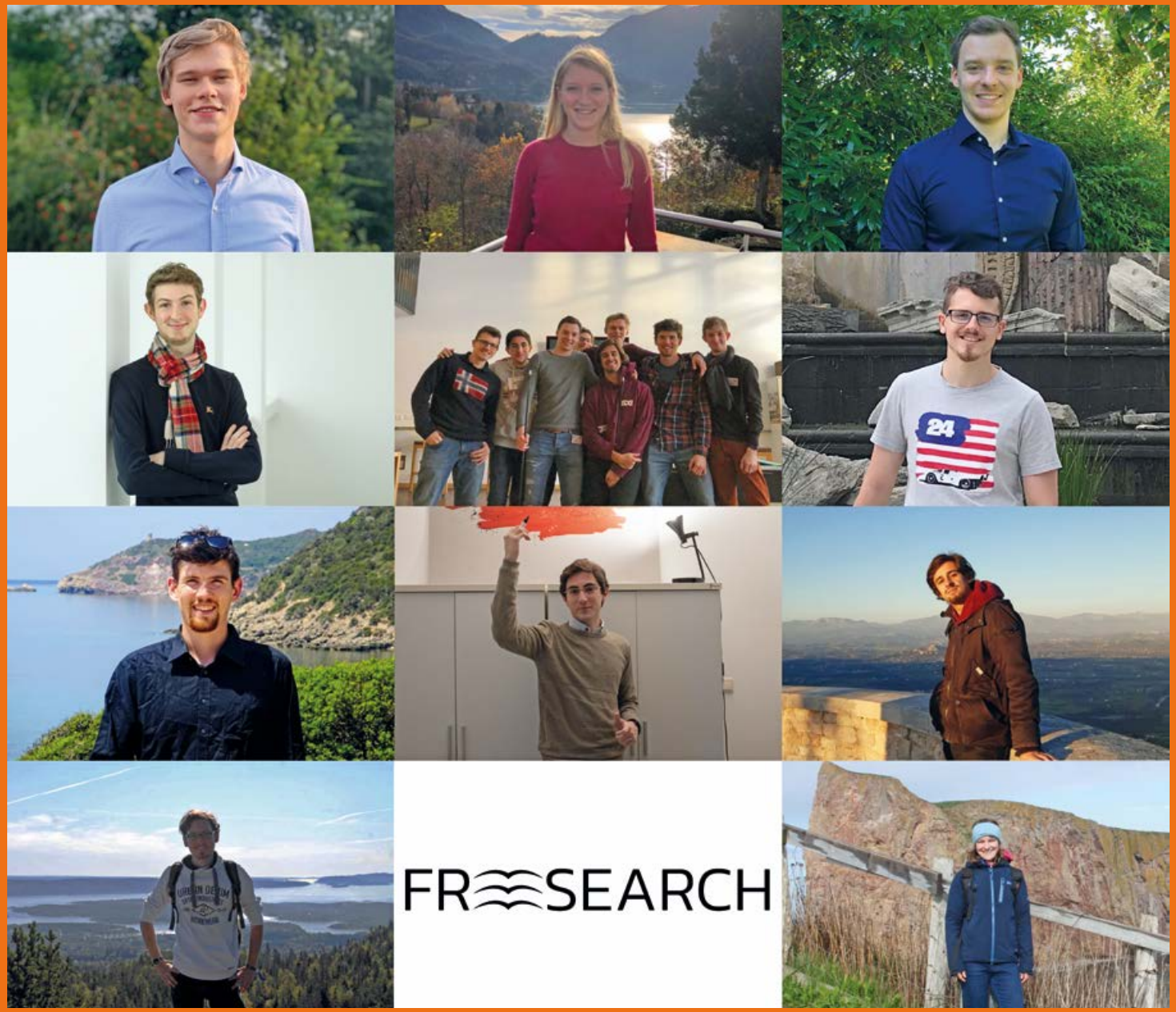
FRØSEARCH

Project Report **Freesearch**

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Preface by the Supervisor

Prof. Dr. Sonja Berensmeier

Within the call ‘Multimodal Science Communication’, the Freesearch team started by asking basic questions about the different funding mechanisms and interdependencies of industrial and academic research. A complex story that is difficult to grasp even for professionals and is the subject of continuous controversial discussions. The final idea of the student team to establish a crowdfunding platform for students aiming to solve scientific questions seems to be a very promising and appealing approach.

My own view on the topic is strongly based on the experience of successfully raising public and private funds for scientific research at our university, often together with industry partners or clients. Teaming up with my colleague Tim Lueth, who has additionally founded several companies himself, we tried to challenge the ideas and hypothesis of our student team in order to identify the most relevant “next-problems-to-solve” in order to focus the team on the way forward. We learned that without these intensive coaching activities it is extremely challenging for a newly set up student team to proceed or pivot in a steadily consequential way based on their previous learning instead of jumping arbitrarily on new ideas that they come across.

We were able to observe the different teamworking phases of a very interdisciplinary team – including how they faced the difficulties of aligning their understanding and language to agree on a project problem and their strengths in analyzing the problem and its potential solution from completely different angles. The training sessions of the Junge Akademie and the discussions with their mentors and supervisors were obviously also particularly helpful. The team succeeded in learning to take and defend common de-

cisions after integrating all team members' different opinions and arguments.

Many discussions circled around the definition of science in general. What finally does scientific work mean? How can scientific work be evaluated? Which rules and legal guidelines have to be respected? Which ethical questions could arise? Highly relevant topics, which are not only important for detailing the crowdfunding platform idea, but are critical success criteria for any kind of scientific projects.

However, equally important and powerful, I perceived the regular and open self-reflection of the team and its commitment to optimizing the team results and making any hurdles transparent. The team finally embraced the understanding that a truly scientific way of working means far more than just designing and using statistics: Asking the right questions, capturing and interpreting relevant data and information, testing hypotheses and pivotal ideas until a solution fits the problem – and not forgetting the willingness and ability to accept associated responsibility and compliance with laws and socio-ethical standards.

What did I learn in my supervisor role? Being a member of the Advisory Board of the TUM: Junge Akademie since 2016, it was a valuable experience to be closer to the students and their challenges. I realized again that a scientific way of approaching problems is a long and intense learning journey, until it comes "automatically." And I am again deeply aware of the fact that it is by far easier to avoid falling in love with certain ideas and asking key critical questions if you are able to keep a sufficient distance from a topic. ■

Swarm intelligence as an alternative money source for science?

"Wer zoid, schaffd o.", "The payer determines what happens." Many people agree with this old Bavarian saying. However, problems occur when this rule applies to the foundation of our knowledge: science. This should be independent and free from external influences and manipulation. But is it? Or is that just a pious wish? An example for such manipulation is so-called "Fake Research," which means research funded by companies and distorted so that it suits businesses' interests. Since the 1960s for example, several studies have claimed that smoking is not harmful, on the contrary, it is actually healthy. Those were all funded by the cigarette company Philip Morris. Another case are papers which claim that fossil fuels do not contribute to climate change. Since the 1980s, this theory has been spread by institutes, founded and funded by oil companies like ExxonMobil. The ludicrousness of those examples shows the problem which accompanies this type of science funding: the reality is misrepresented to support a firm's interests. "Wer zoid, schafft o" – also in science.

However, scientific independence comes under pressure from other quarters. Most of the money researchers receive comes from political bodies. In this case, companies and lobby groups exerting influence on the scientific community is not the problem, as who acquires which amount of funding is not directly decided by politicians. Instead, there are institutions which do exactly this – one famous example is the Deutsche Forschungsgemeinschaft (DFG). In order to gain funding, researchers have to meet several criteria. Undergraduates for example suffer vanishingly small chances of obtaining funding, no matter how good their idea is. Additionally, projects which sound good in the context of DFG's application procedure and criteria have a much higher chance of being accepted and receiving funding. Many truly innovative ideas just die because of those criteria.

But are there any alternatives out there? One currently still relatively unknown model has recently gained increasing attention: this

is crowdfunding. In this model, researchers upload their idea on a platform and explain their goals and why their topic is so impotant. People can then donate whatever amount of money they want. The big advantage of this concept compared to the two already existing models is the low bar that allows researchers to obtain funding: as long as the idea is good and convincing, they will receive money. Moreover, due to the anonymity of the donors, crowfunding promise to be free from manipulation. However, the question is, how big a potential this model really has.

Recently, a team of researchers at TUM investigated this question. Their findings show two main problems for crowdfunding. Firstly, it takes a lot of time until a crowdfunding platform is famous enough to attract enough donors to really work. Secondly, even if accomplished, it won't be possible to raise such a large amount of money as is usually available through the two other models. This means that crowdfunding can only serve as a supplement to the other two funding models, for example to fund undergraduate projects which are not so expensive.

Despite those two weaknesses: Crowdfunding will have to assert itself at least as part of the new financing mix – if only because the current models are problematic. An enlightened society, which makes its decisions on a scientific basis, therefore needs one main thing: independent scientists who are not subject to manipulation and who can research the best ideas without needing to be the best at filling out forms. Crowdfunding can help here. However, because of the two main weaknesses mentioned, it can only do so in a supporting role within the mix of research funding. ■

Freesearch

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Abstract

Advancing science is costly and requires funding. Thus mechanisms to allocate money to scientific projects are needed. Many such mechanisms exist, most notably grant-based public funding and industry sourced funding, but they have been criticized for a variety of shortcomings. Crowdfunding, a novel way of financing projects by pooling funds from a large community, could be used for this purpose. Theoretical considerations show that it may offer distinct advantages particularly in the context of funding small projects, such as student-led or civic science ones. We developed a crowdfunding platform, called crowdTUM, to serve students and alumni of the TUM community, specifically to investigate what are the opportunities and how to overcome the challenges of establishing a crowdfunding platform for scientific projects. We found that the technical and legal implementation of the platform did provide a number of challenges to overcome, most notably organizing the transfer of funds. However, the main challenge was marketing our Crowdfunding initiative. While we managed to host several projects on the platform, we were unable to gather the critical mass of backers necessary to allow projects to get funding. A more concerted social media push, combined with a way of reaching the TUM Alumni community, could potentially have alleviated this problem.

Freesearch: From classical research funding to Crowdfunding

In idealized depictions, science is often regarded as a pursuit "for its own sake." The mathematician G. H. Hardy once argued that "real mathematics must be justified as art if it can be justified at all," and similar attitudes can also be found in other fields.

In practice, however, science, like any other human pursuit, is subject to economic considerations. This has two main reasons: firstly, by adding to the corpus of human knowledge, successful science can translate into new products, higher efficiency, better health or other innovations with considerable economic value; secondly, engaging in science consumes scarce resources. This is obvious for any field where large machines or laboratories are needed. But it is also true of the scholar sitting in a library, as such highly intelligent individuals likely could be usefully employed in many other sectors of the economy.

Accordingly, because science can bring many benefits but also incurs real, substantial costs, society needs mechanisms to decide what resources to allocate to science and how to divide these resources among different fields, projects and scientists.

In this report we will present crowdTUM, a project designed to empirically examine the use of crowdfunding as a funding tool for the scientific projects of TUM students and alumni. The section "Background" will present some criteria to compare mechanisms of science funding, briefly discuss traditional approaches and then discuss crowdfunding in context. Next, the "Goals and Methods" section will present the goals of the crowdTUM case study and the approach used to develop a crowdfunding platform. The "Results" section will critically examine the extent to which these goals have been achieved. Finally the "Conclusion" and "Future Outlook" will offer some general conclusions and opportunities for further research.

Background: A brief introduction to science funding

Theoretical criteria to evaluate science funding mechanisms

To be able to evaluate a science funding mechanism, criteria are needed by which they can be measured and compared. Many such criteria exist in literature and we cannot review all of them here. Instead, we present a few very basic criteria which may serve as a starting point. We propose that a good funding mechanism should:

- **Have low overhead:** the allocation process itself should be fast, not be unduly costly and sufficient money should be available to make participation worthwhile [1].
- **Be Efficient:** Funding should be allocated preferentially to more meritorious projects, as measured by the benefits, costs and probability of success [2].
- **Be Transparent:** criteria used to decide who gets funding should be known and, furthermore, it should be possible to determine how the money has been used and whether the funding has led to conflicts of interest [3].
- **Be Equitable:** everyone with the necessary technical qualifications should be able to participate, regardless of personal characteristics [4].
- **Promote the common good:** the funding mechanism should ensure that the benefits of science are widely shared and help improve society at large.

Of course these criteria are context-dependent, open to interpretation and sometimes mutually contradictory (see for example the conflict between equity and efficiency/ "excellence" [5]). Nevertheless, they provide at least a basis for analysis and comparison between different approaches. It should be noted that major funding agencies, such as the german DFG, often subscribe to these or similar goals. The DFG explicitly lists equality of chances (i.e. equitability) and scientific excellence (efficiency) among its goals, and also sees itself as having a responsibility towards the public [6].

Traditional science funding

Traditionally, a distinction has been made between two main sources of science funding: public and industry. It should be noted that, in practice, each of these come in a variety of forms and additionally many hybrid forms exist. However, the distinction is nevertheless central to many discussions of science funding mechanisms so, accordingly, we will make use of it as well.

Typical examples of public science funding are funding agencies such as the DFG and the horizon program of the EU. The process can be broadly summarized thus: politicians decide on a budget and, in consultation with experts, research priorities. Scientists then write grant applications, i.e. detailed summaries of their proposed projects. A group of peers evaluates these applications and provides recommendations as to which ones should be funded.
The main purported advantage of this process is that it allows funding of research which the private sector considers too risky or insufficiently profitable. Accordingly, public funding is often the preferred mechanism to fund basic research, thus promoting the common good by supporting projects that provide revolutionary breakthroughs which ultimately benefit all of society. The world wide web is a commonly cited example [7].

A complaint levied against public funding is that the grant writing process leads to a high overhead. It is alleged that scientists have to spend an excessive amount of their time writing grants [1], reducing the time they have available to do actual science. Another common criticism is that public funding may be inequitable. Research has shown that there is a systematic bias towards established researchers, beyond the degree which could be justified by considerations of efficiency [8].

Industry funding is often considered more flexible. Industry is capable of mobilizing large sums of money and may give researchers more flexibility in using this money. Public funds have been stagnating in many countries, leading to "hypercompetition" between researchers [9]. Industry funding can be used to bypass this problem. Industry-funded research has been found to lead to more patents [10] than publicly funded research. This may indicate on one hand that industry is good at selecting productive projects. However this likely also reflects industry's desire to generate profits, which limits the extent to which industry-funded science will promote the public good. Additionally, industry funding may be non-transparent and may lead to conflicts of interest [11]. There are also examples of downright unethical practices, such as the manipulation of research on the dangers of smoking [12].

For the specific purpose of funding student-led or citizen science, both mechanisms have large drawbacks. Directly applying for grants will be difficult for outsiders, as will be establishing the necessary contacts with industry. Moreover, such projects are generally non-profit, potentially making them less attractive to industry. Accordingly, students will generally have to work through existing research groups to acquire funds, which may limit their options and creative potential since they do not have full control or responsibility over their project. Examples such as TUM hyperloop, WARR, or TUM: Junge Akademie show that student-led teams are capable of pioneering cutting edge research and engineering.

Crowdfunding

Crowdfunding describes a relatively novel method of funding projects. Instead of relying on traditional financial intermediaries, crowdfunding describes the process of raising funds directly from the community, usually in the form of many small individual contributions, which, given sufficient participation, can add up to a large sum.

Crowdfunding is usually organized through online platforms and generally operates on an all-or-nothing basis. This means that project owners present their projects on the platform, in addition to setting a funding goal. Members of the community (the crowd) then have a specified amount of time to pledge money towards the project. The pledged funds are transferred only if the funding goal is reached in the specified time frame. To entice the crowd to pledge, project owners can specify rewards, often tiered according to the size of the contribution. In contrast to traditional equity investment, these rewards are usually non-financial, though crowdinvesting concepts exist as well [13].

A theoretical evaluation of crowdfunding as funding mechanism

The following analysis considers some theoretical advantages and drawbacks of crowdfunding as a mechanism of science funding.

Criterion	Advantages	Drawbacks
Low overhead	No middleman/expensive layer of bureaucracy between scientists and funders	**Necessity to set up & promote the platform itself to attract projects & funders.** Requires resources (time, marketing) which do not directly contribute to projects/science.
Efficiency	**Projects which are too small to be efficiently funded by traditional mechanisms may become worthwhile in a crowdfunding setting** [14]	Crowd possibly less well equipped to adequately judge the merit of scientific projects compared to domain experts. Could lead to bias towards flashy/entertaining projects, possibly even pseudoscience
Transparency	Crowdfunding encourages scientists to communicate effectively, and, where possible, involve the crowd in their projects [15].	After a project is funded, legal guarantees are limited and project participants may misuse/misappropriate funds
Equitability	**Everyone can participate and barriers to entry are minimal.** Research shows that students are statistically more likely to succeed using crowdfunding than more established researchers [14]	Crowdfunding projects often rely on donations and word to mouth propaganda by friends/relatives, so people with bigger social networks will have an advantage
Promotion of the common good	Donors do not have a profit motive as rewards are non-monetary. This favours non-commercial/idealistic projects. Additionally, by encouraging scientists to communicate with donors, crowdfunding may have educational value.	Not applicable

Table 1: theoretical evaluation of Crowdfunding as Science Funding mechanism

We have emboldened what we consider to be the most essential points. This analysis suggests that crowdfunding may be an effective way for students to acquire funds to undertake their own scientific projects.

Development of our idea

The main goal of our team was to explore ways to improve science and science funding. The name Freesearch, a portmanteau of the words "Free" and "Research," reflects this.

Initially, we focused on researching existing mechanisms of science funding, with an intent to improve them generally. We quickly realized, however, that this goal was too broad and ill-defined to be achievable.

To limit the scope to something more local, we decided to focus our efforts on student-led research in particular. Since every student at TUM must write a bachelor or master thesis, we decided to embark on a project to help students find thesis topics they are personally passionate about. However, after conducting a survey, we discovered that the demand for such a project was too limited or already partly being served.

We returned to our research on science funding and began to consider whether or not we could improve funding for student-led projects. This led to the current project, to try to explore the possibility of using crowdfunding as a science funding mechanism for student research.

Goals and Methods

As our research points to potential benefits of crowdfunding for student-led research, we decided to try to realize these benefits for TUM students. Doing so, however, requires setting up and evaluating a Crowdfunding platform specific to the TUM community. While it would have also been possible to work through an existing platform, this would have involved some notable disadvantages, as such platforms are (1) not necessarily focused on science or students, (2) not specific to the TUM community and (3) may not be willing to share data openly.

Setting up such a platform entails overcoming a wide variety of challenges, including technical, legal and organizational hurdles. We realized that due to time constraints, it would be very unlikely that we would be able to set up the platform and gather sufficient data on the extent to which it has benefited the community before the end of the TUM: Junge Akademie project period. As a result we decided to focus our research on the process of setting up and populating the platform itself. Specifically, we decided to determine which challenges in particular are faced when establishing a crowdfunding platform for scientific projects and how these can be overcome. As such, our research approach is to construct a testbed and to learn directly from this process.

Technical and Legal Implementation of the Platform

A crowdfunding platform, at the bare minimum, consists of two components: a website, where projects can be advertised to backers, and a method of transferring funds from backers to projects. The website has three fundamental requirements that it must fulfill:

- **Ease of use:** How effective is the website in providing the user with the necessary information? How easy is it for a user to discover and back a campaign?
- **Security:** How secure is the personal data provided to us by the user? How secure is the payments system? Could an adversary steal private information or take down the website?
- **Performance:** Is the website fast enough to handle many users at once? Does the website load the necessary information quick enough so that users do not leave the website and trust the website enough to further conduct transactions?

To guarantee such requirements is a complicated process. Especially in the matters of security and performance, one needs to be quite well informed and proactive to ensure the website runs without issues. Although our team includes informatics students, the limited time frame and budget were prohibitive for us to implement our own systems from scratch. Thus, we have decided to use an existing Platform as a Service solution provided by the LRZ (Leibniz-Rechenzentrum), where we used the existing Wordpress content management system with the Crowdfunding plugin. Our website is set up as a subdomain of the official TUMJA website ja.tum.de. The connection to the website is secured by the modern encryption standard TLS with a certificate provided automatically by the LRZ. While the system we used was not designed to scale to a large number of users, we believed that the potential load provided by our ex-

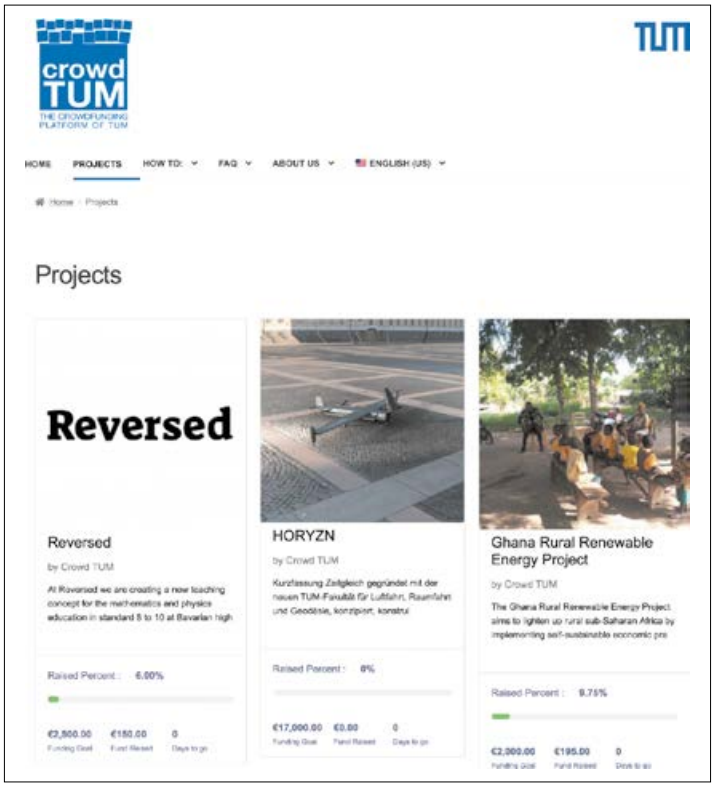

Figure 1: A screenshot of our website

pected number of users could be handled by the single system provided by the LRZ. A more complicated but scalable solution would have only increased both the costs and potential errors in our system.

To implement the transfer of funds, we explored a variety of options, including setting up a company to process the funds directly and paying for a payment processor. We eventually decided to take an indirect approach. When backers pledge funds to a specific project on our platform, it is to be understood as a promise to donate the respective amount if the particular campaign succeeds. Once it does, we sent to backers the account details (of an account managed by the TUM: Junge Akademie) where they should donate to. Then we would send the money to the particular campaign. The advantage of doing it this way is (1) there is no necessity of refunds in case of unsuccessful campaigns, which is a necessary condition to allow funds to be characterized as donations (see below) , and (2) the financial and personal data would all only be handled by TUM. This would also mean that we personally could not be made legally responsible should there have been, for some reason, anything (financially) illegal conducted via crowdTUM. Accordingly, this solution was mainly designed to fulfill legal requirements while minimizing operational risk for us, the users and TUM.

In terms of the legal framework of a crowdfunding platform, two main issues need to be addressed. Firstly, the legal nature of the funding given by backers to projects needs to be determined. We decided to characterize the funds as donations, rather than as payment towards a service, as this does not require setting up a company, drafting contracts or paying taxes. Secondly, compliance with data security provisions needs to be ensured. We did this by using Leibniz Rechenzentrum (LRZ) services to host the platform and by minimizing the amount of personal – particularly financial – data we collect.

For the organizational implementation we developed a set of criteria for scientific projects to satisfy in order to be hosted on the platform. These were inspired by the approach of DFG and required the project to display a scientific approach such as, among others, problem description, solution process, distinguishing features of the solution as well as a clear financial plan.

Marketing the Platform

A crowdfunding platform requires two kinds of users to be successful. Those who desire to set up projects and those who would potentially be willing to fund them.

Our marketing strategy first and foremost was to ensure that there would be some projects on the platform to begin with, so that potential backers wouldn't be met with an empty page. For this purpose, we put up posters advertising the platform and distributed flyers in several university locations. Additionally, we offered a grant, which promised a reward to the first scientific projects to submit to the website, so as to give an incentive for project owners to invest the effort to host their project on our platform.

Project Name	Short description (paraphrased)	Funding goal (Duration)
Ghana Rural Renewable Energy Project	Finding and establishing self-sustainable energy solutions for sub-saharan villages	2000 € (2 months)
Berufsschule Bukit Lawang	Planung und Bau einer handwerklichen Berufsschule in Sumatra mit nachhaltigen Materialien um damit jungen Menschen Ausbildungsplätze und Perspektiven zu schaffen.	5000€ (11 months)
HORYZN	Design and develop a VTOL (Vertical Take.Off and Landing) UAV- (Unmanned Aerial Vehicle) to transport medicine in an easier way to difficult to reach places.	17000€ (3 months)
Reversed	Developing a new engaging teaching concept for the mathematics and physics education at Bavarian high schools based on a modular drone that can be disassembled into individual experiments and thus provides a playful means of exploring physical and mathematical phenomena in an technologically relevant context.	2500€ (2 months)

Table 2: List of projects hosted on the platform

Figure 2: Examples of our various marketing elements.

Outcomes and Discussion

The implementation of our crowdfunding platform posed social, technical, and legal/organizational challenges. The social challenge was to promote our platform to both the project creators and funders. The technical challenge was the challenges related to the website and the payment system. The legal/organizational challenges were related to being an intermediary in the transfer of funds between the funders and the project creators.

The Social Challenge

A successful crowdfunding system cannot exist without people willing to create projects and other people willing to fund those projects. To find the people that would be willing to participate in our crowdfunding experiment, we tried different marketing strategies and measured the number of visitors and page views our website received over time.

In Figure 3, the number of visitors to the website is depicted over time in the time range 17.12.2019 - 19.08.2020. The x axis represents the dates and the y axis represents the number of visitors. The black line depicts the number of visitors per date and it's smoothed representation is the horizontal blue line. Three potentially important dates affecting the marketing are displayed as straight vertical lines. The first vertical line in green on the date 16.12.2019 is the day where posters targeting project creators were initially hung over the TUM campus. The second vertical line in blue on the date 10.02.2020 depicts the distribution of flyers around the TUM campus and Mensa-Garching. The third vertical line in red on the date 12.03.2020 depicts the start of a range of travel restrictions concerning Germany due to COVID-19.

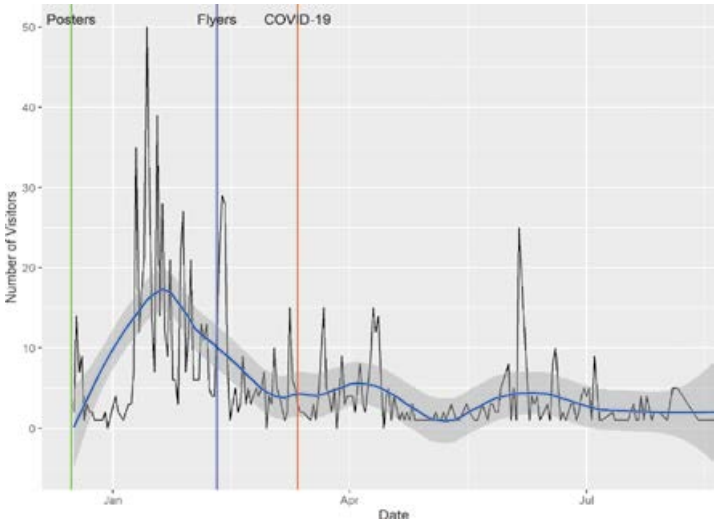

Figure 3: Number of visitors to the CrowdTUM website over time.

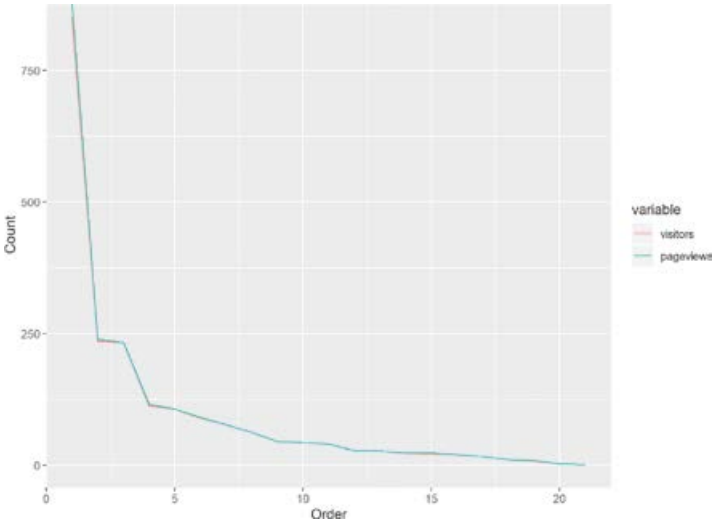

Figure 4: Number of visitors and page views by page, ordered.

The graph shows that while flyers have resulted in a quick and strong peak in views, the peak lasts for a really short time and the website views normalizes to its usual level. Posters, in contrast, result in a much slower change in visitors, but result in a peak that is stronger and lasts longer. It should also be noted that the end of December and the beginning of January correspond to the Christmas/new year holiday which explains the valley of visitor count after the posters were initially hung.

While it has been possible to have some peaks post COVID-19 restrictions via online social media posts and related marketing, we were unable to market the website in a way that could cause the same kind of uptick in views as real physical marketing via posters in the TUM Campus while students still physically attended the university.

There are 5 pages on the website that have been able to garner more than 100 visitors. They are in order:

- The home page with 851 visitors
- The projects page with 236 visitors
- The project “Ghana Rural Renewable Energy” with 233 visitors
- The FAQ with 113 visitors
- The project “HORYZN” with 107 visitors

In Figure 4, the visitors to and page views of pages on the website are displayed. The pages are ordered on the x axis by their views. We can see that there is a small set of pages that are visited a lot of times while the rest of pages are visited significantly less frequently. Additionally, the number of pages seen per visitor is quite close to 1 in our statistics, where we see 1.02 page views per visitor. However, we should note that our website uses as little number of trackers and cookies as possible, so it is technically quite difficult for us to identify separate page views as belonging to the same visitor.

Another interesting statistic is the referrer information we have collected from our website, which denotes where the visitors have come from, in other words, how the visitors discovered our website.

Our most prominent referrers are in order:

- The Junge Akademie website
- Instagram
- Facebook
- Various search engines
- Studinews interview from our team member Jan Kochanowski [16]
- LinkedIn

We can see that promoting the project on the TUM: Junge Akademie website and actively participating on social media platforms led to additional traffic on our website. We also see that official interviews in prominent publications read by the target community lead to increased traffic. A surprising fact is that search engines are not the leading source of referrals. This means that users mostly either wrote down the website URL by themselves by seeing it on our marketing or discovered the URL through the other sources. Our referrals data also shows us that the most prominently viewed project "Ghana Rural Renewable Energy" has conducted additional marketing on LinkedIn. This leads us to believe that projects conducting independent marketing can result in an important increase in their engagement.

The Technical Challenge

The technical challenge proved to be less difficult than expected, as we had the right skills and tools to confront this challenge. One team member is a very experienced programmer and thus had the right skillset to master this task. Additionally, thanks to the availability of services like wordpress and the LRZ web hosting, the technical overhead necessary to create and maintain the website has become very manageable. Furthermore support from the TUM "Referat für Datenschutz" proved highly valuable in demystifying and following privacy law requirements. Overall the support of TUM: Junge Akademie was very helpful.

The Legal/Organizational Challenge

The third and final challenge was the issue of the transfer of funds, which proved more difficult. We had neither a legal nor an entrepreneurial expert in our team, which meant that our ability to fully explore the space of possibilities was limited in this case. We settled for the option relying on voluntary commitments, as explained previously in the "Methods" section. This approach means that the platform never comes into contact with any funds or financial data. It, however, has the distinct disadvantage that backers may renege on their promise when the time comes to donate, or simply forget, which has the very unfortunate side effect that successful campaigns may not actually receive the funds they were hoping for. Thus, while this probably was the best we could achieve given our lack of experience in this area, this is not a fully satisfactory solution.

Related to this was the issue of how to classify funds. As previously mentioned, we opted for classifying them as donations, which coincides well with the non-profit nature of our mission and also means that backers would be able to benefit from tax-deductions. However, this comes with two disadvantages. Firstly, backers have little legal recourse if project owners fail to make good on their promises. Secondly, donations generally are non-refundable, which was also part of the reason why we organized the transfer of funds using the model of voluntary commitments.

Discussion

Marketing the platform proved more difficult than the technical and legal implementation. Initially we believed that the main challenge would be finding interesting projects, and indeed it required some time after launch until we managed to get a project on the platform. In this regard our efforts, particularly the grant, were successful, and we finally managed to have four projects hosted on the platform. Additionally, our marketing efforts also were able to draw some traffic to the site, at least during our marketing pushes. Unfortunately, only a very small number of the people visiting the site decided to visit the projects individual sites, or contribute funds, meaning that, ultimately, no project was successfully funded.

There are several possible explanations for this. Firstly, it is likely that the overall traffic generated was too low to really drive enough potential backers to the platform. While we did attempt some social media based marketing, we were not able to make the platform "go viral".

Secondly, our marketing efforts mostly focused on TUM students. Alumni, however, likely would have access to more funds, but our marketing methods were not capable of reaching them effectively. In this regard, developing a marketing strategy designed to reach Alumni would have possibly helped, although this probably would have required a cooperative effort with the TUM Alumni organizations which were somewhat reluctant to become involved.

Alternatively acquiring reputable projects that were better known could have driven more backers to the platform.

In order to reach more and more popular projects we at some point weakened the rather strict requirement of needing to be scientific and allowed all sorts of projects. We tried to achieve this by talking with the student group "Enactus" about helping them fund some of their social-entrepreneurial projects, which are very well known.

Challenge	Level of difficulty	Explanation
Technical: Programming the Website		Many templates exist, one team member is an experienced engineer
Technical: Implementing a Method to transfer funds		Solution that does not rely on voluntary commitments would require setting up a company
Legal: creating a data protection plan		Leibniz Rechenzentrum services and the TUM „Referat für Datenschutz“ make this relatively easy
Legal: deciding the legal character of the funds		Donations come with no legal complications and offer tax advantages, but are nonrefundable
Social: getting projects on the platform		The poster campaign and grant allowed us to get 4 projects to the website
Social: getting potential backers to the platform		Our offline and social media efforts were insufficient reach enough possible backers

Table 3: The main challenges in developing a working Crowdfunding platform.

Summary and Future Goals

Developing a crowdfunding platform for the TUM community involved a variety of different challenges. Initially, we focused on the technical and legal aspects. While we could not find a satisfactory solution to every legal issue, we nevertheless managed to develop a fully functional crowdfunding platform. Furthermore, in the future, it could be possible to address some of the lingering issues. For example, one could “name and shame” donors who renege on their promise to donate, so as to reduce the likelihood of donors reneging on their promise. Alternatively, one could move beyond the voluntary model entirely by setting up a company or a non-profit organization and possibly moving beyond a donation model. The first would imply large initial costs, and also means that taxes would need to be paid, but it would offer more flexibility in the long run.

The biggest challenge proved to be attracting a large enough number of potential backers. We did not focus on this issue early enough and thus did not place enough importance on this point in our marketing strategy, since we emphasized attracting projects more. In retrospect, it has become clear that we underestimated this hurdle. A more effective social media advertising push combined with some method of directly reaching Alumni and some amount of funding prior to launching the platform may have alleviated this problem somewhat. Overall a greater integration with the different organizations of TUM, like UnternehmerTUM, could be greatly beneficial.

During the Corona Pandemic, we developed the idea that the platform could be used as a way to help students who are facing financial difficulties. Specifically, we envisioned that funds could be raised through Crowdfunding and then distributed as “care packages” to TUM students in need. This work is still ongoing.

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Self Reflection

The initial problem we set out to tackle was the science funding system. We spent a lot of time brainstorming and developing ideas on how best we might contribute to improving this system. We started working on many different approaches to our original question. But either we could not find consensus among all – or even most – of the team members, or we thought we had found a better, more original, or more effective approach. Due to the size of the team of nine members, it was difficult to arrive at a solution with which every team member agreed. That was particularly evident in the early stages of the project while we were sharing our creative ideas, opinions, and enthusiasms. As a result, the meetings were long and full of often unnecessary discussions. Our inexperience and the fact that the tutors could not always be present meant that we were not able to cut down on our inefficient use of time. However, we were always willing to compromise and to agree to a particular direction for the project if the majority of the team were behind it. This indecisiveness and lack of a unified project goal that every member was passionate about cost us, our tutors, and supervisors a lot of energy and time. It also meant that we were only able to decide on building a crowdfunding platform for TUM very late in the project phase. However, we finally had to make a permanent decision. Once some of us had agreed on the crowdfunding approach, we then had one common achievable goal that everyone seemed happy to contribute to, which was very helpful.

The second major problem we faced as a team internally was how to balance and resolve the rather different expectations of all interested parties. It was difficult for us to find a way that would implement our own visions for the project, while at the same time allowing for our shortcomings and satisfying external requirements from (in summary form): a) the project management side of TUMJA (Dr. Alexander Lang, Dr. Matthias Lehner) who were most interested in the concrete implementation of our project; b) the office of TUMJA (Peter Finger and Maria Hannecker), who always had new and interesting suggestions that we might follow; c) our supervisors (Prof. Sonja Berensmeier, Prof. Tim Lüth), who were very keen on and interested in a proper scientific approach; and d) the Fundraising Department of TUM, who were most interested in the results of our research. We are very grateful to all parties for their help and commitment, and we know that we have not always made it easy for them – and

especially for the very busy Prof. Tim Lüth, who was not even an official supervisor of TUMJA, but who was nevertheless very motivated to help and support us. In the end, we think we have achieved something with which every party involved can be satisfied and, for ourselves, we feel we have learned a lot from having to deal with such seemingly orthogonal external demands on our team's work.

When the corona pandemic hit Europe, we already considered our main project work to be over. Therefore, we collectively decided to use the platform we had created for doing some further good by helping students who were in financial difficulties at the time due to the contact restrictions. Since our entire team was behind this great idea, we managed to do the necessary work very quickly and effectively, to contact the people involved and to have all things running internally within two months. This was proof of the skills that all of us had gained during our project phase. However, due to external factors, mainly the financial department of TUM, which was not able to support our charitable work, we were never able to launch our "COVID-19 support packages." But we have learned from those setbacks.

Acknowledgments

We are thankful to the people who have supported our ideas, giving feedback and insight. In particular, we would like to acknowledge and thank our supervisors Prof. Sonja Berensmeier and Prof. Tim Lüth, who both gave us some of their valuable time to teach and guide us. Our tutor Sarah Braun brought us back to more fruitful discussions whenever we lost our way. The designer Ulrich Leyermann worked with us to create a visual identity for our platform. Also, we are grateful to the President of TUM, Thomas F. Hofmann, and the TUM Fundraising Department for their explicit interest in our work and to SVP Gerhard Müller for his encouragement. We thank the Referat für Datenschutz and the Financial Department of TUM for their help, and, of course, Peter Finger and Maria Hannecker from the TUMJA office for always helping and encouraging us and for all of their organizational work. Finally, thanks to the students who had faith in our work and offered their projects to be backed on CrowdTUM!

POSTER 1: Team Freesearch started into its project planning right at the Kick-Off Weekend. Our basic question at that time was: What influences the results of science? In a relatively short time, we realized that we could base our project on two broad approaches: either investigating factors not (directly) related to money or exploring the ways in which the current system of science funding is flawed.

Both approaches suggested two projects. On the one hand, a project considering how science outcomes can be influenced by the trends in the scientific community and by cliques among researchers. On the other hand, a project looking at how researchers, and especially students, find it difficult to develop a scientific idea, even if it is very innovative. For example, students rarely know which chair to contact when they have an idea. At the same time, the chairs obviously cannot be aware in advance of which students may have good ideas.

The hypothesis that science funding is flawed led us towards the idea of two alternative ways which could help to distribute money more fairly to scientific projects. First, there is the so-called "modified lottery," a system in which money is provided randomly to projects which fulfill certain criteria. Secondly, we learned about a mechanism called "Crowdfunding," where anybody can place a project on a website and anybody interested in this project can help to finance it through a donation.

FRESEARCH

WHAT HAPPENED SO FAR?
AND OUR VERY FIRST RESULTS.

At the meeting in Hersching, we further developed our plan to help students find their thesis topics. However, we were still unsure about some issues, including the question of whether we should focus our efforts on an online platform, an offline event (such as a fair) or both. Moreover, it was difficult for us, due to our limited personal experience with the topic, to really judge how much of an added value our project could bring to the table. To help resolve these lingering difficulties, we consulted our supervisor Prof Berensmeier and her colleague Prof Lüth, to get their valuable feedback.

In their opinion, one of the key advantages of the project would be our unique position to promote interdisciplinary research and connect students with a wide range of professors/graduate students. Furthermore our platform (or event) could function as a unified source of information about the multitude of faculties, research groups and subjects available at the TUM. In this aspect we would also not be competing with existing information services, which are often disjointed and sometimes outdated, but rather supplement them. As our approach would imply no, or only minimal (e.g. attending an event), additional work for faculties, we are also likely to face less difficulties in keeping our service up to date and useable.

Another topic that came up in those talks is that even the professors themselves within one faculty are not necessarily aware what their colleagues just down the hall do exactly. Inversely, when a particular group decides to tackle a new topic, it is often not trivial to determine whether other groups are already researching in this area. So a platform with the actual research topics of the professors and graduate students would act as a central information hub not just for students but also faculty staff.

Based on this information we devised a survey for students, which we are currently distributing through the student councils of each faculty. Using the evasys system, the survey was designed to separate two key demographics, students who still have to write a thesis and those who already did, based on their response to the initial question(s). We hope that the response of the second group will help us better understand what difficulties students faced and which types of information were particularly lacking in their experience. Meanwhile, the responses of the first group should give us deeper insight how best to design our offer, so as to maximize its usefulness.

Furthermore, we are inquiring about how we could help students so that their idea for a thesis/ projects gets the support it needs, and to what extent students are motivated to write theses about original ideas.

The results of this survey then will be used to adapt our project goal and the concrete steps to get there. Specifically, careful analysis of the results will hopefully allow us to understand the underlying issues faced by students in a more holistic manner, and thus help us in designing tailor-made solutions. In this way, the survey will compensate for our lack of experience on the subject matter. Moreover, the individual responses and the aggregate response rate will permit us to gauge overall demand for different kinds of offers. This, in turn, will facilitate the planning of the project, since we will have a better indication what kind of scale our intervention can take.

WHERE AND HOW SHOULD
YOU CHANGE YOUR APPROACH?

For changes of the approach to our project goal will depend on the results of the survey which we will get shortly.

In our current approach we have been relatively indecisive – our desire to find an impactful and executable project has slowed down our progression. Feedback from supervisors has been very informative and thought provoking. But through these many inputs and our uncertainty, we lost our own ideas and tried to implement a project, which did not fulfill all of our passions and imaginations. Confused, because of many more ideas and decisions, which had to be made, our advancements decelerated again.

Our pretty large team size also leaves an impact on our team dynamics. Organizing meetings, taking everyones opinion into account and undertaking a project that every member can be excited about, becomes more difficult.

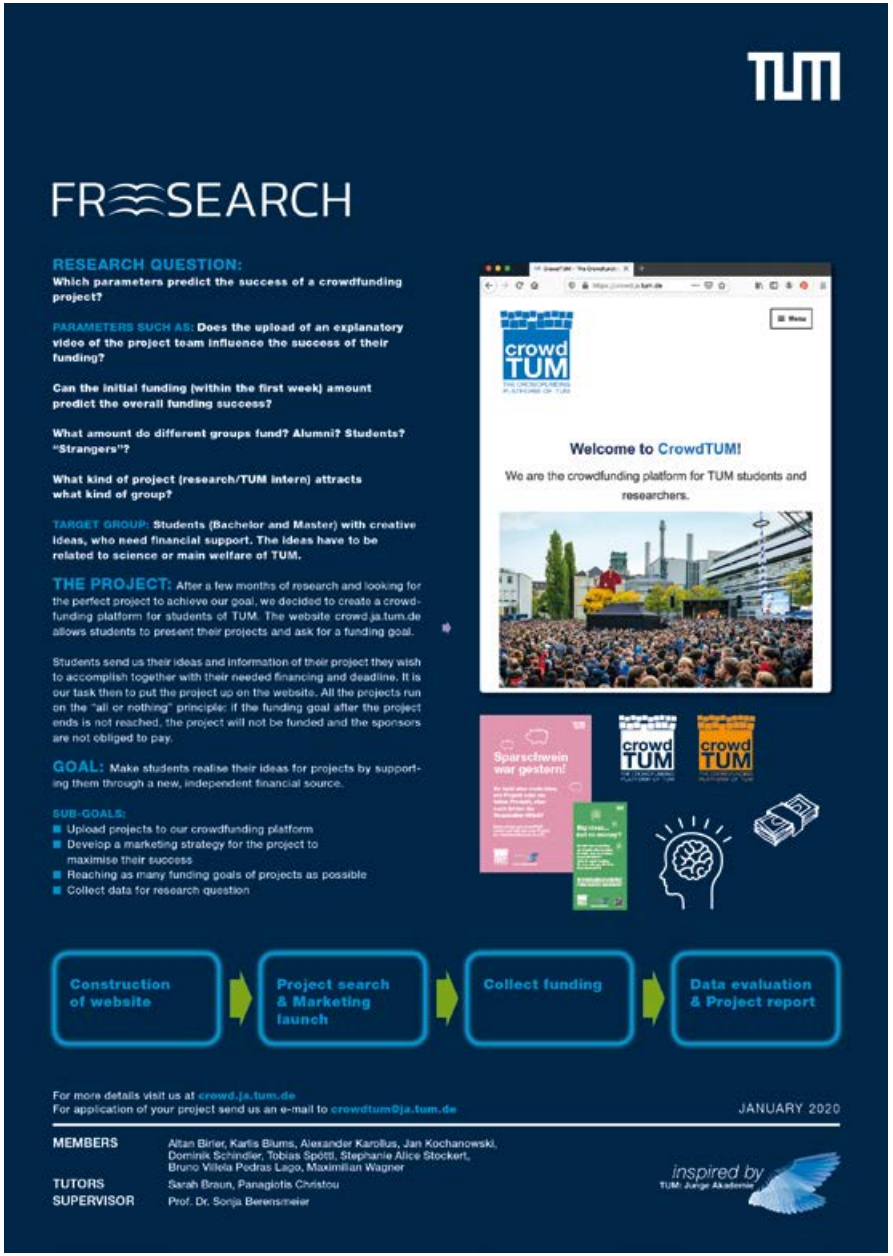
This we want to address by organizing a meeting with high attendance and holding final, binding votes for important decisions.

JUNE 2019

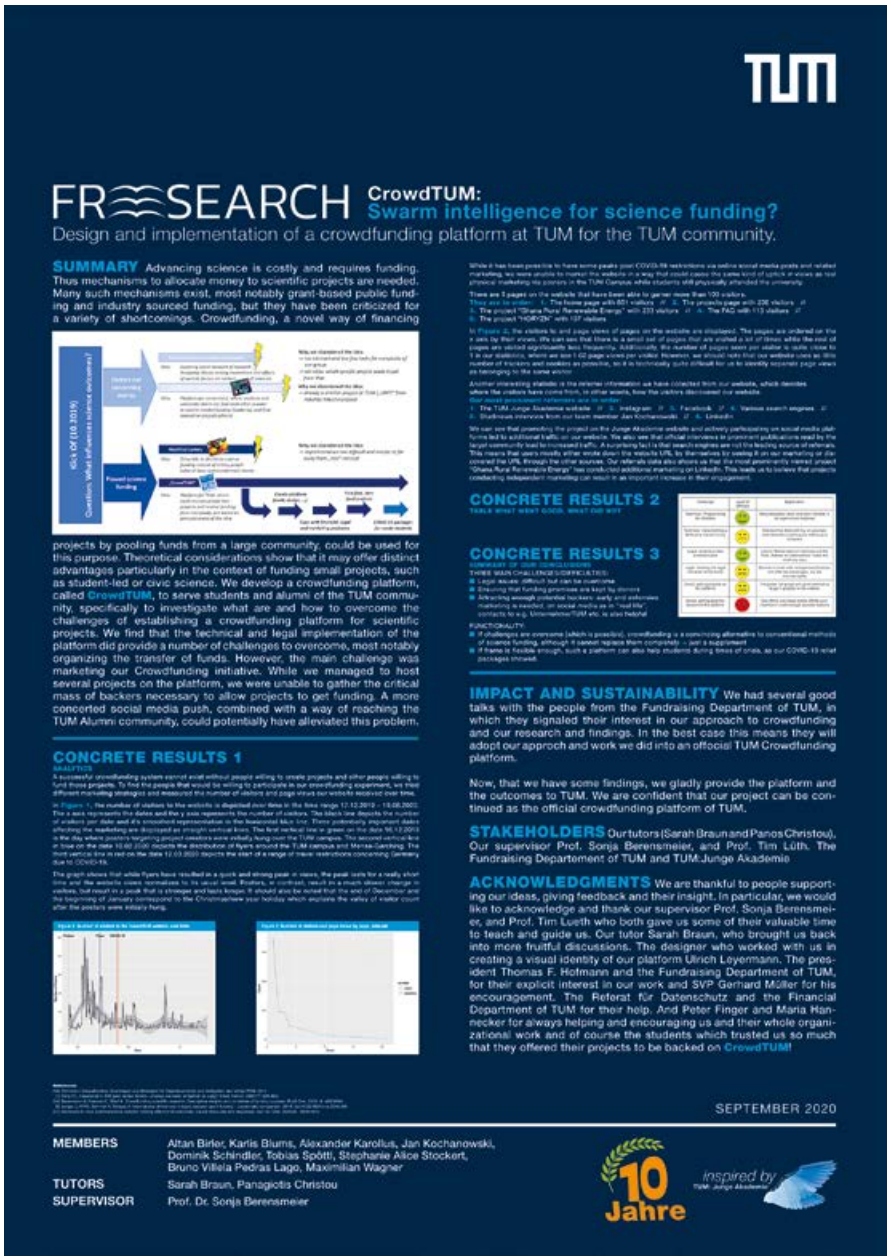
MEMBERS Altan Birler, Karlis Blums, Alexander Kazollus, Jan Kochanowski, Dominik Schindler, Tobias Spöttl, Stephanie Alice Stockert, Bruno Villela Pedras Lago, Maximilian Wagner
TUTORS Sarah Braun, Panagiotis Christou
MENTOR Prof. Dr. Sonja Berensmeier

inspired by TUM: Junge Akademie

POSTER 2: So, which of these four ideas would we choose to base our project on? At the beginning, we did some research on all the approaches. Step by step, we found more and more problems with three of the ideas. The trend analysis would have been too abstract, and moreover, we could not imagine a good scientific project arising from this idea. For the problem of students not knowing where to go with a project idea, we came up with a provisional project called “TinderTUM” in which we would create a platform (either web-based or a based on a convention), which would match students and their ideas with the chairs. However, the problem with this idea was that the faculty of Maschinenbau already had something similar (the LOIFT), and we wanted to come up with something new. For the concept of a modified lottery, we also had problems with thinking of an implementation which would not be too far away from the “real” concept.



POSTER 3: In the end, we decided to focus on one idea: the crowdfunding concept. The project arising from this idea was easy to envisage. We would create a crowdfunding platform for the TUM community to help students realize their ideas through the support of the TUM community. The research phase was about finding out which parts of this concept might work well and which might not. We started designing and building the platform. In the process, we also had to cope with financial, legal, and marketing problems, which we were able partly to overcome with the help of corresponding offices and departments of TUM. Afterwards, we had two phases in which we first searched for and found relevant projects and then tried to raise funding for them. These projects were unsuccessful because the platform was not yet well known and therefore not enough donations were received.



FREESEARCH CrowdTUM: Swarm intelligence for science funding?

Design and implementation of a crowdfunding platform at TUM for the TUM community.

SUMMARY Advancing science is costly and requires funding. Thus mechanisms to allocate money to scientific projects are needed. Many such mechanisms exist, most notably grant-based public funding and industry sourced funding, but they have been criticized for a variety of shortcomings. Crowdfunding, a novel way of financing projects by pooling funds from a large community, could be used for this purpose. Theoretical considerations show that it may offer distinct advantages particularly in the context of funding small projects, such as student-led or civic science. We develop a crowdfunding platform, called CrowdTUM, to serve students and alumni of the TUM community, specifically to investigate what are and how to overcome the challenges of establishing a crowdfunding platform for scientific projects. We find that the technical and legal implementation of the platform did provide a number of challenges to overcome, most notably organizing the transfer of funds. However, the main challenge was marketing our Crowdfunding initiative. While we managed to host several projects on the platform, we were unable to gather the critical mass of backers necessary to allow projects to get funding. A more concerted social media push, combined with a way of reaching the TUM Alumni community, could potentially have alleviated this problem.

CONCRETE RESULTS 1

CONCRETE RESULTS 2

CONCRETE RESULTS 3

IMPACT AND SUSTAINABILITY We had several good talks with the people from the Fundraising Department of TUM, in which they signaled their interest in our approach to crowdfunding and our research and findings. In the best case this means they will adopt our approch and work we did into an offocial TUM Crowdfunding platform.

Now, that we have some findings, we gladly provide the platform and the outcomes to TUM. We are confident that our project can be continued as the official crowdfunding platform of TUM.

STAKEHOLDERS Our tutors (Sarah Braun and Panos Christou), Our supervisor Prof. Sonja Berensmeier, and Prof. Tim Lüth. The Fundraising Department of TUM and TUM.Junge Akademie

ACKNOWLEDGMENTS We are thankful to people supporting our ideas, giving feedback and their insight. In particular, we would like to acknowledge and thank our supervisor Prof. Sonja Berensmeier, and Prof. Tim Lueth who both gave us some of their valuable time to teach and guide us. Our tutor Sarah Braun, who brought us back into more fruitful discussions. The designer who worked with us in creating a visual identity of our platform Ulrich Leyermann. The president Thomas F. Hofmann and the Fundraising Department of TUM, for their explicit interest in our work and SVP Gerhard Müller for his encouragement. The Referat für Datenschutz and the Financial Department of TUM for their help. And Peter Finger and Maria Hannecker for always helping and encouraging us and their whole organizational work and of course the students which trusted us so much that they offered their projects to be backed on CrowdTUM!

SEPTEMBER 2020

MEMBERS Altan Birler, Karlis Blums, Alexander Karollus, Jan Kochanowski, Dominik Schindler, Tobias Spöttl, Stephanie Alice Stockert, Bruno Villela Pedras Lago, Maximilian Wagner

TUTORS Sarah Braun, Panagiotis Christou

SUPERVISOR Prof. Dr. Sonja Berensmeier

10 Jahre inspired by TUM: Junge Akademie

POSTER 4: After the project phase was extended due to the corona pandemic, we decided to use the platform ourselves for a good cause: COVID-19 support packages for students who have fallen into financial difficulties due to the pandemic. Currently, there are still a few challenges that we need to overcome to make the platform work successfully.