with experts and stakeholders revealed requirements and highlighted the strengths and difficulties of Event Organisers in Bamberg. Additionally, they yielded general recommendations on which surrounding conditions can positively influence the long-term success of a Smart Community Event Planning Platform.

Highlight the value of sharing Present the use case of a Smart Community Event Planning Platform in a way that contextualises the monetary costs with the value created. For example, the value of community building by connecting people to come together and share and connecting Room Providers and Event Organisers from completely different backgrounds.

Design interfaces right from the start Focus on the core value of the Smart Commu-

nity Event Planning solution and then integrate the platform with other existing systems, e.g. event calendars and booking systems.

Consider integration into an already established platform Integrating a tool into a known platform can be more successful than attracting users to a new, stand-alone platform. The experience in Nuremberg shows that the stand-alone pan-European platform confuses users. In hindsight, it would probably have made sense to embed a platform for Nuremberg in the city's corporate design into the city administration's website.

Integrate the platform into a long-term strategy As explained at the end of the previous section, the needs of Event Organisers cannot be addressed by a single digital tool alone. As the Nuremberg Raumkompass shows, the platform can only be one building block in a long-term strategy to strengthen the small arts scene. A long-term strategy is necessary to secure the platform's support and the users' trust. It should include, among other things, measures to activate space owners who do not yet make their free spaces available.

These recommendations show the importance of seeing the platform as public benefit-oriented and embedded in a local community environment. Even if it turns out that the platform integrates for-profit services alongside interfaces to non-profit services, it is unlikely that this will result in a business model that can sustain itself. Therefore, a cultural policy and financial commitment from the municipal and state side will be necessary for success. As discussed in section 2.2., for a *Smart Community* initiative to succeed, not only the affected citizens must be open for change, but also the respective municipal authorities. This thesis provides an insight into the needs of citizens towards their city, which can be included in the further development of the Smart City Bamberg.

8. Conclusion

The following sections summarise the research on the "Raumlotse" project idea conducted in this master thesis.

8.1. Interviews and User Stories

In this work, three user groups were considered: Event Organisers (six interviewees), Room Providers (three interviewees), and Material Providers (three interviewees). Each group described their way of operating, challenges and visions for a Smart Community Event Planning Platform. Eleven user stories were written based on these interviews, of which five were selected for discussion within a workshop. To gain additional background knowledge, the expertise of two software providers and a representative of the Nuremberg Raumkompass was gathered in interviews. This master thesis thus provides valuable insight into the working methods and needs of the different actors in the field of event organisation in Bamberg. It contextualises these with experiences from software development and a comparable project from the region.

It is important to note that some of the visions shared by the Event Organisers were influenced by the project description provided before the interviews. This shows the difficulty of not influencing interview partners with one's prior knowledge and assumptions about technical solutions and feasibility. On the other hand, an implementation proposal for discussion during the interview can also have a channelling effect in a positive sense, as an open brainstorming of visions does not suit every interview partner. In this respect, it remains a matter of consideration for each project with citizens to what extent preceding suggestions inform the collection of possible functionalities.

The interviews showed stakeholders are interested in technological solutions supporting their work. However, they also revealed challenges that were out of this thesis's scope and could be addressed in future work (see Chapter 9). They also pointed to challenges such as inadequate funding and barriers to using vacant spaces that cannot be solved by technology alone but should be addressed by cultural policy. The Smart Events web application designed in this thesis shows which room search and event planning processes can be supported technologically.

8.2. App

This section was written in collaboration with Chaudry Hamza Tariq [16]

The report has presented an in-depth analysis of the Smart Events web app. The app is designed with a user-friendly interface that allows users to browse and search for events, view event details, and securely join events with the help of a smart lock.

The application uses Vue.js for the front end and Firebase BaaS, enabling prototypes' rapid development without worrying about creating a whole back-end infrastructure to handle processes. It also provides user authentication and authorisation to ensure that only authorised users can access certain features. It was essential to understand how different roles, i.e., event organiser, location provider, and guest, can communicate with each other with proper GUI. The CFG and OPM diagrams help in understanding the GUI.

In conclusion, this master thesis has presented a solution for community-based room sharing using Nuki smart lock API. By leveraging the capabilities of the smart lock system, we have added an extra layer of security to the access process. Through real-time location monitoring, the system verifies the guest's registration, membership status, and physical presence at the event location. The smart lock system will only unlock when the guest is close to the event entrance to enhance security and prevent unauthorised access to the location.

The system also offers a cost-effective solution using a QR code to unlock the door. A QR code can be printed on anything and placed at the entrance, eliminating the need for expensive biometric devices or keypads. Overall, this solution has the potential to improve the accessibility and security of community-based room sharing at events while also being a cost-effective option for event organisers.

Overall, the smart events web app would provide a convenient, efficient, and secure platform for users to discover and reserve spots at events and for event organisers to manage and promote their events.

8.3. Design for a Smart Community

In addition to exploring technical possibilities, this work addressed how an event planning platform could be used to build a *Smart Community*, defined as a partnership of individuals, organisations and governing agencies using ICT to achieve a shared interest. Not surprisingly, it was easy to identify the common interest of the Event Organisers in Bamberg: To be able to set up events as easily as possible, even at short notice. Defining the common interest of Event Organisers, Room, and Material providers is more difficult or abstract.

Like the Event Organisers, all Room and Material Providers interviewed are interested

in varying degrees in having a strong, visible, diverse and self-organised cultural scene in Bamberg. Their (often voluntary) work makes many events possible. The Room Providers, in particular, are working at the edge of their capacities to meet the demand. Personal contact with their renters is important to the Room and Material providers. The Room providers especially want to be able to stand behind the events at their premises. This means that short-term event organisation via a platform will probably only be possible in a few cases.

Therefore, the strengths of such a platform would be most likely to provide direct contact with Room and Material providers, to support networking, coordination of planned events and the sharing of knowledge. This could break down barriers in event planning in Bamberg, as it currently seems that success and failure depend mainly on knowing the right people. Further research is needed if a greater added value for Room and Material providers is to be created through the platform.

As the interviews have shown, the stakeholders would like to see a commitment from the city to maintaining and expanding cultural offerings and spaces in Bamberg. The Smart City strategy paper published in March 2023 states that Bamberg will offer the cultural scene and other interested parties space to thrive in many decentralised locations [14]. It emphasises that sharing spaces and materials will contribute to a more sustainable society. This master thesis illustrates how the Smart City Bamberg can achieve these goals. As has been highlighted, the commitment of the municipal authorities is required, especially concerning trust in the platform, financial feasibility and integration into the cultural policy strategy.

Event Organisers, Room and Material Providers, and the city of Bamberg wish to strengthen the cultural scene and make more spaces available. This common interest can be furthered by measures like implementing a Smart Community Event Planning Platform to support engaged citizens' work and collaborative networking. Whichever way the Smart City Bamberg pursues the project " Raum- und Materiallotse", it is recommended that a citizen-centred approach will be continued in the design and that further research will be done to improve the involvement of citizens and civil society organisations in building sustainable *Smart Communities*. Civil society actors have shown great interest and willingness to cooperate in the preparation of this master thesis. To give them the opportunity in the future to implement digital innovations sustainably and thus further increase the high quality of life in the city, targeted, empowering participation offers must be created, and it must be made transparent how their input is further used.

9. Future Work

In the following sections, suggestions are made on how the research conducted in this thesis could be extended in the future.

9.1. Support room-sharing with Smart Locks

This section was written in collaboration with Chaudry Hamza Tariq [16]

This section outlines potential future work and development areas for the community-based room-sharing system using Nuki smart lock API. The system has the potential to be further enhanced and expanded to provide additional value for event organisers and attendees.

User Feedback and Ratings: Allowing guests and hosts to rate each other based on their experience and providing a platform for leaving comments and feedback is one potential area for future work. Feedback would help improve the overall experience for guests and hosts and provide valuable insights for event organisers to improve future events.

Integration with Payment Systems: Another area for future work is to integrate the system with payment systems which would allow hosts to charge guests for room sharing, which could be a valuable source of revenue for event organisers. The integration could be done through popular payment gateways such as PayPal or Stripe, making it easy for hosts to receive payment.

Expand to Short-Term Rentals: The system could also be expanded to short-term rentals beyond just events, allowing hosts to rent out their space to guests for a broader range of activities, such as vacations or business trips. Expanding the scope of the system could be used for a broader range of purposes and provide additional value to users.

Integration with Other Smart Home Devices: The system could be integrated with other smart home devices to provide guests and hosts an even more seamless experience. For example, it could be connected to smart thermostats or lighting systems, allowing hosts to adjust the room's temperature or lighting based on the guest's preferences so it would provide an enhanced level of comfort and convenience for guests.

Overall, the community-based room-sharing system using Nuki smart lock API has the potential for further development and expansion. By incorporating additional features and expanding the scope of the system, it could provide even more value for event organizers, hosts, and guests. Further research and development in these areas could lead to a more comprehensive and efficient system for community-based room sharing.

9.2. Support cultural creators in Bamberg

Challenges regarding visibility and funding opportunities for the cultural scene were described in the interviews. In terms of visibility, it would certainly make sense to check the current possibilities of advertising cultural offerings for the potential for improvement and to research whether other Smart City projects have already been implemented or are developing possible solutions. Furthermore, when developing the new offers of the Smart City Bamberg, it could be considered whether visibility can also be created within these frameworks. Regarding funding, it was noted that the processing of applications often takes a long time. There may be potential here to make processes more efficient with the help of ICT, which could be explored in the future.

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A. Workshop Documentation

A.1. IGER Workshop: Designing a Smart Community Event Planning Platform

Agenda

1. Short introduction to the Raumlotse project
2. First look at the prototype and feedback
3. Discussion of selected user stories

Project Idea: "Raumlotse"

- Was proposed by cultural creators during the Smart City Bamberg "Ideenschmiede"
- Open-source platform that supports cultural creators in Bamberg in finding suitable event spaces
  - Venues which are unused during evenings of venues
  - Vacant rooms or venues
- Implementation of a smart lock system to provide access to venues
- Platform could be expanded to include an event calendar which allows users to be aware of events that are taking place at the same time as their planned event

Research Questions

- What communication processes should the platform enable and how should they be implemented?
- What are the requirements to ensure physical access to the venues in a secure manner?
- So far, we have...
  - interviewed cultural creators, room providers and material providers in Bamberg to gather requirements
  - interviewed the person responsible for the Raumkompass in Nürnberg
  - researched smart lock and event management solutions

  - consulted professional software developers about their thoughts on the feasibility of the project and potential business models
  - implemented a selection of the collected requirements into a preliminary prototype

Challenges

- Vacancy management is a sensitive topic which has political implications -> Potential for conflict
- Varying degrees of motivation of stakeholders to take part in the project
- Time: Cultural creators have very full schedules

Prototype

You can try out the prototype either on your desktop or your smartphone: http://smart-events.netlify.app

Credentials

- *Event Organizer:*
  - chhamzatariq524@gmail.com
  - qwertz
- *Location Provider:*
  - hamzatariq10@outlook.com
  - events
- *Guest:*
  - chhamza_tariq@yahoo.com
  - abcdef

Prototype Feedback

- Did something surprise you?
- What did not feel right to you?
- What did you like?

User Stories

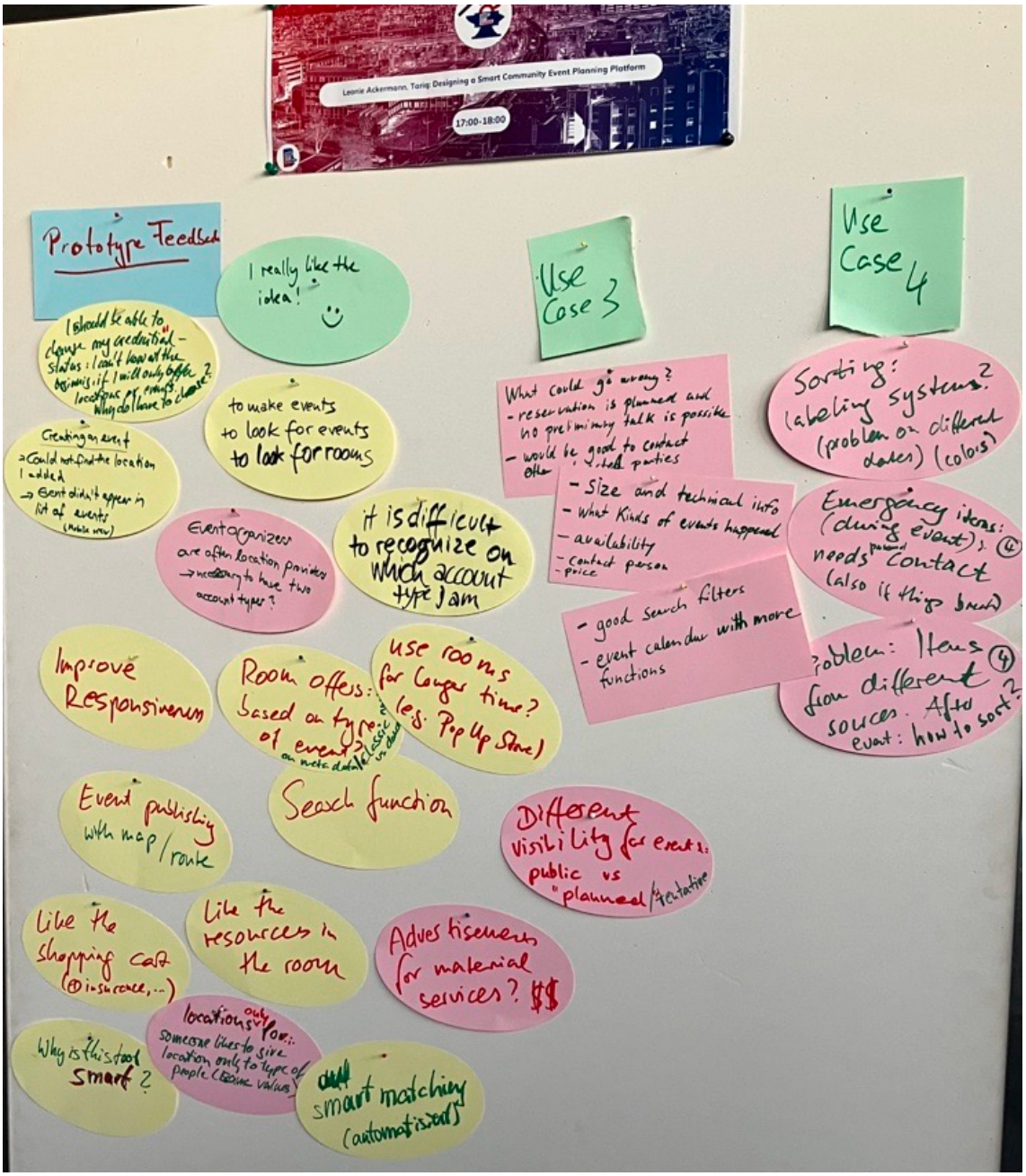
1. The event organizer contacts the room provider via the platform so as not to have to keep track of different communication channels

2. The event organizer receives the necessary information to be able to open and close the room again, to avoid the usual stress with the handover of keys on the part of both the provider and the renter.
3. The event organizer uses the platform to find out about all the relevant features of a room to be sure that the room is suitable for the planned event.
4. The event organizer will find an overview of borrowable materials from providers in Bamberg on the platform, so that it is as easy as possible to get this information and organise a successful event.
5. The location provider receives support and information from the platform on how to offer the rooms in a legally secure manner to be able to offer rooms as low-threshold as possible.

Tasks and Discussion Prompts

- Pick a user story.
- Gather in groups.
- Try to break down the described action into individual steps. Discuss what this process should ideally look like.
- What could go wrong?

A.2. Workshop Results



B. Nuki Smart Lock

The Nuki Smart Lock is a smart home device that enables users to remotely control the locking and unlocking of their doors through a mobile application. Integrating the Nuki Smart Lock with a web application using the Nuki API provides users with added convenience, such as granting temporary access to guests, monitoring access logs, and receiving alerts when the door is locked or unlocked.

B.1. Setup

This section provides step-by-step instructions for setting up the Nuki Smart Lock.

Step-by-Step Guide

- Install the Nuki app on a smartphone from the App Store or Google Play Store.
- Create a Nuki account and follow the instructions in the app to add the Nuki Smart Lock.
- Place the Nuki Smart Lock over the existing door lock, ensuring it is properly aligned and securely attached.
- Calibrate the lock by following the instructions in the app, which involves locking and unlocking the door several times.
- Configure the settings in the app, such as setting up automatic locking and unlocking, configuring access permissions, and enabling integrations with other smart home devices.

When setting up the Nuki Smart Lock, it is essential to ensure that appropriate security measures are in place to prevent unauthorized access. Security can be achieved by configuring the lock settings to require authentication for specific actions, such as creating or deleting access permissions. It is also recommended to enable two-factor authentication for the Nuki account.

Setting up the Nuki Smart Lock is a straightforward process that can be completed in simple steps. Appropriate security measures should be implemented to prevent unauthorized access to the lock.

B.2. Integration with Web application via API

This section provides technical details regarding integrating the Nuki Smart Lock with a web application using API.

The Nuki API is a RESTful API that provides endpoints for developers to control the lock and access lock-related information. The API enables developers to access the functionality of the Nuki Smart Lock programmatically, which allows for integration with a web application. The Nuki API requires developers to obtain an API token, which can be obtained by registering a Nuki account and creating an API client.

After obtaining the API token, developers can send HTTP requests to the Nuki API endpoints to perform actions such as locking or unlocking the door, retrieving lock status, and creating or deleting access permissions. The responses can be parsed and displayed to the user on the web application front end.

When integrating the Nuki Smart Lock with a web application, security measures should be implemented to prevent unauthorized access. Authentication should be required for specific actions, such as creating or deleting access permissions. It is also recommended to enable two-factor authentication for the Nuki account.

Integrating the Nuki Smart Lock with a web application using the Nuki API can provide users with added convenience and flexibility. The Nuki API allows developers to access the functionality of the Nuki Smart Lock programmatically, enabling integration with a web application. It is essential to implement appropriate security measures to prevent unauthorized access to the lock.

B.3. How to Access Smart Events Web Application

This section provides the link and credentials for accessing the Smart Events Web Application for each user role. These credentials were used during the evaluation process of the application.

Application Link
https://smart-events.netlify.app/

Event Organizer
Username: event_organizer@example.com Password: EventPassword123

Location Provider
Username: location_provider@example.com Password: LocationPassword123

Material Provider
Username: material_provider@example.com Password: MaterialPassword123

Guest
Username: guest@example.com Password: GuestPassword123

Note: These credentials provide access to the various features and functions of the Smart Events Web Application for each role. With these credentials, users can log in to the application and perform the tasks associated with their role, such as creating events, uploading locations, and accessing event information.

It is important to note that these credentials were used for evaluation purposes only and should not be used for any other purpose.