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Hackathons at academic makerspaces

Master's Thesis

to achieve the university degree of

Diplom-Ingenieur

Master's degree programme: Production Science and Management

submitted to

Graz University of Technology

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Graz, August 2018

Affidavit

I declare that I have authored this thesis independently, that I have not used other than the declared sources/resources, and that I have explicitly indicated all material which has been quoted either literally or by content from the sources used. The text document uploaded to TUGRAZonline is identical to the present master‘s thesis dissertation.

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Abstract

With hackathons being a global phenomenon, they have already gained momentum at Graz University of Technology as well. As first step, the goal was to identify which events similar to hackathons are already conducted in relation to the university. Then the researcher looked for events of the same kind that take place in Austria and its neighbouring countries. The second goal was to transform the software-based format to a physical prototyping format. This concept was incorporated into a manual which shall serve the reader as a guideline to organise a hackathon event. The study used qualitative methods such as expert interviews and case studies. The first task was to develop a conceptual framework with different characteristics, including duration of the event, number of participants, outcome, type of organiser, which were examined in a next step. To understand the organisational aspects of hackathons in a detailed manner six events were studied by either participation or observation. With the results gathered from these studies a concept for a hackathon at an academic makerspace was developed. To point out the focus of physical prototyping a new name was conceived, makerthon. A draft event was conducted to verify the concept. It was a three days event with 33 participants and two different challenges. Contradicting the previous findings, a few new ideas were tested, such as supporting the teams' projects with product development methods to improve the output. The learnings of the draft event were incorporated into the latest version of the makerthon handbook which is presented within this thesis.

Keywords: Hackathon, hackathons, makerthon, makerspace, FabLab, innovation, physical prototyping, digital prototyping machines.

Kurzfassung

Das globale Phänomen Hackathon hat auch bereits die Technische Universität Graz erreicht. Um diese Events genauer beurteilen zu können musste zunächst geklärt werden welche Formate bereits von den unterschiedlichen Instituten und Organisationen an der Universität angeboten werden. Um einen besseren Einblick in die Hackathonszene zu bekommen hat sich der Autor nicht nur auf Events an der Technischen Universität Graz beschränkt, sondern auch Veranstaltungen anderswo in Österreich und seinen Nachbarländern untersucht. Hackathons sind vor allem in der Softwareszene sehr beliebt und verbreitet. Im nächsten Schritt galt es dieses Konzept zu adaptieren mit dem Fokus auf physischem Prototypenbau. Dieses Eventkonzept wurde in ein Handbuch eingearbeitet welches dem Leser die Möglichkeit eröffnen soll einen Hackathon eigenständig zu organisieren. Um die notwendigen Daten zu sammeln wurden qualitative Forschungsmethoden wie Experteninterviews und Fallstudien verwendet. Es wurde eine Rahmenstruktur entwickelt anhand derer die Hackathons charakterisiert wurden. Dies inkludierte unter anderem die Länge der Events, Teilnehmerzahl, Ergebnis, Art des Veranstalters. Um die organisatorischen Aspekte besser zu verstehen wurden in einem nächsten Schritt sechs Events näher untersucht, entweder durch aktive Teilnahme oder durch Beobachtung. Mit den Erkenntnissen aus diesen Studien wurde Eventkonzept für einen Hackathon in einen Makerspace entwickelt. Um die Fokussierung auf den physischen Prototypenbau hervorzuheben wurde das Event unter dem Namen Makerthon geführt. Im nächsten Schritt wurde das Konzept auf den Prüfstand gestellt in dem ein Makerthon durchgeführt wurde. Es war ein dreitägiges Event mit 33 Teilnehmern und zwei unterschiedlichen Aufgabenstellungen. Dabei wurden einige Dinge getestet die im Widerspruch zu den gesammelten Erkenntnissen standen. Beispielsweise den gesamten Prozess mit Produktentwicklungsmethoden zu unterstützen um bessere Ergebnisse zu erhalten. Die Erfahrung und Erkenntnisse wurden wiederum in die neueste Version des Makerthon Handbuchs eingearbeitet welches in dieser Arbeit präsentiert wird.

Stichworte: Hackathon, hackathons, makerthon, makerspace, FabLab, innovation, physical prototyping, digital prototyping machines.

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1 Introduction

During a hackathon event people gather in one location to create different prototypes within a short time period (Warner and Guo 2017, p. 1). They usually last between one and five days. Hackathons have started in the world of software production but have spread into the corporate and non-profit (Irani 2015, p. 6) as well as the academic world (Warner and Guo 2017, p. 1) within the last two decades. Already Major League Hacking (MLH), an organization which helps to host student hackathon competitions around the world, has more than 65.000 students per year participating in their events (Major League Hacking 2018). Predominantly in colleges in the United States (US) hackathons become more and more an integral part of the education of information technology (IT), design or engineering studies. These events provide the students with the possibility to work on hands-on problems and to enhance their skills. Hackathons are coding-biased. Barely any of them take place in a makerspace or make use of their machines. A makerspace can be defined as community-based workspace that offers its users access to digital prototyping machines and tools in order to realize their physical prototypes and other projects (Weinmann 2014, p. 7).

The goal of this research is to create an event concept to host a hackathon at the university-based makerspace. This facility is called FabLab, which is an abbreviation for fabrication laboratory. The *FabLab Graz* is operated by the *Institute of Innovation and Industrial Management (IIM)* at *Graz University of Technology (TUG)*. The focus hereby is on the utilization of digital prototyping machines throughout the whole event. The *introduction* chapter includes three sections: *motivation, objectives* and *research approach*.

1.1 Motivation

As hackathons seem to be everywhere these days, the main motivation is to utilize this event format as good as possible at TUG. Therefore, it is necessary to get an overview about the already existing events which are hosted at TUG or are conducted somewhere else with TUG involvement. With the gathered information about which institutes are involved, information about the participants and other key factors, a map of the hackathon environment at TUG can be drawn. This map shall help to fill the gaps with new event formats or help other institutions within TUG to get an overview on the existing events. In a next step the research is extended by

non-TUG related events to get better insights in hackathons. The primary intention is to determine typical values for key factors like duration or participants and find other event organisers which are using digital prototyping machines throughout their events.

Finally, a hackathon event concept for less coding affiliated participants is developed and documented. The main intention is to create a new event which is not focused on coding, like the majority of the events, but one that is capable to utilize the given possibilities of a makerspace as good as possible. Therefore, it is necessary to develop a framework which supports the usage of makerspace specific machines like 3D-printers or laser cutters. Further on this concept is called makerthon.

1.2 Objective

The objectives of this research are to understand how hackathons work and how their concept can be transferred to physical prototyping rather than software development. The main research goals can be summarized as follows:

- Development of a holistic understanding of hackathons
- Overview of TUG related hackathon events
- Setup of a draft concept for a makerthon event, its conduction and analysis
- The synthesis of the results to develop a final concept on how to conduct a makerthon at a makerspace based on lessons learned from hackathon events and the results from the makerthon draft event

This can be achieved by learning from actual hackathon events and the experience of people who organised them. Looking at those examples, knowledge will be gathered about the different event formats and their effects on the hosts and participants. Further, an understanding for the makerspace-specific machines needs to be established, especially for 3D-printers, laser cutters and vinyl cutters. This knowledge can be used to set up the draft event customised to the specific infrastructure at the FabLab Graz. With the lessons learned the concept can be refined.

The final outcome of the thesis is a handbook for conducting a makerthon at the FabLab Graz, which provides the future organiser of a makerthon with a handbook on what/where/when certain things need to be done to host a successful event. The concept aims for a good compromise between the different involved stakeholders, represented by the participants, the IIM, the event sponsors and TUG.

1.3 Structure

The structure of the thesis is based on the eleven steps of the generic research process defined by Karlsson (2016): *(1) Identification of a problem or issue to research; (2) Literature review; (3) Specifying the aim, objective, or purpose of the intended research; (4) Determine specific research questions; (5) Choice of research approach and methods; (6) Development of a conceptual framework; (7) Data collection; (8) Analysing and interpreting the data; (9) Synthesizing and concluding; (10) Evaluating the research and suggesting further research; and (11) Reporting and communicating the research findings.*

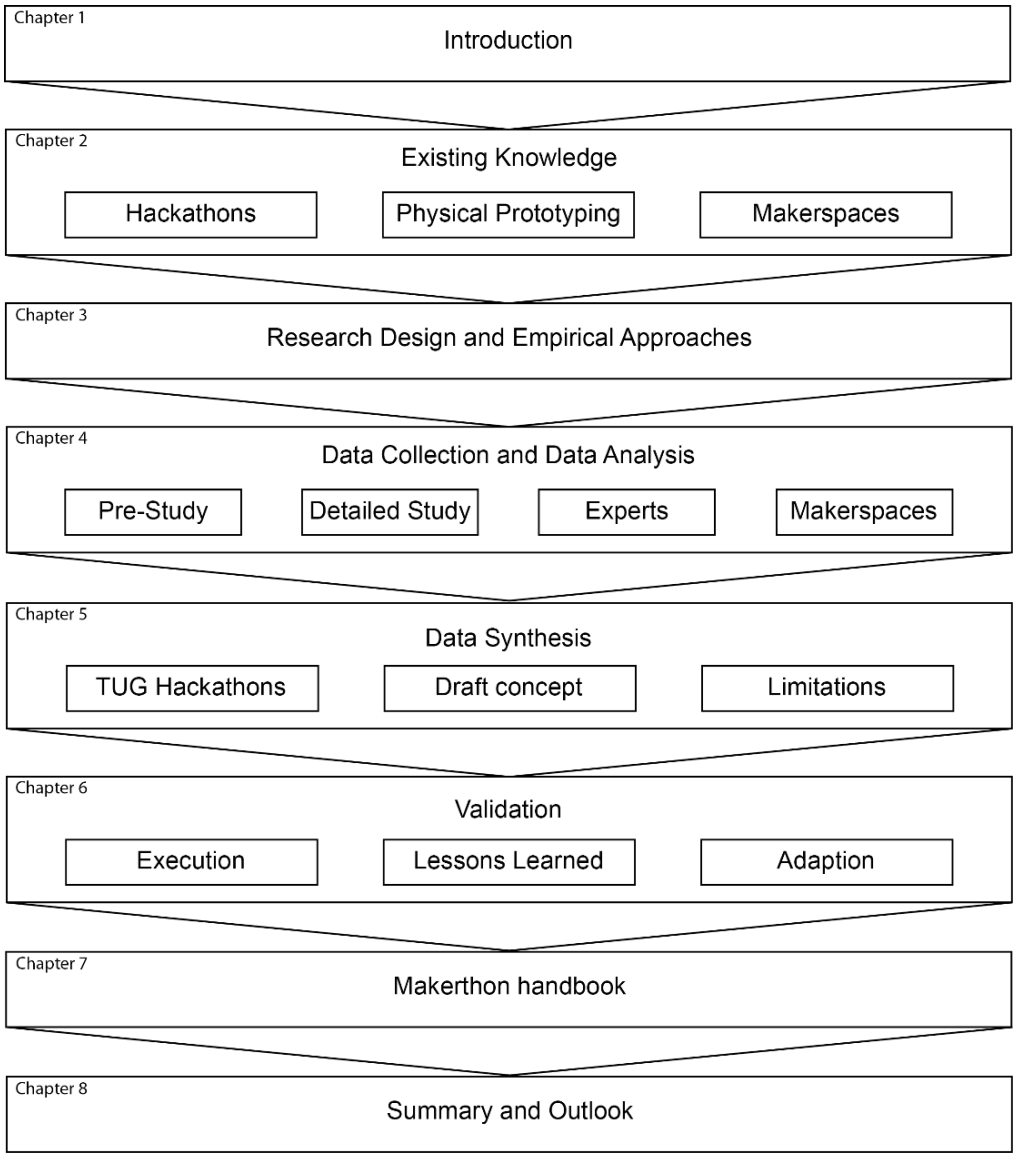

Figure 1: Structure of the thesis[1]

[1] Author's illustration

Chapter 1 introduces the research topic and the motivation behind it. The research objective is stated and the structure is presented (see Figure 1).

Chapter 2 investigates the existing knowledge on hackathons, physical prototyping and makerspaces. The hackathons section covers several aspects, from the general term definition to the motivation of conduction and the legal aspects. Not only are makerspaces elaborated in chapter 2, but also important related machines like 3D-printers and laser cutters.

Chapter 3 provides an insight of the research design and empirical approaches. The created conceptual framework and the applied methods for data collection and analysis are introduced.

Chapter 4 covers the collected data and the results of the analyses. The pre-study consists of data gathered from more than 30 hackathon events primarily in Austria and Germany. A detailed investigation of seven hackathon events was conducted. Furthermore, information through hackathon experts and makerspace operators was collected. For data analysis methods like cross-case evaluation and statistics were used.

Chapter 5 derives out of the gathered information and provides an overview of TUG related hackathon events as well as a draft concept for a hackathon at the FabLab Graz. The draft concept was developed in collaboration with several IIM employees. The limitations of the draft concept are clarified.

Chapter 6 outlines the lessons learned and feedback from the conducted makerthon according to the draft concept. The learnings of the event will be incorporated to the makerthon event manual. The manual itself will be a separate document.

Chapter 7 provides the results of the previous research in form of the makerthon handbook.

Finally, Chapter 8 concludes the results and offers suggestions for further research.

2 Existing Knowledge

In the following chapter the topics hackathon, physical prototyping and makerspaces are derived from a literature research. Different types of hackathons (2.1) are defined and their legal aspects in terms of intellectual property rights (IPR) are investigated. Prototyping is one of the key aspects in hackathons and makerspaces, which is why especially the physical prototyping and building are described. According to Weinmann (2014, p. 10) physical prototyping is an underlying process of the concept of makerspaces. To provide a simpler understanding not only makerspaces in general are elaborated, but also three important digital prototyping machines. These machines are the 3D-printer, laser cutter and computerised numerical control (CNC) mill.

2.1 Hackathons

The history and the definition of hackathons, as well as other selected differently named events, are derived from literature. Often participants of hackathons do not know exactly how the organiser will deal with their created ideas and prototypes in terms of IPR. For this reason, the common legal formats are explained. The word hackathon is a neologism of the words “hacking” and “marathon”, where hacking refers to exploratory programming. Not to be mistaken with the reference of committing a cybercrime (Briscoe and Mulligan 2014, p. 2). Marathon serves as a synonym for long and exhausting activity. Even though hackathons have become very popular in recent years they are not a completely new concept.

2.1.1 History

It is not completely clear which event was called hackathon first, but apparently the term was introduced independently from one another by two different events in the late nineties. The first event was held by OpenBSD 1999 in Calgary, Canada. A couple of developers gathered in a house for a week and developed some software parts. According to OpenBSD either Theo or Niels Provos have coined the new term hackathon (OpenBSD 2016). The second event is to be said the JavaOne conference 1999 in San Francisco, United States of America (USA) (Philips 2014). Attendees of the hackathon had the possibility to develop apps for the Palm V for two days (Aviram 1999). Back then, the Palm V was one of the latest personal digital assistants (PDA). Although those were the first two events called hackathons,

programmers have been participating in hackathon-like events since the 1960s. Back then students from the Massachusetts Institute of Technology (MIT) programmed in a marathon-like process until they had their solution (Pessi et al. 2014, p. 2).

The format of hackathons did not change much until 2005, when Amazon Web Services and Ruby on Rails were introduced to public. In the same year IT companies like Facebook or Yahoo started conducting in-company hackathons (Hainline 2016). Within the last decade the number of conducted hackathon events increased tremendously. Until the name hackathon was entrenched, these events had various different names like Hack-a-Ton, Codeathon, or Hacking Days (Irani 2015, p. 6). In the last couple of years, the increasing power and popularity of hackathons was recognized by other industries and moreover non-business fields, aside from IT, too (Siva 2017).This includes industry branches like finance or media and other institutions like government agencies, non-governmental organisations (NGO) and universities (Irani 2015, p. 6). Because of the spread beyond the classical engineering world, there are hackathon event formats for very unconventional topics or for specific target groups. On one hand there are hackathons to fight autism, hackathons to improve education, hackathons to help veterans or hackathons to troubleshoot water pollution. On the other hand there are women-only hackathons, hackathons for kids or hackathons for college students (Leckart 2012).

2.1.2 Definition

Literature provides various kinds of definitions what a hackathon is. Some of them are defined very widely others may include more details about the timeframe, team sizes or intended target group. Still many refer to the initial origin of the term with a focus on software projects. The following four excerpts provide definitions of a hackathon event stated in literature:

- *“A hackathon is an event where people gather in one location to create prototype software projects within a short time period, usually from one day to one week”* - Warner and Guo 2017, p. 1
- *“Hackathons are events where people who are not normally collocated converge for a few days to write code together”* - Trainer et al. 2016, p. 1
- *“Hackathons, as one type of an increasingly popular ideation contest, are events in which programmers, developers and sometimes individuals from other disciplines collaborate on a software project in a friendly environment by generating a solution to a beforehand specified problem”* - Pessi et al. 2014, p. 2

- *"A hackathon is an event where people in small groups participate in an intensive prototyping activity for a limited amount of time"* - Raatikainen et al. 2013, p. 1

As a conclusion of these definitions and with respect to the latest trend, it is not an IT-only event anymore, a hackathon can be defined as following:

> *For a very short time period people are brought together in order to ideate and solve problems for a given topic*.

The definition was kept very basic to avoid excluding any common types of hackathon events beforehand. The next section describes the major distinguishing features and a provides a classification of different types of hackathon formats.

2.1.3 Distinguishing features

Although there are so many different hackathon events out there, the majority follows a very basic structure. It starts with an introduction session where the participants are welcomed, the sponsors are introduced and the topic or task is revealed or elaborated. The next phase is a teambuilding session. During this step participants who signed up as individuals try to find a team of like-minded people or people who came already as group are trying to add missing competences to their team. Subsequent to the teambuilding the actual hacking begins. At the end of these events the teams have to present their solutions, in the best case on the basis of a working prototype. In case of a competitive event the end is the award-winning ceremony. The focus and the execution details are depending heavily on the host of the event, but the framework is usually the same. Following distinguishing features are important for every event and need to by defined by any organiser.

Timeframe

The chosen timeframe is one of the most essential characteristics which need to be defined. 24 and 48 hours are the most common timeframes. A few events are also shorter than 24 hours but they will not be considered within this thesis. Only a few events last longer than 48 hours due to the fact that it is very hard to find and motivate enough participants for such a long time.

Additionally, what needs to be kept in mind is the difference between net and gross time. Hackathons which promote themselves as 24-hours events often refer to the net hacking time for the participants. Including registration, teambuilding and final presentations the gross time for the event is up to 30 hours. Other events highly recommend you to go home to catch some sleep or even force you to do so by closing down the facilities which reduces the net hacking time tremendously.

Target group

Depending on the overall goal of a hackathon, organisers might focus on a certain participant target group. As an example at the Texx Factor Female Hackathon (2018) women are the intended participants or at the Pioneers Industry 4.0 Hackathon the focus is on start-ups (Nagy 2017). Other target groups could be students, high-school kids, people with a certain job-related background etc. In case an organiser wants to focus on a specific participant group it does not mean that it is exclusively for them. There are two known types. First, they promote their event via selected communication channels in order to address their wanted attendees but are also fine with others as well. Second, a certain number of non-intended people are allowed to participate under defined conditions. For the latter the *Texx Factor Female Hackatho*n serves as an example, where they allowed males to participate too in case they registered as a part of mixed female/male team beforehand (Texx Factor 2018).

Competitive vs. communal event

One factor which establishes the general mindset of hackathon is if it is either a competitive or a communal event. On one hand the focus of communal event is on socializing with like-minded people, giving newcomers the possibility of an easy access to the community or just providing participants with a timeframe where they can immerse into a certain topic. Those events do not reward any of the participants with prizes. Open source software or game development events are usually all about the community. On the other hand there are competitive hackathons where the best teams are rewarded with trophies, goodies, electronics, vouchers or even up to already millions of Dollars in cash (Johnson 2013). The evolution of the possible prizes to win has raised some issues. In the US where high-prized hackathons (more than $10,000 for the winner) are no rarity anymore. It is assumed that pro-hackers will be a legit job in the future. This means that people will make their living out of winning hackathon competitions (Lightstone 2016). High incentives might kill the original spirit of hackathons where it is about collaboration and socializing. Furthermore, the higher the prizes the more likely it will become that people start to cheat in order to win (Conley 2013). At last high prizes for one or a few teams and no prizes for all the others may let them leave the event with a sour aftertaste (The Hack Day Manifesto 2017).

Internal vs. external event

When companies and organisations want to host a hackathon one of the first questions that will arise is whether they want to conduct an internal or external hackathon, which means either they want outsiders to participate or not. With internal events the hosts miss out the opportunity of getting new insights from company-external people or people who are not compromised by the corporate structures and views, and contribute with even more “out of the box”-thinking. Another important aspect is, they do not need to worry about which kind of information and data they will provide for the event. Additionally, they do not need to fear any legal issues from using any of the results, since usually everything that is created by an employee as part of his work, the legal rights belong to the company. For the mentioned characteristics it is respectively vice versa for external events.

Online vs. offline events

At an offline hackathon a participant has to be present at the event venue, while the online event provides the opportunity to participate from home or anywhere else. Although online events are not very personal engaging, they offer a couple of advantages for their hosts. Since more and more companies are using hackathons as a recruitment instrument with an online hackathon, they have the opportunity to go on a global search for talents and the costs for venue, staff, security, etc. cease to apply (Ravisankar 2015). Furthermore, documentation of the results is eased up, because the results need to be handed in digitally. Still offline events are very popular, because of the interaction and collaboration with other people, as well as with the overbearing and exciting physical aspects for the participants. Nowadays it is not a matter of an either-or decision anymore, since events already try to combine the benefits from both worlds, so called online to offline hackathons (Lombard 2017). These events start off as an online event and result in an offline final. Nevertheless, these distinguishing features can determine what kind of event it will be, but in the end the final decision will be made by the given budget.

2.1.4 Classification

According to Jon Gottfried (2013) who is one of the co-founders of the Major Hacking League, hackathons can be classified into the five categories with their individual characteristics. Four of them are explained in the following section. Due to the sharp increase of hackathons the fifth classification was removed and a few more were added in order to take today’s conditions into account.

Start-up hackathon

These events are not about hacking only. Depending on the exact setup of the hackathon, not only a digital or physical prototype is important, but the definition of a business model or the creation of designs are part of the intended outcome as well. All in all, the focus is more on practical concepts (Gottfried 2013). As a result, the final presentation at the end has not the typical hackathon pitching character of "demo or die" (Briscoe and Mulligan 2014, p. 7); it includes the practical demonstration and several slides about the rest of the concept. Such events can be seen as pre-pre-incubator for future start-ups (Gottfried 2013). The "Industry 4.0 Hackathon"[2] which took place in May 2018 in Linz, Austria is an example for start-up hackathon.

Open-source hackathon

Open source hackathons serve as pure community events (Gottfried 2013). Their main purpose is to make major progress in their software development (Warner and Guo 2017, p. 1). With the community in focus there is no judgement of the outcome and therefore no financial incentives for the participants. The final pitch is just a demo of the realized feature, function, fixed bug, etc. As a nature of the event the focus lies on a particular technology (Gottfried 2013). The first hackathon conducted by OpenBSD in 1999 in Calgary, Canada can be classified as an open source hackathon.

Brand hackathon

The hosts of these kind of hackathons are brands which want to create a higher brand awareness or look for new and innovative ways to increase their popularity. The organisers are specially interested in the ideas of developers, as well as functioning demo apps. If participants are looking for a community event, these are in general the wrong events for them. The prizes are the incentive to participate at a brand hackathon (Gottfried 2013). One host already used a new neologism for his event which is an example for this category, namely the Brandathon[3].

Non-technical hackathon

The outcome of such a hackathon is neither a software nor a hardware prototype. It is about developing business plans, service concepts, etc. Some of these events have used other names than hackathon, like ideathon or innovation marathon to point out their difference beforehand. As a result of the missing prototypes only

[2] More details: https://pioneers.io/discover/industry-hackathon2
[3] More details: https://www.brandathon.biz/

ideas and concepts can be presented at the end which can lead to galore slides (Gottfried 2013). The Innovations-Marathon[4] is held every year while the Forum Alpbach serves as an example for this classification.

The four described hackathon types serve as a good foundation in order to classify hackathon events. The following 3 categories should be added to cover the latest trends of hackathons:

Educational hackathon

With the increased popularity of hackathon events, they have found their way into educational institutions too. A hackathon gives pupils and students the possibility to apply their in classroom learned skills and utilize their problem solving abilities. The participants will fail throughout the development process which is a great learning factor (Zoran 2015). The focus of these events is on the learning process of the participants. HackingEDU[5] is a holding organisation which helps educational institutions to conduct hackathon events.

Competitive hackathon

As the competition at these hackathons is one of the essential aspects, potential participants get lured with prize money and/or gift prizes like electronics, flight tickets, etc. At some events winning teams can get several thousands of dollars (Lightstone 2016). In order to win, convincing the jury is vital. Therefore, the presentation at the end has a high priority. Practicability and usability of the created solutions is often of secondary importance (Gottfried 2013).

Internal hackathon

Conducting internal hackathons has become increasingly popular approach for organizations to innovate. Not only new ideas are created, it can be used to test new products as well (Rosell et al. 2014, p. 1). One question that could arise is: why should companies organise hackathons for innovation if there are tons of innovation management software solutions on the market? Because a hackathon can generate more energy and enthusiasm between the team members (Priestley 2016). Further they can foster the possibility to include non-technical staff more into the development process or bring together people from different departments. The element of competition is usually omitted. Still there might be incentives for good ideas.

[4] More details: https://www.innovations-marathon.org/
[5] More details: https://hackingedu.co/#home

The majority of hackathon events can be assigned to at least one of the above described classes. Still events can be also a mix out of several different classes.

2.1.5 Special formats

Due to the huge number of hackathons conducted all over the world, a few deviating or more specific terms for hackathons have become common in order to indicate a potential participant what the event is about. Commonly used terms would be civic hackathons, science hackathons or game jams. These three formats are briefly described in the following:

Civic hackathon

Nowadays governments are opening up their available municipal data more and more. With it, they started conducting hackathons for using the input and skills of civic hackers in order to program mobile apps or find solutions to problems of the public to improve the quality of people's life's (Robinson and Johnson 2016, p. 1). The focus is usually on innovative services which address social issues (Shiramatsu et al. 2015, p. 1) rather than on software for public officials or physical prototypes.

Science hackathon

A science hackathon is aiming for the transition of postdocs to become a fully independent researcher. It provides early career researchers with the opportunity to be exposed to new scientific research questions. It is supposed to be an opportunity for them to see how their own ideas might fit into the larger research landscape and to set up their individual research agenda (Groen and Calderhead 2015).

Game jam

These kind of events enjoy high popularity. Game jams are held all around the world. *Global Game Jam* is the organiser of the world's largest game jam event taking place at many different physical locations at the same time. In 2017 they had 700 locations in 95 countries with more than 7000 games developed within one weekend (Global Game Jam 2018). Kultima (2015, p. 1) conducted a research on game jams and defined these events as follows:

> "*A game jam is an accelerated opportunistic game creation event where a game is created in a relatively short timeframe exploring given design constraint(s) and end results are shared publically.*"

In general game jams are focusing on the community of game developers and serve furthermore as entry point for people who have not done any game development so far.

There are still many more other formats which have evolved, but they will not be described within this thesis. The excerpt of the previously explained three hackathon formats shall serve as an insight of what is possible with hackathon events.

2.1.6 Potentials and downsides of hackathons

Hackathons have become so popular nowadays, because they offer companies, authorities or educational institutions a high potential not only on innovation but also on creating awareness for certain topics. Nevertheless, not all aspects of hackathons are seen positive and a few of them already raised a lot of criticism. In the following section the positive and negative aspects are pointed out.

Positive effects of hackathons

From a participant's perspective the benefits include the possibility to learn to fail, which can be beneficial for future job situations (Artiles and Wallace 2013, p. 2). Socializing and networking is another reason why people like to attend hackathon events. Furthermore, it can serve as an easy access point to certain communities like game developing.

There are several additional benefits for companies. In case of an internal event, networking between employees from different departments and how they work is one aspect. Furthermore, it is a break with daily routines for them, which increases inspiration and work motivation. Compared to other company-organised social events, a hackathon has a direct value for the company, in form of the results (Raatikainen et al. 2013, p. 9). A hackathon can be used as an employer branding event. Potential employees have the chance to get insights on what a certain company stands for. Further they get to know what they could be working on and with whom they could work together in the future (Hackerearth 2017). Organizing a hackathon as a method of brand promotion is an interesting aspect especially for backend companies. A last potential for companies is to use a hackathon as an instrument for recruiting. By conducting an event they have the chance to get to know many talents at once or with the opportunity of online hackathons go on a global hunt for talents (Ravisankar 2015).

Criticism on hackathons

As hackathons are nowadays related to the term innovation, criticism has raised that this is not true. It is claimed that such an event barely leads to anything truly innovative. They utilize the fun part and creative part of the development process and the hard work of the next process steps are not executed anymore. One of the reasons for that is that the participants do not have possibility to do so within the framework of a hackathon. It is not possible to do conduct a proper market research or to cross-check if competitors are not already working on anything similar (Sastry and Penn 2015). Regarding the actual programming it is claimed that hackathons foster bad coding skills, because projects are usually unstructured and the created code is barely reusable (Weddehage 2017). Another issue is that the usual non-stop event timeframe messes up with your bio-rhythm and some participants need quite some time to recover from that. There is many more critique[6] that has been raised, but the most important ones were covered above.

2.1.7 Legal aspects

For internal hackathons the legal situation regarding the IPR between organisers and participants is in general quite clear since all of them are employees of the event hosting company. In many countries like Germany, United Kingdom, Japan, China and more (Gupta 2000, p. 4) as well as in Austria (Majoros 2017) law says that the exploitation right for created work as part of regular job tasks or at tasks which were specifically assigned to an employee belong to the employer. Whereas the legal situation of public hackathons is usually handled within the participation terms that everyone has to sign before the event starts. The legal situation between the participants will not be covered within this thesis, because the focus is on the organisers' perspective.

Before continuing with the legal aspects during hackathon events a few types of IPR need to be defined:

Copyright – It is work which is considered as an original intellectual creation. They need to have a certain originality. A copyright is generated automatically. A creator does not need to register it anywhere in order to protect his/her rights. Typical examples would be photos, jingles, layouts as well as computer code. A copyright is not transferable only in case of death of the author. The creator only can grant exploitation rights to someone else (Austrian Copyright Act).

[6] HackathonFAQ provides a list with further criticism of hackathons: http://hackathonfaq.com/frequently-asked-questions/critiques-of-hackathons/

Trademark – Trademarks could be anything which can be visualized with words, graphics, names, letters, numbers or even the shape of the packaging in order to distinguish one's product from a competitor's product. (§ 1 Austrian Trademark Law)

Patent – For any inventions in technology, as long as they are new, not an obvious result of the state of art and commercially useful, the inventor can apply for a patent. If a patent gets granted it provides the owner of it with the exclusive rights of usage on a certain market (either local in the country of application or international). Usage includes every action from production, distribution, sales, licencing or actual usage as long it is in a commercial matter (Austrian Patent Law).

The following is not an IPR type in the common sense, but since this license agreement is used at various hackathons it will be included here.

Creative Commons License – If an author distributes his/her work with a *Creative Commons License*, others are free to copy and redistribute their work in any other medium or format. Furthermore, they are allowed to remix, transform or build upon it for any purpose, even commercially (Creative Commons 2018).

With the different types of IPR and their individual characteristics it is very important for organisers to think beforehand what they potentially want to do with the outcome of the projects. In case they want to use created code, they need to have the exploitation rights. For work which is potentially patentable they need to be aware that with the regular setting of hackathons which includes final pitches, the novelty aspect of the patent law is gone, because it was already presented publicly. With a *Creative Commons License* a good solution is devalued, as no one can use it commercially. So, for anyone who organises a hackathon it is important that they think about how to deal with the IPR. In best case they add it to the participation terms or have it separately given to the participants for signing before the event starts. An unclear legal situation can cause expensive law suits in case of successful project outcomes. If all the rights stay with the participants and those who have actually created the work, there is not much to consider for an organiser. If the host or the sponsoring companies want to keep the exploitation rights on the created ideas, concepts, prototypes etc. they need to prepare a declaration of assignment for the participants. This declaration should be checked by the company's legal department to avoid legal grey areas (Steele 2013). Furthermore, the declaration should not go too far as two negative examples show: One agreement included a clause which gave the company an irrevocable and worldwide right to use the created applications without remuneration. At the second event participants had to sign a contract which gave the company the exclusive rights on any new creation

the participants will develop within the following 18 months after the hackathon (Rosseau 2017).

One issue that can still arise is that although a participant grants the wanted rights with his signature that person might not be in the legal position to grant them to the organiser or sponsoring company. This can happen if an employment agreement includes clauses were the company claims rights not only on job related work (Steele 2013). This special case is barely researched so far, but as it is of importance for TUG it will be covered briefly in chapter 4.3.5.

2.2 Physical Prototyping

Prototyping is an essential activity that supports innovation, collaboration and creativity in design (Hartmann et al. 2006, p. 1). The *definition* (2.2.1) is derived from literature and the *manufacturing methods* (2.2.2) are introduced, with a focus on techniques relevant for rapid prototyping (Weinmann 2014, p. 10).

2.2.1 Definition

General definitions can be found in dictionaries like: "*A first or earlier form from which other forms are developed or copied*" (Paperback Oxford English Dictionary 2005). In an engineering related context prototyping means that functionality and practicability of ideas need to be validated. The level of detail of a prototype increases with every iteration. A prototype does not have to have all functions of the final product, only those which are relevant for the current testing. The testing can be conducted on real test benches or with the help of numerical calculation methods (Steinbatz and Rabl 2009, p. 241).

Chua and Leong (2017, p. 2) defined three aspects of a prototype:

- *Implementation* partially to fully functional prototypes
- *Form* physical or virtual prototype
- *Degree of approximation* rough to full-scale representation of final product

Figure 2 provides a visual representation of the three aspects and shows how to categorise different kinds of prototypes. In the next section potential manufacturing methods are introduced since the focus is on creating physical prototypes during hackathon events. Nonetheless, especially 2D and 3D computer aided design

(CAD) modelling will be needed to use the digital prototyping machines although they are considered as virtual prototyping techniques.

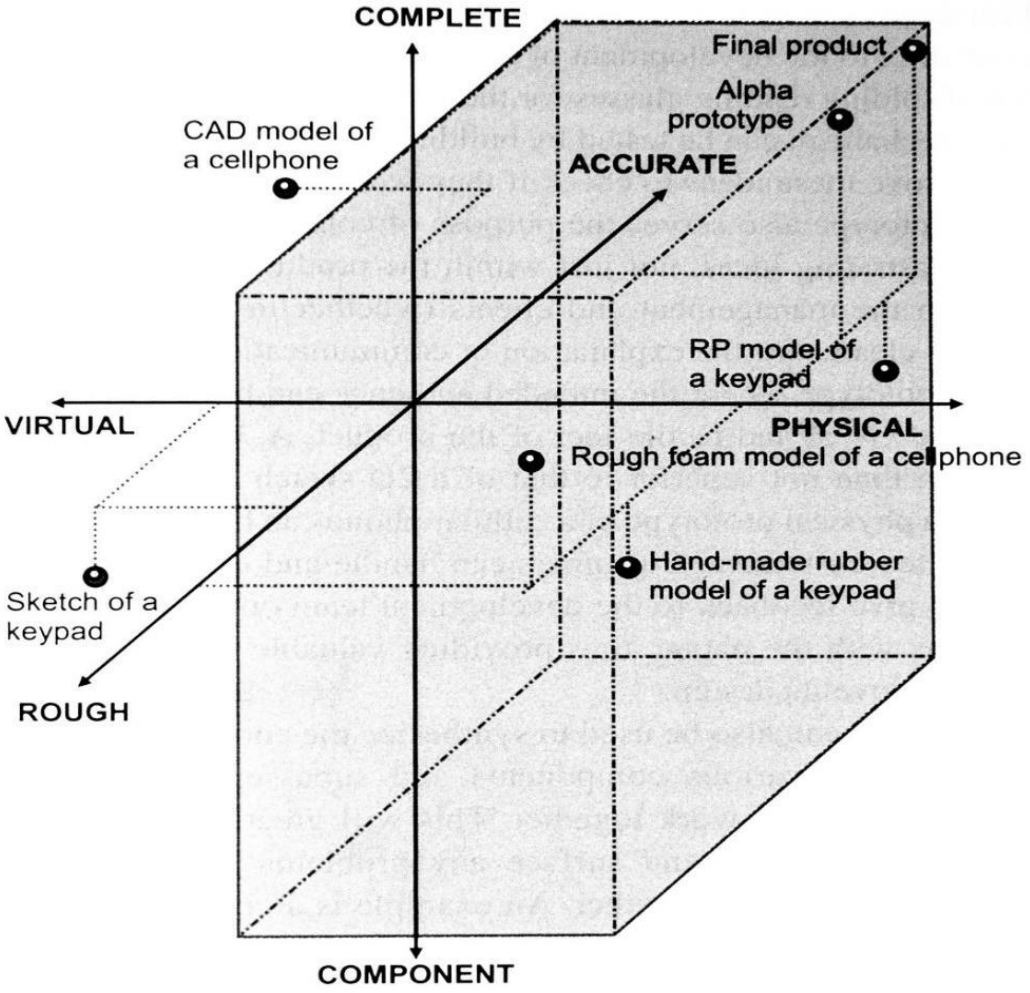

Figure 2: Visualisation of types of prototypes according to the three aspects implementation, form and degree of approximation (Chua et al. 2010)

2.2.2 Manufacturing methods

When thinking about building physical prototypes what often comes to mind are high quality prototypes which require expensive high precision machines. For building simple prototypes paper, cardboard and glue is already enough. Because it is only about bringing the first ideas into the physical world. In a later development stage when the prototype gets more sophisticated, the production technology needs to be more sophisticated too, like CNC-machining centres or metal 3D-printers. According to DIN 8580: 2003-09 there are six main groups of manufacturing processes:

1. *Casting*
2. *Transforming*
3. *Separating (Machining)*
4. *Joining*
5. *Coating*
6. *Changing material properties*

Casting – Out of formless raw material a solid workpiece is created. It includes classic manufacturing processes as casting and sintering, but also modern additive manufacturing technologies like 3D-printing. Latter is used in the majority of makerspaces.

Transforming – A workpiece is subjected to intended plastic deformation. Examples would be rolling, forging or pressing.

Separating – Material will be removed from a workpiece. The most important subcategory includes processes like milling, drilling, scraping or filing among others. Beside conventional tools machines like laser cutters, CNC mills or water jets can be found in makerspaces.

Joining – Creates a permanent connection between two or more different parts. Typical methods are welding, riveting or gluing.

Coating – Coating processes are used to add one or several layers to the surface of a part to adapt the physical, electrical or chemical properties of a workpiece. Painting and galvanizing are two common examples.

Changing material properties – Mainly metallic material needs to have changed material properties to adapt them to their field of application. Hardening and tempering represent two processes of this group.

Depending on the equipment of the makerspace machines and tools for all six groups might be available. Still the processes casting, separating and joining are more relevant than the others since machines like laser cutters, 3D-printers and soldering stations can be found in most makerspaces.

2.3 Makerspaces

As a last part, makerspaces in general are introduced and defined. FabLabs as a special type of makerspaces are explained more in detail since the prototyping facilities at the IIM are part of the FabLab network. Finally, three different digital

prototyping machines are inducted with respect to the fact that these machines have been used at the draft event.

2.3.1 Definition

Karl Hess started in the 1970s with neighbourhood-based shared machine shops initiatives, which serve as one of the first examples of physical spaces that had opened production (Seravalli 2014, p. 109). Until today, various names, models and manifestations exist for the basic concept of offering a facility for do-it-yourself and do-it-with-others projects and making activities (Böhm 2018, p. 30). As a result of the variety of different characteristics of makerspaces it is difficult to specify the term. According to Weinmann (2014, p. 15) a makerspace can be defined as following:

> *"Physical location with a community, where members build physical prototypes and objects by using manufacturing tools and machines in a hands-on manner"*

Five main aspects are included in the definition (Weinmann 2014, p. 15):

- Physical location – there is one physical location with all machines and tools which is accessible by the makerspace members
- Community – interaction between members as a result of their makerspace engagement establishes a community amongst them which leads to synergy and networking effects
- Physical prototypes – the main purpose of the facilities is building physical objects
- Manufacturing tools and machines – a broad set of manufacturing tools and machines is available for the members
- Hands-on – machines and tools are operated by the members themselves

To name another few initiatives FabLabs, Techshops, and hackerspaces (Böhm 2018, p. 30) can be mentioned. It is not within the scope of this thesis to discuss the different types of initiatives. However, the FabLabs will be briefly introduced in the next section as the prototyping facilities of the IIM Institute are part of the global FabLab network.

2.3.2 FabLabs

The concept of a FabLab was developed by Prof. Gershenfeld at the MIT, Cambridge in 2002. It started with the course "How To Make (almost) Anything" as

Prof. Gershenfeld realised the necessity of rapid prototyping machines as part of the product innovation process. Therefore, a space was necessary where easy-to-use, standard and inexpensive manufacturing equipment is provided (Gershenfeld 2007). From this starting point a network has developed with currently more than 1.280 FabLabs around the globe (FabLabs 2018).

The Fab Foundation is a non-profit organization formed in 2009 to facilitate and support the growth of the global FabLab network (Fab Foundation 2018). According to Fab Foundation (2018) a FabLab serves as a technical prototyping platform for invention and innovation as well as a platform for learning and innovation. Four qualities and requirements are necessary in order to join the FabLab network. First and foremost, free public access at least part of the time each week is essential. Second, commitment for the FabLab Charter is important. The FabLab Charter is a document stating the key characteristics of a FabLab. Third, a certain standard of available equipment and implemented processes. In an ideal situation for example FabLab Graz can send their files and documentation to someone at a FabLab in India and the project should be fairly painlessly reproducible there. Fourth and last, a FabLab must take part actively in the global network (Fab Foundation 2018). Figure 3 shows a typical setting of a makerspace.

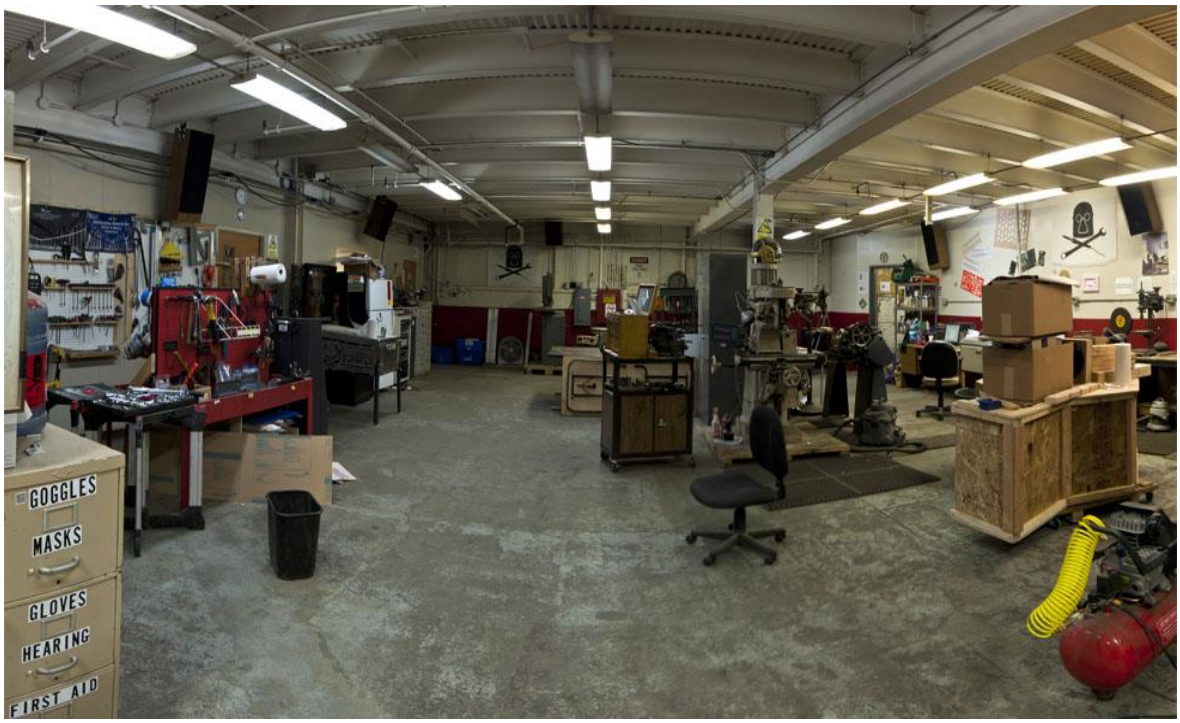

Figure 3: Typical makerspace (Chris 2014)

According to Fab Lab Inventory (2018) a certain set of manufacturing equipment, like laser cutters and 3D-printers, is recommended. In the next section these two commonly used machines as well as a vinyl cutter are introduced.

2.3.3 3D – Printer

3D-Printers are additive manufacturing machines as they create objects by depositing raw material layer by layer. This contrasts with traditional manufacturing processes as subtractive, formative or joining processes (Conner et al. 2014, p. 64). Despite the fact that additive manufacturing technologies were already available in the 1980s (Wong and Hernandez 2012, p. 1) it took until late 2000s, early 2010s until the additive manufacturing industry caught great attention. The industry has grown in 2017 by 21% and has reached a volume of $7.336 billion worldwide (Wohlers et al. 2018).

There are various existing 3D printing processes and technologies, because not all 3D-printers are alike. According to the ISO/ASTM 52900 Yusuf (2018) there are seven defined 3D printing processes which results in ten different 3D printing technologies. These technologies include Fused Deposition Modelling (FDM), Stereolithography (SLA), Digital Light Processing (DLP), Selective Laser Sintering (SLS), Material Jetting (MJ), Drop on Demand (DOD), Sand Binder Jetting, Metal Binder Jetting, Direct Metal Laser Sintering (DMLS) and Electron Beam Melting (EBM) (Yusuf 2018). With respect to the available machines at FabLab Graz FDM and SLA are briefly introduced.

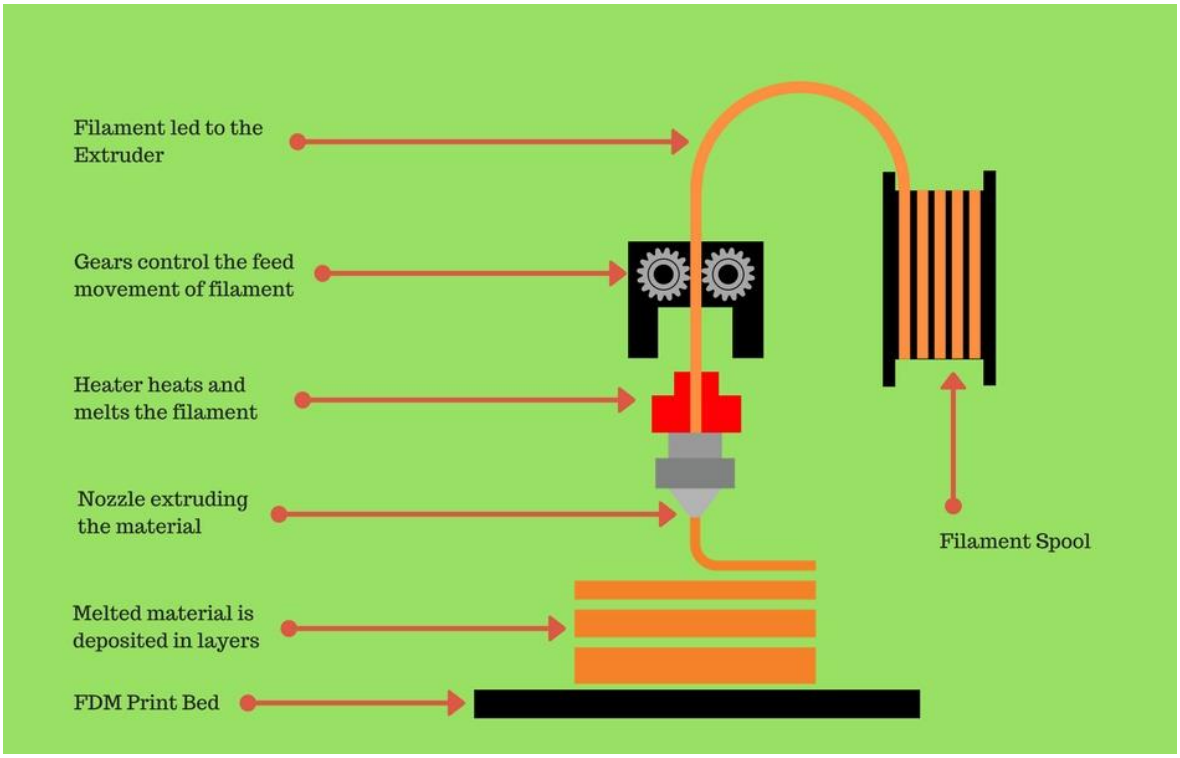

Figure 4: Representation of FDM 3D-printing (Manufactur3d 2018)

Fused Deposition Modelling (FDM) – FDM was invented in the 1980s by Scott Crump (Stratasys 2018). A thermoplastic gets liquefied and is extruded layer by layer until the 3D object is finished. Support structures are required with this technology. Commonly used thermoplastics are polylactides (PLA) and acrylonitrile-butadiene-styrene copolymers (ABS). Figure 4 shows the basic process of FDM 3D-printing.

Stereolithography (SLA) – SLA uses a laser beam or a digital light projector for controlled solidification of the surface of a liquid resin by photo-polymerisation (Melchels et al. 2010, p. 6122). The depth of solidification is equivalent to the chosen layer height. Figure 5 shows how SLA 3D-printing works.

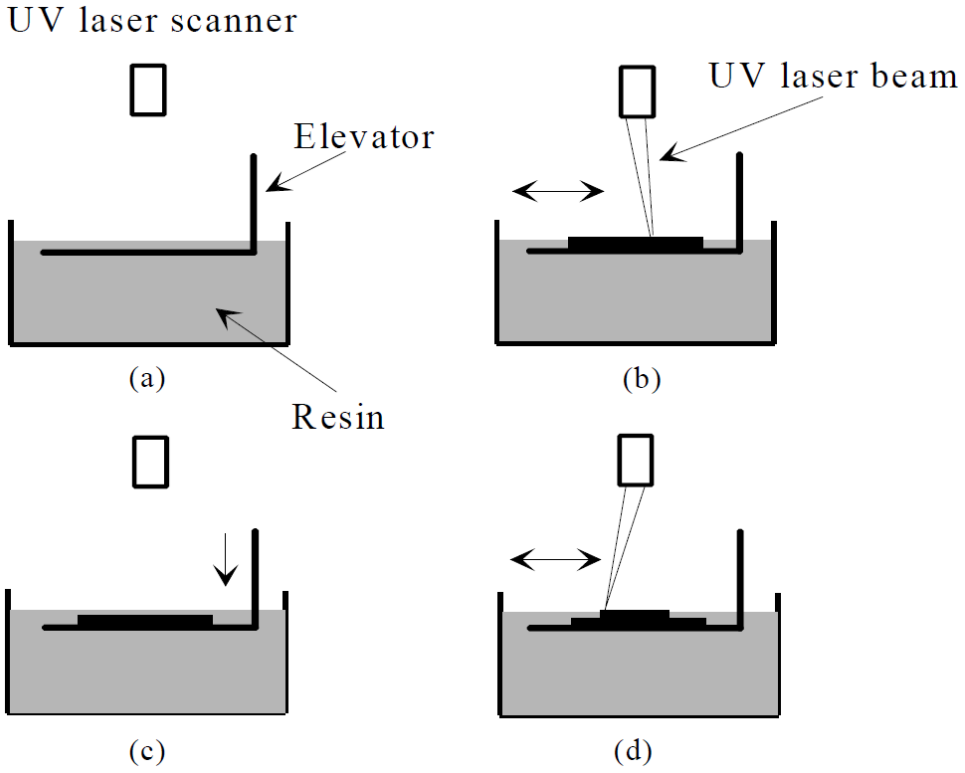

Figure 5: Process steps SLA 3D-printing (Centre for Instructional Technology 2017)

Before the print process can be started the 3D-CAD model which is usually in *stereolithography/standard tessellation language* (STL) format needs to be converted into a format the 3D-printer can understand. A slicing tool generates the required data which does not only include the sliced original 3D model with the chosen parameter, but also the filling and support structure. The generated layers typically have a layer thickness of 50-400 µm (Cain 2018) and 25-100 µm for SLA printers (Melchels et al. 2010, p. 6122).

2.3.4 Laser Cutter

In 1967 Peter Houldcroft used a focused carbon dioxide (CO_2) laser beam to cut a 1mm thick sheet metal (Hilton 2007). It was when the success of laser cutting started off. As laser cutters were primarily used in industry these machines entered makerspaces too with the availability of desktop sized machines. These laser cutters are capable of engraving and cutting and even of bending acryl potentially. Three types of lasers are in use: CO_2 lasers, *neodymium-doped yttrium aluminium garnet* (Nd: YAG) *lasers and fibre* lasers. The most common laser type in a makerspace is the CO_2 laser. Depending on the power of the laser it is possible to cut wood, leather, acryl, glass, synthetic materials, foams, cardboard and other paper-like materials (Koslow 2018) with a thickness of several millimetres. Figure 6 shows the basic principle of a CO_2 laser cutter.

As input file laser cutters do need a 2D CAD file or a vector graphic. The cutter control software once again converts this file into usable data for the cutter.

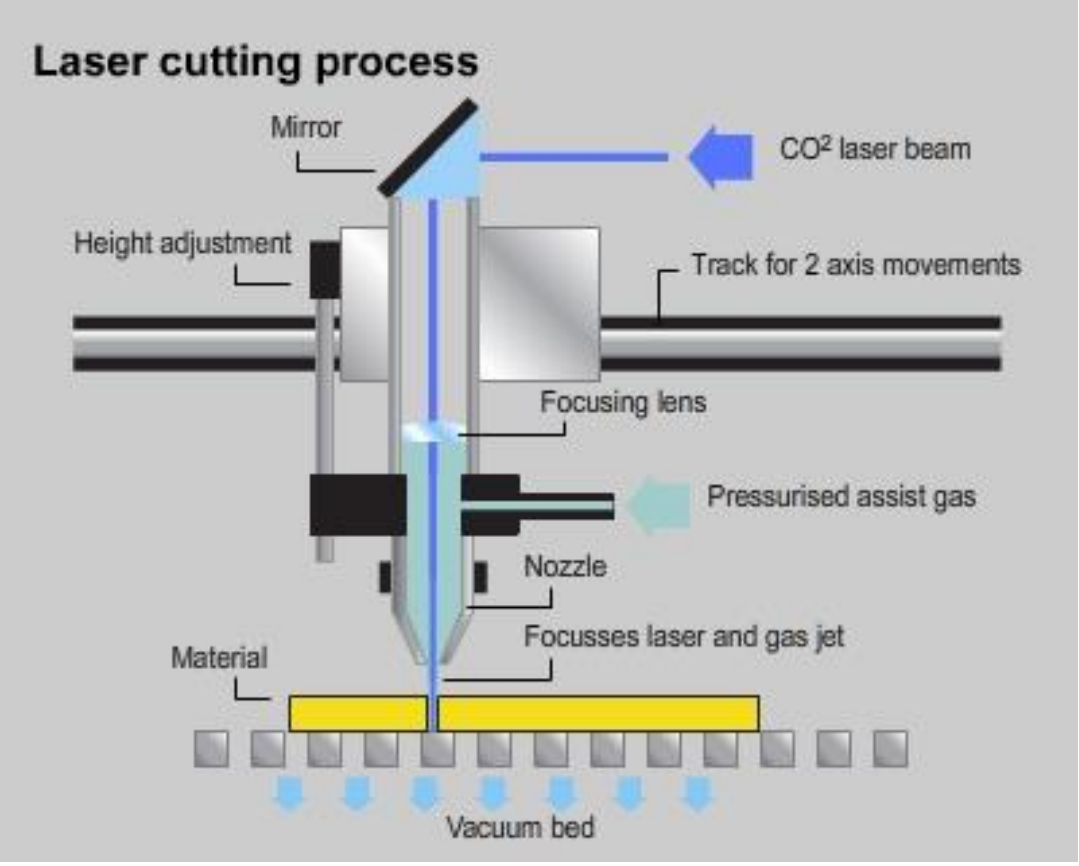

Figure 6: Principle of CO_2 laser cutting (Graphic products 2015)

2.3.5 Vinyl Cutter

A vinyl cutter is not a typical machine used for prototyping as it only cuts foil - it is primarily used for labelling and decoration. Since it still has been used at the draft event it is briefly introduced for the sake of completeness.

The foils used consist of two parts, the actual adhesive vinyl foil and a base material, same principle as of casual stickers. As input, a vector file is needed. Additional software tools are also capable of generating vector files out of high resolution images. After transmitting the data to the laser cutter, a small knife cuts according to the plans. The third step includes the removal of the excessive vinyl foil so that wanted output remains. The base material is still present. With the help of a transfer tape the stroke, logo, image, etc. can be transferred to the intended surface (Hovsepian 2013, pp. 4–20). Figure 7 shows the basic principle of a vinyl cutter.

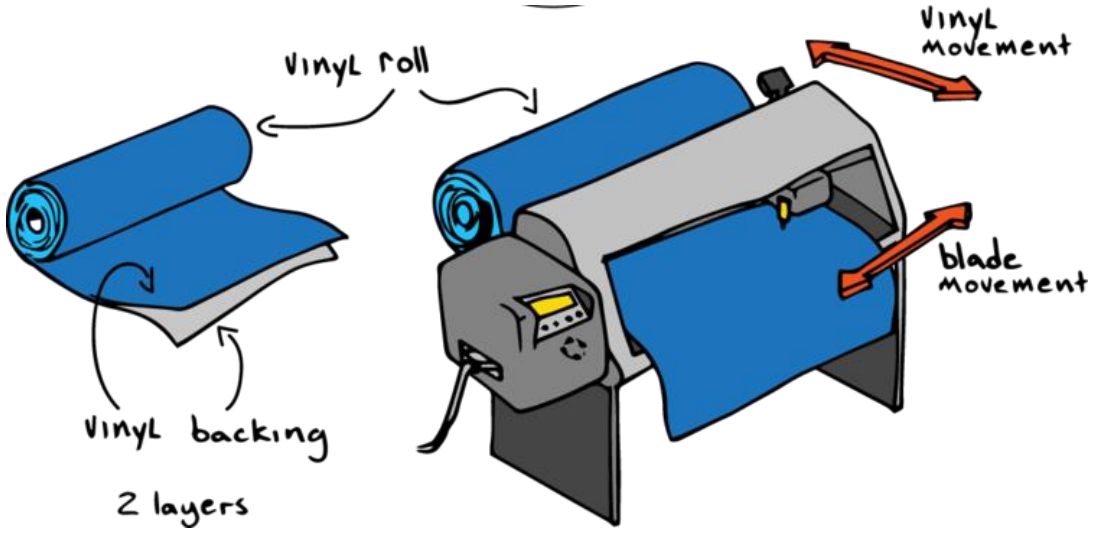

Figure 7: Basic principle of a vinyl cutter (A&R Screening 2018)

2.3.6 Potential issues at hackathons

While using the previously introduced machines, two issues might occur during a hackathon event. First, the time constraints regarding the usage of 3D-printers as already printing a few grams takes a couple of hours. Second, the creation of the input files. In principle, all three machines are rather easy to use. The issue is usually to have properly prepared input files. Certain measurements need to be taken to ensure that the participants will lose as little time as possible with preparing the CAD and vector files for each machine.

3 Research Design and Empirical Approaches

In order to answer the defined research questions a certain research design needs to be developed and appropriate empirical approaches need to be chosen. Two main approaches can be distinguished for research studies, qualitative and quantitative approaches (Töpfer 2012, p. 240). Both approaches are defined by Brannen (2016, pp. 10–17) as following: A quantitative approach the researcher defines variables and variable categories, which are linked together to form a hypothesis (can occur prior to the actual data collection). While with a qualitative approach a very general concept is defined to find patterns of inter-relationships between previously unknown aspects. For this research both types were used. With a quantitative method for the pre-study and qualitative methods for the detailed event investigation, expert interviews, makerspace visits and conduction of the draft event. In the following, every section of this research and the applied methods are briefly described.

Pre-Study

This evaluation serves as a starting point for further investigations. The intention was to collect basic information such as type of host, duration, number of participants, etc. about existing hackathon events in Austria and its neighbouring countries. The two main approaches for acquiring data about the events was their online presence and email contact with someone of the organizing team. For the online research a search engine for hackathons[7] was used. As it is necessary to register one's event at the webpage, additional research was required to complete the data set. Therefore, a standard search engine was used with different combinations of countries and commonly used names for hackathon events like hackathon, Codeathon or hacking days. In most cases it was not possible to gather all information just with an online research. Thus, the author got in contact with the event organisers. Email addresses found in the event's contact information have been used. This way 36 out of 52 started datasets had been completed.

Detailed Study

For the detailed investigation a multiple case research was chosen. Case research uses case studies as a basis (Karlsson 2016, p. 167). Case studies are used to understand complex social phenomena (Yin 2009, p. 4) and are part of the qualitative research approaches (Merriam 1998). The origin of a case research can either be theory or observation (Karlsson 2016, p. 171). For this thesis both, theory

[7] https://www.hackathon.com/

and the observations of the first event were used to set up a framework for further cases. Observation, formal and informal interviews were used as methods throughout the different cases. In total, seven events were investigated with this approach focusing on organisational aspects as well as the general process of the event. The events were selected according to relevance, accessibility and proximity to researcher's location, which is why the investigated events either took place in Austria or Germany. The collected data was analysed with a cross-case comparison. Case research is a research method that supports the comparison of commonalities or differences in the events, activities, and processes of a specific characteristic in case studies (Kahn and VanWynsberghe 2008).

Expert interviews

For data triangulation expert interviews were conducted in addition to the detailed event study. Interviews are a common practice of qualitative research methods (Dicicco-Bloom and Crabtree 2006). Interviews can be executed through many different ways of communication such as surveys, online, phone, face-to-face, etc. (Brinkmann 2014). As experts, people who have participated in and organised several hackathons were chosen. A semi-structured interview guideline supported the process. This way four persons were interviewed with an average interview length of 40 minutes.

Makerspaces

To leak one of the outcomes of the pre-study beforehand: Only a few events are somehow related to makerspaces or their typical machines. In order to still find perhaps any makerspace related events, a business trip of the researcher was used to investigate makerspaces in New York City (NYC), USA. The aim was to find some which have already served as event venue for a hackathon. Therefore, available makerspace managers, operators and members have been interviewed. Limitations were the accessibility of the makerspace and time constraints of the researcher. Eventually, four makerspaces have been scrutinized.

Draft Concept

The already available data was synthesised to develop a draft concept. The concept was executed as a 48 hours makerthon event at the FabLab Graz. It was part of the validation process for the makerthon event manual. Observation, informal interviews and feedback surveys were used as methods throughout the event.

The collected data of the pre-study, detailed study, expert interviews, makerspace information all together with the lessons learned and the feedback from the makerthon were incorporated into the makerthon event handbook.

4 Data Collection and Analysis

This section includes the following four research parts: pre-study, detailed study, expert interviews and makerspaces. The pre-study consists of the selection process of considered events, the definition of the investigated criterions and a statistical evaluation of certain distinguishing features. The detailed study encompasses a summary of all investigated events and a cross case comparison. For the expert interviews a summary of the outcome is provided. In the makerspace section each space is briefly described and the results are presented.

4.1 Pre-Study

After the literature research, the pre-study was the first step towards not only a theoretical knowledge about hackathons, but to a more practical understanding of its phenomena. As many key characteristics have a wide range within this event format type, like the duration between one and several days, the study aimed for finding the typical values and handling of certain characteristics. TUG-related events have two more detailed characteristics, which are the related institute and statistical information about the participants. Depending on the organiser this is either information regarding the fields of study or the main university. The following section elaborates the event selection process, defines the selected criterions and presents the results of the analysis.

4.1.1 Events

Due to the non-uniform nomenclature of hackathons and hackathon-like events, finding all the events online was not as easy as it is with clearly defined terms. As previously mentioned primarily a webpage[8] for hackathons was used to find the events. To complete the search process, it was crucial to use a standard search engine with different combinations of countries and known hackathon event names as search terms. For an event to be added to the table it was necessary that at least some basic information was available online. Nontheless information about the date, location, overall timeframe and host must have been available before email contact to be considered for the list. Beside this general exclusion criteria five more selection criteria were considered.

[8] https://www.hackathon.com/

Public event – In this context it meant that hypothetically the researcher could have been a participant in case he fulfils the requirements in terms of skills, personal criteria (sex, age, occupation, etc.) or other criteria. This criterion excluded employee-only hackathons.

Min 24 hours, max. four days – An event must have lasted at least 24 hours. That means if the hackathon started at 9 a.m. the first day, it was not allowed to end before 9 a.m. the next day. If the event was paused throughout the night is irrelevant in this case. The maximum duration was four days. In this context it does not mean that the maximum duration is 96 hours, it refers to the circumstance that only on four days' official programme items were offered by the organiser.

Given Task/Topic – The event must have had at least to a certain extend a given topic or task. That excluded events especially from hacker communities which take place once in a while where they meet for two days or a whole weekend and work together on their individual projects.

Year of conduction – In order to ensure an up to date data set, only events which took place either in 2017 or 2018 were selected.

Most recent – In case of events which take place on a regular or annual basis only the latest were taken into consideration. The aim was not to create any kind of duplicates, because repeating events were usually carried out very similar to those of the preceding year(s).

Offline events – Online events have not been considered, as they are hardly possible in combination with a makerspace. So, the core event needed to be an offline event.

All mentioned characteristics above were neglected for events which are somehow related to the TUG

4.1.2 Criterion definition

In total 30 different criterions were defined. For TUG-related events, two more were added. With the surprisingly high email response rate it was possible to complete 36 out of 52 datasets. A few datasets could not be fully completed as some of the organisers were not allowed to share all the information. The criterions were divided into three main categories: (1) general information; (2) organisational information, and (3) makerspace-relevant information. As many of the queried characteristics are self-explaining, like name of the event, date or country a few others need to be

explained to provide the context or intention behind it. In the following section, ten criterions are described:

Head event – Was the conducted hackathon part of something bigger? This could be a conference, a fair or that the event is part of a multi-location hackathon, like the Global Game Jam.

Organiser category – What kind of organisation is hosting the event? To simplify the classification five categories were defined: industry, university, incubators, knowledge centres and others. Whereas industry in this context does not only refer to classical producing businesses, they can be any other type of company as well, like law firm, tech company, resellers, banks, etc. as long as they sell a product or service. University refers not only to university themselves, but to any other educational institution. Business incubators, business accelerators and any other organisation which supports the start-up are process unified in the category incubator. The meaning of the term knowledge centre did not get extended. If none of the previous four categories did apply, an event was categorised as *others*. These events are often hosted by governmental institutions or open source organizations. Often two or more organisers hosted an event together why it was permitted for investigated hackathons to have more than one organiser category.

Outcome – What was the intended outcome of the organiser? Were they open to anything or did they want to have a specific result like hardware prototypes or business plans?

Product development – This criterion aimed to find out if the organisers offered the participants typical methods, which are carried out along the innovation process, like creativity techniques, business modelling, etc. In case they did so, it was distinguished between mandatory and voluntary use.

Target group – It is about who was the targeted type of participant for the event. Many events are open to anyone; others are looking for students only or anyone who is related to a certain topic.

Application – If it was necessary to file an application form in order to participate, this question was answered positive. Considered as an application form was anything that requested more than general information about the applicant, like motivation for the event or other extended application requirements. Although anything more than basic participants' information is considered as application it shall not imply that the organisers performed an actual application process, where applicants were chosen according to their qualifications.

Gross time – The overall time of the event. It starts with the beginning of the first official programme item on day one and ends with the last one on the final day. If the last item was a dinner, get together or after show party which had an open end, a sweeping time of two hours was added to the gross time.

Net time – It is the actual time the participants had the chance to work on their projects. The net time is a result of the gross time reduced by the time the event venue was closed.

Resources for prototyping – What kind of prototyping material was provided? It could have been something simple as paper, cardboard and glue or more sophisticated materials like wooden boards, round logs, synthetics, foils, etc. or any electronic gadgets and basic electronics for self-tinkering.

Requirements for participants – The initial intention was to find out if participants need a certain experience with the machines in order to participate. Along the research process this criterion was more generalised. Any other participation restriction like passing the application process or being invited by the organiser was noted here.

The full list containing all 30 defined criterions can be found in the appendix 13.1.

4.1.3 Analysis and results

In this section the results of the pre-study are presented. After the data collection, data smoothing was performed to merge together similar information. If data smoothing was done for a chart the details will be explained at each chart separately. The statistical analyses include information about the host country, event duration, month of conduction, type of organiser, event size, no-show rate, IPR owner, and usage of a makerspace. The sample size for the first four graphs is 52, while the others have a smaller number but not less than 39. Missing information is considered in the charts in the category *No Information*.

Host country

Figure 8 provides an overview where the investigated hackathon events took place. The majority of events where hosted either in Austria or Germany. Each of them makes up more than a third of the overall number. For the neighbouring countries, especially Italy, Slovenia, Slovakia and the Czech Republic, it can be said that it was difficult to find any online information in English, as many of the events were promoted only in the respective native language. To be able to add at least a few events online translation tools were used. As the required minimum online information for further consideration are basic characteristics the usage of these tools was sufficient.

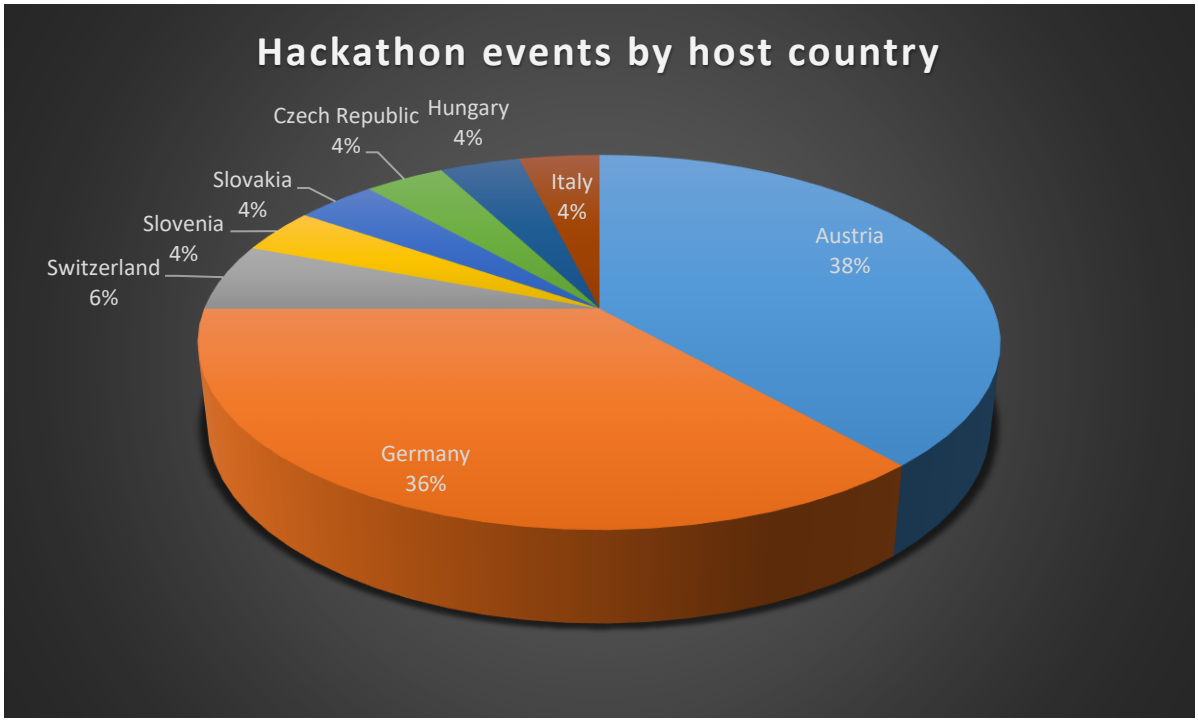

Figure 8: Hackathon events by host country[9]

[9] Author's illustration

Duration

The event duration only represents how many days there was at least one official programme item. It does not show how long an event actually did last. For example, one event was promoted as a 24-hours hackathon from Saturday to Sunday. The 24 hours here refer to the absolute hacking time. With the introduction, team building, pitches and award ceremony it took 32 hours. This would be a classical example of a two days' event. But they had a non-mandatory informal get-together on Friday already which only lasted about two or three hours, why it is represented in Figure 9 as a three days event. Although hackathons lasting less than 24 hours were neglected, still two events are shown in the graph as they were closely related to TUG. The evaluation shows that more than 60 % of the events last two days. Further three-day events are still popular as they make up almost 30 % of all hackathons. The average gross time, which is calculated from the first to the last point of the event agenda, of all 52 examined hackathons is 33 hours and 40 minutes. The net time is the gross time minus official sleeping breaks which is 26 hours and 30 minutes within this study.

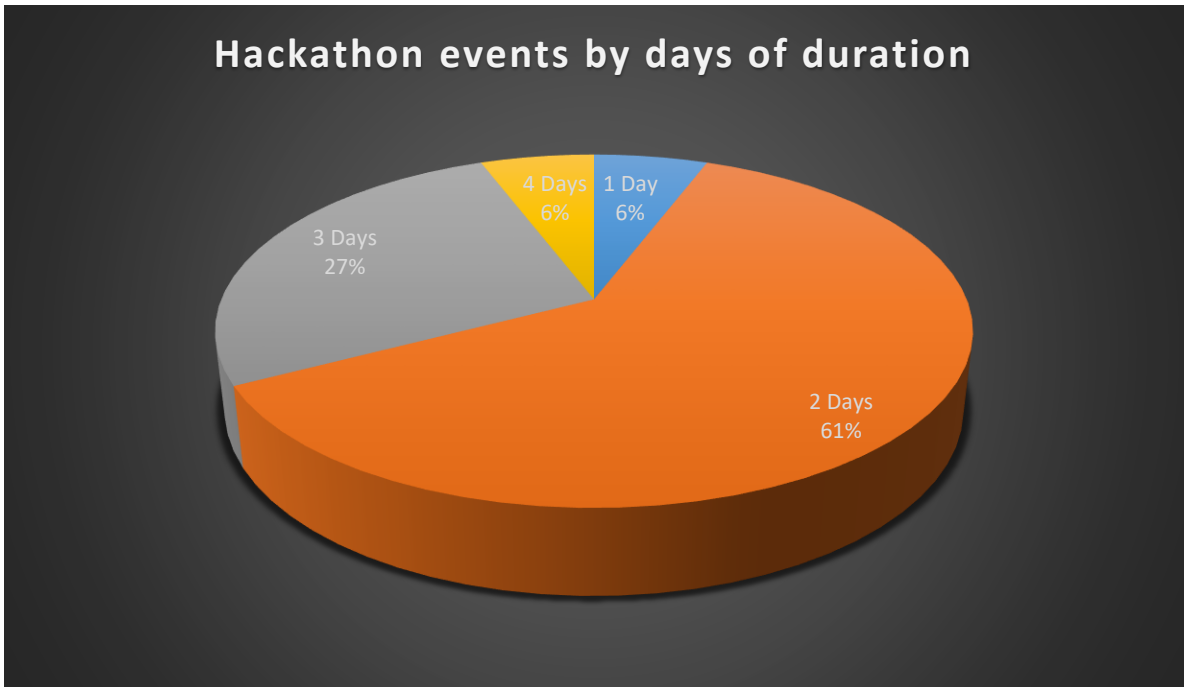

Figure 9: Duration of hackathon events[10]

[10] Author's illustration

Month of conduction

Not every period of the year is the perfect time to host a hackathon. Figure 10 indicates that there is one peak time in year were most hackathons are carried out. The month April shows a significant higher number of events than the others. That might be owed to the fact that this was the month were the pre-study was primarily conducted. Therefore, more recent information showed up during the research. But March and May have an above-average number of events too, which is why it can be assumed that this is an ideal time to run a hackathon. As the majority of hackathon participants are students the results visualize a typical student schedule, because February, July, August, September and December are traditionally either exam or holiday months in Austria and Germany. Further noticeable is the fact that three out of the four events conducted between July and September are TUG related events.

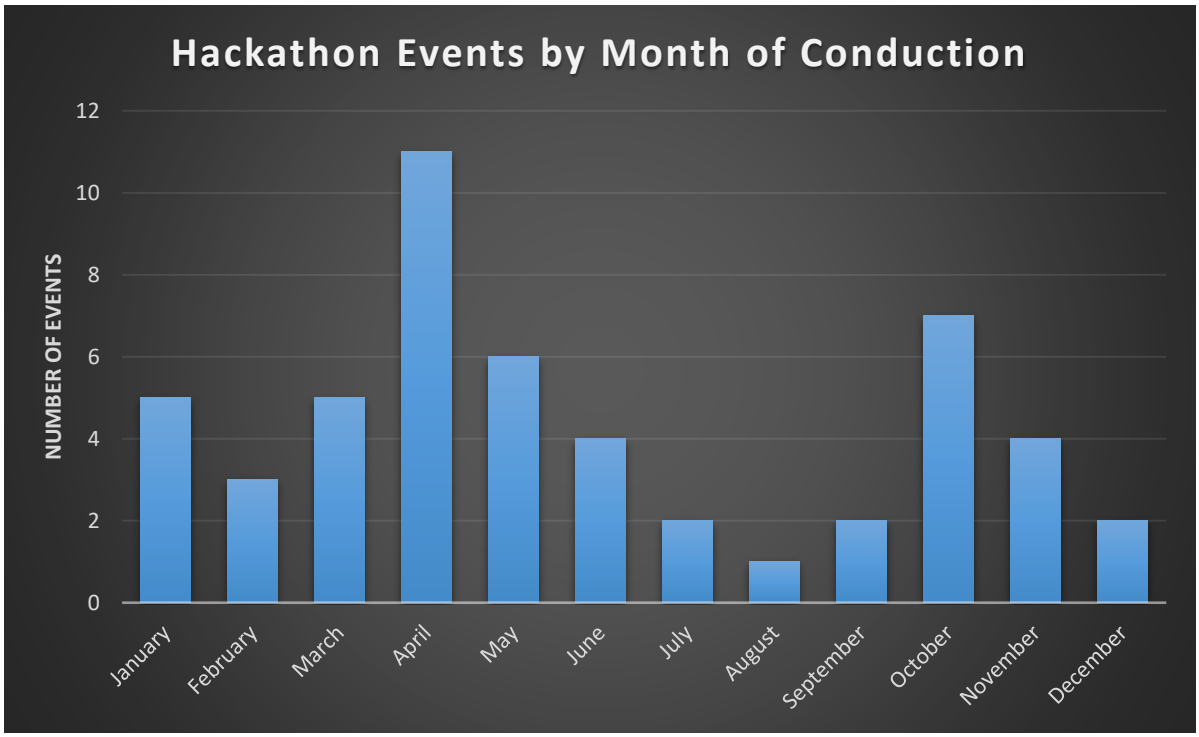

Figure 10: Hackathon events by month of conduction[11]

[11] Autor's illustration

Organiser type

The organisers got classified according to different categories. Multiple answers were possible as sometimes two or more partners hosted a hackathon and they were from two different categories. The sample size is still 52, but six of them had more than one organiser type. In total 59 answers were given. The category “Others” encompasses primarily governmental related institutions and NGOs. Except for knowledge centres, every type of organiser is hosting a sufficient and similar number of hackathon events. In contrast to the Global Hackathon Report, where nearly 1000 events have been investigated (Global Hackathon Report 2017) Figure 11 shows that less events are conducted by universities. Within this pre-study 20 % of the events were hosted by universities compared to the global trend of more than 30 % (Global Hackathon Report 2017, p. 11).

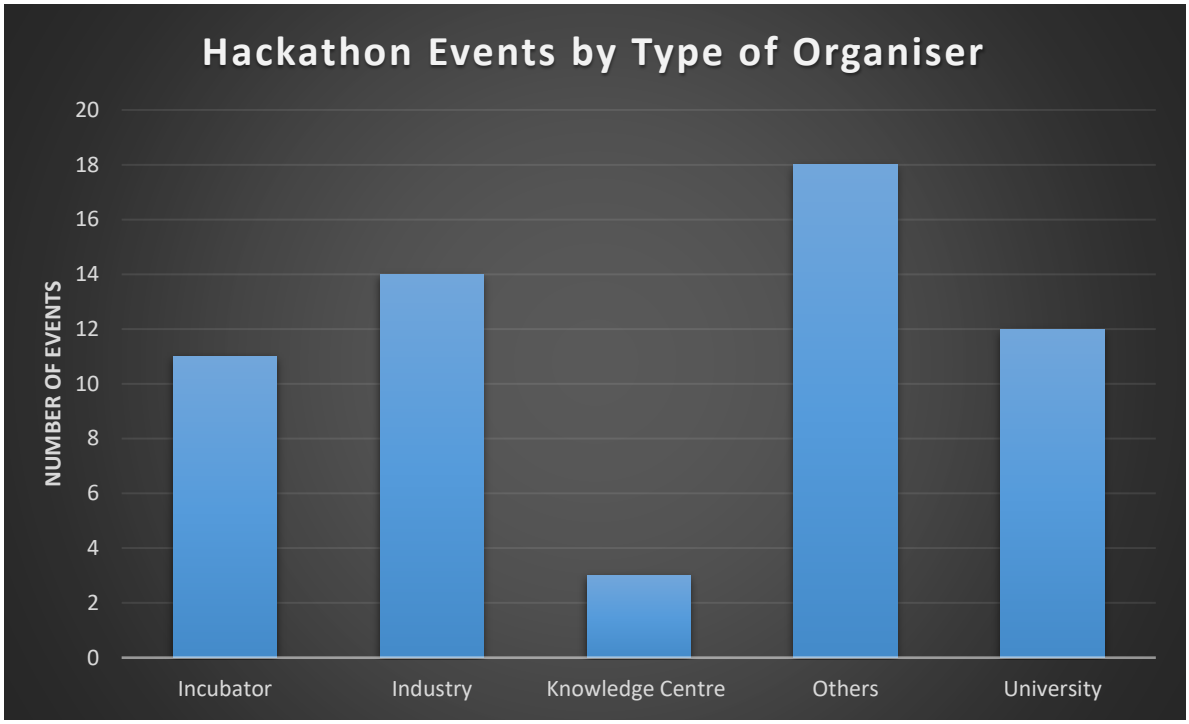

Figure 11: Hackathon events by type of organiser[12]

[12] Author’s illustration

Event size

The size of an event refers to the number of participants. While organizing a hackathon, the possible size is depending on several influencing factors like space, financial resources, human resources, internet bandwidth etc. For this research events were classified in five categories: (1) small events with up to 20 participants; (2) medium events with 21 to 50 participants; (3) big events with 51 to 100 participants; (4) huge events with 101 to 249 participants; and at last mega events with more than 250 participants. The results shown in Figure 12 indicated that medium sized events take place most often. As expected mega events are quite rare as they require a lot of resources. For 42 events was information available.

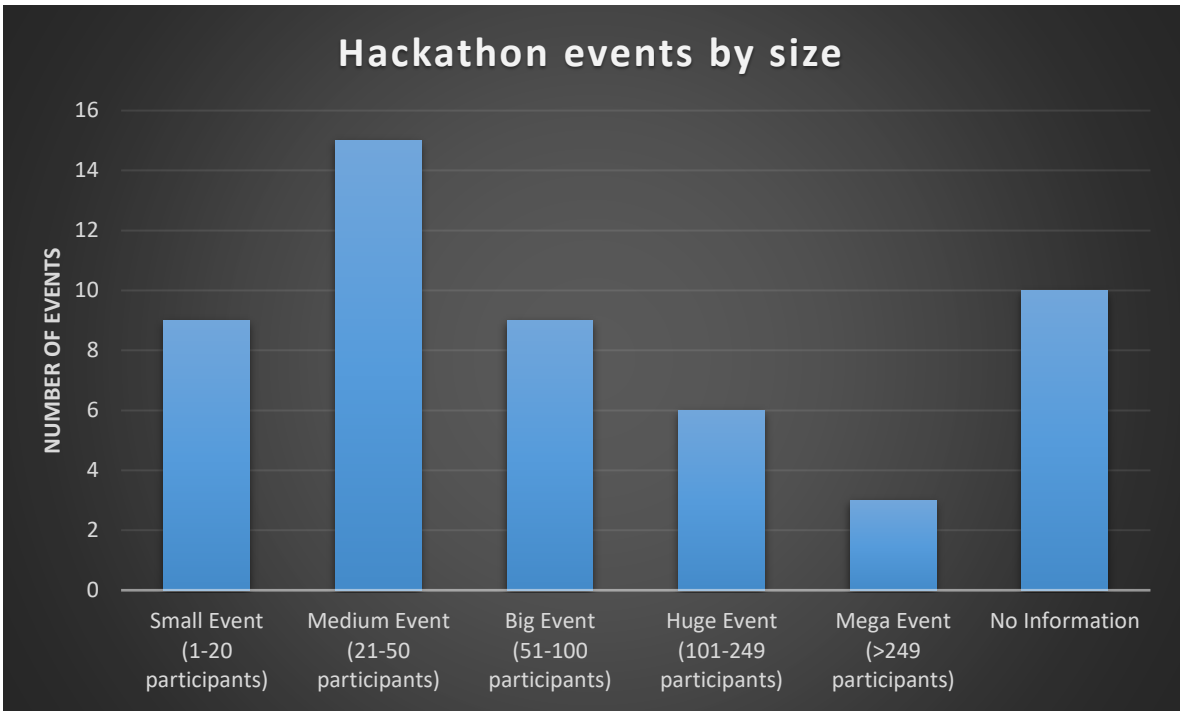

Figure 12: Hackathon events by size[13]

[13] Author's illustration

No-show rate

Although people usually have to register or apply to be part of a hackathon it is a matter of fact that not all registered participants show up at the event. The no-show rate visualizes how many intended to participate in a hackathon and how many did show up. Despite the fact that it is more likely that people do not show up, still a relevant number of events have more participants than they actually wanted or expected. On the one hand, Figure 13 shows that many events have a rate less than 10% which is totally acceptable, but on the other hand almost every fifth event has a no-show rate of more than 50%. The overall average no-show rate is 26,73% with a sample size of 39. 13 events did not provide any information. The limitation of this no-show rate is that for a few events it is not clear to which numbers the organisers are referring. For example, an event was planned for 100 participants but had only 80 registrations. So, if 75 people show up, the no-show rate compared to the planned participants is 25%. However, the organiser was anyway only expecting 80 participants in the end. The no-show rate is only a bit more than 6% which is absolutely reasonable. If possible, the no-show rate was always calculated with the expected participants, which was the case at more than 80% of the events.

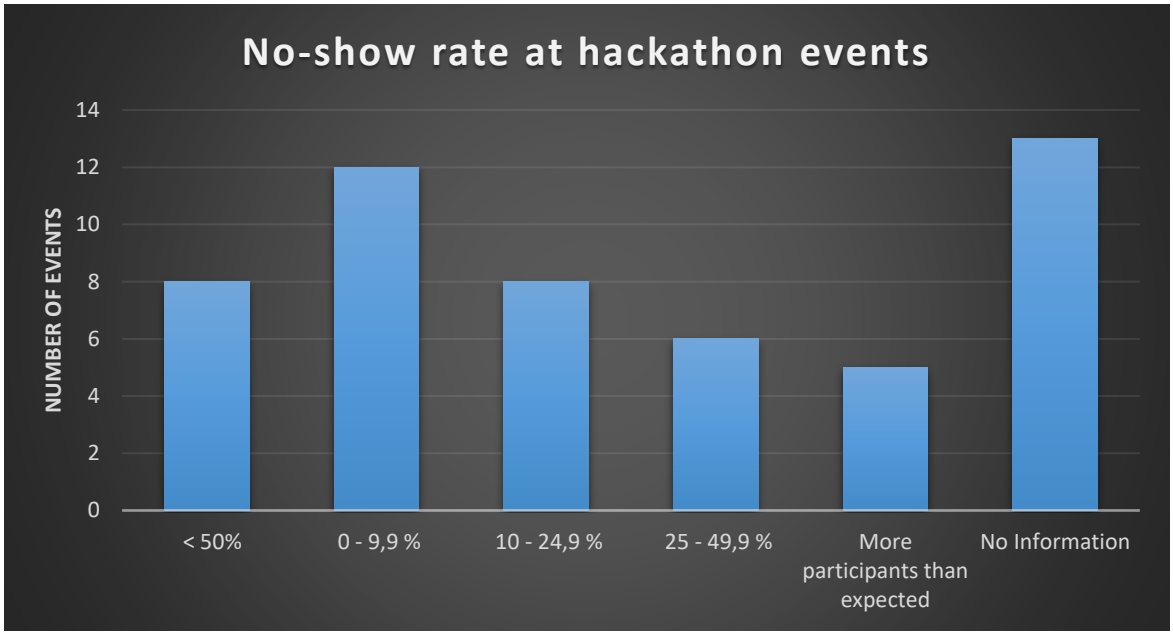

Figure 13: No-show rate at hackathon events[14]

[14] Author's illustration

IPR owner

While experimentation and development of something is new and exciting, people often forget to think about intellectual property rights of the new creations. Consequently, it is even more important for a hackathon host to ensure a transparent communication on the ownership of IPR. This is not only relevant for the potential participants, but for challenge sponsors too. Especially if the sponsoring company wants to claim any rights on the projects, they should let the participants sign a respective agreement. Out of 42 events still the majority of the projects will belong to hackathon project teams afterwards as shown in Figure 14. The collected data only shows the relation between the participants and other organisations. It does not provide any information about the IPR situation within a team.

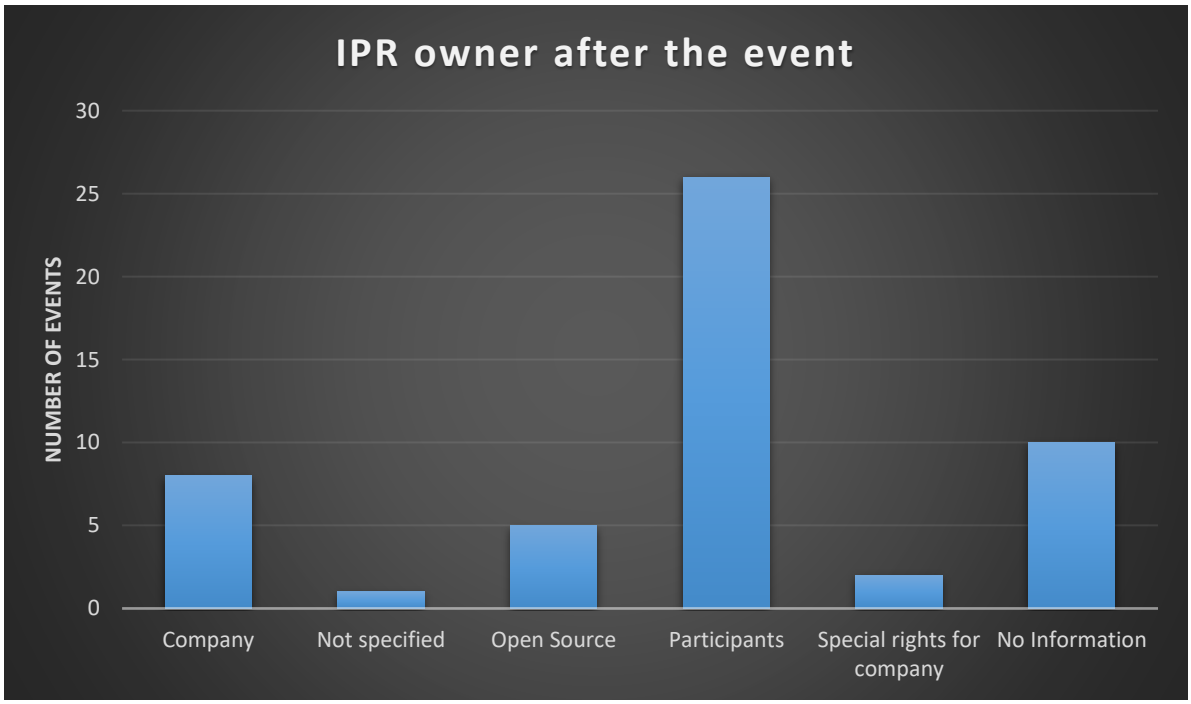

Figure 14: IPR owner of hackathon projects[15]

[15] Author's illustration

Makerspaces

As this thesis is about bringing the hackathon concept into a makerspace, one of the most important criterions was to find out how many hackathon events already used makerspaces during their event or are planning to do so. Figure 15 shows impressively that only a small number of events take place in an actual makerspace. The third category in here is machines only. That means that certain events did not use a makerspace but did provide makerspace typical machines. Not surprisingly the only machines used this way were 3D-printers as they are plug and play technology and easy to relocate. 44 events provided information about their makerspace and machine usage.

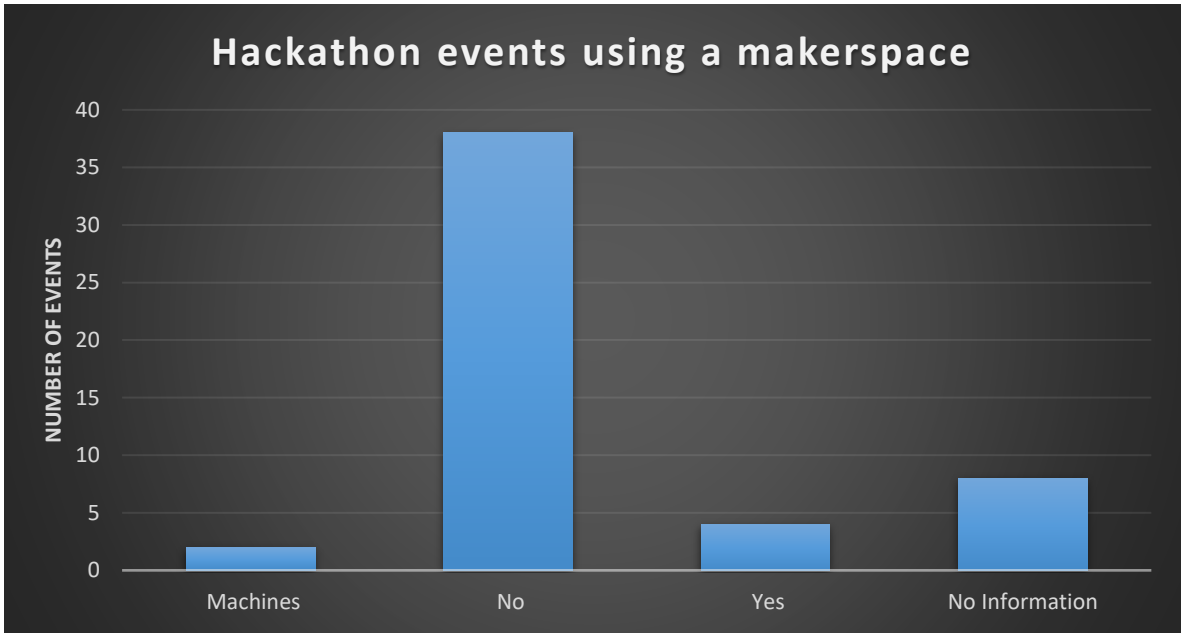

Figure 15: Hackathon events using a makerspace[16]

[16] Author's illustration

4.1.4 Overview of TUG related events

Out of the data collection process for the pre-study, an overview of TUG related events was created (see Table 1). A few key features are emphasised in the summary. In total, twelve events with eleven characteristics including the event name are listed. The column *faculty* shows which TUG faculty the organiser belongs to or which faculty was involved. The challenge sponsors provide the task for the event. That does not mean that the event does not have any other sponsors. The event size refers to the planned maximum number of participants, not the actual. The last column *participants distribution* provides an insight in the academic background of the participants. Depending on the event it is either listed by field of studies or university. For easier readability and formatting, a few abbreviations have been used which are introduced in the following:

BEST	Board of European Students of Technology
Biomed	Biomedical Engineering
CS	Computer Science
CSBE	Computer Science and Biomedical Engineering
EBEC	European BEST Engineering Competition
EYA	European Youth Award
ISDS	Institute of Interactive Systems and Data Science
KFU	University of Graz (Karl-Franzens-Universität)
ME	Mechanical Engineering
Med Uni	Medical University of Graz
MEES	Mechanical Engineering and Economic Sciences
Nat. Sci.	Natural Science
NE	Institute of Neural Engineering
PhD	Doctor of Philosophy
Soc. Sci.	Social Science
Sustain.	Studying fields related to sustainability
TCCPEB	Technical Chemistry, Chemistry and Process Engineering, Biotechnology
TU Austria	Austrian Universities of Technology

Half of the events take place on regular basis. These are the EBEC Challenge, Global Game Jam Graz, Green Tech Jam, Makerthon, Science 2 Business Challenge and TU Austria Innovationsmarathon. The most diligent Institute at the TUG is the ISDS. As they do not only conduct two events on a regular basis, but they organised stand-alone events too. In the following section the selected key features get analysed and compared to the general findings of the pre-study.

The TUG related hackathon events have in general a challenge sponsor, only the two game jams and Science 2 Business Challenge do not have one. The Task description shows that the events have a wide topic range. There are intense core engineering challenges with software and hardware topics as well as idea and concept developments or even events with social aspects. The typical duration is two days which corresponds with the general findings. Further, the preferred size is medium sized events (21-50 participants). For seven of these events it can be more specified to the range of 30-40 participants. What can be seen as negative aspect so far with TUG related events is that participants more often cannot keep the IPR on their projects and ideas compared to the average value of the pre-study. In terms of different target groups many are covered, as there are events for everyone, students, university assistants as well as experts.

Table 1: Summary of TUG related hackathon events

Name	Organiser	Faculty	Challenge Sponsors	Brief Task Description	Duration	Size (maximum)	IPR	Makerspace	Target Group	Participants Distribution	
A2LT Hackathon	Integrated Consulting Group (ICG)	-	Yes	Process Optimization	1 Day	30	Company	No	Experts	-	
BR41N.IO	Guger Technologies and NE	CSBE	Yes	Predefined Projects	2 Days	75	Participants	No	Everyone	-	
EBEC Challlenge	BEST	-	Yes	1 Design Challenge 1 Case Study	1 Day each	-	-	No	TUG students	-	
Experthon	IIM	MEES	Yes	Hardware Development	2 Days	4	50% University 50% Company	Yes	University assistants	-	
EYA Games Jam	Game Development Graz and ISDS	CSBE	No	Game Development	3 Days	40	Participants	No	Everyone	-	
Global Game Jam Graz	Game Development Graz and ISDS	CSBE	No	Game Development	3 Days	40	Participants	No	Everyone	-	
Green Tech Jam	Green Tech Cluster and ISDS	CSBE	Yes	Code and concept for "Green Tech"	2 Days	80	Not specified	No	Students	CS Sustain. ME Others	28% 25% 16% 31%
Hackathon for a world without barriers	ISDS, NE	CSBE	Yes	Innovative solutions for blind or vision-impaired people	2 Days	40	Participants	No	Everyone	CS Biomed Others	38% 33% 29%
Mondi Speed Data Hackthon	Institute of Paper, Pulp and Fibre Technology	TCCPEB	Yes	Industrial Big Data Applications	1 Day	50	-	No	PhD Students	-	-
Makerthon	IIM	MEES	Yes	Product Development	3 Days	30	Company	Yes	Everyone	ME Physics CS Others	57% 12% 9% 22%
Science 2 Business Challenge	Zentrum für Wissens- und Innovations-transfer (ZWI)	-	No	Business model Development	2 Days	20	Participants	No	Students	TUG KFU Med Uni Others	50% 50% 0% 0%
TU Austria Innovations-marathon	TU Austria	-	Yes	Ideas and Concept Development	2 Days	40	Company	No	Students	Nat. Sci. Arts Soc. Sci. Others	63% 17% 13% 7%

4.1.5 Summary

The important findings are briefly summarized in the following. The pre-study shows that almost two thirds of all investigated events last for two days. They last in average for about 35 hours in total. The preferred time of the year is spring, with the month April being the busiest. Incubator, industry and university as type of organiser are involved each in about every fourth event. Medium sized events are the most popular ones. Those events have between 21 and 50 participants. The overall no-show rate is 26,06 %. It means that an event host needs in average 35 % more applications or registrations than the actual number of participants they are intending to host. As a positive aspect the IPR situation can be emphasised, because in about 6 out of 10 events the rights on the created content stays with the participants. The pre-study illustrates that so far only a small number of events make use of makerspaces. Two non-TUG-related events used a makerspace and another two used at least 3D-printers.

4.2 Detailed Study

In a next step selected events were investigated more in detail. The studied aspects are introduced briefly. Then the chosen events are introduced and the main aspects are pointed out. Finally, the results of the cross-case comparison are presented.

The pre-study results served as a foundation for the event selection. Throughout the research process many events were found which take place on a regular basis. Further it was inevitable to not only find past events, but future ones too. This list of potential events was supplemented by events which were recommended to the researcher. Those events were not found during the pre-study, because they were conducted either prior or after the actual research process. Overall, more than ten potential events were listed. The events were finally chosen with respect to the researcher’s skills, personal criteria, personal time constraints and proximity to the event. In the end six, events were investigated within this thesis. As a result of the limited number of makerspace-related hackathon events, only one of the selected events used these facilities during the event. One event provided soldering stations and material for electronic tinkering. Three events were IT-focused but still provided electronic gadgets to work with. The last event was focused on finding business applications for university related inventions.

The main research methods were observation and interview. While four events were attended by the researcher actively as a participant, the remaining two were investigated as an outside observer. In general, the targeted interview partners were the main event organiser or one of their assistants. At the observing-only events, interviews with participants were conducted as well to get their perspective. All gathered information of each event was logged in a separate event report. The report template can be found in the appendix 13.2. In the following section the structure and content is explained. Every category has several subitems.

4.2.1 Event report framework

The framework consists of seven different categories, which are general information, goals of the organisers, process, participants, place, marketing and personal opinion. Only the relevant subitems of each category are explained below. Every category has a section for additional comments.

(1) General information

The provided information prior to the application for an event was analysed with a check list. This included schedule, accommodation, task description, incentives, required skills or the number of expected participants, among other details. Further on, the organiser was asked how often the event was already conducted and if it is planned to be hosted in the future.

(2) Goals of the organiser

The questions in this category were answered by the organisers being about their motivations and intentions. The first subitem is equal to the title of the category. The only goal that was specifically asked for was if recruitment was important to them. As there are so many hackathons taking place everywhere, one question tried to figure out if anything makes this event more special or different from others. The last important subitem in this category was the IPR situation.

(3) Process

The process was primarily from a participant’s perspective. How well were they informed and supported by the organisers? As a first step it was documented if any product development methods were used. If some were applied the method and point in time was noted. This was only done if the methods were introduced or recommended by the hosts. In case teams used such techniques on their own, it was neglected. Often the tasks were described only in a few sentences beforehand. How much more information about the task was provided at the event. As many

topics are very specific and many participants do not have a lot of knowledge about it, mentors on site are crucial. The last part documented information about the mentors, like their quantity, expertise or availability.

(4) Participants

Interviewing the responsible event hosts and actively observing the hackathon opened up the opportunity to get more detailed information about the participants. Not only exact numbers about intended, registered and actual attendants were gathered, but a rough overview of the skill set of them too. Further, general positive and negative influencing factors which are related to the organisers were noted.

(5) Place

This section was about the venue of the event. The importance of the event location and facilities should not be underestimated. It can not only help while advertising the event, but it can also influence the participants positively or negatively. The first question aimed for specifying the event location. Was it at a lecture room, a seminar room, something extraordinary or anything else? That leads to the available equipment. What was provided in general, makerspace-specific or what had the participants to bring themselves? Finally, the prepared food, drinks and snacks were documented.

(6) Marketing

Getting enough participants is one of the most crucial aspects for a hackathon organiser. Therefore, they need a good marketing strategy. A checklist was used to determine the utilised platforms for event promotion. The list included the items flyer, poster, webpage, social media, promotion video, presentation and other. In a latter step the actual social media platforms used were noted. Closing this category, the interview partners provided their opinion on which marketing channel works the best for them.

(7) Personal opinion

The last category is based on the personal opinion of the researcher or in respect to his interview partners. It aimed for a general impression of the event, including challenges, issues, assets, potential improvements etc.

The findings of the six events are chronologically presented in the following sections.

4.2.2 Zeiss Hackathon, Munich

Figure 16: Topic presentation at Zeiss Hackathon Munich 2018 (ZEISS Hackathon Munich 2018)

Organiser: Carl Zeiss AG

Date: 19.01.2018 – 21.01.2018

Topic: *"VISIONary ideas wanted"* (ZEISS Hackathon Munich (2) 2018)

(0) Introduction

The *Zeiss Hackathon Munich 2018* was a so called 24-hours event. The 24 hours refers to the actual hacking time the participants had. Including introduction, team building, final presentations and award-winning ceremony, it lasted from Saturday morning until late afternoon on Sunday. Impression from the topic introduction can be seen in Figure 16. On Friday there was an informal get-together with no mandatory attendance. The topic was dealing with solutions for the business field vision. It was kept open. A visual impaired person was present to give the participants insights on his daily life restrictions. Teams who worked on solutions for people like him or who are completely blind had the chance to win a special price.

(1) General Information

Only key data was provided to the participants beforehand. Beside the overall schedule, a brief topic description, the availability of recreation area and what every participant had to bring along, not much more information was given. Regarding the food only a comment about the previous reviews was made (ZEISS Hackathon Munich (2) 2018). It was not the first hackathon organised by *Carl Zeiss AG* and they are planning to host them in the future too.

(2) Goals of the host

The main target was to create awareness of the brand *Zeiss*. They are primarily known for vision-related products, especially lenses. As it appears as a very non-digital business field, they are facilitating the hackathon as a kind of open-day event. By hosting a hackathon and inviting coding affiliated people they created a platform where they can represent themselves as interesting and challenging employer, also in the IT sector. This event was used for internal purposes as well. With more than 25000 employees around the world (ZEISS Hackathon Munich (2) 2018) it is an opportunity to bring together Zeiss staff from different departments as mentors. One aspect was still finding potential new employees, but recruitment was not performed proactively. The first step had to come from a participant.

In the opinion of the interviewees, one of the distinctive characteristics is the amount and quality of provided food, snacks and drinks amongst the majority of other hackathons. Further, dozens of electronic gadgets were provided for the participants to work with. This emphasises the intention that they want to grant a playground for hackers.

The IPR belongs to the participants. In case any of the projects were interesting to *Carl Zeiss AG* or the other challenge sponsor, they approached the respective teams.

(3) Process

The organiser did not provide any instruction or training sessions regarding methodical product development. As a result, no team spent any time for checking the projects regarding feasibility, price or usefulness. However, this is accordance with their event goal of providing a playground for hackers. The task description did not get specified to remain as open as possible. The number of available mentors was immense as it was relatively equal to the number of participants. Every department had at least two experts present until midnight and they returned early in the morning. Same situation for the experts from the challenge and technology sponsors. In addition to the mentors there was an in-depth presentation for every topic on the first afternoon.

(4) Participants

The event was planned for 50-70 participants. Zeiss had nearly the maximum number of registered participants. Due to bad weather conditions they had many short-term cancelations. In the end about 40 showed up. The majority of participants were software developers followed by user experience (UX) designers. Others were physicists, mechanical engineers or graphic designers. The presence of so many

experts and the amount and quality of food boosted the teams' motivation. Negative aspects were not noticed.

(5) Place

An old industrial building, where the *Zeiss Digital Innovation Partners* department is located served as event location. The main hall was where the hacking took place. There still would have been enough space in case there would have been 70 participants. In front there was another room which served as a community and dining room. Another two rooms were reserved for the individual topic presentations and as recreation area. In between the meals different muesli and chocolate bars, fruits and drinks were provided. In addition to dozens of electronic gadgets, materials and tools for electronic tinkering were available. This includes soldering irons, electronic parts, plug boards and wires.

(6) Marketing

The main marketing channel was the hacker community which the leading organiser is part of. Respectively they barely did any other marketing. They started advertising about one and a half months in advance. Social media channels were used only two weeks ahead of the event.

(7) Personal opinion

To start off with a criticisms it should be noted that the team building process could be a bit more structured. Although the hosts tried to support the process, participants felt a bit left alone. Idea creation process could have been supported more, but both issues are only of minor relevance for this event. A major advantage of the event was the excellent food and supply especially the midnight food trucks, the two *Xbox* gaming stations and the open-mind of every involved mentor. All in all, it was a very well-organized event.

4.2.3 Science2Business Challenge 2018, Graz

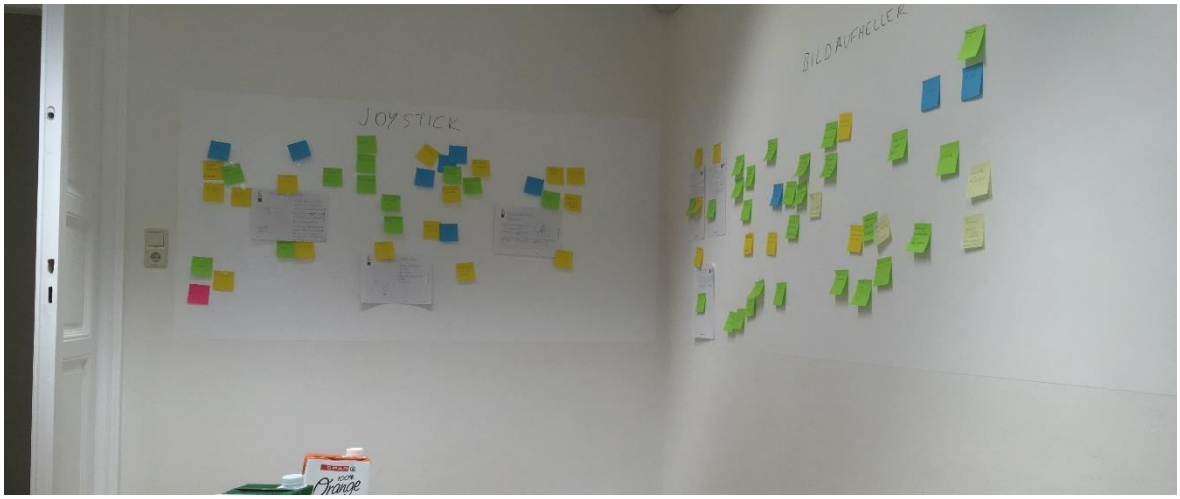

Figure 17: Ideation process at Science2Business Challenge 2018[17]

Organiser: Wissenstransferzentrum (WTZ) Süd

Date: 01.03.2018 – 02.03.2018

Topic: Business concept development for university inventions

(0) Introduction

The two days event was dedicated to the commercialisation of university inventions. The KFU, Med Uni and TUG provided one invention each. These technologies were developed for very specific use cases. The task of the participants was to find new business applications for the existing technology or recommend further directions of development to open up new markets. The event itself was fragmented, so the participants had to go home at night.

(1) General Information

At the *Science2Business Challenge 2018* only the general time frame was available beforehand. A participant did not know what was going to happen at what time. In general, only very limited information was presented. Two essential info that were missing was the required skills and things a participant has to bring along. The registration required more than just filing a form with basic information. The participants had to describe their skill and why they are suited for the challenge. Further they had to rank the three challenges according to their personal preferences. It was the first event for *WTZ Süd* and they are planning on hosting more in the future, although the first event offered potential for improvements. There is more about it later on (see (4) participants).

[17] Author's illustration

(2) Goals of the organiser

The basic idea behind the event was to get promising inventions to the market. The event should serve for the inventors as a starting point for entrepreneurship. *WTZ Süd* supported them after the *Science2Business Challenge* onwards. For students from humanities, social science and arts the awareness should have been created that it is possible to become an entrepreneur with these studies. In the best case participants and inventors team up for the ongoing development and commercialisation process. The main difference compared to other events is that the provided technologies were already very well developed and tested. The IPR on the invention itself remained with the inventors and involved parties. The intellectual property of any business concepts stayed with the associated team members. This could be participants as well as inventors.

(3) Process

During the introduction session the business model canvas was illustrated. The event schedule was reworked on short-term which is why the creativity techniques were not extensively explained. After a very brief introduction of each method, the organisers relied on learning by doing. The different technologies were elaborated in much detail. The technical limitations were shown too. Two kinds of mentors were available throughout the event. On one hand the inventors as technology experts. On the other hand, mentors for business establishing related topics. The number of staff was sufficient. Figure 17 shows the results of the idea creation phase.

(4) Participants

From the start the organisers planned the event as a small one. Their goal was to have 15 participants. They received 8-10 registrations, but finally only two participants did show up. As a result, the two-day event was compressed to a one-day. Consequently, no further feedback was possible.

(5) Place

The presentation room was big enough for the expected number of attendees. For the group work, every team would have had their separate room. No designated dining area.

(6) Marketing

The marketing started approximately one and a half months before the event. Flyers, university newsletters, webpage, social media (Facebook and LinkedIn) and word of mouth were used for advertising.

(7) Personal opinion

A serious evaluation was impossible with only two participants. After getting insights into the different technologies, it was a pity that not more students were attending the *Science2Business Challenge*. The organisers selected three very interesting inventions with great future potential. Negatively, it can be mentioned that there were not any seating possibilities with back rests in the two main rooms.

4.2.4 Green Tech Jam 2018, Graz

Figure 18: Working space at Green Tech Jam 2018[18]

Organiser: Austrian Federal Ministry of Sustainability and Tourism, Green Tech Cluster Austria, TUG

Date: 09.03.2018 – 10.03.2018

Topic: *"Code and concept for the green"* (Green Tech Cluster 2018)

(0) Introduction

At the *Green Tech Jam 2018* people had the chance to work on projects for companies in the energy sector, recycling industry or machine manufactures for the aforementioned industries. The eight challenge sponsors provided nine different tasks. Although it was officially a non-stop event, the organiser highly recommended the participants to have regular sleep at night.

(1) General Information

The detailed schedule was available for the participants prior to the event registration. Compared to other events, the applicants knew how many others potentially will be there, as the number of maximum participants was stated. More,

[18] Author's illustration

information about the venue, accommodation, topic background, required skills and incentives was provided. As the challenges were sponsored by several different companies, no input about their specific task was given. An interested person did not know if any of the tasks was appealing to them. It was the second event of this series and organisers are planning to continue their cooperation.

(2) Goals of the organiser

The ultimate goal was to have interdisciplinary teams. In the best case, the team consisted of engineers of different disciplines like software development or mechanical engineering, economists and others. As all the companies are responsible for sustainability in Austria, the aim of the organisers was to provide a platform for them to get new and innovative ideas and to present themselves. Many of the companies operate in the background, so they are struggling to find new talents. Thus, potential recruitment was a selling point of the organisers while negotiating with the sponsors. The sustainable and ecological topic and the nine different challenges were the distinctive characteristics in contrast to other events. The IPR situation was not clarified at any point during the *Green Tech Jam 2018*.

(3) Process

In the beginning the actual task was introduced by every company sponsor. They had about ten minutes each. These persons were also the mentors and stayed for about another hour at the event. Later they were available via cell phone and returned for the final presentations as they were the jury members too. The provided materials and gadgets contained a booklet with different product development methods. Besides that, no introduction or training sessions were performed.

(4) Participants

The initial aim was to have up to 80 participants. This number was reduced during the application to 50. Finally, there were significantly less than 50 registrations with slightly more than 20 people showing up. The desired participants' diversity was attained. Mechanical engineers, software developers, industrial designers, mathematicians, sound designers and students for energy and environmental systems took part.

(5) Place

Two lecture rooms at TUG served as venue for the *Green Tech Jam*. There was no designated dining or relaxing area. Commercial accommodation was arranged for remote participants. Electronic gadgets for experimentation with augmented reality,

virtual reality, voice control and gesture control were prepared. Figure 18 shows the work places at the *Green Tech Jam 2018*.

(6) Marketing

The social media channels which were used are Facebook and Twitter. Further marketing methods were posters, webpage, promotion video, gaming community, studying councils and the *Studo App*. In the organisers' opinion Facebook and the *Studo App* caught most attention.

(7) Personal Opinion

From an organisational perspective the event passed quite smoothly. Potential improvement can be seen in the transitional phase between the topic introduction and the start of hacking. With nine partly completely different challenges, there was not much time for the participants to choose their projects or to clarify any issues regarding the given topic with the experts.

4.2.5 eTourism Hackathon 2018, Seefeld

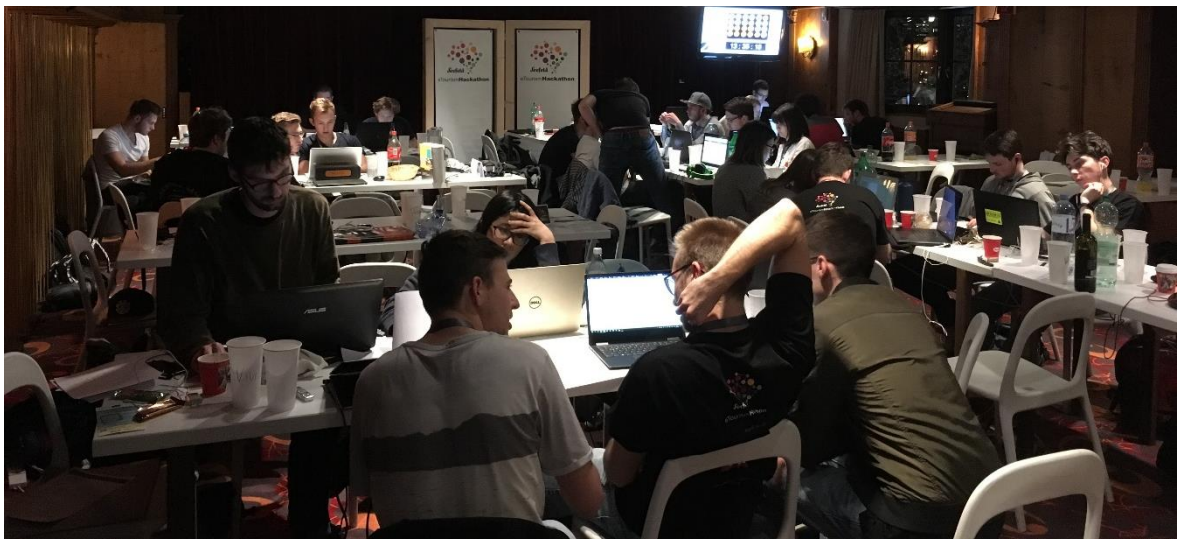

Figure 19: Working space at eTourism Hackathon 2018[19]

Organiser: Olympiaregion Seefeld

Date: 26.04.2018 – 27.04.2018

Topic: *"eTourism"* (Tourismusverband Seefeld in Tirol 2018)

(0) Introduction

The aim of the organiser was to find digital solutions to support and increase the tourism in the region of Seefeld. With the involvement of the *Standortagentur Tirol*

[19] Author's illustration

feasible and useful solutions could have been transferred to other regions in Tirol or whole Austria easily. As the hackathon was focused on software and apps, the target groups were primarily people from software development and marketing. There was no specific task given. Participants could work on projects for tourist accommodations, skiers, passionate hikers or any other type of tourist and the respective industry.

(1) General Information

Interested people received a lot of information on the events' webpage. It included details about the jury, the solution categories and the team sizes. What did not work out was the notification about the parking situation. The reminder email included a map with an assigned parking lot. It was about 15 minutes walking distance to the event venue. This parking spot still included a fee. At the registration participants could get tokens for the parking machines, but this was not communicated. Even more, these tokens were valid everywhere around the city, so attendees could have parked closer as well. In addition, there was a big parking lot for free only three minutes away. It was the second hackathon organised by *Olympiaregion Seefeld* and they will conduct more in the future.

(2) Goals of the organiser

The promotion of Tirol especially in the tourism sector was paramount to the organisers. The contact to high potentials was the second target. Recruitment was a selling point while acquiring sponsors. The focus on tourism differentiates the event from others. All created content remained with the participants.

(3) Process

Methodical idea creation was not performed. After the teambuilding the teams started right of with their ideas. The only limitation regarding the potential solution was that it had to add value to the tourism business in Seefeld. The mentors were either tourism or IT experts. Lacking enough good programmers, there could have been more IT experts to support the teams. Partly the waiting for help was long.

(4) Participants

The organisers had almost 100 registrations. They had to reject a couple of applications. The expected no-show rate was lower than the actual one which why in the end about 55 participants showed up. Many participants already knew each other which lead to a loose and friendly atmosphere. A competitive rivalry was never present.

(5) Place

The operating casino as event location was something new. Not only the participants had the chance of a welcomed distraction while they were gambling in the casino, but regular casino guest could come by and have a look on what the teams were working on. A downside of the location was the limited space. It was furnished for about 80 participants. The aisles between the tables were narrow and the tables itself too small for the whole team. Figure 19 gives an impression of the space situation at the *eTourism Hackathon 2018*.

(6) Marketing

What helped the hosts to recruit enough people was that they managed to include the event into the curriculum of several universities of applied science in the region. The attendance was mandatory for course participants. However, the event was promoted through traditional marketing channels too. With the close relation to universities, the event was presented in several lectures.

(7) Personal Opinion

The casino as event location was perfect as it provided unusual opportunities to spend breaks and was located in the city centre which left the opportunity for other activities. The staff was motivated and helpful. Potential for improvement has the communication about the parking situation and the long wait until dinner time. The event started at 12:00 pm and dinner was at 8:00 pm. At this time the participants were already very hungry and were not concentrated and focused anymore.

4.2.6 Techfest Munich 2018

Figure 20: Final Presentations at Techfest Munich 2018[20]

Organiser: UnternehmerTUM

Date: 14.06.2018 – 17.06.2018

Topic: Several different categories

(0) Introduction

The event was promoted as 72-hours hackathon, but this timeframe included everything from the pre-party until the closing session. The actual hacking time was about 40 hours. The huge number of participants allowed the organisers to have multiple challenges. They were divided into four tracks with a main sponsor each. In addition to the main sponsors challenge each track had in average 3 sub-challenges sponsored by different companies. To complete the rich offer there was an open challenge. Participants had the chance to work on whatever they wanted. Figure 20 shows one of the pitches of one challenge winner.

(1) General Information

On the webpage almost all necessary information for an interested person was provided. Details about the incentives were missing as every challenge sponsor had their individual prizes. It was the third *Techfest* organised by *UnternehmerTUM*. It will be continued on an annual basis. Additional similar event formats are offered throughout the rest of the year.

[20] Author's illustration

(2) Goal of the organiser

It is an event dedicated to hackers. First of all, it shall bring together the existing hacker community and boost the ecosystem of hackers and creators to increase their number. As it is the purpose of *UnternehmerTUM* to foster entrepreneurship at *Technical University Munich* one target is to create teams who continue working with their sponsors or even establish a start-up. Techfest tries to differentiate itself from others by creating a more festival character rather than a typical hackathon atmosphere. This is achieved by a lot of side program and other activities. The participants can use the huge makerspace and “techlibrary” (a storage where electronics, tools and other materials were stored) throughout the event. Not only hackers could participate, but existing start-ups too. The IPR on ideas, concepts and prototypes stayed with the creators.

(3) Process

As the first investigated event they performed a guided idea creation workshop. Several different methods were used. In a next step the ideas got pinned up and the ideas were rated. For the most promising ideas teams started to form. The number of mentors was sufficient. For every aspect there was at least one expert. Because it was a three days hackathon, the typical stress never came up at any point of the event.

(4) Participants

At this hackathon an application was necessary for participants. The applicants were divided into three categories: hackers, designers and makers. Every category was represented by about a third of the almost 400 participants. Compared to other hackathons people from around the world attended.

(5) Place

As the proximity to the makerspace made it necessary, the facilities around it were used. Additionally, two spacious event tents were set up. The tents sheltered the main stage and the catering service. The dining and the relaxing areas were outside. That made them dependent on good weather conditions. Inside, every track and challenge got their own rooms and spaces. The accommodation was not on-site and not in walking distance. At night a participant had to choose between proper sleep or working, because the shuttle service was not operating between midnight and seven o’clock in the morning. The makerspace offered laser cutters, 3D-printers, vinyl cutters, electronics, soldering stations, tools and much more for the teams to work with.

(6) Marketing

Every possible marketing channel was used for the *Techfest Munich*. Supplementary they hosted promotional events and let their sponsor promote themselves. If the organiser could only choose one media for advertisement they would go for Facebook.

(7) Personal opinion

The size made the event different than any other, although the number of participants was already critical. Unfortunately, the facilities around the makerspace are not arbitrary scale able. This includes everything from hacking spaces, dining area, washrooms etc. The number of participants at the *Techfest Munich* has reached its maximum if it were not too many already. Including staff, mentors, press and security more than 500 people were there. Apart from that everything was very well-organised and the goal of hosting a festival rather than a hackathon was achieved.

4.2.7 Hackathon for a world without barriers, Graz

Figure 21: Hackathon for a world without barriers (Rauch 2018)

Organiser: Arbeitskreis “Ecomobility barrierefreie Wirschaft” der WKO Steiermark/UBIT, ISDS and NE

Date: 05.07.2018 – 06.07.2018

Topic: *“…Innovative solutions for vision-impaired or blind people” (Game Lab Graz 2018)*

(0) Introduction

It was the first hackathon event at TUG which worked together with the targeted user group. About ten vision-impaired or blind people were at the event to give the students a glimpse of their daily problems. They were available for both days. The teams were able to work on general problems for the user group or on individual solutions for a certain person. Figure 21 shows the audience during the final presentation.

(1) General Information

Most of the needed information was briefly provided on the web page. It indicated what's different about this hackathon as well that it is a fragmented event. Information about what everybody had to bring along was missing. It was the first event of this kind for the organisers. According to the great feedback and the good results it probably wasn't the last one.

(2) Goals of the organise

The main goal was to bring together visual impaired and blind people with students to create awareness for them and their daily issues. As the visual impaired and blind people were the target group of the created ideas and solutions, the students had the opportunity to work more focused and with better input on their solutions. For the organiser it was the first hackathon they have conducted with the user group present at one of their events. For this particular characteristic it served as a draft event for themselves for potential future hackathons like this.

(3) Process

Product development methods were not applied. The user group presented their issues with specific examples. In case the teams wanted to develop an app for a mobile phone they got informed that the majority has iOS-based devices. Beside the user group no other mentors were available, but some of them were software developers too.

(4) Participants

About 20 people took part at the hackathon. The event was designed for 40 participants at maximum. Salient factors for the teams' motivation were not observed.

(5) Place

Same as at the *Green Tech Jam 2018* a lecture room at the TUG was used. The participants got a few electronic devices for prototyping. Other than that, no prototyping material was provided.

(6) Marketing

As the main organisers were the same as for the *Green Tech Jam 2018* similar media channels were used. It includes Facebook, Twitter, webpage, gaming community, studying councils and the Studo App. Only posters were not used for the *Hackathon for a world without barriers*.

(7) Personal opinion

As it was the first event with this new concept for the organisers, it passed by smoothly. Only two issues leave potential for improvement: First, it was not clear to the participants what the framework for the presentations was (time, important content, demonstration, etc.). Second, it was not necessary for the target group to be present all the time on the second day, as the teams were busy with executing the plans which they developed on the first day with them.

4.2.8 Comparison

Before the lessons learned are presented the most important characteristics of the six investigated events are shown in Table 2. If applicable the ratings poor, fair, average, good and superior were used for the parameters.

Table 2: Key characteristics of investigated hackathons

Parameters	Zeiss Hackathon 2018	Science2Business Challenge 2018	Green Tech Jam 2018	eTourism Hackathon 2018	Techfest Munich 2018	Hackathon for a world without barriers
Size [participants]	Medium: 40	Small: 2	Medium: 21	Big: 51	Mega:390	Small: 18
Teams	11	1	6	10	80	4
Days	3	2	2	2	4	2
Non-stop event	Yes	No	Yes	Yes	Yes	No
Provided Information	Average	Average	Average	Good	Good	Fair
Product Development Methods	No	Yes	No	No	Yes	No
Mentors	~40	~8	~8	~5	~60	~10
IPR	Teams	Teams	Not defined	Teams	Teams	Teams
Event location	Industrial building	Co-working space	Lecture rooms	Casino	Lecture rooms	Lecture rooms

Event size and participants' background

The number of participants contributes to a certain degree to the success of an event. It is vital to have a minimum number of attendees as the interaction between them is inspiring and fosters creativity. The low number of participants at the *Science2Business Challenge* serves as an example for this issue. Another trend that appeared is that the number of team members and their background has a strong influence on the results of the teams. With the small sized teams at *Green Tech Jam* not many working prototypes were realized. Due to the limited capacity, it was not possible for the participants to focus on the prototype and the business concept. At the *eTourism Hackathon* and the *Techfest Munich,* both offering coding-intense challenges, it was shown that teams consisting of software developers only are no guarantee for success. Several, in terms of hackathons perfectly coded and functioning prototypes, did not win, because the teams were not able to present and sell their product to the jury.

Non-stop events

Only the *Science2Business Challenge* and the *Hackathon for a world without barriers* were fragmented events. At night everyone went home and returned on the next day. At the *Green Tech Jam*, it was possible to work all night, but it was highly recommended by the organiser to go home and sleep normally. By eleven o'clock at night one team was still working. The other events were official non-stop events. One team worked all night long at the *Zeiss Hackathon*. The other teams left between 9:00 pm and 1:00 am. At the *Techfest Munich* only a few teams worked all night. The others went to bed or started partying. The *eTourism Hackathon* was the one event were many participants worked all night. Apparently, no significant correlation was observed between the project results and the sleeping conditions. The influence of non-stop events on the participants when returning to their regular life was not investigated within this research.

Provided information

It is important to provide enough information before and during an event. This helps the organiser to focus on the relevant things rather than answering basic question. Moreover, it serves the participants as a guideline throughout the event. As the general schedule of a hackathon is always very similar hackathon-experienced, people already know what to expect and can assume certain details, but for first-timers it is important to explain relevant details briefly. *Techfest Munich* and the *Green Tech Jam* solved that issue with their frequently asked questions (FAQ) on their website. Many details were briefly provided by the *Hackathon for a world*

without barriers and the *eTourism Hackathon* but might not be informative enough for beginners. The *Techfest Munich* or the *Zeiss Hackathon* did not provide any details about whether the attendance at the pre-event is mandatory or not. Potential solutions should not be anticipated by the organisers, as it narrows the participants' creativity. This was the case at the *Science2Business Challenge*.

Product development methods

The only two events who actively used a couple of product development methods were the *Science2Business Challenge* and *Techfest Munich*. The quality of the outcomes improved as the participants had to deal with the topics and did not start right away with their first idea. For events like the *Zeiss Hackathon* where the results are secondary it is fine to let the participants start right away with hacking. However, the researchers' interpretation is that better results could have been achieved at the *eTourism Hackathon* and the *Green Tech Jam* with a problem understanding and idea creation workshop. Still, to validate these findings more events need to be investigated. In contrast, high-quality results can be achieved with close cooperation with the user group too.

Mentors

Mentors are either there to help the teams understanding the challenge or to realize their ideas. At the *Zeiss Hackathon*, *Science2Business Challenge* and *Techfest Munich* a good mix and number of both types were on-site. The *Hackathon for a world without barriers* had many experts for the challenge but limited staff for the technical realization. Reversed was the situation at the *eTourism Hackathon* were many coding experts were present. The availability of mentors was very limited at the *Green Tech Jam*. The challenge experts only were on-site for the first hour and afterwards reachable by phone. Technical experts were present sporadically.

IPR

In this category, at one event, it was not clarified with whom the IPR will remain. At the *Green Tech Jam* the legal situation was unsolved. The *eTourism Hackathon* and the *Techfest Munich* stated on the website that the rights will remain with the teams. At the *Zeiss Hackathon*, the *Science2Business Challenge* and the *Hackathon for a world without barriers* this information was provided on request.

Event location

Three events used university facilities as a venue for the hackathon. These were the *Green Tech Jam*, the *Techfest Munich* and the *Hackathon for a world without barriers*. The *Science2Businees Challenge* used a co-working space; the *Zeiss*

Hackathon an industrial building and the *eTourism Hackathon* a casino. It was observed that for the working area the event location itself is irrelevant. It only needs to be ensured, that there is enough space and plugs, as well as a sufficient internet connection. Issues with it occurred at the *Techfest Munich* and the *eTourism Hackathon* as especially the space was very limited. For the side events and activities an unusual location is not necessary, although it worked perfectly fine and gave a positive impression at the casino. Nevertheless, the *Zeiss Hackathon* and the *Techfest Munich* showed that with enough commitment and/or resources good hackathon environment can be created.

4.2.9 Learnings

Insights on serval aspects of hackathons were gathered with the individual event analyses and the cross-case comparison. The lessons learned are mainly based on the observations from a participants' perspective at the investigated events. The results can be categorised as follows:

- Team size
- Venue
- Mentors
- Product development methods

Team size

The appropriate team size is foundation for good results. With teams of three or less members usually the capacity is not given to solve all aspects of a challenge. Further on, it is necessary that all required skills are existing. There is no time for learning something new. With six or more members there is a risk that the communication is not working anymore and that some people are underutilised. However, more team members open the opportunity to new skills that can be acquired by individuals. For example, how to code a chatbot or how to realize a server architecture. As experienced during attended events by the author it seems that the ideal number is four or five members. But with respect to the challenge scope and the participants' skills, three or six team members still can lead to good results.

Venue

Regarding the workplace, it does not matter to the participants if they are sitting in lecture room, a seminar room or any other big room. It is important that they have enough space to spread for their work, the room can be aired and that the infrastructure is provided (plugs, Wi-Fi and lighting). To keep up the mood and

energy level enough food is the first key feature. The second one is to provide alternatives to the working routine. There should be facilities for relaxing, because barely anyone can work focused for several hours. It starts with simple things as seating areas, ideally not inside the workspace, to gaming corners, to finally very special ones like a casino or a swimming pool. Recreation throughout the event is necessary.

Mentors

Mentors play an essential role at hackathons. The investigated events showed that projects highly benefit from good input. It is important to have a sufficient number of both types of experts available at an event. Challenge experts help to improve the overall results as they are represented either by the user group or the sponsors. Technical mentors contribute instructions concerning the implementation of solutions and the application of methods.

Product development methods

Not every event necessarily needs product development methods. At hackathons were the outcome is secondary, these methods are not needed. Such events are typically community focused. It is different for events which are aiming for useful results. Here, these methods can support the whole project process. Usually at hackathons none of these methods are introduced, which often leads to results which are the obvious next step, not feasible, have no target customer or cannot be commercialised.

4.3 Experts Interviews

For data triangulation, the second type of data was gathered through expert interviews. Three experts were interviewed. They were chosen in respect to their experience as either hackathon organisers or participants. The interviews were conducted with a semi-structured interview guideline. They lasted in average 40 minutes. The interview guideline is presented in the appendix 13.3. For anonymity reasons personal details about the interview partners are not presented. Table 3 shows an overview of the main statements of the experts, excluding information about facilities, participants and process.

Table 3: Overview statements of hackathon experts

Parameters	Expert A	Expert B	Expert C
Hackathons as participant	33	3	0
Hackathons as organiser	3	5	8
Start event planning	-	~ 1year	6-9 months
Start event promotion	6 weeks	2 months	6-9 months
Typical event size	Medium – Big	Big – Huge	Mega
Marketing channels used	Few	Many	Many
Most sufficient channels	Community	Word of mouth & Social media	Facebook
Ideal team size [members]	up to 5	3-5	3-6
No-show rate	50 %	33%	10-20%

4.3.1 Organisational facts

This section compares the statements of the interview partners regarding the organisational facts.

Start event planning

Expert B usually starts to plan an event about a year ahead. However, it was mentioned that the core time for event organisation is about three to four months prior to the event. Although the events organised by *Expert C* are bigger than those of *Expert B* planning starts later, about six to nine months prior to the hackathon.

Start event promotion

Every expert stated a different time when to start with the event promotion. In combination with the typical size of events they organise, the trend is that the more participants an event needs the earlier the promotion needs to start.

Marketing channels

Expert A primarily relies on the connection to the hacker community. Other media are scarcely used. The others are basically using every possible channel. In the opinion of *Expert B* social media and word of mouth work best. *Expert C* claims that Facebook works best for them.

Team size

Expert A only stated a maximum number of participants as it is always depending on the individual skills of the participants how many resources they need. Otherwise the opinion correlates with the findings of the detailed investigated hackathons.

No-show rate

All three experts take a certain no-show rate into account when it comes to accepting registrations for their events. Regarding their experience, no clear trend about the average no-show rate is identifiable.

4.3.2 Facilities

All three experts agree that a hackathon venue needs to have a good Wi-Fi connection and enough power (plugs). According to *Expert A* the internet bandwidth should be at least 1 mega bit per participant. Further, *Expert A* states that there should be additional rooms for the following: common room, sleeping room, reception area and enough bathrooms. *Expert B* adds that the main room needs good lighting and the possibility to be aired.

4.3.3 Participants

Everyone stated that a great mix of participants is crucial for an event, but when it comes to the composition the opinions differed. For *Expert A* it is important that there is a good balance between beginner and experienced hackathon participants. The individual skills are only of secondary importance. Contrary, *Expert B* and *C* said it is important to have a satisfying mix regarding the skills. Hackathon experience is not important to them.

4.3.4 Process

Expert C expressed that about 10-15% of the participants' number is a sufficient reference value for the number of needed staff. From the organisational staff potentially, everyone should be capable of doing anything, but there should be at

least two people who know all event details, in case one is temporarily unavailable. *Expert B* added that if external facilities are used, one person needs to know everything about the building, especially where to regulate the lights and the air condition and how to reset the Wi-Fi.

According to *Expert B* no product development methods should be applied. The event is supposed to be focused on learning by doing. *Expert A* never applied any methods so far and has no experience from other events. For *Expert C* it serves as a good starting point for the new teams. But an event host should be careful that the hackathon does not become to structured, so that there is still enough freedom for the participants.

4.3.5 Excursion on IPR

In chapter 2.1.7 the legal aspects about hackathons were introduced. The question was if it is possible for an employer to claim any on content created by its employees at hackathons in their spare time. The following section is referred to Austrian law and might be not applicable in other countries. First two things need to be distinguished: invention according to patent law and copyright.

According to Mertinz (2014) a job-related invention is given, if:

- the invention is content wise part of the industry sector where the person is employed
- the task which has led to the invention are part of the employees' work
- the employee got the stimulation for the invention because of the work tasks
- the realisation of the invention was significantly simplified because of the facilities of the employer or the experience an employee has gathered at work

It is different with copyrights. The employer can only claim rights if it was directly work-related content. The rights remain with the author in the four cases mentioned above (Majoros 2017).

These are the general interpretations of the copyright and patent law. They do not consider alternating company specific agreements between employees and employer. Therefore, it can be concluded that as long as a participant is voluntarily at a hackathon, issues only can occur with inventions, but not copyrights (especially created code). As physical prototypes, and therefore potential inventions, are the

intended outcome of a makerthon an organiser might be confronted with these concerns.

Not only the above-mentioned experts but also other contacts made by the author while the research were asked if they have ever experienced legal issues with the created projects. None of them were confronted with such an issue so far. Due to that and because it is not within the scope of this thesis, it will be left as suggestion for further research.

4.4 Makerspaces

The last method for data collection was to find makerspaces which hosted hackathons so far. The main target were facilities in Austria. Information from a webpage[21] which lists makerspaces in Austria was used to contact the managing staff. The search was completed with a general online research. One of the contacted makerspaces already conducted a hackathon while using digital prototyping machines. The information was incorporated into the draft concept.

Further, four makerspaces in NYC were investigated. The *Staten Island Makerspace, Hackmanhatten*, *Fatcat FabLab* and *NYC Resistor* were chosen with respect to availability and accessibility during the limited timeframe of the researcher. The *Staten Island makerspace* already hosted hackathons at their facility, but these events were not related to digital prototyping machines. Either the prototyping consisted of forging, welding and other heavy tooling or regular objects were equipped with electronics to make them smart. One of the staff members at *NYC resistor* recommended some events in New York to investigate, but those were similar to the hackathons at the *Staten Island Makerspace* regarding the type of prototyping. Information other than that was not obtained.

[21] http://www.makerszene.at/makerspaces-in-oesterreich/

5 Data Synthesis

The gathered information from chapter 4 was used to develop a draft concept for a hackathon at an academic makerspace, a so called makerthon. The concept development was a collaborative work of the researcher and several IIM employees. First, the framework of the event is presented. Second, the limitations and amendments are explained. Limitations in this case were internal or external factors which did not allow to implement something as learned. As there is no existing ultimate hackathon success concept, some modifications were made on purpose to test something new.

5.1 Draft Concept

The draft concept is divided into three sections; organisational, facilities and process. Only the important event details are explained briefly.

5.1.1 Organisational

At first the general timeframe was determined. A fragmented three days-event was chosen. Three days were necessary to give the participants enough time to prototype. The event was promoted as 48 hours makerthon which started at 3:30 pm on Friday and ended at 3 pm on Sunday. The facilities were closed at 10:00 pm and opened again at 09:00 am. Including the preparations and the follow-up work, a working day easily can have 14-15 hours. Therefore, it is necessary to have enough staff for the personnel scheduling, because in Austria employees are only allowed to work 10 hours a day (Austrian Working Hours Act).

Two IIM industrial partners served as sponsors and challenge providers. *Magna Steyr* asked the participants to reinvent the urban mobility 2030+. The second sponsor *Miba* wanted the teams to find new slide bearing applications. Every challenge got 3 teams with 5 participants each. In total 30 attendees were needed. At least one company representative of each was supposed to introduce the challenge, support the teams during the problem understanding and be back on the final day to act as jury member. The IPR of all created content remained with the sponsor companies as it was their demand in order to fund the event.

One caterer was chosen to provide all meals (breakfast, dinner and lunch on all days). For the main meals always regular and vegan dishes were provided. The

drinks were organised by the institute staff. In total five IIM employees were directly involved in the makerthon. For the preparation and the follow-up work another five were engaged in the makerthon.

As part of the application process, potential participants had to provide a motivation statement and which project they were interested in. Both information served the selection of suitable participants in case there were too many applications. Further, the people had the opportunity to apply as individual groups or full team.

Despite the little number of participants, the draft concept includes a competitive element. The best team of each challenge could win a trophy and non-monetary prizes.

5.1.2 Facilities

The *FabLab Graz* is on the *Inffeld Campus* of TUG on the first floor of the *Frank Stronach Institute*. Two additional lecture rooms were used to host the event. These rooms are on the ground floor of the same building. Room number one has 130 m² and room number two 62 m². The bigger room was used as working space for the teams, the smaller one served as dining and relaxing area. The participants could help themselves with drinks and snacks all the time and use the couches to take a break from work. The FabLab itself provided several working areas for the prototyping phase. It included several 3D-printers, two laser cutters, one vinyl cutter, two electronic workspaces and wood shop.

5.1.3 Process

After the welcome session the company representatives had the opportunity to introduce their challenge for 15 minutes each. Next, the teams should be formed followed by a small ice-breaking challenge. Then the teams did not start right away with prototyping as it is usual at the majority of other events. The process was segmented into five stages as it is shown in Figure 22. Several product development methods were introduced to the participants. Some of them were mandatory and some were optional to apply. Every working day ended with a checkpoint were the project progress was controlled. Before starting with the actual challenge an ice breaking mini challenge was performed. Especially the newly formed teams had now the chance to get to know each other a bit, further it served as motivational aspect.

The first phase was about understanding the challenge. Two methods were selected: *customer journey map* and *ask the experts*. Basically, a *customer journey map* is a simple diagram that illustrates every contact point a customer has in engaging with a company, whether it is a product, an online or retail experience, a service or any combination (Richardson 2010, p. 1).The complexity of a proper customer journey required an experienced facilitator for each challenge to create sufficient outcome. Two institute employees had the needed qualification. *Ask the experts* is self-explaining. For this phase, the company representatives were present.

The second session was dedicated to determine the real problems. The methods *"how might we…"* and *lightning demos* were used. With the gathered insights from the problem understanding *how might we* questions need to be formed to turn the challenges into opportunities for design (IDEO.org 2018). To take a look at competitors' products or non-competitive products that solve the same issue is called *lightning demo* (Knapp 2012).

Day two started with the idea generation. Five methods were introduced for the teams to choose from. Those were *brainstorming*, *mind mapping*, *X-3-5 method*, *brain writing pool* and *six thinking hats*. Many deviating definitions of the X-3-5 or mostly called 6-3-5 method can be found in literature. X refers to the number of participants, three to the number of ideas each round and five to the length of each round in minutes. Drews and Hillebrand (2007, pp. 105–110) explained the *6-3-5 method* as following: Every participant receives a sheet with 18 boxes (three columns and six rows). In round one everyone starts to note three ideas in row one. After five minutes the sheets get passed on to the neighbour. Now in the next row new ideas can be added or existing ones iterated. This is done until everybody receives their initial paper. In best case a session results in 108 ideas. The *brain writing pool* method has several variants too. Schröder (2012) suggests that after the topic definition participant starts to note ideas on a piece of paper. If someone runs out of ideas the sheet gets placed in the middle and another sheet from the middle can be taken for inspiration. The ideas can be refined, changed, structured or a new idea is created. These two methods were briefly introduced as they were the most popular among the teams[22].

The next phase was to select the right ideas with either a *morphological box* or an *art museum*. According to Ritchey (2013, p. 3) a *morphological box* is an n-dimensional matrix out of parameters. A cell contains one particular condition of a

[22] For more details on the other methods see: http://www.ideenfindung.de/%C3%9Cbersicht-Liste-Kreativitaetstechniken-Ideenfindung.html

parameter. A solution is created by selecting one condition of each parameter. It can be either used for idea generation or valuation. For an *art museum* the ideas should be transferred to an idea card. An idea card contains key features of an idea, like brief description, sketch, advantages, disadvantages, potential customers etc. These idea cards are pinned to a wall. The idea selection will be made by a team discussion.

The last main section was prototyping. Here, the selected ideas and concepts were realized with prototypes. In parallel other team members set up a story board. It is a quick and low resolution prototype to visualize the concept from start to finish (IDEO.org 2018). On the third day the prototyping session was terminated by lunchtime. By then the teams had to finish their prototypes and hand in the presentations. After lunch the presentations, feedback session and award-winning ceremony followed before closing the event. The presentations were split into two parts. The first one was the project pitch and the second one a question and answer (Q&A) session with primarily the jury. Every participant got rewarded with a 50 € voucher for the FabLab Graz. The winning teams got festival passes and a trophy.

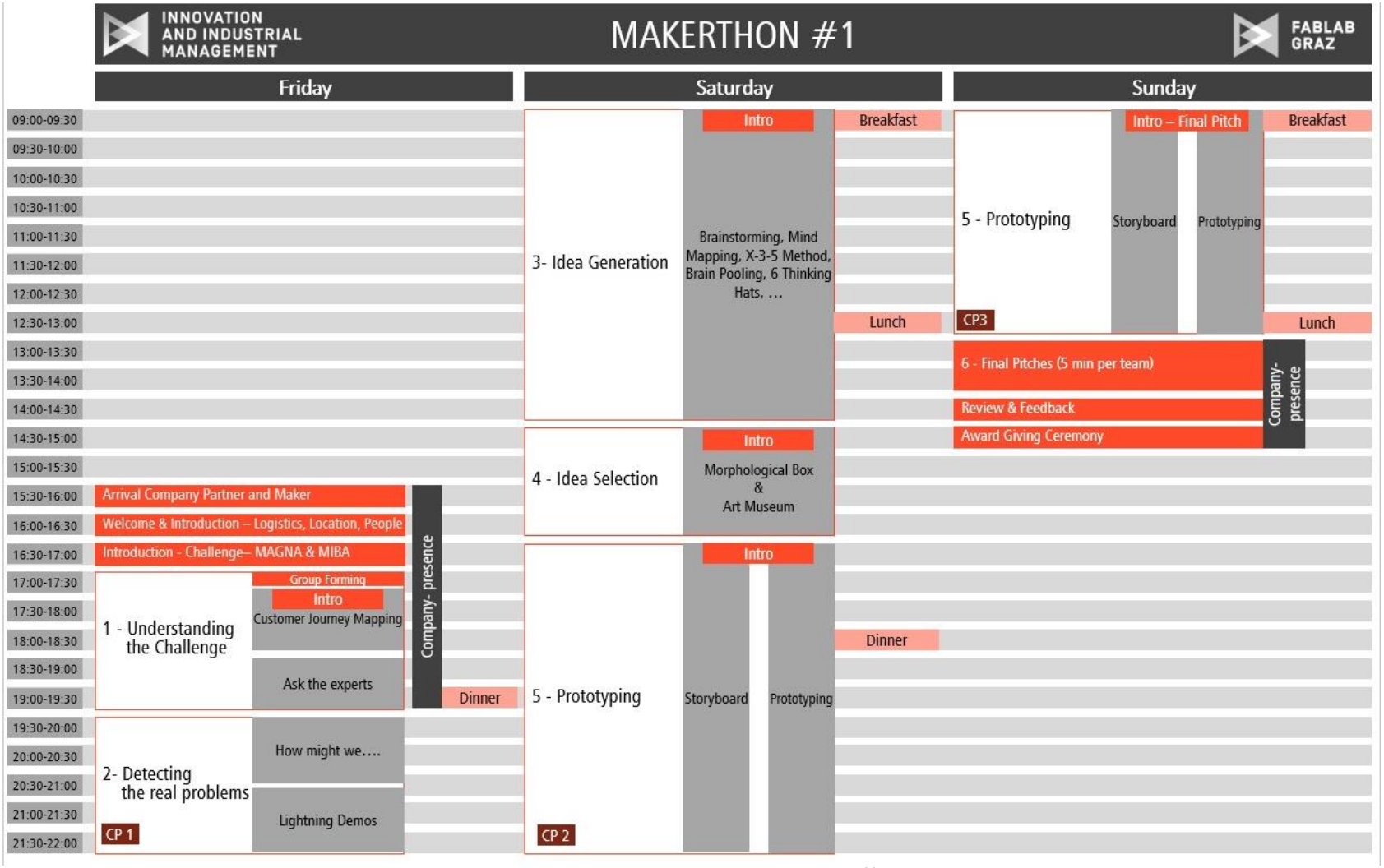

Figure 22: Timetable of the makerthon draft event[23]

[23] Author's illustration

5.2 Limitations and Amendments

It was necessary to conduct the makerthon early on, because of existing sponsoring contracts. It led to the fact that the draft event took place before all data was gathered from the pre-study and the detailed analysis.

Developing a structured process was tested, which was to satisfy the sponsor companies. Still, the aim was also to give the participants the opportunity to experiment with different solutions and prototyping technologies. Therefore, the second 24 hours were less structured. This was a necessary test implementation as the companies did not have good experience with the results at other events they had sponsored.

While at the majority of detailed investigated events the IPR stayed with participants, this was not possible at this event. In order to sponsor the event, the companies insisted on receiving the IPR on the projects. To prevent any legal issues, every participant had to sign a declaration of assignment before the event started. As the importance of the company mentors was not foreseeable, it was not planned to have them available at the makerthon for a long period.

5.3 Summary

The first makerthon conducted by the IIM was conceptualised as a 48-hours event over a whole weekend. The intended number of participants were 30, 15 for each challenge. These challenges were provided by *Magna Steyr* and *Miba*. The event staff included 8 members: 5 IIM employees and 3 technical experts from the companies.

The event was hosted at the TUG campus. Besides the *FabLab Graz,* two lecture rooms served as event venue. One room was the main working area and the second one was used as dining and recreation area.

Compared to other events, the schedule was very structured. Many product development methods were introduced, including *customer journey map*, *how might we*, *brainstorming*, *mind-mapping*, *six thinking hats*, *morphological box* and others. While the idea creation methods were optional or at least the teams did not have to use them all, the methods from section one, two, four and five were mandatory (see Figure 22).

6 Validation

To validate the draft concept, it was essential not only to develop but also to test it. To test the concept, a makerthon was conducted. Chapter 6 is split into three sections. First, observations and challenges during the event are elaborated in execution (6.1) which leads to the lessons learned from the makerthon (6.2). At last, the adaptions (6.3) for future events are explained and additional recommendations are stated.

6.1 Execution

This section is divided into the same three categories as the draft concept (5.1), organisational, facilities and process.

6.1.1 Organisation

The 48 hours timeframe did not only work well for the participants. The key staff members who have to be present at any time had the opportunity of a proper rest too. Only on day two, one team would have liked to continue working longer.

Both challenges received similar attention. No one had to work on a challenge she or he did not select. It was visible that the technical challenge needed more support during the event. It was mainly necessary when the teams reached a dead end due to limited knowledge about the specific challenge characteristics. Small impulses were enough to bring the teams back on track and revive their motivation level. Regarding the IPR situation declaration of assignment forms were prepared for the participants. Everyone signed them at the beginning, still a few would have preferred to know that in advance.

The teambuilding hardly did take place as four almost complete teams did sign up for the event (two for each challenge). The remaining participants were then assigned to the teams, either to be part of the third one or to complete other groups. A lot of effort was put into the recruitment process. Within the last couple of days every applicant was contacted personally to confirm if they are attending or not. The experience from the investigated events was that not always everyone shows up, so 33 applications were accepted to reach the intended 30. It turned out that in this case everyone showed up. However, no one was sent home and the event was performed with more participants than the intended number.

This decision increased the issues occurred with the catering. The participants, mentors and staff were about 40 people in total. For this number of people food was ordered at the caterer. What was not considered was the fact that the majority were young and male participants. This resulted in a shortage of food. At the first dinner it was indicated that the food was scarce, but everyone got replete. On the second day it was clear that it was not enough. The fruit tray which should last the whole day was gone after breakfast and the first lunch was emptied quickly so additional pizzas had to be ordered. For the remaining meals the caterer was briefed to increase the number of meals. Further additional fruits were bought as snacks in between. Originally it was not planned to provide any alcoholic drinks during the makerthon. Mainly for safety reasons, as it is not allowed to operate any machines or tools intoxicated. Monitoring every single participants' alcohol consumption would have been to extensive. On the first day the initial plan was revised and after the day was officially over everyone got offered a "afterwork beer". It turned out that this idea was great for socialising. The participants had the chance to come down after an intense work day and started to interact not only with their team mates, but with the other teams too.

The mentors were initially planned to be available only until the end of section one and return on the final day for the pitches. However, the enthusiasm and motivation of the teams as well as the preceding results of the teams encouraged the company representatives to stay longer. On day one some of them stayed until the "afterwork beer". Actually, the two main mentors had already plans for Saturday but did some rescheduling to support the teams for a couple of hours too. As the participants knew that the mentors were not supposed to be here anymore it was an additional motivation for them to continue their work.

6.1.2 Facilities

All in all, the chosen facilities suited the purpose and were spacious enough. The dining and recreation area needed a few more sitting opportunities during the meals. The FabLab working areas were suitable on Saturday as everything evened out during the day, but on Sunday the wood workshop was quite crowded as every team was eager to finish or perfect the prototype. The main room was big enough to fit all participants easily. It was observed that, because the applied methods require a lot of group discussion, a few teams moved outside or to other rooms to keep focused. While prototyping the noise level was not an issue as smaller teams were formed or participants worked on their own.

6.1.3 Process

The ice breaking challenge fully fulfilled its purpose. Besides that, not all applied methods were equally successful or popular. The *customer journey map* was the first example. For the majority of the participants it was the first time they have heard about this method. To start with it was not the easiest technique even with trained facilitators. The created content was quite abstract for several participants. In a later project stage some of the issues became clearer as the connection was made to the relevant topic. In general, the observation showed that it was a slightly rough start as hackathon beginners were overwhelmed with the new input and the hackathon experienced were wondering why they could not start right away. In section two when both types had adjusted to the circumstances the resonance was mainly positive regarding the process structure. On day two the participants enjoyed the fact that from now on the applied methods were selectable. Every team was able to use their preferred techniques.

The prototyping phase was supported by the two FabLab employees. Their challenges in the beginning were to clarify the possibilities and limitations for the machines in general and specifically for this event. Time consuming fabrication characteristics needed to be avoided, such as high-volume or high-density 3D prints or big engravings with the laser cutter. Later the teams needed a lot of support to create the actual CAD files. As many of the participants were mechanical engineers, they were capable of creating CAD models in general. Apparently for the machines certain rules need to be respected or constructions to be simplified to use the machines more effectively and efficiently. As a few of the participants had experience with the machines and respectively with the CAD files, the capacity of the FabLab staff was sufficient. Without the experienced users the two employees would not have been enough or the teams would have had to wait for help unreasonably long. What did not happen during the event was that a few prototype iterations were performed with the FabLab machines. As first step paper and cardboard were used for prototypes, the final ones were built in the workspace with advanced materials and machines.

6.2 Lessons Learned

This section merges the insights of the staff with the feedback from the participants. Each participant filled out a feedback form. For details about the questions see appendix 13.4.

48 hours for the makerthon were a suitable timeframe. It left enough time for every team to finish their prototypes and generate several other ideas too. The fragmented structure was preferred by more than half of the participants. These people primarily were hackathon-beginners. The hackathon-experienced team cohesively voted for a non-stop event as they wanted to continue prototyping. However, the break after day one was no issue for them.

During the challenge introduction the sponsors presented their company. The observation agrees with the participants' feedback, that this presentation should be shorter. About a minute or two is sufficient, the rest of the time should be used for the challenge description. Although it should be the goal to find sponsor companies for the next event who will not claim any rights from the beginning, the participants should get informed beforehand. It should not happen again that they will be affronted with the declaration of assignment.

For food calculations the factor 1,1 – 1,15 in terms of ordering quantity for male dominated events worked quite well after the adaptions on day two. That means if 40 people are at the event, food for 44 – 46 needs to get ordered. The "afterwork-beer" served perfectly as socialising instrument. The teams used the time to exchange between each other not only on a makerthon related level, but on a private one too. Further, all the participants understood the fact, that it is not possible due to safety reasons to provide any beer or other alcoholic drinks during the official parts.

Somehow it was the case anyway, but for the next events the mentors should be available longer on a planned basis. First for more detailed questioning, as it takes some time for the participants to get familiar with the topic. Second for the ideation and idea evaluation phase to support the teams more.

Regarding the facilities, it was learned that more space for assembling and tool working should be provided to avoid any crowds and queues. Other than that, nothing specific was noticed.

The *customer journey map* was too difficult and abstract as a starting method for the participants. It was the only method that was rated negatively by several attendees. Here, a simplified version or a different and easier method should be chosen for the next event. However, the teams appreciated the guidance with the methods. Every method was supported with a one pager where the key characteristics were explained. Those one-pagers were handed to the participants after the introduction. It was noted that these one-pagers could have been provided in a collected form with other essential information in the beginning. The other

details were timetable, Wi-Fi-passwords, deliverables and deadlines. The methods and the checkpoints helped the teams to keep track on their progress. The stress for them was reduced to a necessary minimum.

All in all, the teams were satisfied with the support in the FabLab. Without the staff, many prototypes could not have been realised. What should be kept in mind for the next application phase is to ask for makerspace experience as these people can create their prototypes more independently. For a good team experience, it feels better if one of the teammates could realize certain parts rather than with the help of externals.

6.3 Adaptions

The following adaptions compared to the draft event were integrated into the makerthon event manual:

From the 15 minutes' timeframe each sponsor gets to introduce themselves, only two minutes will remain for company presentation. The focus should be on the challenge itself. The company representatives need to get briefed accordingly. Further their presence at the makerthon was extended. That should be made clear while negotiating with the potential sponsors.

As it can be expected that the female rate will not be significantly higher at the next events, the food calculation factor was changed to 1,1. For cost reasons the catering was split. Lunch remained with catering while for breakfast, snacks and dinner alternatives were chosen. As the number of participants was manageable and will not change drastically at future events, the other meals are organized and prepared by the staff. For the afterwork session alternative drinks were added as not everyone likes beer.

All handouts get prepared beforehand and they will be given to the participants at the beginning. It avoids many unnecessary questions from the participants' side and helps them as guideline.

Other changes were made too, but because of neglectable relevance for the reader they are not described here.

7 Makerthon Handbook

This section includes the latest version of the researchers makerthon handbook.

7.1 Introduction

This handbook shall serve the reader as a guideline to organise a makerthon. It provides a detailed process which is divided into four main sections: long-term preparation, short-term preparation, event execution and follow-up work. Although this handbook is specifically designed for the *FabLab Graz*, it is possible to use this guideline for regular hackathons too. Deviating characteristics are commented with alternative suggestions.

In the following section the key characteristics of the makerthon are described. It is designed as a 48-hours event lasting for three days. The first 24 hours are dedicated to problem understanding, ideation and idea evaluation. The second part shall be used for prototyping and pitch preparation. It is a medium sized event with 20-40 participants. The limiting factor for the number of participants is the size of the makerspace and the number of machines. For regular hackathons, regardless if they are focused on software solutions or business concepts, the parts related to the makerspace can simply be left out. The event is fragmented which means participants and staff do not stay overnight. Last but not least, it is carried out as competition, which means the presentations are rated by a jury and there are prizes for the winners. Adaptions regarding duration, size or anything similar need to be done by the reader themselves.

The following four main chapters contain a general description of what has to be done in each planning stage. Except for a few, every chapter has a respective checklist in the appendix. Sometimes TUG can be found in brackets in certain checklists. It means that these organisations, people, etc. are only relevant for TUG related events.

It is recommended to read through the whole handbook before starting to plan an event.

7.2 Long-term Preparation

As the IIM has a close relation to their industrial partners and has their individual facilities for their own disposal the whole planning can start later as usual. Still three to six months are recommended. For organisers who need to find new sponsors and organise a suited venue the preparation should start about six to nine months ahead.

7.2.1 Staff

Before starting to plan an event, the core organisation team needs to be defined. For a medium sized event 2-3 people are sufficient. The responsibilities can be split according to the sections in this chapter: *partners & sponsors*, *catering & supplies* and *marketing*. Ending up with one person in the lead, the others still should be kept in the loop to avoid any information loss when the team leader is not available for unforeseen reasons.

Appendix 13.5.2.1 includes a table to assign each role. One person can have more than one role, but the roles should not change until the event is over.

7.2.2 Organisational

The organisational aspects include decisions of general principle to set the basis for the makerthon. Still a few points are subject to changes as they are closely related to the acquired sponsoring. A summarised checklist can be found in appendix 13.5.2.2.

The first task for the organisation team is to define the key characteristics of the event. These are *topic*, *general timeframe, date, venue, and the number of participants.*

7.2.2.1 Topic

For a makerthon the section topic is not relevant as the direction is given with the aspect of focusing on physical prototyping, whereas regular hackathons need to think about this in the first place. There are various possibilities such as finance, games, sustainability, waste reduction, music, etc. Defining the topic is necessary to address the right potential sponsors. For example, a game development company is more likely to sponsor a game focused event than a finance one.

7.2.2.2 General timeframe

The general timeframe for the makerthon is three days. Starting on Friday afternoon and ending on Sunday afternoon. For an event focused on physical prototyping it should be at least a three days event, otherwise the time for prototyping might be too limited (especially referring to the printing time of 3D-printers). Further on, the decision should be made, either it is a fragmented or a non-stop event.

For marketing purposes, the start and end time of each day should be determined. The exact planning about what is going to happen when can follow later.

7.2.2.3 Date

As the majority of participants are students, a few things need to be considered while choosing an event date. First, student holidays (summer holidays, winter holidays, semester break, Easter holidays, extended weekends, etc.) should be avoided as they usually have other plans than attending a makerthon. Second, January and June are considered as exam time in Austria. Finding enough participants with free capacities for three days might be difficult during this time. Before fixing a date, check for other hackathons on the same day/weekend in the same area (e.g. TUG Veranstaltungskalender or hackathon.com).

Last but not least a “save the date” message needs to be sent to everyone who might be potentially involved. This refers especially to internal staff members.

7.2.2.4 Venue

At a makerthon the size of the makerspace and the available rooms in proximity are related to each other. The smaller number of maximum people in either of the two facilities determines the general size of the event. As a reference: at the draft event the 90 m² sized FabLab Graz reached its limits with 33 participants during the final prototyping phase. Not only the size, but also the number of available machines and tools play an essential role. At a regular hackathon event any room can be chosen as long as the following factors are considered:

- Good Wi-Fi bandwidth (about 1 Mega bit/participant)
- Good lighting
- Room is easy to air
- The needed reconstruction for the event setup (as little as possible)
- Tables and chairs available (otherwise they need to be rented)
- Optional: kitchen close by for drink and snack preparation

For the venue it is assumed that no temporary facilities like event tents, toilet containers or storage containers are needed.

7.2.2.5 Number of participants

For a makerthon this is the next step as it is bound to the available venue size. For a regular hackathon this could be done before the venue selection as well. First defining the size of the event and the choosing a suited location.

7.2.3 Partners and sponsors

After determining the key characteristics of the event, the next step is to find sponsors to fund it. This section is about the long-term preparation regarding potential partners and sponsors. A checklist is provided in appendix 13.5.2.3.

7.2.3.1 Partners

Partners can be helpful when it is about adding competences and networks. Networks are essential for recruiting participants. For example, as the IIM belongs to the mechanical engineering department, partnerships with software- or electronics-related organisations can help to reach more potential participants from these fields. Further, these organisations may support the event with mentors.

7.2.3.2 Sponsors

Unless it is a hackathon organised by companies themselves, it is inevitable to acquire sponsors for the event. This can be either sponsors who support the event monetary or non-monetary. With the sponsor money expenses like food, staff, prizes, materials, etc. can be covered. Others may just support the event with goods, e.g. giveaways, drinks, snacks or others.

As challenge sponsors are the main targets, a few things need to be considered before and while negotiating with them. Prepare the event concept as well as selling propositions. Determine what they will receive in return for their money beside the ideas, concepts and prototypes (that does not imply that they will automatically receive the rights on the created output). For example, where their logos will be placed or when they will be announced during official presentations, etc. To clarify the IPR situation is a crucial part of the sponsorship. In case the rights should be transferred to the sponsor, an organiser should take care that the teams will get at

least an additional compensation if the company continues to work on the idea. Other characteristics to consider: the general topic of the challenge, the number of mentors and their availability, the jury members, the prizes and if they wish any special winning criteria. In best case the mentors are available in the first 24 hours of the makerthon. So, they can support the teams during the problem understanding, ideation and idea evaluation phases. At least they should be present on day one (see appendix 13.5.3.1). Representatives of the company should be part of the jury and ideally be different people than the mentors. This might influence their judgment as they have worked together with the teams.

7.2.4 Catering and supplies

For the long-term preparation it is necessary to collect proposals from different caterers and to determine which equipment needs to be rented for the event. Appendix 13.5.2.4 provides a checklist and tables for cost estimation.

7.2.4.1 Catering

The kind of catering is depending on the available budget. The most convenient way for an organiser would be to get full catering from one supplier. This way less time is spent on coordinating the different suppliers, but usually it costs more. For a tight budget it is recommended to engage a caterer only for the main meal (in Austria it is lunch). For the other meals easy alternatives can be chosen, such as party services, bakery stations or simple self-prepared dishes. For the three days makerthon following meals need to be considered:

- Friday
  - Dinner
- Saturday
  - Breakfast
  - Lunch
  - Dinner
- Sunday
  - Breakfast
  - Lunch
- Snacks for in between

As the experience has shown, at the events the majority of the participants are male, the food calculation should be multiplied with the factor 1.1 to provide enough food for everyone. Regarding specific dietaries each meal should have a vegetarian

alternative. At the makerthon draft event about 20% of the meals were vegetarian. For this event the number of vegetarian meals was sufficient, but it needs to be validated for the future. With respect to the increasing number of people who are not allowed to eat pork it shall be avoided to serve meat meals containing it. In case it is not possible to avoid pork, the number of vegetarian dishes needs to be increased. For small events it is nearly impossible to consider any other dietaries like vegan, lactose-free, gluten-free, etc. as it increases the costs tremendously (when ordering it at a catering service).

In case the caterer shall provide drinks as well that needs to be considered in the request. Regardless if the drinks are provided by the caterer or the organiser themselves, for a sustainable event coffee cups and glasses should be rented. The usage of disposables should be reduced to a minimum.

As a reference value for the reader, the experiences from the makerthon draft event shall serve as a guideline for the demand (the net time of the event were 26 hours):

- Beer: 3 half litre bottles (one per day)
- Sparkling water: 3 litres
- Sodas: 2.1 litres
- Coffee: 70 grams
- Fruits: 700 grams (primarily apples and bananas)

These are the actual numbers. To avoid any shortage, the numbers should be increased for the calculation.

7.2.4.2 Supplies

Depending on the chosen event location it might be necessary to rent additional equipment, which could be:

- Tables
- Chairs
- Beamer
- Sound-equipment & lighting
- Fridges
- Power supply
- White boards, magnet boards and flip charts

7.2.5 Marketing

The size of the event determines the beginning of marketing and recruitment. The bigger an event is the earlier it should be started. For the makerthon it is necessary to have the challenge sponsor already on board as at the registration form the participants are asked for their preferred challenge. There are many possible ways to promote an event, like posters, flyers, social media, presentations, online presence, etc. For the makerthon posters, Facebook, LinkedIn, word of mouth and partners are the selected marketing channels. Before starting the registration phase, the mode of participant acceptance should be defined. This means whether the participants get selected by the organising team or if it is first come first serve principle. With only about 30 participants, the first steps should start about two months in advance. This includes setting up the registration form on the webpage, promotion on the IIM-related webpages and creating a Facebook event. The next step is to instruct the FabLab staff to actively promote the event to FabLab users and visitors.

As an alternative to the event registration via application form, services like Eventbrite can be used. Eventbrite[24] is free of charge if the tickets are free of charge. The registration should close two or three days to adjust the quantities for everything that needs to be prepared (e.g. food, drinks, handouts, etc.).

To increase the recognition factor of the event, a corporate identity should be developed. Regardless the purpose (e.g. promotion, press-release, review, etc.) everywhere the same logo, wording and colours are used. With the finished designs, posters and eventually flyers can be printed.

[24] https://www.eventbrite.at/organizer/pricing/

7.3 Short-term Preparation

The makerthon is getting closer and closer. Topics discussed in the in this section need to be dealt with primarily in the last two weeks prior to the event. In certain cases, it can be up to four weeks. To cover different possibilities, it will be assumed that the IPR of the projects and ideas will remain with the challenge sponsors as it requires additional preparation.

7.3.1 Organisational

This section is divided into three subparts: *documents, staff & awards* and *venue*.

7.3.1.1 Documents and staff

Setting up the final schedule four weeks in advance helps to plan, prepare and distribute information accordingly. Before the main part starts, an introduction session, a challenge introduction, a teambuilding phase and an icebreaking challenge take place. At the makerthon draft event a bridge building challenge was used.[25] The timetable (see appendix 13.5.3.1) is segmented into five main phases: *(1) understanding the challenge*, *(2) detecting the real problems*, *(3) idea generation*, *(4) idea selection* and *(5) prototyping*. Each phase is supported with different product development methods. A segment starts with a brief introduction of the recommended methods. To support this process, for each method a one-pager should be prepared. A one-pager briefly summarizes the method with its step of execution. Additional trained staff needs to be present to help the participants to apply the methods properly. The timetable template provides an overview of potentially used methods in each phase. It includes *customer journey map, ask the experts, how might we.., lightning demos, brain writing pool, mind mapping, X-3-5 method, brainstorming, 6 thinking hats, morphological box, art gallery, storyboard* and *prototyping*.[26] To apply these methods, different writing material is needed. Especially paper, permanent markers, whiteboard markers, text markers and sticky notes, all mentioned in various colours. At the IIM workshop boxes including these tools and other additional materials are available.

[25] For more details: http://pdfkurs.com/Download_PDF_7.php?PDF_Kurs=32869&PDF_Corriges=br%C3%BCckenbau_spiel_l%C3%B6sung

[26] Descriptions of many of the mentioned methods and possible alternatives can be found here: http://www.ideenfindung.de/%C3%9Cbersicht-Liste-Kreativitaetstechniken-Ideenfindung.html

For easier orientation, necessary information should be gathered in a guideline. This guideline is handed out either individually or team-wise to the participants at the beginning of the makerthon. It includes: timetable, Wi-Fi guest accounts, cloud link & guideline for file structure, every one-pager, winning criteria and the requirements for the final pitch. The cloud link is only needed if the outcome stays with the sponsor companies. It serves as a storage for all created content. For this case declarations of assignment need to be prepared.

With the finalised schedule the needed staff can be allocated and informed. Keep substitutes in mind and inform them as well, in case of unforeseen unavailability. In addition, one person needs to be assigned with the task of digital documentation. As it might get stressful throughout the event, this person is responsible of taking pictures and if needed videos, especially from the opening session, project pitches and award-winning ceremony. Other roles to consider are general planning and overview, contact for companies, contact for catering, preparation of venue, preparing all documents, preparing prizes and purchase of goods. One person can have more than one role, but they need to be clearly assigned.

An early finalised schedule supports the challenge sponsors too, as it simplifies the planning for them. A late release of the timetable might force the companies to send a substitute person, as their experts are not available on short-term.

7.3.1.2 Venue

As the makerthon is hosted in IIM-related facilities at TUG, regarding the venue not much preparation is necessary. Only Wi-Fi guest accounts need to be organised from the IT service at TUG (ZID-Zentraler Informatik Dienst).

For an external location, the start of preparation is linked to the renting conditions. In addition, the following needs to be checked with the facility manager:

- How to control the lights?
- How to control the air-condition?
- How to reset the Wi-Fi?
- Where is the first aid kid?
- Where are the fire extinguishers?
- Contact details of facility manager
- Lecture room key (to control electric)

7.3.1.3 Rewards and nametags

As physical prototyping is the focus of the makerthon, the trophies for the winning teams are self-made in the makerspace. First it needs to be designed and then build. Every team member of the winning teams is supposed to get one. With one or two extra, 10-12 need to be manufactured (depending on the team size).

An opportunity to foster the creator spirit and enlarge the maker community is to provide vouchers for the FabLab to the participants. They can spend the money on material and machine hours for their individual projects after the event. These vouchers need to be designed as well.

For an event were dozens of people come together who do not know each other, name tags are a convenient way to ease communication. The simplest way are white stickers and markers. For the first makerthon, name tags were made out of passe-partout with help of the laser cutter. Name tag pins were attached on the backside. If customised nametags want to be used, the files need to be prepared.

7.3.2 Partners and sponsors

In addition to the finalised schedule the challenge introduction needs to be clarified. With an introduction of about 12 to 15 minutes not more than two minutes should be spent on the introduction, e.g. company details, history etc. The focus is supposed to be on the challenge. If possible, the sponsor should bring as many tangible objects as possible for the participants to interact with. Either these objects can be directly used for prototyping or they will help at least to get an idea of the product/topic.

7.3.3 Catering and supplies

Only a few tasks are necessary to be performed for *catering & supplies* in the short-term preparation phase.

7.3.3.1 Catering

After the registration has closed any changes in the demand need to be forwarded to the caterer (e.g. planned for 40 persons, but only 35 have registered). Drinks, food and snacks which are not part of the catering deal can be purchased the day before the event. Ensure to have a car available the day before the event and during the event for transportation.

If all meals are not provided by the same caterer, it is dependent on the type of meal if pre-ordering is required. For example, “party bretzln” need to be pre-ordered, but various sausages do not. If necessary, it should be done two weeks ahead. For certain meals additional equipment might be needed (e.g. for sausages one or two 10 litre tea cooker) and should be organised at the same time.

Furthermore, a coffee machine is essential. For the makerthon draft event one fully automated coffee machine was sufficient.

7.3.3.2 Supplies

Depending on the delivery times the next two tasks shall be done about two weeks in advance.

For the makerthon the workshop boxes which contain paper, sticky notes, pens, markers, stapler, etc. need to checked for completeness. If anything is missing it must be ordered. If no workshop boxes are available the following material is needed: paper, permanent markers, whiteboard markers, text markers and sticky notes. Everything mentioned in various colours.

The stock of prototyping material needs to be checked and refilled if necessary. Table 4 provides the amount of used materials as a reference value:

Table 4: Used prototyping materials at the makerthon draft event

What	Size	Quantity	Remark
Medium-density fibreboard (MDF)	300x600x4 mm	40 plates	
Acrylic sheet	300x600x3 mm	10 plates	Primarily transparent
PLA	-	1 kg	Various colours
Cardboard	-	-	

Beside the above-mentioned, various screws, nails and glues were used.

For the participants’ laptops power supply must be ensured, so several extension cables and distribution boxes must be available.

7.3.4 Marketing

Four weeks prior to the event the marketing effort gets intensified. On university campuses posters get pinned up and social media should be addressed more frequently. The makerthon should be promoted in different topic- and/or university-related Facebook groups. The IIM Facebook channel needs to post new content about the event progress on a regular basis.

About a week prior to the event, a reminder should be sent to the registered participants with the most important details. Further on, participants shall unsubscribe this way if they have decided not to attend the makerthon.

If it is foreseeable that until the registration deadline way more people will have applied for the makerthon as wanted, the reminder only should contain details about how to confirm participation or how to unsubscribe from the event. The reminder with the important details should then be sent after the registration has ended to the chosen participants. Everyone who was rejected in the first place should be informed that they will be on the waiting list.

7.3.5 Staff

To ensure a successful event preparation numerous tasks still need to be executed. This section provides an overview of these tasks and the link to the description. Appendix 13.5.3.5 provides a table to assign the different tasks. For easier planning they should be assigned four weeks prior to the event.

7.4 Event Execution

This section covers all actions performed during the event itself and one day ahead of it (incl. Thursday).

7.4.1 Organizational

The organisational aspects for the event execution are described in this section.

7.4.1.1 Documents and staff

All previously created files need to be printed for the makerthon. Always consider one or two extra. For the full list see Appendix 13.5.4.1.

All slides and documents need to be copied to a flash drive. This flash drive is used for the presentation laptop.

7.4.1.2 Venue

Depending on the availability and the need of reconstruction, the venue can be prepared either on Thursday or Friday. For the set up at the makerthon Friday morning is sufficient. For the full list see Appendix 13.5.4.1.

At the end of the event on Sunday, a rough clean up shall be conducted while the participants are still present. With many helping hands it takes 15 minutes at maximum.

7.4.1.3 Rewards and nametags

On Thursday the participants list is fixed. The vouchers can be printed and the nametags engraved and cut. The tags are not only needed for the participants, but for the staff and company representatives as well.

7.4.2 Partners and sponsors

Before any company representatives show up on Friday, the venue should be checked if all company and sponsor logos are presented accordingly to the agreement.

If the companies have not sent their challenge introductions beforehand ask them for it as soon as they arrive to test it with the laptop and beamer.

7.4.3 Catering and supplies

This section consists the shopping lists for food, drinks and supplies.

7.4.3.1 Catering

On Thursday food, drinks and snacks can be purchased. A shopping list can be created with the tables found in Appendix 13.5.4.3.

7.4.3.2 Supplies

Additional needed supplies shall be purchased on Thursday as well. For details see Appendix 13.5.4.3.

As no cleaning staff will be around on the weekend at TUG the facility manager must be asked for extra paper towels and toilet paper.

7.4.4 Marketing

The section marketing is only relevant during the event if any live updates shall be posted on social media channels. In this case pictures and videos taken need to be posted on the same day (e.g. Facebook posts, Facebook stories, Instagram stories, etc.). Other than that, marketing has no other duties during the event.

7.4.5 Staff

Preferably on Friday morning, or if not possible on Thursday, there should be a meeting of every staff member involved. This meeting is the final briefing before the event starts. The tasks and responsibilities of each role (see Appendix 13.5.3.5) shall be explained once more to everyone. In case of an absence for any reason it is easier to step in for others.

7.5 Follow-up Work

After a (hopefully) successful event there is still follow-up work to do to finally complete the makerthon. What needs to be done is described in the following section.

7.5.1 Organisational

If everything was not cleaned up on Sunday it should be done on Monday morning.

For a successful event evaluation all steps of the review process shall be started right after the makerthon as long as the impressions are present. The first step is to evaluate the collected feedback of the participants. In parallel or after the feedback evaluation the results of the makerthon need to be listed. The next steps are the sponsors feedback, quantity check of catering and supplies, lessons learned and a systematic preparation of the results. Each steps' details follow in the respective section.

7.5.2 Partners and sponsors

Request feedback from the partners and sponsors to evaluate it and improve future events.

7.5.3 Catering and supplies

For catering and supplies the numbers between estimated and used need to be compared to identify any adaptions. For a full list see Appendix 13.5.5.3.

7.5.4 Marketing

To present the event to the public, a press release and social media posts shall be prepared. If it is already decided that there will be a makerthon in the future as well, these are the first opportunities to promote the upcoming event. In best case the date for the next event is already fixed and the registration can be opened, if the date is not fixed maybe a pre-registration can be offered.

7.5.5 Lessons learned and preparation of results

With the feedback and the results of every evaluation, the organising team can formulate the lessons learned for the event. Evaluate why certain things did not work out and how they can be improved for the next time. The lessons learned need to be incorporated into this handbook to have the latest values and experiences.

7.5.5.1 Documentation

To finally finish the follow-up work of the makerthon a short report with the key characteristics should be written. Find a list of things to include in the appendix (see 13.5.5.6).

Additionally, a photobook and/or video of the even can be created. This material can be used for marketing purposes as well.

8 Conclusion and Outlook

Hackathons are a global phenomenon that not only allow companies to kick-start innovation, but it provides a playground for enthusiastic, talented and creative people to apply their skills to create something new. The research objectives of this thesis were to investigate hackathons to develop a holistic understanding of hackathons and their organisational characteristics. With the gathered knowledge, the mainly IT-based event concept was transferred to physical prototyping-based event. The final chapter includes a conclusion of the results. These results include an analysis of hackathons in Austria and its neighbouring countries and the lessons learned from investigated events as well as from the draft event itself. The section outlook summarizes the implications of the results and outlines potential future research topics.

8.1 Conclusion

Hackathons are an increasingly popular type of events, which are hosted by all kinds of industry sectors, educational institutions and other organizations. Within a short period of time it can foster creativity, hands-on experience and entrepreneurial spirit among its participants. For the challenge providers it is an easy and fast way to gather dozens of new ideas and several working prototypes within a few days. This must not be necessarily realised by the companies' employees. The insights from external participants can open new possibilities as they are not spoiled by internal culture. Hackathons were defined in this thesis as following: *"For a very short time period people are brought together in order to ideate and solve problems for a given topic."*

As hackathons originated from the IT industry many events are coding-intensive. With their success, this event concept found its way into other industries. Although, hackathons with a focus on physical prototyping are still rare in Central Europe. One of the main reasons for this imbalance is that hackathons with advanced physical prototypes (basic ones would be paper and cardboard) require more resources and are geographically bound to a certain location. Basically, it is possible to host a coding event anywhere were enough power and a sufficient internet bandwidth is provided. There are no additional costs for any machines as the participants bring their own laptops. A makerspace requires a lot of money and trained staff. To conduct a makerthon a minimum number of machines and tools need to be usable depending on the participants number. Enough machines and well-trained staff are available at the FabLab Graz. Therefore, the overall goal was to transfer the benefits of a hackathon to an event that takes place in a makerspace. To fulfil the task following research questions were formulated and answered:

- Development of a holistic understanding of hackathons
- Overview of TUG related hackathon events
- Setup of a draft concept for a makerthon event, its conduction and analysis
- The synthesis of the results to develop a final concept on how to conduct a makerthon at a makerspace based on lessons learned from hackathon events and the results from the makerthon draft

In a first step, past hackathon events were investigated to develop an understanding for the key organizational facts. This pre-study considered more than 50 events mainly in Austria and Germany, but in neighbouring countries as well. The gathered data was analysed to identify certain trends, such as typical duration, size, no-show rate and more (see chapter 4.1). A second objective was to create an overview of TUG-related events. In a next step six, selected hackathons were investigated more in detail (see chapter 4.2). With respect to the researchers' timeframe the events range a wide spectrum. With the *Green Tech Jam 2018* and the *Hackathon for a world without barriers* are two of the three TUG-related events. The *Techfest Munich 2018* served as an example for a hackathon in combination with a makerspace. The *Science2Business challenge* showed that it is not necessary to either come up with software or hardware prototypes as the focus was on business concepts. The *Zeiss Hackathon 2018* provided insights into community-based events. The data was gathered by participation and observation or observation and participants' interviews. In addition, the main organisers of each hackathon were interviewed. The cross-case comparison points out differences and similarities regarding size, timeframe, provided information, product development methods, mentors, IPR and location. The lessons learned included that the right team size plays a vital role. Ideally a team has five interdisciplinary members. The venue itself is not as important to the participants as the extras that are offered. Experts were interviewed to complete the findings from the in-depth investigation of the hackathons (see chapter 4.3). A fourth approach was to obtain hackathon relevant information from makerspaces directly, but it did not reveal any new insights (see chapter 4.4). The different hackathons showed that their outcome is depending on several factors as successful marketing, mentoring and the organizational framework.

The previous findings resulted in a hackathon concept at the FabLab Graz, the makerthon. It is a fragmented 48 hours event over one weekend. Between 10 pm and 9 am in the morning the doors are closed each day. The first 24 hours are structured with many different product development methods, whereas the second part is dedicated to physical prototyping. The event includes two challenges provided by industrial sponsors for the 30 participants. In addition to the makerspace facilities, the TUG serves as event venue. The concept was validated by execution. The results

showed two aspects. First, that only little changes are necessary to refine the concept. This includes a change in the opening product development method, provided mentoring and food calculations. Second, that it is not possible to satisfy every participant type with a concept. As example serves the feedback regarding the timeframe. While many liked the fragmented structure, others preferred the usual non-stop version.

In conclusion, there is no ultimate success formula for hackathons. Depending on the targets of the organiser there are several factors positively influencing the outcome. A solid organizational structure, which means that information is presented accordingly, food is on time and enough, technical equipment works, enough space is provided and other long waiting times are prevented, serves as foundation. Based on this framework, it is important to address the right people and have the needed skills available among the participants. Commitment from the sponsors in form of proper mentoring is crucial for valuable outcome.

8.2 Outlook

As the focus was on organizational aspects of hackathons, other topics were neglected, but should be investigated more in detail. This includes:

- As mentioned in chapter 4.3.5 a detailed investigation on the legal situation of employees attending a hackathon could be conducted.
- Continuing with the legal topic, what about the input from mentors and experts. Although a sponsor company granted any rights to the teams, what happens if a lot of input of the sponsor company's employees was necessary to achieve the results?
- The impact of different timeframes on the results. It could be studied if non-stop or fragmented events provide different outcomes.
- The sponsor companies were satisfied with the results of the makerthon. A potential research could investigate what role the application of product development methods plays.

With the increasing number of hackathons, they are not only changing the company cultures as they open up more and more, but they introduced a new method of learning. The results from this thesis showed that it is possible to conduct successfully a physical prototyping-focused event. The findings can help other makerspaces to develop their individual hackathon concepts, for example for the purpose of increasing the community or for educational aspects. Moreover, this thesis can serve as a foundation for first time hackathon organisers to understand

the organisational aspects and derive their own version. Based on the current development it can be assumed that hackathons will undoubtedly increase in number and will spread into new areas within the next couple of years.

9 Abbreviations

2D ..... two-dimensional
3D ..... three-dimensional
ABS ..... Acrylonitrile-Butadiene-Styrene Copolymers
am ..... ante meridem
ASTM ..... American Society for Testing and Materials
BEST ..... Board of European Students of Technology
Biomed ..... Biomedical Engineering
CAD ..... Computer Aided Design
CNC ..... Computerised Numerical Control
CO_2 ..... Carbon Dioxide
CS ..... Computer Science
CSBE ..... Computer Science and Biomedical Engineering
DIN ..... Deutsches Institut für Normung
DLP ..... Digital Light Processing
DMLS ..... Direct Metal Laser Sintering
DOD ..... Drop on Demand
EBEC ..... European BEST Engineering Competition
EBM ..... Electron Beam Melting
etc ..... et cetera
EYA ..... European Youth Award
FabLab ..... Fabrication Laboratory
FAQ ..... Frequently Asked Questions
FDM ..... Fused Deposition Modelling
IIM ..... Institute of Innovation and Industrial Management
IPR ..... Intellectual Property Rights
ISDS ..... Institute of Interactive Systems and Data Science
ISO ..... International Organisation for Standardisation
IT ..... Information Technology
KFU ..... University of Graz (Karl-Franzens-Universität)
ME ..... Mechanical Engineering
Med Uni ..... Medical University of Graz
MEES ..... Mechanical Engineering and Economic Sciences
MIT ..... Massachusetts Institute of Technology
MJ ..... Material Jetting

MLH.....Major League Hacking
Nat. Sci..... Natural Science
Nd: YAG .....Neodymium-Doped Yttrium Aluminium Garnet
NE ..... Institute of Neural Engineering
NGO ..... Non-governmental Organisations
NYC.....New York City
PDA..... Personal Digital Assistant
PhD ..... Doctor of Philosophy
PLA ..... Polylactides
pm .....post meridem
Q&A.....Question and answer
SLA ..... Stereolithography
SLS ..... Selective Laser Sintering
Soc. Sci. ..... Social Science
STL..... Stereolithography / Standard Tessellation Language
Sustain. ..... Studying fields related to sustainability
TCCPEB Technical Chemistry, Chemistry and Process Engineering, Biotechnology
TU Austria ..... Austrian Universities of Technology
TUG.....Graz University of Technology
US ..... United States
USA..... United States of America
UX ..... User Experience
Wi-Fi..... Wireless Fidelity
WTZ ..... Wissenstransferzentrum

10 Figures

11 Tables

12 Publication Bibliography

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13 Appendix

The used forms and templates that were used for observation, interviews and feedback are in the following sections

13.1 Appendix A: Criterions Pre-study

General Information:

- Name
- Country
  - In which country was the event hosted?
- City
  - In which city took the event place?
- Date
  - When did the event took place?
- Days
  - How many days does the event last?
- Head event
  - Part of conference, fair, multi-location hackathon etc.
- Organiser
  - Who is organising the event?
- Organiser category
  - 5 categories: Industry, University, Incubators, Knowledge Centre, Others

Organisational Information:

- Task
  - What are the given tasks?
- Outcome
  - What was the outcome of the projects; software, hardware, business concepts
- Physical Prototype
  - The teams build physical prototypes?
- Product Development
  - Were any product development methods in use, like creativity techniques, cost-utility analysis, business model canvas, etc.
- Target Group
  - What is the target group of the event?

- Monetary prices
  - What kind of monetary prices were given to the winners?
- Non-monetary prices
  - What kind of non-monetary prices were given to the winners, incl. gift prices as well
- Max. or expected participants
- Actual participants
- Number of teams
- Companies sponsors
  - Which companies sponsored the event
- Companies task
  - Which companies provided the tasks
- Application
  - Was it necessary to file an application form in order to participate?
  - As soon as it is necessary to provide more information than details about yourself (e.g. name, address, contact, occupation, etc.) it is considered as an application
- Time Day 1, 2, 3
  - Timeframe for each day
- Gross time
  - Overall time of the event (Start day 1 until end of final day)
- Net time
  - Net time participants spent working on the projects
- IPR
  - Who owns the IPR after the event?
- Location
  - Which type of venue was used as event location?

Makerspace Information:

- Resources for prototyping
  - What kind of resources were provided for the prototyping process?
- Actual use of FabLab/Makerspace
  - Did they use a FabLab/Makerspace during the event?
- What kind of machines are in use (Laser cutter, 3D printer, CNC mill, etc.)?
- Requirements for participants (experience with machines, pre training, etc.)
  - Were there any requirements for the participants regarding the experience with the machines?

Event selection criteria:

- Public event
- Min. 24 hours (gross time), max. 4 days
- Given Task, Topic
- Took place 2017 or 2018
- If it is a regular/ annual event only consider the most recent one

13.2 Appendix B: Hackathon Event Report

General Information

- Contact person:
- Date:
- What kind of organisational details were provided to the participants beforehand?

Table 5: Event report organisational details

Details about	Yes	No
the time schedule		
- **only time frame, no details (e.g. Fri. 09:00 – 22:00)**		
the venue of the of the event (e.g. seminar room, event centre)		
the accommodation		
the background of the topic/task		
the task		
- **short description (<150 words)**		
- **detailed description (> 150 words)**		
- **a video with additional information**		
incentives		
- **what are the winning criterias**		
- **who is in the jury?**		
what every participant has to bring along		
the required skills for the event		
the number of participants (expected or max.)		
the team sizes		
similar or previous events		
the mentors on-site		
the food and drinks		
- **any diets**		

- Additional comments to organisational details:

Questions to the organiser:

- How often did they conduct this event?
- Is this event part of another bigger event (e.g. conference)?
- Are they planning to host such an event in the future? (maybe regularly?)
- Internet presence:

Goals of the hosts and organisers

- What are the goals of the event?
- Is recruitment an important goal of the hackathon?
- What do you think is your point of difference to other events?
- Which topics do you focus on? (e.g. Industry 4.0, VR, Games, AR, Services, …)
- Which type of development is pushed ahead?

Table 6: Event report innovation type

Development type	Yes	No
Incremental improvement of existing product(s)		
Disruptive innovation		
Open innovation – everything new is allowed, no limitations		
Finding business case(s)		

- Who will own the IPR?
- Comments:

Process

- Are there any instruction/training sessions? (If yes, describe them)
- How detailed is the task description and the desired goal of the task?

Table 7: Event report task description details

Description details	YES	NO
Short description (<150 words)		
Detailed description [>150 words)		
Video of a use case or example		
Legal restrictions		
Technical limitations		
Skill requirements		
Software requirements		
Hardware requirements		

- Are there any restrictions regarding the solution(s)? (e.g. legal restrictions)
- Are there mentors who can be asked for further information about the task?
- How many mentors are there?
- What kind of input do the participants get from the mentors?

- What is the profession of the mentors?
- How is the atmosphere at the hackathon?
- Comments:

Participants

- How many participants are there?
- What is their occupation or field of studies?
- How is the team atmosphere?
- What boosted the team motivation?
- What influenced the team motivation negatively?
- Comments:

Place

- Describe the venue of the event!
- Which equipment is available? (all non FabLab specific machines)
- What kind of equipment do the participants have to bring themselves?
- What kind of tools and machines are available? (e.g. laser cutter, 3D-printer, etc.)
- What kind of catering is provided?

Marketing

- How did you promote your event?

Table 8: Event report promotion channels

Method	Yes	No
Flyer		
Poster		
Homepage		
Social Media		
Promotion Video		
Word of mouth		
Presentation (e.g. in lectures, at conferences, etc.)		
Other:		
Other:		

- Which social media channels did you use?
- What works the best in your opinion?

Personal opinion

- What kind of issues did occur?
- What could be improved?
- What were the assets?
- What was really cool?
- What were the challenges at the event?
- What was the overall impression of the event?
- Who and why should anyone attend this event?

13.3 Appendix C: Expert Interview Guideline

Interview Partner

- Name:
- Company:
- Position:
- Hackathons:
- Contact:

Organisational Facts

- When do you usually start the event planning?
- When do you start promoting your event?
- Which channels do you use?

Table 9: Expert interview promotional channels

Method	Yes	No
Flyer		
Poster		
Homepage		
Social Media		
Promotion Video		
Word of mouth		
Presentation (e.g. in lectures, at conferences, etc.)		
Other: Community		
Other:		

- Which social media channels did you use?
- What do you think works the best?
- How many participants should be there?
- How many participants per team?
- What is the no show rate?
- What is the perfect time frame?
- Continuous or fragmented event?

Facilities

- What kind of facilities should you use?
- What is important for the facilities?
- Comments:

Participants

- What should be the skill level of the participants?
- What should be the profession of the participants?
- Comments:

Process

- How much staff should be there?
- Who is responsible for what?
- Should there be any guiding or training sessions?
- What should be provided by the host regarding working materials?
- Comments:

Other comments

Comments:

13.4 Appendix D: Makerthon Feedback Form

Marketing

How have you heard about the makerthon?

Table 10: Feedback form makerthon media channels

Method	Yes	No
Poster		
IIM-Webpage		
FabLab-Webpage		
Facebook		
LinkedIn		
Word of mouth		
FabLab OpenDay		
Other:		

Organisational Facts

- What were your expectations for this event?
- Did the event meet your expectations?
  - If not, what could be improved?
- Were you satisfied with the input of the industrial partners?
  - If not, what could be improved?
- What do you think about the timeframe/schedule?
- Especially the duration and that it is fragmented?
- Describe your motivation to participate in the makerthon.
- What do you think about the "training sessions" (theoretical input)?
- Did you have any experience with our physical prototyping machines?
  - How was it to create appropriate CAD-models?
  - What were the difficulties?
- What did you like best?
- What could be improved?
- Any other comments?

13.5 Appendix E: Checklists and Tables for Makerthon Handbook

13.5.1 Introduction

For better orientation the following checklists and tables are structured in similar to the numbering in the written part.

For example, the section *2 Long-term preparation* can be found in appendix 6.2. The subchapters have the number 6.2.x. Same for any other chapter.

13.5.2 Long-term preparation

13.5.2.1 Long-term preparation – Staff

Table 11: Core organisation team

Responsibility	Who
Main coordinator	
Partners & Sponsors	
Catering & Supplies	
Marketing	

13.5.2.2 Long-term preparation – Organisational

Topic	
General Timeframe	**Days** — Day 1: to Day2: to; Day3: to Day4: to
Date	

- ☐ No student holidays
- ☐ No public holidays
- ☐ No exam times
- ☐ Cross checked with local event calendars (e.g. TUG Veranstaltungskalender or hackathon.com)
- ☐ “Save the date” sent to potentially involved staff
- ☐ Register event at authorities (for TUG @ Veranstaltungsreferat)

Venue	

- ☐ Book rooms/venue
- ☐ Good Wi-Fi bandwidth (about 1 Mbit/participant)
- ☐ Good lighting
- ☐ Room is easy to air
- ☐ The needed reconstruction for the event setup (as little as possible)
- ☐ Tables and chairs available (otherwise additional costs)
- ☐ *Optional: kitchen close by for drinks and snack preparation*

Number of participants	

13.5.2.3 Long-term preparation – Partners and sponsors

Sponsors

- ☐ Prepare event concept
- ☐ Prepare selling propositions
- ☐ Contact potential sponsors
- ☐ Prepare sponsoring agreement
- ☐ Let the legal department proof the sponsoring agreement
- ☐ Sign the agreement

What should be considered in the sponsoring agreement:

- ☐ The general challenge topic
- ☐ The IPR situation
- ☐ Number of mentors
- ☐ Hours of mentor availability
- ☐ Number of jury members
- ☐ Prizes
- ☐ Special winning criteria
- ☐ The amount of money they will sponsor
- ☐ Where, when and they will be represented before, during and after the event

Partners:

- ☐ **Look for competence and network partners**
  - Institute of Interactive Systems and Data Science (TUG)
  - Institute of Machine Components and Methods of Development (TUG)
  - Institute of Innovation and Industrial Management (TUG)
  - ÖH Makerspace (TUG)
  - E-Lab (TUG)
  - Phy-Lab (TUG)
  - Student representations
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____

13.5.2.4 Long-term preparation – Catering and Supplies

Catering

The number of people to order for at the catering service is calculated as follows:

(_____ + _____ + ____) x 1.1 =_____ PAX (persons approximately)

(participants) (mentors) (staff)

Information included in the catering request:

- Where
- When
- Who
- PAX
- Regular and vegetarian meal (about 20% vegetarian)
- Meals to consider
  - Saturday Lunch
  - Sunday Lunch
  - *Optional: Friday Dinner*
  - *Optional: Saturday Breakfast*
  - *Optional: Saturday Dinner*
  - *Optional: Sunday Breakfast*
  - *Optional: Snacks in between*
- *Optional: Fridge*
- *Optional: Drinks*
- *Optional: Glasses and coffee cups*
- *Optional: Extra dishes for self-prepared meals*
- *Optional: Earlier delivery date for rented equipment (before start of the event)*

Following meals can be organized by the organiser themselves:

- Breakfast:
  - Bakery station from various supermarkets and discounters
  - Mensa (TUG)
  - _____
- Dinner:
  - Various sausages with biscuits (e.g. Frankfurter, Debreziner, Krainer, etc.)
  - Meatloaf sandwiches (Leberkässemmeln)
  - Hotdogs
  - Filled sandwiches (e.g. “Party-Bretzln”)
  - Barbeque
  - _____

Cost estimation

Catering offers:

Table 12: Cost estimation - catering offers

Who	Date of request	Date of offer	Price

Alternative meals:

Table 13: Cost estimation - alternative meals calculation

	What	Calculation	Sides**	Price
Friday Dinner				
Saturday Breakfast				
Saturday Dinner				
Sunday Breakfast				
Snacks				

*Calculation size: e.g.: *4 sausages and 2 rolls*, or *3 hotdogs*

** Sides: e.g.: salt, pepper, ketchup, mustard, etc.

Beverages:

Table 14: Cost estimation - beverages

What	Amount (l or kg)	Price per unit	Price
Sodas (Cola, Fanta, etc.)			
Coffee			
Sparkling water			
Beer and shandy			

Total	

13.5.2.5 Long-term preparation – Marketing

- **Corporate identity**
  - Design logo
  - Determine event name
  - Determine colours and fonts
  - Determine slogan and/or key words

- **Set up registration form. Details to consider:**
  - Name
  - Contact details
  - Challenge preferences
  - Promote the sponsors as agreed
  - Prepare a declaration which conforms to the new General Data Protection Regulation
  - Registration deadline (2 or 3 days in advance of the event)
  - *Optional: Check the declaration with the legal department*
  - *Optional: Participants motivation*

- **Prepare information for participants**
  - Either within the event description or separate FAQ
  - Where and when?
  - What about food?
  - Schedule
  - Accommodation
  - Challenges
  - Prizes
  - Who can participate?
  - IPR
  - Participant selection: *Done by staff* or *first come first serve*

- **Webpages**
  - Launch the application form
  - Promotion on FabLab Graz webpage
  - Promotion on IIM webpage
  - Promotion on _____
  - Optional: Launch separate webpage only for the event
  - Optional: If it is not included in the event description a link to the FAQ

- **Facebook**
  - Set up event
  - Include information for participants

- **Posters**
  - Design posters (place sponsor logos accordingly)
  - Order posters

13.5.3 Short-term preparation

13.5.3.1 Short term preparation - Organisational

Schedule Template

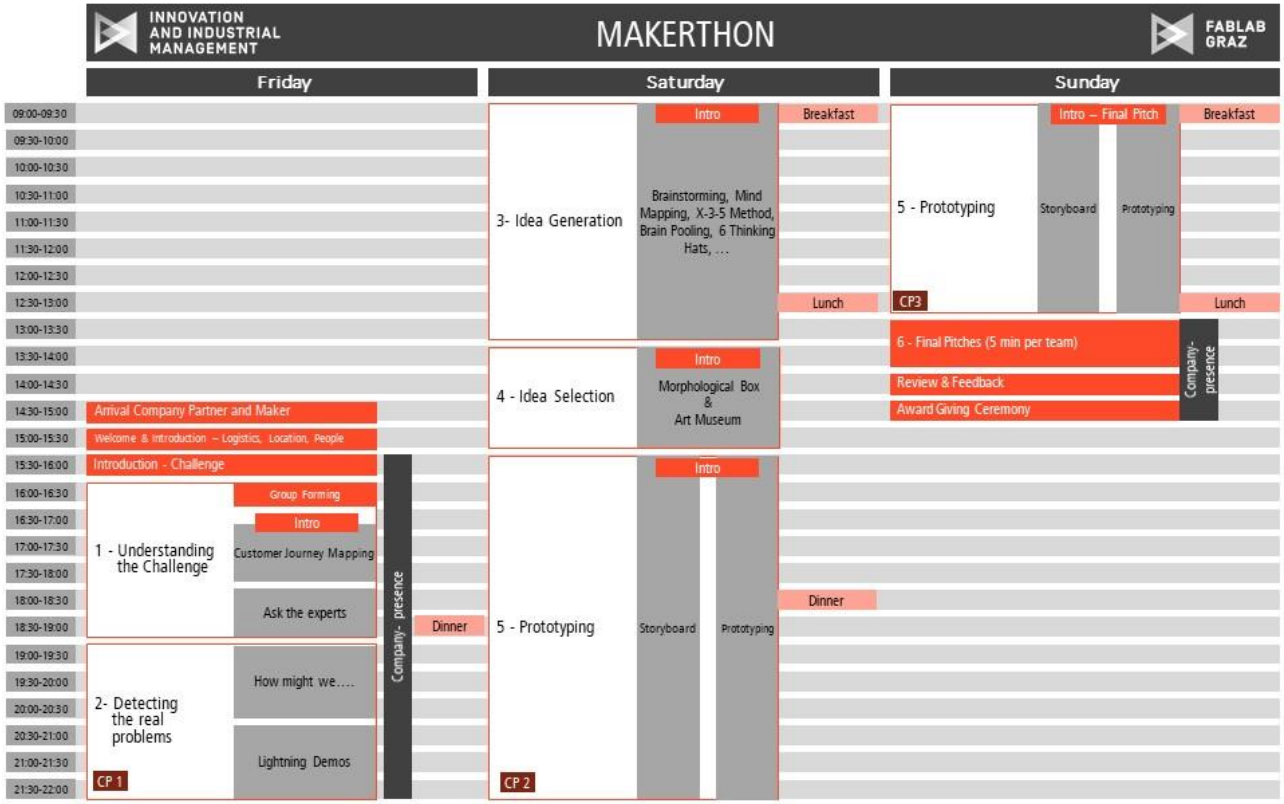

Figure 23: Makerthon timetable template[27]

[27] Author's illustration

Documents and staff

The following should be done about 4 weeks in advance:

- **Finalize schedule**
  - Select the methods
  - Select icebreaking challenge
  - Finalize meal times

- **Documents to prepare:**
  - One-pager for each method (digital)
  - Prepare slides for each method (digital)
  - Prepare certificates of participation (digital)
  - Prepare winners certificates (digital)
  - Declaration for usage of photos (digital)
  - Prepare makerspace terms (digital)
  - Prepare slides for the welcome session (digital)
  - Prepare slides for the icebreaking challenge (digital)
  - Prepare feedback forms for the participants
  - Prepare makerthon guideline (digital), includes:
    - Timetable
    - Wi-Fi guest accounts
    - Cloud link + guideline file structure
    - Winning criteria
    - One-pager of the methods
    - Requirements for final pitch

Venue

- Get Wi-Fi access codes for the makerthon

Rewards

- **Trophies**
  - Create design
  - Manufacturing
  - Quantity: 10-12
- **Design the FabLab vouchers (digital)**
- **Nametags**
  - Create design
  - Prepare file for laser cutter
  - Order name tag pins

13.5.3.2 Short-term preparation – Partner and sponsors

- **Inform sponsors (~ 2 weeks in advance)**
  - Include timetable
  - Include map
  - Include instructions about parking possibilities
  - Guideline for introduction presentation

- **Introduction presentation guideline**
  - 12-15 minutes
  - 2 minutes max for company presentation
  - Current problems
  - Goals
  - Bring tangible objects
  - Limitations

13.5.3.3 Short-term preparation – Catering and supplies

Catering (~ 2 weeks in advance)

- **Organise coffee machine**
- **Update caterer about:**
  - Final quantity
  - Optional: changed meal times

- **Organize a car for the event**
  - Availability: Thursday-Sunday

- ***Alternative: Pre-order Food and organise additional equipment***
  - *Optional: Friday dinner*
  - *Optional: Saturday breakfast*
  - *Optional: Saturday dinner*
  - *Optional: Sunday breakfast*

Supplies (~ 2 weeks in advance)

- **Check workshop boxes**
  - Order missing material

- **Check prototyping material**
  - MDF plates
  - Acrylic sheet plates
  - Cardboard
  - PLA
  - Order missing material

- **Power supply**
  - Organise extension cables
  - Organise distribution boxes

13.5.3.4 Short-term preparation - Marketing

Posters (~ 4 weeks in advance)

Table 15: Task assignment for poster pin up

Where	Who	When	Done

Facebook groups (~ 4 weeks in advance)

Table 16: Task assignment for Facebook postings

Which group	Who	When	Done

- **Regular posts and updates**
  - On Facebook
  - On LinkedIn
  - On _____

- **Reminder email (~ 1 week in advance)**
  - Confirmation of participation/how to unsubscribe (start with it)
  - Timetable
  - Location
  - What to bring
  - Parking possibilities

13.5.3.5 Short-term preparation – Staff

Staff – Task Assignment Short-term preparation

The following table provides an overview of the responsibilities during the short-term preparation. The second column provides the chapter number where to find the related tasks. The person who gets assigned a responsibility does not necessarily have to do everything on its own. This person is primarily responsible that the tasks get done.

Table 17: Task assignment short-term preparation

Responsibilities	For tasks see	Deadline	Who
One-pager	13.5.3.1		
Declaration of assignment	13.5.3.1		
Makerthon Guideline	13.5.3.1		
Declaration for photos	13.5.3.1		
Prepare makerspace terms	13.5.3.1		
Wi-Fi Access	13.5.3.1		
Build trophies	13.5.3.1		
Prepare vouchers	13.5.3.1		
Inform sponsors	13.5.3.2		
Check workshop boxes	13.5.3.3		
Check prototyping inventory	13.5.3.3		
Pre-order food	13.5.3.3		
Posters	13.5.3.4		
Promotion social media	13.5.3.4		
Reminder email	13.5.3.4		

Staff – Role assignment at event

- **Assign staff to each phase and role**
  - Consider substitute staff
  - Inform staff about assigned shifts

The following table shows the roles for the execution of the event. The times stated in the column *availability* always refer to the schedule template (see Figure 23)

Table 18: Makerthon role assignment

Role	Main tasks	Availability	Who
Main organiser	General overview	All the time	
Moderator	Moderate all sessions	Fr.: 14:30 – 22:00 Sa.: 09:00 – 16:00 Su.: 13:00 – 15:00	
Expert for methods #1	Support of participants	Fr.: 14:30 – 22:00 Sa.: 09:00 – 16:00	
Expert for methods #2	Support of participants	Fr.: 14:30 – 22:00 Sa.: 09:00 – 16:00	
FabLab Staff #1	Support of participants	Sa.: 15:30 – 22:00 Su.: 09:00 – 15:00	
FabLab Staff #2	Support of participants	Sa.: 15:30 – 22:00 Su.: 09:00 – 15:00	
Photographer	Photos and videos	Fr.: 14:30 – 20:00 Sa.: occasionally Su.: 09:00 – 15:00	
Sponsor contact	Contact person for company representatives and mentors	While mentors are present	
Catering	Contact for caterer, Preparation of alternative meals, refilling stock, clean up	All the time	
Preparation venue #1	Prepare venue, see 13.5.4.1	Fr.: 08:00 – 14:00	
Preparation venue #2	Prepare venue, see 13.5.4.1	Fr.: 08:00 – 14:00	
Print	Print all required documents See 13.5.4.1	Th.: 08:00 – 16:00	
Supply #1	Buy food, drinks and supply	Th.: 13:00 – 17:00	
Supply #2	Buy food, drinks and supply	Th.: 13:00 – 17:00	
Legal responsibility	Responsible that every participant signs all forms (declaration of assignment, photography and makerspace terms)	Fr.: 14:30 – 15:30	
Feedback	Hands out and collects feedback forms	Su.: While jury discussion	
On demand	Available on demand for major issues or short-term absence	On demand	

13.5.4 Event execution

13.5.4.1 Event execution – Organisational

Documents and staff

- **Before print final check**
  - Off content
  - If sponsor logos are placed as agreed

- **Documents to print**
  - Certificates of participation
  - Declaration for usage of photos
  - Makerspace terms
  - Makerthon guideline
  - Feedback forms

Venue

- **Main room**
  - Arrange tables and chairs
  - Wiring (for power supply)
  - Setup presentation laptop
  - Setup beamer
  - Check sound and presentations
  - Place workshop boxes
  - Place flipcharts and whiteboards
  - Place makerspace guideline
  - Optional: Decoration
  - Optional: Place company logos
  - Optional: Place roll-ups

- **Dining area and recreation area**
  - Arrange tables and chairs
  - Setup coffee machine
  - Setup fridge
  - Cool drinks
  - Prepare milk and sugar
  - Setup glasses and cups
  - Setup fruits

Rewards and nametags

- **Print FabLab vouchers**

- **Prepare nametags**
  - Participants
  - Staff
  - Company representatives

13.5.4.2 Event execution – Partners and sponsors

- Check event venue if all sponsor logos are placed accordingly
- When company representatives arrive, get and test their challenge introduction

13.5.4.3 Event execution – Catering and supplies

Catering

Table 19: Shopping list - Food and drinks

Category	Product	Quantity (l, kg or #)	Check
Drinks	Sodas (e.g. cola, fanta, etc.)		
Drinks	Ice tea		
Drinks	Juices (e.g. apple, orange, etc.)		
Drinks	Energy drinks		
Drinks	Beer (incl. shandy and alcohol free)		
Hot drinks	Tea Various flavours		
Hot drinks	Coffee beans		
Hot drinks	Milk		
Hot drinks	Sugar		
Snacks	Fruits (e.g. apples, bananas, etc.)		
Snacks	Chocolate or muesli bars		
Snacks	Savoury snacks (e.g. chips, salted sticks, etc.)		

Optional: Alternative meals

Table 20: Shopping list - Alternative meals

Meal	Product	Quantity (l, kg or #)	Check
Friday Dinner			
Friday Dinner			
Friday Dinner			
Friday Dinner			
Friday Dinner			
Saturday Breakfast			
Saturday Breakfast			
Saturday Breakfast			
Saturday Breakfast			
Saturday Breakfast			
Saturday Dinner			
Saturday Dinner			
Saturday Dinner			
Saturday Dinner			
Saturday Dinner			
Sunday Breakfast			
Sunday Breakfast			
Sunday Breakfast			
Sunday Breakfast			
Sunday Breakfast			

Supplies

- **Bathrooms (check with facility management)**
  - Extra toilet paper
  - Extra paper towels

Supplies shopping list:

Table 21: Shopping list - Supplies

Product	Quantity (l, kg or #)	Check
Kitchen roll		
Tin foil (e.g. for left overs)		
Trash bags		
Optional: Cups		
Optional: Plates		
Optional: Napkins		

13.5.4.4 Event execution – Marketing

No checklist or table

13.5.4.5 Event execution – Staff

No checklist or table

13.5.5 Follow-up work

13.5.5.1 Follow-up work: Organizational

- **Final clean up**
- **Define responsible person for evaluation, feedback and guideline reworking**
- **Participants' feedback evaluation**
- **Results of the makerthon**
  - Outcome of the participants
  - Impressions and observations of staff

13.5.5.2 Follow-up work: Partners and sponsors

- Request feedback from partners and sponsors

13.5.5.3 Follow-up work: Catering and supplies

- **Compare calculated/estimated values with actual consumption**
  - Was the catering enough or was trouble shooting necessary (e.g. extra pizza order)?
  - Were the self-prepared meals enough?
  - Drinks
  - Snacks
  - Prototyping materials
  - Workshop materials
  - Was anything missing?

13.5.5.4 Follow-up work: Marketing

- ☐ **Prepare press-release**
- ☐ **Prepare social media postings**
  - Facebook
  - LinkedIn
  - Instagram
  - _____

- ☐ *Optional: Include promotion for next event*
  - *Set up registration or pre-registration form*

13.5.5.5 Follow-up work: Lessons learned and preparation of results

- ☐ **List lessons learned**
  - Discuss them with staff

- ☐ **Incorporate lessons learned into makerthon handbook**
  - Update values (catering, drinks, snacks, materials etc.)
  - Other adaptions, for example:
    - Timetable
    - Methods
    - Staff roles
    - Marketing
    - Partners & Sponsors
    - Duration of planning and execution

13.5.5.6 Follow-up work: Documentation

- ☐ **Write documentation, include:**
  - Event characteristics with actual values (see. 13.5.2.2)
  - Involved staff
  - Partners & Sponsors
  - Relevant positive feedback
  - Relevant negative feedback
  - Project results
  - Lessons learned