Developing Guidelines for a Collaborative Open Source Trishaw Platform

An Interactive Qualifying Project submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfilment of the requirements for the degree of Bachelor of Science

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Abstract

Cycling Without Age (CWA) is an organization that provides the elderly with trishaw rides to help them remain active. Trishaws are three wheeled bikes with front passenger seating. Some volunteers lack trishaws due to many constraints. Our goal is to provide CWA with a design for a web-based community platform. This open source platform will accommodate trishaw purchases or design downloads for significantly less money. Through interviews, surveys, and strategic observation, we identified desired platform features, user motivations, and interests.

Acknowledgements

There were key individuals that provided significant support to the planning and execution of this project and are recognized here.

Project Advisors

Professor Alex Sphar and Professor Gary Pollice provided guidance and advice throughout this report, which we utilized to improve the quality and organization of our writing and overall project.

Members of Cycling Without Age

Ole Kassow, Pernille Bussone, and Ignacio Fernandez Maza originated the idea for this project and provided critiques throughout the whole creation. Their instruction aided us in creating a project that would be helpful and work efficiently for the Cycling Without Age organization.

Previous Work

The previous Cycling Without Age Spring 2020 IQP Team was gracious enough to share their data with us and provide more insight on how their project could influence ours.

Key Interviewees

Georg and Harald from EOOS were kind enough to free up their schedule for an interview to help us learn more about alternative trishaw designs and their expectations of an open source platform from designer perspectives.

We would like to give a big thank you to everyone mentioned above and to the countless others that played a role in this project through our surveys, user evaluations, and conversations.

Executive Summary

Physical limitations prevent people from participating fully in their local community, decreasing their quality of life. These physical limitations come in many forms, including birth defects, injury, paralysis, and aging. Regardless of cultural and geographical differences, people with limited mobility experience less socialization in their community.

An organization called Cycling Without Age is addressing this social issue. Through established chapters around the world, volunteers help those with limited mobility reconnect with their local community by providing rides in an alternative bike design known as a trishaw. An emerging problem is that most of the trishaws the organization uses start at 7,000 USD and are only manufactured in Denmark. Many chapters cannot afford the baseline price of a trishaw, not to mention the very high shipping costs.

Our team tackled the challenge of making trishaws more available by making guidelines for an open source web-based platform. Our guidelines addressed website features such as community, collaboration, licensing and intellectual property protection, security, and distribution. The platform will serve as a place for members to collaborate and innovate new trishaw and alternative cycle designs. Additionally, this allows designers to modify designs for local geography and cultures. In order to achieve our project goal, we first established the intended users' motivations for joining an open source collaborative platform. Then we determined their desired user experience through surveys and interviews. We analyzed all of this feedback and applied it to our guidelines. As an embodiment of our guidelines, we created a platform prototype.

Based on our background research, a vital step in properly orchestrating an open source initiative was to provide the trishaw community with a platform to collaborate and communicate their ideas simply and efficiently. We based our guidelines for the platform and its longevity on the results of interviews and surveys of stakeholders, and they will set Cycling Without Age on the right path toward an effective and long-lasting platform.

Our first step was to identify the most significant features that the main stakeholders were looking for in an open source platform. We did this through interviews, website evaluations, a stakeholder map, user stories, and surveys. In these interviews, we discovered what key components designers and manufacturers would wish to see in the platform, as well as their opinions on security, licensing, compensation, and moderating. We then performed website evaluations on multiple popular open source companies to determine the different types of security measures and components that we could incorporate.

With the intended features and security choices determined, we created a mock-up of an initial platform design. The goal of this low-fidelity prototype was to test the functionality of the intended characteristics of the open source platform. After building the prototype, we created a secondary survey with access to an interactive prototype for users to test. We also conducted user evaluations to determine if the platform was designed well enough for new users to navigate easily. We used results of the secondary survey and user evaluation feedback to improve the prototype and guidelines.

Our data analysis revealed findings related to the interests and motivations of stakeholders, as well as their desired features for the platform. We collected data through three designer interviews, four website evaluations, various user stories, 22 stakeholder preliminary surveys, 13 user evaluations, and 12 stakeholder secondary surveys. We also sent preliminary and secondary surveys to 130 chapters throughout Eastern North America, Central America, and South America. While compiling valuable information, we also encountered limitations that hindered some of our

data collection methods. Some of the limitations included lack of responses from surveys, denial of interview requests, COVID-19 related delays, and a limited timeframe.

Our first objective was to determine interest in our proposed open source platform and the motivations of different stakeholder groups. Through the preliminary survey and interview responses, we identified trends and discrepancies to support our findings.

We observed a consensus on the general interest these users had in the open source platform we proposed. When asked about their interest in an open source platform, a majority of respondents' chapters responded positively. Our interviews with the designers from companies such as EOOS also provided promising results. They were very interested in the idea of the platform as a place to publish their designs and collaborate with others.

We then determined the stakeholders' motivations. The chapter surveys and interviews gave two primary motivations for using the platform: reduced trishaw costs and community involvement. A majority said a primary motivation behind joining a collaborative platform would be cheaper access to trishaws. They also emphasized the importance of providing trishaw rides in their community and building relationships within the trishaw community.

Many features appear on different open source platforms and have the potential to influence the longevity and user experience for an open source initiative. We made note of any that frequently appeared in our interviews, surveys, or existing open source initiatives. These features regarded stakeholder relationships, platform security, and supplemental elements that allowed for a more positive user experience. After thoroughly evaluating four successful open source web-based platforms, we created a table to note consistencies that exist on all or most of the platforms. We used these features as requirements when outlining our platform guidelines and designing the prototype. Then, in our preliminary survey, we gave Cycling Without Age chapters a list of possible interactions to incorporate into a platform and asked them to choose the ones they thought would be most useful. From data gathered from our interview with EOOS and our Arduino website evaluation, we determined community moderation is a necessary feature. The purpose is to filter out spam or irrelevant discussion, engage the community in new discussions, and help to answer any questions users may have.

Based on the features that were consistently noted in our previous methods, we created a platform prototype using Proto.io. With our completed platform prototype, we gathered more data from the users to uncover additional findings crucial to further improving the platform. We gathered feedback from both stakeholders and unaffiliated participants to determine if our prototype met expectations and was formatted intuitively.

We sent out a secondary survey to the same respondents as the preliminary survey. Attached to this survey was the prototype for chapters to navigate through and see for themselves. We wanted users to get a better idea of how the website would ideally perform and interact with key features. In this secondary survey we asked questions related to functionality of features, aesthetics, and if the users had any recommendations to make the prototype better.

One of the final steps of our methods was to conduct user evaluations of our prototype. We conducted these evaluations with people unaffiliated with our project or sponsor to understand if the layout of our prototype was intuitive. The goal was for them to use the prototype and quickly understand the purpose of the platform and where resources were located. Heat maps were used to reinforce the user evaluations and provide visual representation of the data. The data from these evaluations show that the prototype in its current state effectively displays how users can create an account and learn how to build an open source trishaw. On the other hand, the user evaluations show that our prototype in its current state, inadequately displays how the user can go about

starting their own Cycling Without Age chapter as well as getting contact information for finding part vendors.

With our data collecting and analyzing completed, we compiled the final conclusions for our project that were the most valuable for Cycling Without Age to know. Our findings and analysis showed that community building was the major motivator behind the primary stakeholders' interest in an open source platform. According to preliminary survey results, the primary focuses of chapters were being able to interact with fellow stakeholders and providing rides to the chapter's local community.

Through the website evaluations, we saw that all of the businesses we investigated had a variant of a paid product. This should be applied in the Open Source Trishaw Initiative, giving users the option to download the digital files for free (or low cost), or purchase a pre-assembled or flatpack version of the trishaw for a fee. The consistency of instructional media among our website evaluations emphasizes its necessity for successful open source, and such tools should be utilized for an open source trishaw platform to ensure its success as well. The data gathered from the website evaluations displayed which features were or were not apparent to a non-affiliated user. We concluded that the non-apparent features should be made more evident on the prototype to optimize ease of use and user experience.

Based on our findings, we investigated what areas of the project could be expanded upon to further enhance the future of the project. We recommend connecting with the stakeholders that we were unable to get in touch with to gain a better understanding of their interests regarding the platform. Determining manufacturer, designer, and part seller interest is critical before building the platform, and a positive response from most or all stakeholder groups is necessary to ensure the success of the platform.

Although our guidelines and wireframe prototype showcase several recommended interactions for the final open source platform, they are by no means exhaustive. More features will likely be needed, and what we created will need to be improved. Another big step Cycling Without Age will need to take is finding a web designer to transform the wireframe prototype and guidelines into a functional website. We recommend starting off simple when creating the platform and only incorporating the key features specified in the guidelines to make sure they function properly and are well received. Cycling Without Age should also decide how the open-source initiative will be implemented. This will be either through their current website or through an independent one.

One of the main attributes that our team believes is necessary for the longevity of this platform is some form of platform moderation. Moderators would ensure the uploaded designs would meet the safety and quality standards required by Cycling Without Age, filter, or guide community discussion, and help answer questions or concerns of users.

Finally, it is crucial for Cycling Without Age to expand their social media presence in order to gain more platform attention. By utilizing social media platforms, Cycling Without Age can both expand their organization as well as the open source initiative.

Even if all recommendations are followed, there will still be a need for additional research related to the open source platform. One possible research opportunity would be to find global trishaw designers, manufacturers, and part sellers that are interested in the platform and want to contribute. Since our results show that trishaw building from scratch is not feasible for most chapters, we recommend that Cycling Without Age and these designers focus on trishaw designs that can come in flat packs or can use standard bike parts.

Through the creation of this open source trishaw platform, it is our hope that more chapters of Cycling Without Age can obtain a trishaw and overcome the financial hurdle that may have previously deterred them from doing so. It is also our hope that chapters with unique geographical communities can collaborate with designers to create trishaw designs that are fit to their specific conditions. Ideally, local bike shops and manufacturers will also get more clients, as users in open source trishaw communities seek out their services. With more affordable and accessible trishaws, the goal of getting people with limited mobility further involved in their community is more attainable than previously possible. Ultimately, all stakeholders involved with the open source trishaw initiative will have been positively impacted.

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1 Introduction

Physical limitations prevent people from participating fully in their local community, decreasing their quality of life. These physical limitations come in many forms, including birth defects, injury, paralysis, and aging. Regardless of cultural and geographical differences, people with limited mobility experience less socialization in their community.

Cycling Without Age (CWA) is an organization that addresses this issue. Through chapters around the world, volunteers help those with limited mobility reconnect with their local community by providing rides in a trishaw, a three-wheeled, alternatively designed bike. Riders can share their life stories, adventures, and experiences with each other and the driver while they travel. While Cycling Without Age's mission continues to spread worldwide, an emerging problem is that most of the trishaws the organization uses start at 7,000 USD and are only manufactured in Denmark. Chapters in low income countries frequently cannot afford the baseline price of a trishaw and additional shipping costs.

A previous Worcester Polytechnic Institute Interactive Qualifying Project team created an open source business model and tested select chapters' abilities to resource trishaw parts. That team investigated and made conclusions on the financial feasibility of the open source initiative; however, the project still lacked a designated place for the open source initiative to grow. For our project, Cycling Without Age asked us to investigate the feasibility of a collaborative web-based platform, a key component of successful open source projects.

Our project goal was to create guidelines for a collaborative web-based platform for sharing open source designs and manufacturing steps of trishaws and alternative cycles. We first determined the intended users' motivations for joining an open source collaborative platform. Then we determined their desired user experience through surveys and interviews. We analyzed all of this feedback and applied it to our guidelines.

Our team tackled this challenge by creating guidelines for an open source web-based platform. Our guidelines addressed website components such as community, collaboration, licensing and intellectual property protection, security, and distribution. The platform will serve as a place for members to collaborate and innovate new trishaw and alternative cycle designs. Additionally, this allows designers to modify designs for local geography and cultures. As an embodiment of our guidelines, we created a platform prototype.

In this report, we discussed important information for developing guidelines for an ideal open source platform. We first discussed the background information that was pertinent to our project and helped enhance our project execution. This report also included the methods used to collect data, our analysis and findings, our final deliverables, conclusions, and recommendations.

2 Background

In this chapter, we review the social issues that come with the isolation and lack of mobility faced by the elderly and discuss Cycling Without Age's efforts to resolve this multifaceted issue. More specifically, we delve into their desire to create an open source trishaw initiative. Next, we examine the best practices related to open source initiatives, including licensing and security measures. We conclude by discussing the open source and financial research that has been completed by a previous Interactive Qualifying Project team for CWA, and how their final deliverable relates to this project.

2.1 The Effects of Decreased Mobility on the Elderly

As people get older some experience a lack of socialization, sometimes due to deteriorating mobility. Troublingly, an unfulfilled desire for meaningful relationships leads to depression and issues dealing with grief in the elderly (Paque, 2018). There are many causes of this debilitating mental illness, but a strong support system is critical to improving it. To fill this gap, many go to nursing homes when they no longer feel they can take care of themselves. However, most who choose this route do not feel their social needs are met by nursing homes and need additional socialization beyond them (Russell et al, 1997).

Since living in a nursing home does not ease the social isolation, finding more activities for the elderly to participate in and get them outside their homes is one way to ameliorate their quality of life. Unfortunately, limited mobility and lack of accessibility to the community results in seniors entering homes earlier and a continued feedback loop of decreased socialization and community involvement for the elderly (Paque, 2018). By implementing more accessible methods of transportation, the elderly can have another option for overcoming the barrier against their social needs.

One case study, taking place in a Canadian long-term care home, supports the fact that increased mobility improves quality of life, especially in the elderly. For the study, two groups formed, a biking group and a non-biking group. The biking group recruited 24 residents, and volunteers biked these residents around their area twice a week for 12 weeks. The non-biking group consisted of 16 people and, instead of biking, went for walks or wheelchair rides for the same period of time. The study collected data based on happiness levels and quality of life. After collecting and analyzing this data, it showed the biking group had a higher quality of life at the end of the 12 weeks, supporting the effectiveness of the biking program (Cotnam & Zecevic, 2019).

2.2 Cycling Without Age's Open Source Initiative

Cycling Without Age, a nonprofit organization based in Denmark, attempts to resolve this issue of limited socialization and mobility by popularizing trishaws. As shown in Figure 1, trishaws have a frame similar to that of a typical bicycle, but have a carriage in the front for people to sit in.

Figure 1 - Example of a Trishaw (Trishaws for Cycling Without Age, 2020)

Founded by Ole Kassow in 2012, Cycling Without Age volunteers provide those with limited mobility the chance to interact with their community via trishaw rides. (Legacy Lodge, 2018). This movement started in Copenhagen, Denmark and has now expanded across the globe to more than 2,200 chapters in 50 countries (Mcniel and Westphal, 2019). For more information on Cycling Without Age, see Appendix A.

While trishaws help resolve the issue of local socialization and mobility, many chapters cannot afford them. The most affordable and widely available model costs 7,000 USD, a financial burden for most chapters. In addition, international shipping and repair costs add significant costs for chapters located far from the European manufacturers (Christiania Bikes, 2020). Unfortunately, this price tag is infeasible for many chapters and prevents the growth of Cycling Without Age.

Cycling Without Age recognizes these barriers and sponsored our team to help overcome them through a set of recommendations for a potential open source platform. We believe that the continuation of an already established Open Source Trishaw Initiative would be the most effective solution for this issue. This initiative aims to create connections between trishaw designers, manufacturers, and chapters. Using these connections, local manufacturing of trishaws becomes possible, which would significantly lower the cost of trishaws for chapters far from Europe. Our contributions to this initiative may ultimately lead to greater accessibility to trishaws and the further spread of Cycling Without Age.

2.3 The Possibilities of Open Source

Today, the idea of "open source" is well known, particularly in the world of software. According to the Danish Board of Technology (2005), open source developers give "free access…to the source code…through a user license that guarantees the right to study, apply, and develop the code." Open source follows the principles of collaboration, openness, and knowledge sharing to accelerate the innovation of the world's technologies. It also resists the competitive and protective practices of many companies that rule today's marketplaces.

In 2005, a movement known as "The Maker Movement" began spreading open source initiatives outside the domain of software and into the world of hardware (Davis, 2018). This thriving movement supports the goal of collaboration and the advancement of learning, sharing, and innovation. Open source hardware is sometimes called 'open hardware' or 'open manufacturing,' and follows the same principles as open source software, but in different ways. The Open Source Hardware Association defines open source hardware as the following:

> Open source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design. The hardware's source, the design from which it is made, is available in the preferred format for making modifications to it. Ideally, open source hardware uses readily-available components and materials, standard processes, open infrastructure, unrestricted content, and open-source design tools to maximize the ability of individuals to make and use hardware. Open source hardware gives people the freedom to control their technology while sharing knowledge and encouraging commerce through the open exchange of designs (Open Source Hardware Association, 2010).

Hardware designers give free access to the object's blueprints or models, which allows others to collaborate and improve upon the original design. The localization of supply and demand chains is a significant benefit of open source hardware. Making things with one's own tools, parts, and labor means that more people can afford and use open source hardware, as opposed to more expensive mass-manufactured products.

Cycling Without Age plans to use the Open Source Trishaw Initiative to provide their chapters with more options of purchasing and building trishaws to better suit their resource availability and financial standings. People around the world will be able to build their own trishaws from blueprints, increasing trishaw availability and accessibility and encouraging further growth of the CWA movement.

2.3.1 Open Source Benefits

Open source creations ignore borders. Anyone with an Internet-enabled device can see or edit products shared on the Internet. Once submitted, users can download the design and either build it themselves or go to a local manufacturer or makerspace for more experienced assistance (see Appendix B).

Open source hardware is customizable and adaptable. Since the user builds the product, they have full rein to alter the final creation (McNamara, 2007). For a global movement like The Open Source Trishaw Initiative, this freedom of choice is a major advantage for all participants. Different parts of the world have different landscapes and may require more or less wheels, power, or support—all things that can be part of an open source design. Designers may share the modifications with the rest of the world, providing an assortment of iterations instead of just one, default design. This constant collaboration and innovation also results in consistent improvement of open source hardware designs, as multiple case studies support (Moritz et al., 2016).

Open source hardware poses little financial risk to organizations implementing it. Leaving production to the user gives the freedom of self-manufacturing and saves the original designers the cost of manufacturing and shipping. One example of a company based on open source hardware is Opendesk, a furniture business that contracts designers to upload furniture schematics to their website. They allow furniture designers to reach beyond their local communities and modify their designs for the specific needs of each consumer. When a customer wants to purchase a certain design, Opendesk connects them to local makers who produce and sell the piece directly to the customer. Once the customer pays Opendesk and receives the product from a local maker, 8% of the profits go to the designer and 12% to Opendesk, leaving the manufacturer with 80% of the profits (Opendesk, 2020). While Opendesk is taking minimal financial risks with open source

products, they still obtain a profit off of each piece of furniture sold—all while providing quality hardware to the customer. This strategy also lets Opendesk and similar companies expand to new, global markets without creating physical presences throughout the world (McNamara, 2007). The designs that open source organizations distribute are accessible anywhere in the world and not limited by the location of the organization's headquarters.

While there are many apparent benefits to open source hardware, there are some major downfalls that need consideration. Most importantly, there are legal risks and challenges that could result in designs being misused. Without the right licensing, designers could have their work stolen or abused. Open source hardware also brings with it serious liability, warranty, and safety issues for all users involved. Additionally, in order to utilize the full potential of open source hardware, organizations must be "willing to play on eye level with community users" (Moritz et al., 2016). Companies that put major restrictions on the creative processes of open source lose out on the benefits of constant improvement, customization, and adaptability. If organizations like Cycling Without Age are unable to connect local and global communities to let them iterate upon, improve, adapt, and share their open source trishaw designs, then they risk losing a majority of the benefits that come with open source hardware.

2.3.2 Licensing and Intellectual Property Protection

When it comes to collaborative design, multiple iterations on an original design are necessary to serve specific needs. One concern that arises with an open source initiative is the protection of the designers' intellectual property and the innovations of the community. Companies address this concern through basic security measures such as requiring a license, contract of intent, organization affiliation, etc.. Another method of protecting intellectual property is to utilize licensing specific to open source hardware.

One popular license in the open source community is the GNU General Public License Version 2. The purpose of this license is "to guarantee your freedom to share and change all versions of a program--to make sure it remains free media for all its users" (Free Software Foundation, 1991). When submitting changes to software or hardware under the terms of this license, nobody can take the original design and claim it as their own. This license does not restrict the ability to profit off of open source; rather, it enforces a freedom to modify. Another aspect of this license is that it is a "Copyleft", meaning if an iterator redistributes a design under this license, they must use the same license in their distribution. The TAPR Open Source Hardware license is a fairly new license that is analogous to the GNU General Public License but also takes into consideration potential patent issues. It states that all users and designers waive their right to pursue legal action regarding patents against all other users and designers.

Creating custom licensing agreements that guarantee creators forfeit all ownership of their content is another common practice in the open source community. Companies such as FarmBot use this practice (FarmBot, 2020). The danger to this practice is that third parties can flood a market with someone else's innovation and force the original creator out of business. The trade-off is that it promotes innovation and increases user interest.

On the other hand, licenses that heavily restrict what a user can do are controversial in the open source community, and many argue that they nullify the open source model. In the case of the Creative Commons Attribution Non-Commercial license, users may copy, redistribute, remix, or build upon the original product, either software or hardware. They must, however, give appropriate credit to the creator and indicate what they changed, and they cannot use the original design for commercial purposes. This license contradicts the official definition of open source

hardware provided by the Open Source Hardware Association, stating “Open source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design” (Open Source Hardware Association, 2010). Although this may be the case, companies such as Opendesk continue to distribute their products with the Creative Commons Attribution Non-Commercial license and yet advertise as open source.

Organizations aspiring for unrestricted open source often use the Creative Commons Attribution Share-Alike License. This option gives the same rights and freedoms as the Creative Commons Attribution Non-Commercial license, but also lets users use the product for commercial purposes. One company utilizing this concept is Arduino. If clones of the Arduino are sold or distributed, the seller must use the same licensing terms as the original and state that it is no longer the original product. Table 1 identifies six commonly utilized open source licenses from opposite ends of the open source “spectrum” (highly restrictive to minimally restrictive) and discusses their strengths and weaknesses, along with a brief description of what the license accomplishes.

Table 1 – Open Source Hardware Licenses

License	Brief Description	Strengths	Weaknesses
GNU General Public License Version 2	"the GNU General Public License Version 2 is intended to guarantee your freedom to share and change all versions of a program--to make sure it remains as free media for all its users"	-All derivatives of the work must be distributed under the same circumstances of the original work. -For example, if the original work is open source, every derivative must remain open source and unrestricted	-Does not prohibit free redistribution
Attribution-ShareAlike 4.0 International	Users must give credit to designer, indicate changes to source design, not suggest an endorsement, and redistribute their iteration under the same license as the original	-One of the most used and understood licenses in Open Source Hardware community -Ensures future iterations use the same license terms and remain open while giving credit to original designer	-Does not prevent the reselling of the original design by someone other than the original designer
Creative Commons Attribution Non-Commercial license	"a Creative Commons license which a copyright holder can apply to their media to give public permission for anyone to reuse that media only for noncommercial activities."	-Very restrictive terms but also protective of intellectual property	-Does not prohibit free redistribution -Product no longer truly fits definition of open source provided by the Open Source Hardware Association
CC0 1.0 Universal (CC0 1.0) Public Domain Dedication	"You can copy, modify, distribute and perform the work, even for commercial purposes, all without asking permission."	-Ensures all iterations remain as open and free as possible	-Only protective of digital media regarding hardware such as CAD, Schematics, and other documentation
The TAPR Open Hardware License	Analogous to the GNU General Public License but for tangible products. Users also waives right to pursue legal action regarding patents against designer or other users	-Protects against patent legal action being taken against anyone using product	-Does not prevent the reselling of the original design by someone other than the original designer
SolderPad Hardware License v2.1	A modified version of the Apache License Version 2.0 to incorporate hardware instead of software. Users have the right to use, reproduce, modify, redistribute, and sell source objects with appropriate attribution. Iterators can use other licenses but must include copy of original license (SolderPad, 2012).	-Permissive license that allows iterators to use other licenses	-Does not prevent the reselling of the original design by someone other than the original designer

2.4 The Open Source Trishaw Initiative: Past Work

This project is not the first to investigate the implementation of The Open Source Trishaw Initiative by Cycling Without Age. A team of Worcester Polytechnic Institute students oversaw the first part of the Open Source Trishaw Initiative project in Spring of 2020. They researched potential stakeholders, manufacturers, and open source representatives, and provided Cycling Without Age with an open source business model (Chea et al., 2020).

The group compiled a matrix of open source options and rated relevant factors among different sourcing processes. It showed the advantages and disadvantages of the varying levels of "openness." The team created a business model framework, which consisted of multiple open source options. The least open is the purchase of a pre-built trishaw. The next version is a trishaw kit that requires on-site assembly. The third and most open option requires buying individual parts needed and locally sourcing or building the rest. If the customer can resource every part themselves, they would opt for the most open option, and would only purchase the trishaw design.

To test this business model, the team chose two test locations, one in Panama and one in Peru. However, barriers including lack of funding and the global shutdown due to COVID-19 prevented either chapter from purchasing or receiving any trishaws or components. Additionally, COVID-19 social distancing protocols discouraged CWA trishaw rides, significantly decreasing motivation among chapters. Unfortunately, there was little progress made at the test locations since May 2020. The previous team's project gave us helpful insight, and we used parts of their interview results in our data and analysis.

3 Methodology

Based on our background research, a vital step in properly orchestrating an open source initiative is to provide the trishaw community with a platform to collaborate and communicate their ideas simply and efficiently. This chapter delves into the objectives and research conducted to achieve our goals. The following objectives describe the steps we took in order to create guidelines and a prototype for a collaborative community platform for Cycling Without Age:

1. Determine optimal user experience
2. Design a prototype and develop platform guidelines

3.1 Determine Optimal User Experience

Our first step was to identify the most significant features that the main stakeholders wanted in an open source platform. We did this through interviews, website evaluations, a stakeholder map, user stories, and surveys. In the interviews, we discovered what key components designers and manufacturers wished to see in the platform, as well as their opinions on security, licensing, compensation, and moderating. We performed website evaluations on multiple popular open source companies to determine the different types of security measures and components we could incorporate. Through our stakeholder map and user stories, we identified possible motivations of each major stakeholder and confirmed our assumptions through interviews and surveys.

3.1.1 Manufacturer and Designer Interviews

The first stakeholders we evaluated were designers and manufacturers. We interviewed several of these stakeholders to learn their expectations. We wanted to ensure our platform was a suitable place for these designers and manufacturers to upload trishaw designs, as well as connect them to chapters and trishaw enthusiasts.

The first designer we interviewed was a representative from EOOS, a social design enterprise. EOOS' mission is to use design to solve challenges faced by society, with a focus on sustainable and social design. The second designer was Dalavuelta, a project team from a university in Uruguay that aims to innovate the design and development of low-cost technical aids for people with disabilities.

In these interviews, we asked questions focused on aspects of the proposed platform as well as security and licensing (see Appendix D). The platform questions pertained to concepts such as monetary compensation, possibilities for design collaborations, platform moderation, and community involvement. The security and licensing questions allowed us to gauge designer and manufacturer expectations on specific licenses and understand how protected they wanted their intellectual property. From these questions, we gained a better understanding of the motivations and needs these designers and manufacturers expected from an open source platform.

The previous Interactive Qualifying Project team conducted an interview with Lester Bikes, a bike manufacturer based in Argentina. We examined a recording of this interview, and collected information pertaining to licensing and security, platform features, and their overall reaction to the idea of the platform.

We then compiled and compared the information from each interview. The responses included topics on licensing, moderation, and other website functions. We identified commonalities in the interview data and created a list of significant elements that we could incorporate into the platform.

3.1.2 Website Evaluations

The goal of this method was to find which features of an open source platform enable its longevity and improve the overall user experience. We used the number of times a website feature appeared as a measure of desirability and implemented the most desirable of these features into our recommendations and prototype.

We selected a pool of well-known open source platforms to evaluate: Arduino, FarmBot, Opendesk, and Raspberry Pi. We inspected each platform and took note of prominent aspects, including security features, content purchasing/downloading processes, and community interactions such as forums. We compiled this information into a table to indicate which common elements were present in each website.

3.1.3 Stakeholder Map & User Stories

Before sending out surveys to intended users, we determined who they were and what roles they would play in a collaborative platform. We created a stakeholder map (Figure 2) as a tool to understand the connections of the different types of users and help find which of these groups were the best to interview and survey.

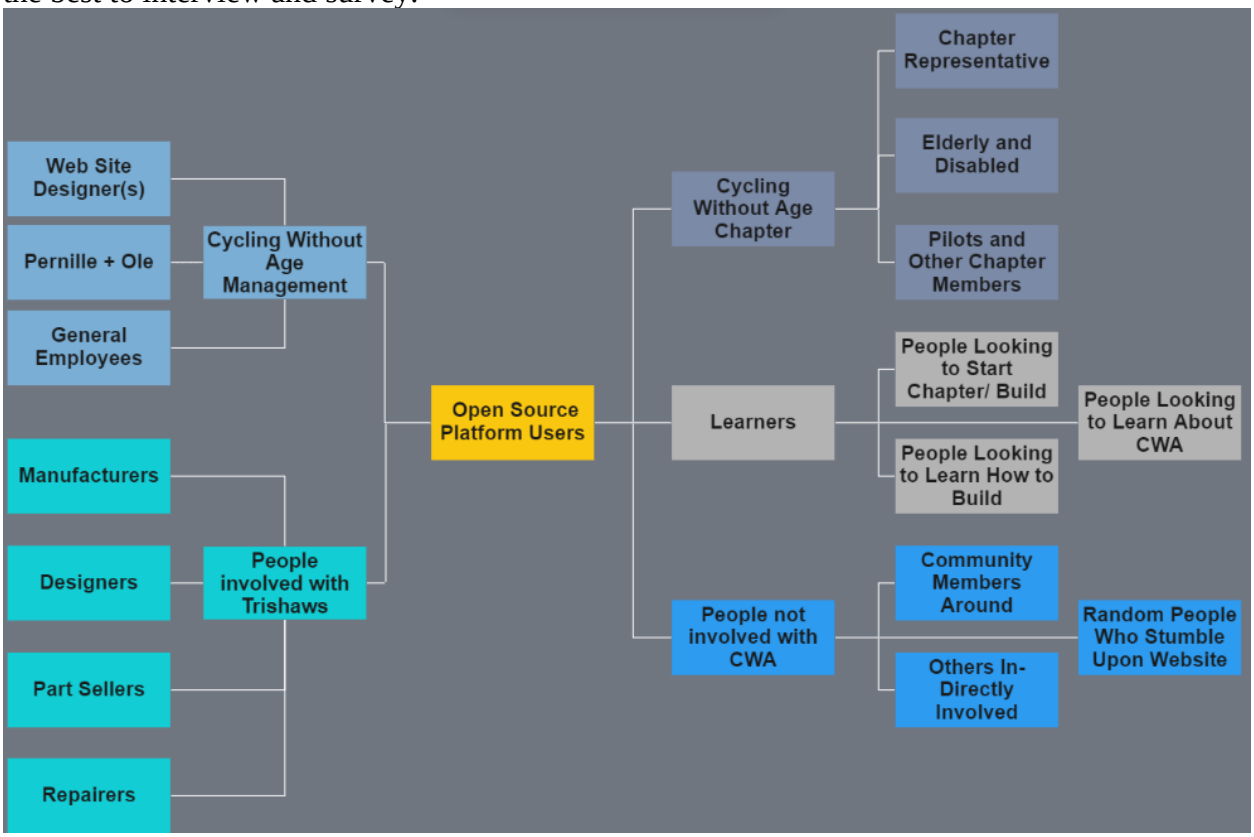

Figure 2 - Stakeholder/User Map

Using the stakeholder map, we wrote user stories, which are descriptions of users' desires told from their perspective (see Appendix C). These were our assumptions of what users would want and expect from a platform of this kind before we got their actual feedback (Cohn, 2020). The stakeholder map and user stories helped us think through the more niche user groups and their motives for being a part of the platform.

3.1.4 Find User Expectations and Motivations (Preliminary Survey)

After identifying the most important stakeholders for our project, we created a preliminary survey using Qualtrics[1] to identify their desires for a collaborative platform and to confirm their motivations. We asked the CWA chapters how many trishaws they had and what factors prevented them from acquiring one, to allow us to get a better understanding of the limitations chapters were facing. We also found out how familiar chapters were with open source platforms and presented a list of features that could be available on the platform. The feedback we got from the surveys allowed us to confirm which interactions users wanted and what their possible concerns were. Using this data, we prioritized specific components while keeping the user perspective in mind. This survey served as a preliminary survey, and its questions can be found in Appendix E.

3.2 Design a Prototype

With the intended features and security choices determined by our methods in 3.1, we created a mock-up of an initial platform design The goal of this low-fidelity prototype was to test the functionality of the intended characteristics of the open source platform. After building the prototype, we created a secondary survey containing screenshots and a link to an interactive version prototype for users to test. We also conducted user evaluations to determine if the platform was well-designed and easily navigable by non-CWA affiliated users. The results of the secondary survey and user evaluation feedback were then used to improve the prototype and guidelines.

3.2.1 Wireframe Prototype

Using information gathered from 3.1, we created a prototype to gauge user feedback on our initial design and its features. There are two primary types of prototypes for user interface design: low fidelity and high fidelity. Figure 3 shows the most significant differences.

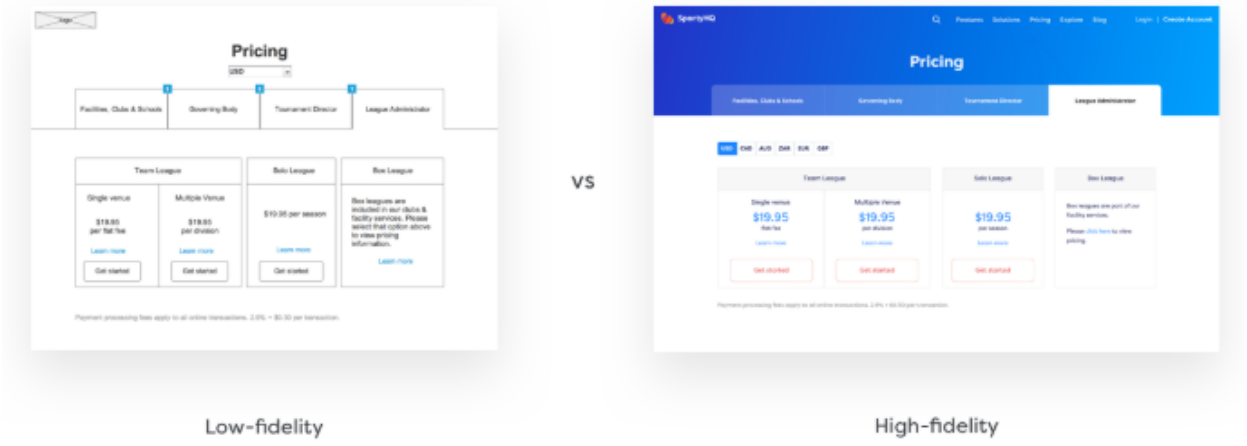

Figure 3 - Comparison between a low and high-fidelity prototype (Pierzchała, 2018)

Creating high fidelity prototypes is time-consuming and exhaustive, but they are useful for closely replicating the final user experience (Rettig, 1994). Our team instead created a low fidelity

[1] An online service partnered with Worcester Polytechnic Institute that allows users to generate surveys and gather feedback from anywhere in the world

prototype to focus on layout, design, and features rather than the end product. This prototyping method is quicker to develop, easy to change, and allows rapid user feedback. These simple solutions allow for multiple incremental iterations in a small time period (Ko, 2013).

For our prototype, we used the web-tool Proto.io. This tool allowed us to quickly create a visually pleasing prototype that was eventually a final deliverable. It supports most of the features we wanted to implement and displayed the functionality that a final website would have (see Appendix H).

3.2.2 Confirm Stakeholder Expectations (Secondary Survey)

We used a secondary survey on Qualtrics to determine if our prototype met the initial user expectations acquired from the preliminary survey (see 3.1.4) and interviews. This survey also allowed users who were unfamiliar with open source to get a better idea of the platform. It was sent to the same chapters that were sent the preliminary survey. This survey and its questions can be found in Appendix F.

The survey included a link to the prototype discussed in section 3.2.1. Based on this content, we asked a series of questions to get a better understanding of how users expect to use the system, what they like about the current components or layout, and what they think is missing or needs improvement.

3.2.3 Non-Affiliated User Evaluations

Using the prototype created in 3.2.1, we gathered feedback from non-CWA affiliated users through user evaluations. For these evaluations, we chose unaffiliated people to participate in a series of tests to determine whether or not the platform was suitable for someone unfamiliar with Cycling Without Age. Ideally, these users had little to no prerequisite knowledge of prominent open source platforms. The goal was to see how a normal user would interact with the system, where there was major confusion, and any possible wrong paths one could take (Rettig, 1994).

In the user evaluation, an observer provided a subject with the interactive prototype and asked them to complete various tasks within the system. These tasks reflected common interactions we expected users to do, such as uploading/downloading a trishaw design, commenting on the community forum, and contacting local builders and designers. The evaluations were either conducted in-person with a note taker or online using a Qualtrics survey. The online Qualtrics survey asked the same questions as the in-person evaluation and, instead of an observer, had the participant click on an image of the prototype to show how they would navigate the site. From the data of where all participants clicked the image, we generated a heat map (see Figure 4). If the platform was designed intuitively, all tasks would be completed with minimal errors. This outcome was how we defined a successful test. We planned to use the data from these tests to improve the platform prototype and guidelines.

Figure 4 - Heatmap Example (Churm, 2020)

4 Data Analysis and Findings

Our data analysis revealed findings related to the interests and motivations of stakeholders and their desired features for the platform. We collected data through three designer interviews, four website evaluations, various user stories, 22 stakeholder preliminary surveys, 13 user evaluations, and 12 stakeholder secondary surveys. The preliminary and secondary surveys were sent to 130 chapters throughout Eastern North America (113) and Latin America (17). Respondents did not have to answer every question and could stop at any time. While compiling valuable information, we also encountered limitations that hindered some of our data collection methods. Some of the limitations included lack of responses from surveys, denial of interview requests, COVID-19 related delays, and a limited timeframe.

4.1 Interest and Motivations for an Open Source Platform

Our first objective was to determine interest in our proposed open source platform and the motivations of different stakeholder groups. Through the preliminary survey and interview responses, we identified trends and discrepancies to support our findings.

4.1.1 Stakeholders' Interests

We observed a consensus on the general interest these users had in the open source platform we proposed. When asked about their interest in an open source platform, 18 out of 22 chapters responded positively, while the others abstained from the question.

This positive response exhibited that chapter representatives believed there was a need for a collaborative platform and that they would use it if available. We also inferred that, due to the great interest in the platform, there was a higher chance the collaborative aspect of the platform would perform well. If the majority of users are interested, they will be more likely to regularly visit and participate on the platform. This data supported our claim that an open source platform would be a vital part of a solution to trishaw accessibility in the eyes of Cycling Without Age chapters.

Our interviews with the designers from EOOS and Dalavuelta also provided promising results. They were very interested in the idea of the platform as a place to publish their designs and collaborate with others. The ability to collaborate and edit other creators' designs piqued their interest and became the main focus of our discussion. This finding demonstrated that the designers were responsive to the idea of the platform and were likely to be significantly involved in its creation.

4.1.2 Stakeholders' Motivations

The chapter surveys and interviews gave two primary motivations for using the platform: reduced trishaw costs and community involvement. Of the 22 chapter responses, eight chapters said a major motivation behind joining a collaborative platform was cheaper access to trishaws. Fourteen chapters emphasized the importance of providing trishaw rides in their community. Of these 14, three chapters also expressed the importance of building relationships within the trishaw community.

In our interview with EOOS designers, they expressed that their main priority was social impact as opposed to financial gains. As a social design enterprise, they feel that being a part of the open source and trishaw community is the priority. If more designers and manufacturers share similar values to EOOS, the price of trishaws and their designs would drop.

The interview and chapter results indicated that the community-building aspect of the platform was a major motivation behind designer and chapter involvement, with finances being more of a barrier of accessibility for chapters. The strong interest in community building is reflected in 4.2.3, where desired features confirm the chapters enthusiasm for a strong trishaw community.

4.1.3 Users' Familiarity with Similar Platforms

After receiving our survey results, it is clear that chapter representatives have little to no experience with other open source platforms. On the survey, we asked a question to gauge chapters' familiarity with platforms based on open source or community driven development. We included a list of web-based platforms and asked chapters to select as many as they knew about. This list of platforms included Arduino, Raspberry Pi, GitHub, Reddit, StackOverflow, Opendesk and FarmBot. Out of our 22 respondents, only three made at least one selection.

Using this data, we saw that there is very little knowledge about open source platforms in the regions we included in our surveys. From these findings, we gathered that we needed explicit detail in our guidelines to avoid confusion. We used these limitations to take a step back and ensure we made a straightforward platform that users with no previous knowledge could easily understand and use effectively.

Alternatively, in our interviews with designers, we found most of them had a general knowledge of the open source community, existing open source platforms, and features that are necessary to an active and successful open source community. While the designers may not require a simplified and intuitive interface, we wanted to make sure that our platform guidelines and prototype are simple and provide the necessary educational tools necessary for all demographics.

4.2 Suitable Features for an Open Source Platform

Many features appear on different open source platforms and have the potential to influence the longevity and feedback for an open source initiative. We made note of any that frequently appeared in our interviews, surveys, or existing open source initiatives. These features regarded stakeholder relationships, platform security, and supplemental elements that allowed for a more positive user experience.

4.2.1 Community Moderation

From data gathered from our interview with EOOS and our Arduino website evaluation, community moderation is a necessary feature. The purpose is to filter out spam or irrelevant discussion, engage the community in new discussions, and to help answer any questions users may have.

The representatives we interviewed from EOOS emphasized that not only is having community moderation vital for a successful and well-received open source platform, but also such moderation would make them, as designers, more comfortable collaborating on the platform. They stated that they saw open source collaborations fail because of a lack of moderation.

Through our website evaluation of Arduino, we investigated the history of their open community previously known as "Arduino Playground." It was a completely user-driven wiki dedicated to all things Arduino. This platform ran unmoderated for about four years before shutting down in December of 2018. An Arduino representative stated the following reasons for the unexpected shutdown: "We had/have a lot of spammers writing there,…there [is] either wrong information in some articles or pages sponsoring clones/low quality products, articles not related

to Arduino,...[and] some malicious users also used it to claim they are affiliated in some way with the official Arduino company just because they wrote an article there" (Cipriani, 2018). Without ways to moderate user input, these problems ran rampant throughout Playground's lifetime. The platform was eventually replaced with the "Arduino Project Hub" and their website's forums, both of which are thoroughly moderated by employees and community leaders. The shutdown of Arduino Playground shows why it is discouraged to have an unmoderated user-driven platform, further supporting the EOOS representatives' claims.

Ignoring the idea of community moderation can lead to serious consequences and problems, so we needed to ensure that Cycling Without Age understood the urgency of this issue and handled it in a suitable way. Putting all this information together, we found it extremely important to include some kind of moderation in our platform guidelines.

4.2.2 Prominent Features on Existing Open Source Platforms

After thoroughly evaluating four successful open source web-based platforms, we created a table to note consistencies that exist on all or most of the platforms (Table 2). We used these features as requirements when outlining our platform guidelines and designing the prototype.

Table 2 - Comparing Open Source Platform Features

Platform	Collaborative Forum	Required account?	Free, Paid, Both?	Forum Moderators?	Instructional Media	Content Submissions	License Details
Arduino	Yes	No	Both	Yes	Yes	Yes (project hub; account required)	Creative Commons Attribution Share-Alike License
FarmBot	No; Blog	No	Both	n/a	Yes	No	CC0 1.0 Universal (No Restrictions)
Opendesk	No; Blog	Yes	Paid	n/a	Limited	Needs to create account through request	(Often but not limited to) Creative Commons Attribution Noncommercial
Raspberry Pi	Yes	No	Paid	Yes	Yes	Informally through forums	None; Trademarks and must include "powered by raspberry pi"

Paid Product. All of the open source businesses we investigated had a variant of a paid product. This product could be hardware, supplemental software, or digital media required to get hardware (bill of materials, digital schematics, etc.). While some services such as FarmBot offer free CAD[2] and CAM[3] files, they still offer a paid alternative for users who want a pre-assembled or assembly-required hardware kit. In an interview the previous Cycling Without Age Interactive Qualifying Project team conducted with a FarmBot representative, they explained that FarmBot's primary source of revenue was through selling the kits for their hardware. This shows that even

[2] Computer-Aided Design

[3] Computer Aided Manufacturing

when open source hardware has a free "do it yourself" option, many users will still purchase the product pre-built.

Instructional Media. A prominent feature present on all four evaluated open source platforms was a form of instructional media. Instructional media came in the form of video tutorials, easy-to-read documentation, blog posts, and interactive educational software. The media primarily regarded product setup and usage, but platforms such as Arduino and Raspberry Pi also included educational tools to train users in how to operate the product and use it in different applications.

Account Creation. Only one of the evaluated websites required the user to create an account to obtain a product. However, platforms that had a way to submit content, such as designs, forum posts, and so on, all required the submitter to have an account. Therefore, restrictions on who acquires content from the website should be less than restrictions on who distributes content on the website.

Intellectual Property Protection. All platforms evaluated had some form of intellectual property protection. This protection came in two forms: licensing, and trademarking. For the three platforms that chose to use licensing as a form of I.P.[4] protection, they all utilized one of the many variations of the creative commons license. Opendesk stated that although it is up to the discretion of the designers to choose how they protect their designs, they often chose Creative Commons Attribution-Noncommercial 3.0. Raspberry Pi chose to not use licensing at all in the spirit of open source, but instead use trademarks on their brand, so that if their product is cloned or used in another project, they must be given appropriate credit.

4.2.3 Stakeholders' Most Desired Features

Within the preliminary survey, we gave Cycling Without Age chapters a list of possible interactions to incorporate into a platform and asked them to choose the ones they thought would be most useful. Sixteen of the 22 chapters answered this question. We compiled their responses into the graph shown in Figure 5, through which distinct trends emerged.

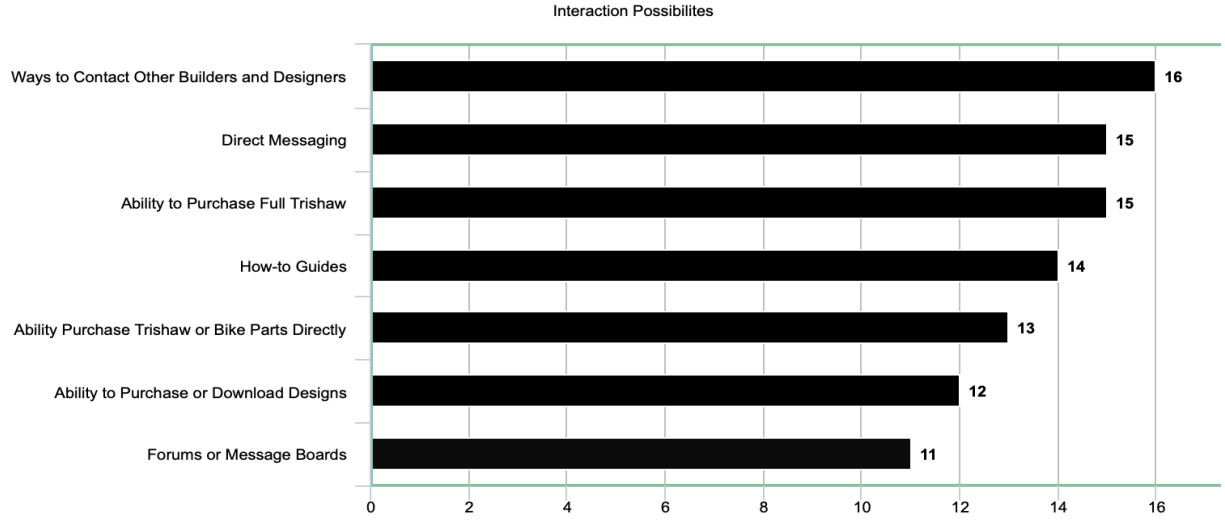

Figure 5 - Interaction Possibilities Chart

[4] Intellectual Property

The ability to contact local builders and designers was the most popular interaction, which showed that chapters were interested in having their trishaws made locally by getting in contact with regional builders and designers.

Direct messaging other stakeholders and having the ability to purchase a full trishaw were tied as the second most requested interaction with 15 out of 22 responses. The direct messaging result was consistent with the user motivations discussed previously as it would help build a strong and sustainable community by promoting stakeholder collaboration and teamwork. However, being able to purchase a trishaw directly was an interesting outcome as it contradicted the previous finding and suggested that the chapters did not have a definitive preference for local trishaw manufacturing.

Looking further at Figure 5, how-to guides were also in high demand. This result was consistent with information we had gathered from the EOOS designer, who had also advised the inclusion of how-to guides and tutorials for designs. By incorporating these tools, it would make the user experience much smoother and lead to less frustration when building the trishaws.

Lastly, the ability to purchase trishaw bike parts, download designs, and access forums and message boards were the three interactions with the least responses. The trend that came about from these preliminary survey results showed chapters held more interest in interactions that would allow them to connect with local builders and designers to have trishaws made instead of personally building the trishaws themselves. These findings were reflective of the user stories (see Appendix C), and by comparing them with the website evaluations, were essential in determining the features and interactions that were included in the platform.

4.3 Prototype Feedback

With our completed platform prototype, we gathered more data from the users to uncover additional findings crucial to further improving the platform. We gathered feedback from both stakeholders and unaffiliated participants to determine if our prototype met expectations and had intuitive formatting.

4.3.1 Secondary Survey

After creating the prototype, we sent out a secondary survey to the same 130 chapters as the preliminary survey. Attached to this survey was the prototype for chapters to navigate through and see for themselves. We wanted users to get a better idea of how the website would ideally perform and interact with key features. In this secondary survey, we asked questions related to functionality of features, aesthetics, and any user recommendations to make the prototype better. We collected 12 total responses from users.

The main finding we gained from this secondary survey was that, after using the prototype, six out of 12 chapters felt satisfied with the end result, while the other six respondents abstained from answering the question. These users felt like the prototype had met their initial expectations and that we fulfilled all of the needs they expressed in the preliminary survey. Corroborating this result, none of the users felt like there were any unnecessary features or sections. Five respondents said that the prototype was well-organized and easy to navigate without any help. This data showed us that our prototype met one of our largest stakeholder expectations, which we infer will lead to a greater chance of success with the platform. It also showed that each feature we included in the prototype was significant in the stakeholders' eyes, and that adding or removing major features was unnecessary. Finally, these results exhibited that the aesthetics of the prototype and general organization were well received. Overall, these findings demonstrated that the prototype was

fulfilling its purpose and no major changes needed to be made to accommodate the stakeholders' needs.

Lastly, we were able to compile the most popular features according to the seven users that responded (see Figure 6). From these findings, we believed that the most popular features included how-to pages, design pages, and the ability to get in contact with local builders or designers.

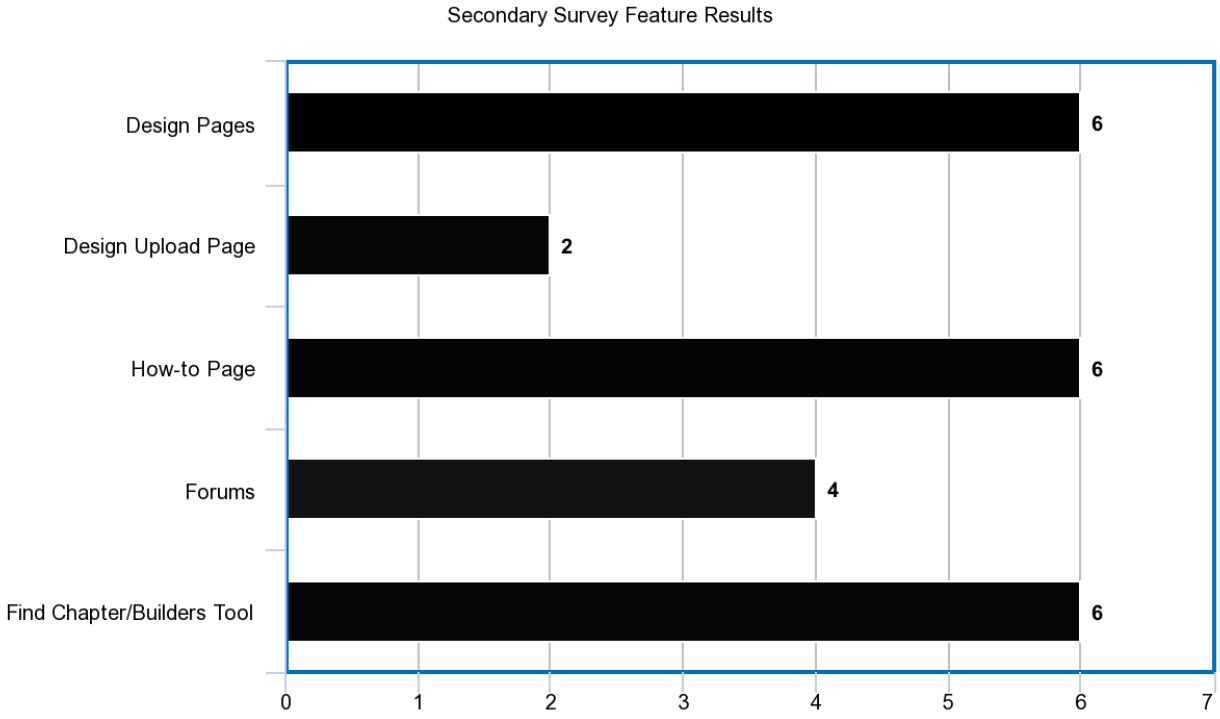

Figure 6 - Secondary Survey Feature Results

4.3.2 Non-Affiliated User Evaluations

One of the final steps of our methods was to conduct user evaluations of our prototype. We conducted these evaluations with people unaffiliated with our project or sponsor to understand if the layout of our prototype was intuitive. The goal was for them to use the prototype and quickly understand the purpose of the platform and where resources were located. We ultimately had ten people do an online Qualtrics evaluation, and three people do an additional in person user evaluation, for a total of 13 unaffiliated participants. We used heat maps to reinforce the user evaluations and to provide a visual representation of data. These can be found with their respective tasks in Appendix G.

Our first task in the evaluations was to discover if the user could easily determine where to go to create an account on the platform. The heat map results show how all but one user correctly inferred where they should navigate to complete this task. One user seemed to click around an unrelated tab, but since this data is an outlier and likely a misclick, it was disregarded.

The goal of the second task in the evaluations was not to determine if our prototype was intuitive, but rather what an unaffiliated user's intuition expected from our prototype. In short, the task requested that the participant click where they would expect to find resources regarding licensing options from the upload a design page. At this point, we did not have those resources present on the prototype, so the data gathered from this heat map showed us where we should put

these resources so that users can easily find them. The majority of participants assumed that resources regarding licenses could be found in either the forums tab or the FAQ tab. A minority of participants guessed that these licenses could be found in the "upload design" page.

Next, participants were asked to click where they would expect to find the resources necessary for starting a Cycling Without Age chapter. The data from this heat map shows that the majority of users would expect to find this resource in one of its correct locations. The heat map also shows that there was some confusion because there were four erroneous clicks that all made different assumptions as to where they would find these resources.

The final task for the user evaluations asked the participants to locate where on the prototype they would expect to find contact information for trishaw part vendors. Similar to the data gathered from the previous task, the final task resulted in a clear majority of participants expecting to find this information in its actual location. There were again erroneous results, demonstrating that there was still some confusion among unaffiliated users.

We concluded these user evaluations by gauging the overall participant impressions of the prototype. Most participants strongly agreed that the prototype was aesthetically pleasing and that they naturally understood the contents of the platform. The majority of participants also somewhat agreed that the prototype was easy to navigate. These responses can also be found in Appendix G.

4.4 Data Limitations

While we believed we gathered sufficient data to draw our conclusions and recommendations for the final prototype and guidelines, there were limitations that arose while we were conducting our methods and analysis. One primary limitation was the lack of responses to both survey and interview requests. We reached out to a multitude of companies based on open source ideals to interview them and learn more about what features they felt led to the success of their platforms. Unfortunately, everyone declined to be interviewed, leaving us to rely upon publicly available information on their platforms and from previously conducted interviews. We also had difficulties getting responses from CWA chapters for both our preliminary and secondary surveys, which is why we broadened the demographic from only South American CWA chapters to include North American chapters. Originally, we sent surveys to all South American chapters, 17 in total, but after getting little response, we sent the same survey to 113 chapters in the United States to gather more data. Finally, we had trouble contacting designers and manufacturers. While this lack of communication was an unforeseen challenge, we adapted to work with the people available and altered our methods to better accommodate these changes.

The COVID-19 pandemic also caused many limitations, the biggest one being the inability to travel to the project site. It limited our meetings with our sponsors to weekly video conference calls and prevented us from getting daily feedback. The eight-hour time zone difference also limited our opportunities to contact our sponsors outside of our meetings, as their workday hours were coming to an end while ours began. This reduced communication overall slowed down the defining of our project's scope.

5 Conclusions and Recommendations

Through our analysis, we were able to create a platform prototype and guidelines that will bring major benefits to the trishaw community. From these deliverables we have drawn conclusions and determined the different areas of this project that could be expanded upon. These areas are detailed in our recommendations for both Cycling Without Age and further research groups.

5.1 Conclusions

With our data collecting and analyzing completed, we compiled the final conclusions for our project that we felt were the most valuable for CWA and users to know. The following sections pertain to conclusions made about stakeholder motivations and interests, platform security, and platform functionality.

5.1.1 Stakeholders' Motivations and Interests

Our findings and analysis show that community building was the major motivator behind the primary stakeholders' interest in an open source platform. According to preliminary survey results, the primary focuses of chapters were being able to interact with fellow stakeholders and providing rides to the chapter's local community.

Community interactions were the most desired category of features, as shown in all of our data collection methods. As described in 4.2.3, two primary features that the chapters expected to see were the ability to communicate with designers and manufacturers and directly message other stakeholders. Our interviews also made it clear that maintaining an active trishaw community was important for design innovation. The website evaluations showed that community interactions like blogs and forums were commonplace on all four open source initiatives reviewed, further supporting the finding that community building is a vital aspect of open source.

Additionally, our interview with EOOS showed that community moderators were vital for the success of an open source initiative. Our case study of Arduino Playground revealed that moderators are necessary for updating community interactions, eliminating inappropriate content, and monitoring design or post submissions. Incorporating platform moderators is also vital for maintaining and driving new discussions within the community.

Survey results revealed that many factors deterred chapters from acquiring a trishaw such as lack of volunteers or COVID-19 related delays. The largest barrier preventing chapter growth and access to the trishaw community was a lack of funding. The features chapters desired reflected that there was a greater demand for easy assembly, as the ability to purchase a full trishaw had greater demand than both the ability to purchase trishaw parts or designs. Chapters lack the ability to build bikes from scratch, which may impact potential trishaw designs for the platform, as only designs with available parts will be relevant to most chapters.

5.1.2 Platform Security

Through the website evaluations, we saw that all of the businesses we investigated had a variant of a paid product. This should be applied in the Open Source Trishaw Initiative, giving users the option to download the digital files for free (or low cost), or purchase a pre-assembled or flatpack version of the trishaw for a fee. The consistency of instructional media among our website evaluations emphasizes its necessity for successful open source, and such tools should be utilized for an open source trishaw platform to ensure its success as well. Website evaluations also revealed

that all of the businesses evaluated utilized licensing or trademarks to protect the intellectual property (I.P.) of the community. Our intention is to propose all of the observed methods of I.P. protection as potential options in our open source trishaw platform guidelines (see Appendix I). This way, Cycling Without Age can be informed about the different protections, and apply them on a case by case basis for the products they ultimately choose to distribute. In these evaluations, all businesses required account creation to post content and participate in community discussion. Therefore, account creation should be utilized on Cycling Without Age's platform as a means to moderate the content that is posted on the platform and not necessarily as a means to moderate who receives said content.

5.1.3 Platform Functionality

The results of our non-affiliated user evaluations allowed us to draw conclusions on how the layout of the prototype should be. We first concluded that our prototype in its current state effectively displays how users can create an account and learn how to build an open source trishaw. On the other hand, the user evaluations show that our prototype in its current state, inadequately displays how the user can go about starting their own Cycling Without Age chapter as well as getting contact information for finding part vendors. As such, the prototype needs to be enhanced so that these resources are more apparent to a user with little to no prerequisite knowledge of the platform. We can also now determine where users expect to be able to find licensing information on the prototype. Since there were three total locations users expected to find this information, it would be necessary to choose the two more common locations. Making these changes would create a more user-friendly experience and help reduce clutter on the platform.

5.2 Recommendations

Based on our findings, we investigated what areas of the project could be expanded upon to further enhance the final product. The next few sections detail a set of recommendations for Cycling Without Age's next iterations of the platform.

5.2.1 Further Researching Stakeholders' Interests

We recommend that further research be done with stakeholders we were unable to get in contact with to gain a better understanding of their interests regarding the platform. Local trishaw and bike manufacturers, trishaw designers, trishaw part sellers, and chapter representatives are a few that will be a vital part in making the open-source platform and its community thrive. Before building the platform, determining manufacturer, designer, and part seller interest is critical. A positive response from most or all stakeholder groups is necessary to ensure the success of the platform.

5.2.2 Refining Guidelines

We provided extensive guidelines, detailing every recommended feature for the platform and all possible implementations (See Appendix I). Although our guidelines and wireframe prototype showcase several recommended interactions for the final open source platform, they are by no means exhaustive. As such, more features will likely be needed, and what we created will need to be continuously iterated on. While our team cannot predict or provide the specifics of what may be added, we fully understand the likelihood of the entirety of our prototype being changed in the future.

It is also crucial to continue improving upon the platform based on any further feedback from stakeholders - especially manufacturers, designers, and consumers. We recommend that Cycling Without Age keep an open line of communication between themselves and all users of the platform. Using their thoughts and opinions to improve the platform past our guidelines and recommendations is essential to its success.

5.2.3 Finalizing the Platform

Another big step Cycling Without Age will need to take is finding a web designer to transform the wireframe prototype and guidelines into a functional website. We recommend starting off simple when creating the platform and only incorporating the key features specified in the guidelines to make sure they function properly and are well received. This focus will create a solid foundation for more components to be added on and will provide a higher quality product in the end.

Before a web designer implements the open-source platform, CWA should first decide how the open-source initiative will be implemented. This will be either through their current website or through an independent one. The details of each possible option are laid out in our guidelines (see Appendix I).

5.2.4 Finding Moderators

One of the main attributes that our team believes is necessary for the longevity of this platform is some form of platform moderation. Moderators would ensure the uploaded designs would meet the safety and quality standards required by Cycling Without Age, filter or guide community discussion, and help answer questions or concerns of users.

Moderation of a platform can come in different forms, such as a team of volunteer moderators or pre-programmed settings. We found that volunteer moderation had great success on CWA's The Hood, so this would be a viable option for recruiting a team of moderators. The same Hood moderators could even be asked to help with this platform as well. Overall, we agree with the stakeholders that some form of moderation is essential to the platform's longevity.

5.2.5 Expanding Community Reach

Finally, it would be prudent for Cycling Without Age to expand their social media presence in order to gain more platform traction. In a FarmBot interview, it was stressed that much of FarmBot's success was due to an active social media presence across many mediums. By posting on various other places frequented by others, Cycling Without Age can both expand in general as well as spread the use of the open source platform. This expansion will allow the community to grow even faster, further increasing trishaw accessibility around the world.

5.3 Future Work

Even if all recommendations are followed, there still will be a need for additional research related to the open source platform. There are multiple research projects that CWA or other research teams can investigate to improve the platform's longevity and expand the movement. One possible research opportunity would be to find global trishaw designers, manufacturers, and part sellers that are interested in the platform and want to contribute. Since our results show that trishaw building from scratch is not feasible for most chapters, we recommend that Cycling Without Age

and these designers focus on trishaw designs that can come in flat packs or can use standard bike parts.

Another possible research project following the platform launch is gauging the success of the open-source platform. This could consist of determining stakeholder satisfaction and involvement, verification that it is enabling chapters to obtain trishaws for cheaper and providing CWA with guidelines on how to improve the platform and increase engagement. Investigating the feasibility and interest of bike building workshop programs in low income countries could also be a catalyst to the Open Source Trishaw Initiative's success. This project could consist of determining chapters' interest in learning trishaw building skills, investigating local resources chapters have, and finding workshop teachers and spaces.

5.4 Closing Remarks

We recommend that Cycling Without Age develop a web-based open source trishaw platform using the guidelines and wireframe prototype provided. Through the creation of this open source trishaw platform, it is our hope that more chapters of Cycling Without Age can obtain a trishaw and overcome the financial hurdle that may have previously deterred them from doing so. It is also our hope that chapters with unique geographical communities can collaborate with designers to create trishaw designs that are fit to their specific conditions. Ideally, local bike shops and manufacturers will also get more clients, as users in open source trishaw communities seek out their services. With more affordable and accessible trishaws, the goal of getting people with limited mobility further involved in their community is more attainable than previously possible. Ultimately, all stakeholders involved with the open source trishaw initiative will have been positively impacted.

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Appendices

Appendix A: About our Sponsor: Cycling Without Age

The increased social isolation and lack of mobility faced by older adults and people who are disabled can lead to a drastic decline in health and quality of life. To combat this, many movements and organizations have been created to address and spread awareness of this problem. One organization that has devoted themselves to improving this issue and spreading their mission globally is our sponsor Cycling Without Age.

Guiding Principles

Figure A1 - Diagram displaying the connection between the Sustainable Development Goals and CWA Five Guiding Principles

The 2030 Sustainable Agenda was initiated in 2015 by the United Nations General assembly, and with this established 17 Sustainable Development Goals to address global issues (Colglazier, 2015). Cycling Without Age has made it a priority to address these goals within their program to make their organization not only beneficial in Copenhagen, but all over the world. The three main Sustainable Development Goals Cycling Without Age addresses are promoting good health and wellbeing, reducing inequalities, and creating more sustainable cities and communities. Cycling Without Age established five guiding principles based on these three goals. These principles include generosity, slowness, storytelling, relationships, and "without age"(Cycling Without Age, 2012). Generosity is one of the most imperative parts of the program as it takes volunteers to become pilots to get the trishaws moving. Slowness extenuates simplicity and reflectiveness that a single ride can have on the passengers where they can see more of their environment. The ride is designed to be slow to see more of the environment and allow for conversations to occur. Storytelling is where passengers and pilots can truly bond. This also helps older adults with retaining memories when recalling their past. Relationships can occur naturally from the experience and can create friendships between generations, which is somewhat difficult to achieve in society today. Finally, without age is supposed to imply that there is no judgement

for any age. Aging is not to be taken in a negative context as we can celebrate all ages and share in the comfort that we all age.

The Hood

Cycling Without Age has their own collaborative online platform, called "The Hood." It is a fairly new online community that allows users from around the world "to share information in an easy and structured way" (Cycling Without Age, 2019). Currently, it is used as a place to share common knowledge, advertise CWA events, and connect with members from all over the world. Users can ask questions or participate in discussions about funding, new chapters, news, etc. There is also an expansive "Knowledge Base" that contains guides, tutorials, guidelines for fundraising, and more. There is room for expansion within The Hood, and with further research and analysis, it could be used as the home for an open source platform, or at the very least, could be a great place to advertise the initiative.

Effectiveness of Cycling Without Age

To test the effectiveness of the Cycling Without Age program the Cotnam and Zecevic study was performed (Cotnam & Zecevic, 2019). The case study took place in the Canadian LTC home, where two groups were made, a biking group and a non-biking group. A total of 24 residents were recruited for the biking group, and these residents were biked around twice a week for 12 weeks. The non-biking group was made of 16 people and instead of biking these people just went for walks or wheelchair rides for the same period of time. As the study was being conducted data was taken based on happiness levels and quality of life. Happiness was measured using a visual analog scale and quality life was measured using the LTC QoL assessment. After collecting and analyzing this data it was shown that the biking group had a higher quality of life at the end of the 12 weeks, supporting the effectiveness of Cycling Without Age's program (Cotnam & Zecevic, 2019).

Global Impact and Obstacles

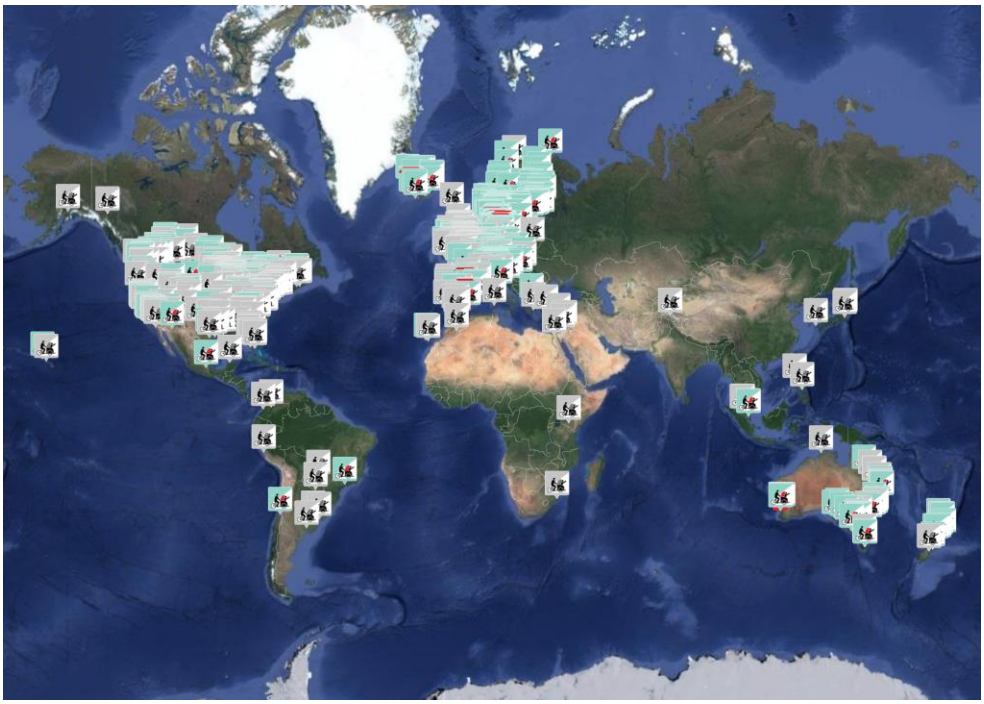


Figure A2 - Map of the current Cycling Without Age Chapters (Cycling Without Age, 2012)

As shown by the map above, the chapter locations are spread all over the world, with a large number centered in the United States and Europe. This demonstrates how the Cycling Without Age program currently is more accessible for more well-established countries. One main reason being that trishaws are very expensive. Trishaws can range from $7,000-$12,000 (Legacy Lodge & Hole, 2018). Also, because Cycling Without Age is becoming a global organization, shipping can also increase the price and time it takes for a chapter to get a trishaw. Currently chapters can obtain trishaws in multiple ways such as municipalities, nursing homes, foundations, private companies, crowdfunding, and personal funding (Cycling Without Age, 2012). However, this has not been adequate in providing all chapter's access to trishaws, and many are unable to afford a trishaw, let alone multiple. This is a large problem as the cost and lack of accessibility of trishaws is preventing chapters from growing bigger, as well as new chapters from forming. If chapters are unable to get trishaws then the amount of older people that can be served decreases, which begins to inhibit the main goal of the organization. Therefore, the expenses and accessibility of these trishaws need to be adapted in order to more all global communities regardless of financial or material resources.

Overall, due to Cycling Without Age's mission there is now a greater global awareness of the lack of mobility and freedom for the elderly, and a solution to this through trishaw rides. To continue growing globally the accessibility and affordability of the trishaws must be adapted to apply to all chapters.

Appendix B: Makerspaces

One of the greatest benefits to open source hardware is having the freedom to customize, modify, and adapt a project to fit the needs or desires of the user. However, users are required to have access to the tools and resources necessary to make modifications and in some cases, build the project from scratch. A makerspace would provide a solution to Cycling Without Age chapters with the ability to purchase a trishaw but lack the resources to build it. Maker spaces would not only be the perfect solution for the chapter, but also a great resource for the community. By definition, "A makerspace is a collaborative workspace inside a school, library or separate public/private facility for making, learning, exploring and sharing that uses high tech to no tech tools" (Makerspaces, 2017)

Figure B1 - An example of a typical makerspace (Image © Rory Hyde)

Besides benefiting chapters of Cycling Without Age, makerspaces are proven to benefit people beyond those using the facility, including the communities around the makerspaces, small businesses, and the disabled population. To elaborate, in 2011, an organization known as e-Nable was formed by a community of innovators with similar interests. E-Nable is a community of makers who design, 3D-print, and manufacture open source hands and arms for those who were born missing fingers or who have lost them due to war, disease, or natural disaster. People such as those previously described benefit from makerspaces as it gives the e-Nable community a platform to innovate and improve upon their quality of life. e-Nable also provides the files to the prosthetics so that in the case where an e-Nable representative is not local, you can still print the prosthetics.

In a study exploring *The Wider Role of Makerspaces in Public Life*, it was also found that makerspaces in a community fulfilled the themes of a social space, wellbeing support, serving the needs of their community, and reaching out to excluded groups (Taylor et al., 2016). Some of the ways that they found the makerspaces achieving these themes were through assisting small businesses by producing custom parts, employment, skill development, etc.

Figure B2 - A picture of an e-Nable prosthetic

In the situation where a local community of makers cannot get the funding to create these makerspaces, or the local government is not interested in implementing a makerspace, it would be up to global organizations such as Nation of Makers to assist that community. The mission of Nation of Makers "is to support the full range of organizations that impact makers by encouraging connections, broadly sharing resources, facilitating funding opportunities, engaging in policy development, and advocating for the maker movement" (Nation of Makers, 2020). A collaboration between Cycling Without Age and Nation of Makers would be ideal for chapters located in developing countries or low income economies because it would provide a location for the construction of open source trishaws and also provide the previously mentioned benefits that a makerspace has on a community.

Appendix C: User Stories

Appendix C pertains to user stories which are short statements that describe a specific expected feature or capability, told from the user's perspective. They acted as baseline data and an assumption of the feedback we expected to receive. Each user story was influenced by the stakeholder map we created. These user stories helped us gain a better perspective of all the stakeholders' motivations for the platform.

Web Site Designers:

- As a website designer, I want to know what consumers want from the platform so that I can create the best user experience for consumers.
- As a website designer, I want to know what the designers plan to distribute so that I can create the best user experience for vendors.

Pernille & Ole:

- As an administrator of Cycling Without Age, I want to be able to monitor activity on the website to ensure are finding no problems with the website
- As an administrator, I want to easily be able to review designs and certify them under CWA to allow chapters to openly use them under our name

CWA Employees:

- As a CWA employee, I want to have a designated place for the management of trishaws so that I can efficiently handle and keep track of the distribution among CWA chapters
- As a CWA employee, I want to have a simple organized trishaw program so that I can easily refer Chapter representatives or interested parties to this and make my job easier and faster

Manufacturers:

- As a manufacturer, I want to be involved with a high traffic website so that I can gain more business and spread my companies' name
- As a manufacturer, I want to be able to set my own fee for the production of trishaws so that I can afford the materials and also make a profit

Designers:

- As a designer, I want to be able to post my designs on a well-established website that receives a lot of visitors, so that I can spread my designs quickly
- As a designer, I want to be able to remove my designs at my discretion without any consequences so that my personal property is not taken advantage of
- As a designer, I want to have a say in my percentage fee for each download of my design so that I can make a profit
- As a designer, I want to have proper licensing and security measures available for my work so that it is not stolen or reproduced without my consent

Part Sellers:

- As a bike part seller, I want to be able to list my parts on the open source platform so that I can expand my business

Repairers:

- As a bike repairer, I want to be able to display my services and contact information on the open source platform so that people can reach out to me when they have technical cycle issues.

Chapter Representatives:

- As a chapter representative, I want customers to be able to find my chapter for rides so that my chapter gets business, and the customers are happy.
- As a chapter representative, I want to connect with other chapters and stakeholders at will so I can collaborate easily without going through email or CWA.

Elderly/Disabled:

- As a person with limited mobility, I want to be able to quickly find a local chapter so I can get to where I need when I need to.

Pilots and Other Chapter Members:

- As a pilot, I want to be able to sign up for times to work and communicate with other pilots and my chapter easily.
- As a pilot, I may want to be able to download designs and learn how to build them myself.

People Looking to Start a Chapter:

- As someone looking to start a chapter, I want to be able to easily locate resources for the process of starting so that I can ensure the process and paperwork go through smoothly.
- As someone looking to start a chapter, I want to find guides on how to advertise to get more people to join so I can ensure the success and outreach of the chapter.
- As someone looking to start a chapter, I want to be able to compare pros and cons of various trishaws so I can easily choose one that suits my chapter in terms of geographical location and other needs.

People Looking to Learn About CWA:

- As someone looking to learn more about CWA, I want to be able to easily find information about CWA's mission and the purpose of both the organization and the initiatives they empower so that I can decide if I want to contribute to any of it.

People Looking to Learn How to Build Trishaws and other Alternative bikes:

- As someone looking to learn how to build trishaws or alternative bikes, I want to find resources about welding and other skills required to build the bike design I purchased so I can ensure it is done correctly.

Community Members Around Chapters:

- As a community member around a chapter, I want to know how I can get involved so that I can help the chapter.
- As a community member around a chapter, I want to find out what CWA is and what they do so that I know what is going on in my community.
- As a community member around a chapter, I want a place to get in contact with chapters so that I can let them know about bike builders and workshops in our area.

People Who Stumble Upon Website:

- As a random person stumbling upon the website, I want an easy to find informational page that explains what the site is, so I know if I am interested.
- As a random person stumbling upon the website, I want a homepage that briefly explains what the site is so that I do not waste my time.
- As a random person stumbling upon the website, I want straightforward navigation so that I can quickly explore everything the website has to offer.

Misc. People:

- As anyone visiting the website, I want an easy to find informational page that explains what the site is, so I know if I am interested.
- As anyone visiting the website, I want a homepage that briefly explains what the site is so that I do not waste my time.

As anyone visiting the website, I want straightforward navigation so that I can quickly explore everything the website has to offer.

Appendix D: Interview Questions

Read to all interviewees before interview (requires verbal consent):

We are a team of university students from Worcester Polytechnic Institute and our team is working alongside Cycling Without Age (CWA). CWA is an international non-profit organization that provides the elderly and disabled with an opportunity to remain an active part of society and the local community. CWA achieves this mission by recruiting volunteers to offer trishaw rides through their local communities. The major issue with this organization's growth is the rising cost of trishaws. Our solution to this problem is to outline some kind of website for CWA chapters to acquire trishaw designs and let them build it themselves. This platform would also enable collaboration between designers and customers to meet specific needs, and to promote more localized business. This website will help users decrease the cost of the trishaws by providing them with the designs needed and pointing them in the direction of parts that the builder cannot locally source.

If you are willing to participate in this interview, please understand that it is completely voluntary, and you may stop the interview at any time. You do not have to answer any questions you do not feel comfortable answering. All of the information you provide will help us with our research and project development. You do not have to consent to all of the following and can change your decision at any point during this interview.

Do you consent to the following?

- The interview itself
- Audio recording of the interview
- The future paraphrasing of what you say in this interview
- The future quoting of what you say in this interview
- The use of your name and organization when your words are used

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: (gr-cyclingwithoutage_dk_a20@wpi.edu, the IRB Chair [Professor Kent Rissmiller- Tel: 508-831-5019 & Email: kjr@wpi.edu], or the Human Protection Administrator [Gabriel Johnson- Tel: 508-831-4989 & Email: gjohnson@wpi.edu).

Interview Questions

Background

- What is your role in *company name*?
- How did your company form?
- How or why did your company decide on becoming open source?
    - Did you use any other companies as inspiration for becoming open source?

Open Source

- What does success mean to your company?
- Has user feedback had a role in the features and aspects of the platform?
- How has making your company open source affected its ability to succeed?
    - Monetary? Sustainability?
- What aspects of open source do you believe benefits your company the most? Do you think your business would not be successful without these aspects?
    - Are there any aspects of open source that you feel are unnecessary or hurtful?

- How did you spread the word about your organization being open source and getting people to use your products?
- Do you have an estimate on the amount of site traffic that your platform sees?
    - What are the specific factors that affect this number?
    - Any seasonal events or patterns?
- Does your company charge for any downloads?
    - If open hardware, do you have fees to pay designers, the company, external services, etc?

Licensing and Security

- Have you encountered issues with people profiting off of or abusing other people's designs?
- Which license type(s) do you use for protecting you and your community's intellectual property and why?
    - Do you know how this licensing was chosen?
- Are there any additional security measures your company takes to keep designs safe?

Wrap Up

- If you could change anything to make your open source platform more efficient, what would it be?
- Is there any other information or advice you would like to share?

Appendix E: Preliminary-Survey Questions

Given to all survey participants before survey (Will require physical consent):

Contact Information: gr-cyclingwithoutage_dk_a20@wpi.edu

Title of Research Study: Open Source Platform Survey

Sponsor: Cycling Without Age

Introduction: We are a team of university students from Worcester Polytechnic Institute. Our team is working alongside Cycling Without Age, an international non-profit organization that provides the elderly and disabled with an opportunity to remain an active part of society and the local community. Cycling Without Age achieves this mission by recruiting volunteers to offer trishaw rides through their local communities. The major issue with the organization's growth is the rising cost of trishaws. Our solution to this problem is to outline some kind of website for CWA chapters to acquire trishaw designs and let them build it themselves. It will help users decrease the cost of the trishaws by providing them with the designs needed and pointing them in the direction of parts that the builder cannot locally source. This platform would also enable collaboration between designers and customers to meet specific needs and to promote more localized business. If you are willing to participate in this survey, please understand that it is completely voluntary, and you may stop the survey at any time.

Purpose of the Study: The goal of this survey is to define the usability and development goals of an intended open source collaborative platform. We would like to get the users' thoughts and suggestions on the features or requirements that they would most expect in a platform like this. It is significant to gain a deeper understanding of what the actual users of the platform would like to see in order to create the most effective and sustainable guidelines.

Your participation in this research is voluntary. You do not have to answer any questions you do not feel comfortable answering. You can skip any question you do not feel comfortable answering. All of the information you provide will help us with our research and project development. The answers you provide may be used or quoted in our project report (without referencing any identifying information). If you do not consent to the use of the answers you will provide, you are not required to continue with the survey.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: (gr-cyclingwithoutage_dk_a20@wpi.edu, the IRB Chair [Professor Kent Rissmiller- Tel: 508-831-5019 & Email: kjr@wpi.edu], or the Human Protection Administrator [Gabriel Johnson- Tel: 508-831-4989 & Email: gjohnson@wpi.edu).

Preliminary Survey Questions

CWA Chapter Questions (If affiliated)

- Where is your chapter located?
- How large is your chapter? (Number of Volunteers)
    - 1-3
    - 3-10
    - 10+
- How many trishaws does your chapter currently have available or use?
    - 0
    - 1
    - 2
    - 3+
- (Only if they have 0 trishaws) What is the main reason limiting your chapter from having trishaws?
    - Lack of Funding
    - Lack of Interest
    - Currently working on getting one
    - Other: (Fill In)
- Does anyone involved with your chapter have bike building capabilities or skills? (Yes or No)
- Does your chapter have access to bike building tools or workshops? (Yes or No)
- Is there still a local demand for accessible transportation? If so, do you think that Trishaws are the way to go about this in your area? (Fill in)

Non-CWA Questions

- What role are you?
    - Manufacturer
    - Designer
    - Bike/Bike Part Seller
    - Rider

Open Source Platform

The Open Source Hardware Association defines open source hardware as the following:

> Open source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design. The hardware's source, the design from which it is made, is available in the preferred format for making modifications to it. Ideally, open source hardware uses readily-available components and materials, standard processes, open infrastructure, unrestricted content, and open-source design tools to maximize the ability of individuals to make and use hardware. Open source hardware gives people the freedom to control their technology while sharing knowledge and encouraging commerce through the open exchange of designs. (2010)
> Open Source Hardware Definition. (2010). https://www.oshwa.org/definition/

- Are you familiar with any of the following platforms that feature open source elements? (Select as many apply)
    - Arduino
    - Raspberry Pi
    - GitHub
    - Reddit
    - StackOverflow
    - Opendesk
    - FarmBot
    - None of the Above
- If there are any other open source websites or platforms that you are familiar with please list them below: (Fill in)
- Would you be interested in using an open-source platform to collaborate with other chapters, bike designers, and builders? (Yes or No)
- If you were to use a collaborative website for building trishaws or other inclusive transportation methods, what would you initially expect? (Fill in)
- What kind of information would you expect to find? (Fill in)
- What type of interactions do you expect to be able to perform? (Select as many apply)
    - Forums or Message Boards
    - Direct Messaging to other chapters, designers, or builders
    - Other Ways to Get in Contact with Local Builders or Designers
    - How-To Guides
    - Ability to Purchase or Download Designs
    - Ability to Purchase a Full Trishaw Directly
    - Ability to Purchase Trishaw or Bike Parts Directly
    - I do not expect any of the above interactions.
- Rank these expected interactions by your importance as you see fit.
    - Forums or Message Boards
    - Direct Messaging to other chapters, designers, or builders
    - Other Ways to Get in Contact with Local Builders or Designers
    - How-To Guides
    - Ability to Purchase or Download Designs
    - Ability to Purchase a Full Trishaw Directly
    - Ability to Purchase Trishaw or Bike Parts Directly
- Are there any other specific features or interactions you would expect to see in a final product like this? (Fill in)
- Are there any features or interactions you would NOT like to see? (Fill in)
- Briefly describe what goal(s) you believe a platform like this could achieve for you. (Fill in)
- Do you have any additional suggestions or comments about the proposed platform? (Fill in)

South American Group Interest (Only shown to chapters in South America)

- Do you know what Cycling Without Age's "The Hood" is? (Yes or no)
- Do you or someone involved with your chapter currently have access to The Hood? (Yes or no)

- Would you be interested in learning more or getting access to The Hood? (Yes or no)
- Would you be interested in joining a Hood channel to connect with other Latin American chapters, as well as designers and builders in the future? This would be used to maintain connections and help grow the Open Source Trishaw Movement. (Yes or no)

Appendix F: Secondary Survey Questions

Given to all survey participants before survey (Will require physical consent):

Contact Information: gr-cyclingwithoutage_dk_a20@wpi.edu

Title of Research Study: Open Source Platform Survey

Sponsor: Cycling Without Age

Introduction: We are a team of university students from Worcester Polytechnic Institute. Our team is working alongside Cycling Without Age, an international non-profit organization that provides the elderly and disabled with an opportunity to remain an active part of society and the local community. Cycling Without Age achieves this mission by recruiting volunteers to offer trishaw rides through their local communities. The major issue with the organization's growth is the rising cost of trishaws. Our solution to this problem is to outline some kind of website for CWA chapters to acquire trishaw designs and let them build it themselves. It will help users decrease the cost of the trishaws by providing them with the designs needed and pointing them in the direction of parts that the builder cannot locally source. This platform would also enable collaboration between designers and customers to meet specific needs and to promote more localized business. If you are willing to participate in this survey, please understand that it is completely voluntary, and you may stop the survey at any time.

Purpose of the Study: The goal of this survey is to define the usability and development goals of an intended open source collaborative platform. We would like to get the users' thoughts and suggestions on the features or requirements that they would most expect in a platform like this. It is significant to gain a deeper understanding of what the actual users of the platform would like to see in order to create the most effective and sustainable guidelines. This survey is a follow-up to one previously sent. It will be demonstrating and asking about a prototype of the platform we are developing.

Your participation in this research is voluntary. You do not have to answer any questions you do not feel comfortable answering. You can skip any question you do not feel comfortable answering. All of the information you provide will help us with our research and project development. The answers you provide may be used or quoted in our project report (without referencing any identifying information). If you do not consent to the use of the answers you will provide, you are not required to continue with the survey.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: (gr-cyclingwithoutage_dk_a20@wpi.edu, the IRB Chair [Professor Kent Rissmiller- Tel: 508-831-5019 & Email: kjr@wpi.edu], or the Human Protection Administrator [Gabriel Johnson- Tel: 508-831-4989 & Email: gjohnson@wpi.edu)

Secondary Survey Questions

Introduction

- Here is a link to a prototype of the potential Cycling Without Age Open Source Platform: *Link is no longer active*
  Please take some time (At least 5 minutes) to explore the prototype and try to remember your initial thoughts and feelings. There are features that are intentionally not working or not yet fully developed- remember this is a prototype and not a final product. If you find any bugs or issues, please include it in your survey response. Thank you!

Platform Evaluation

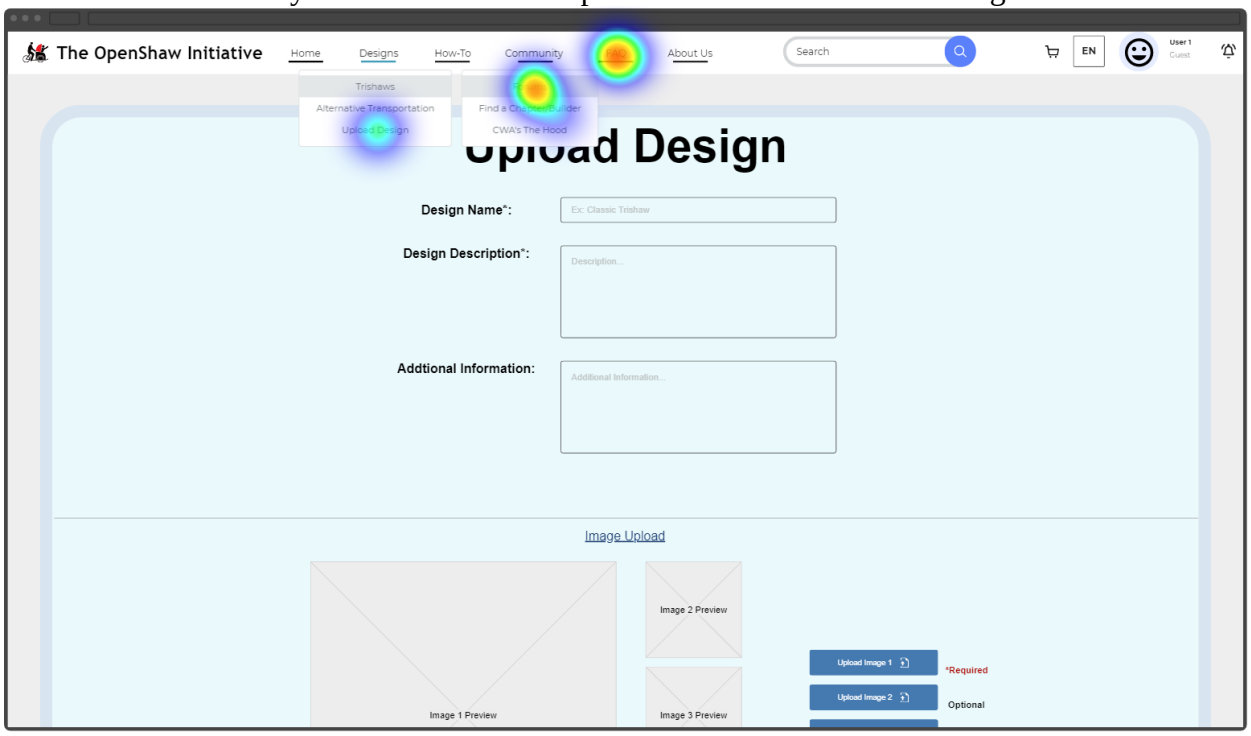
- Where is your chapter located? (Fill in)
- How large is your chapter? (Number of Volunteers)
  - 1-3
  - 3-10
  - 10+
- Did you take the pre-survey? (Sent 1-3 weeks ago- asking about the expected features and interests in the platform) (Yes or No)
- If you have taken the pre-survey, is the prototype similar to what you expected?
- If you have not taken the pre-survey, does this demo meet your expectations for a platform made for open source collaboration for trishaws? Why or why not? (Fill in)
- Which features did you like?
  - Design Pages
  - Design Upload Page
  - How-To Page
  - Forums
  - Find Chapter/Builders Tool
- Are any features unnecessary?
  - Design Pages
  - Design Upload Page
  - How-To Page
  - Forums
  - Find Chapter/Builders Tool
- Which features do you think need improvement?
  - Design Pages
  - Design Upload Page
  - How-To Page
  - Forums
  - Find Chapter/Builders Tool
- Were there features not included in the platform that you think we should add? If yes, what are they: (Fill in)
- Did you feel the platform was well organized? Please explain below: (Fill in)
- Do you think you could successfully use a platform like this without additional help? (Fill in)
- Do you have any additional suggestions or comments about the proposed platform? (Fill in)

Appendix G: User Evaluation Heat Maps and Feedback

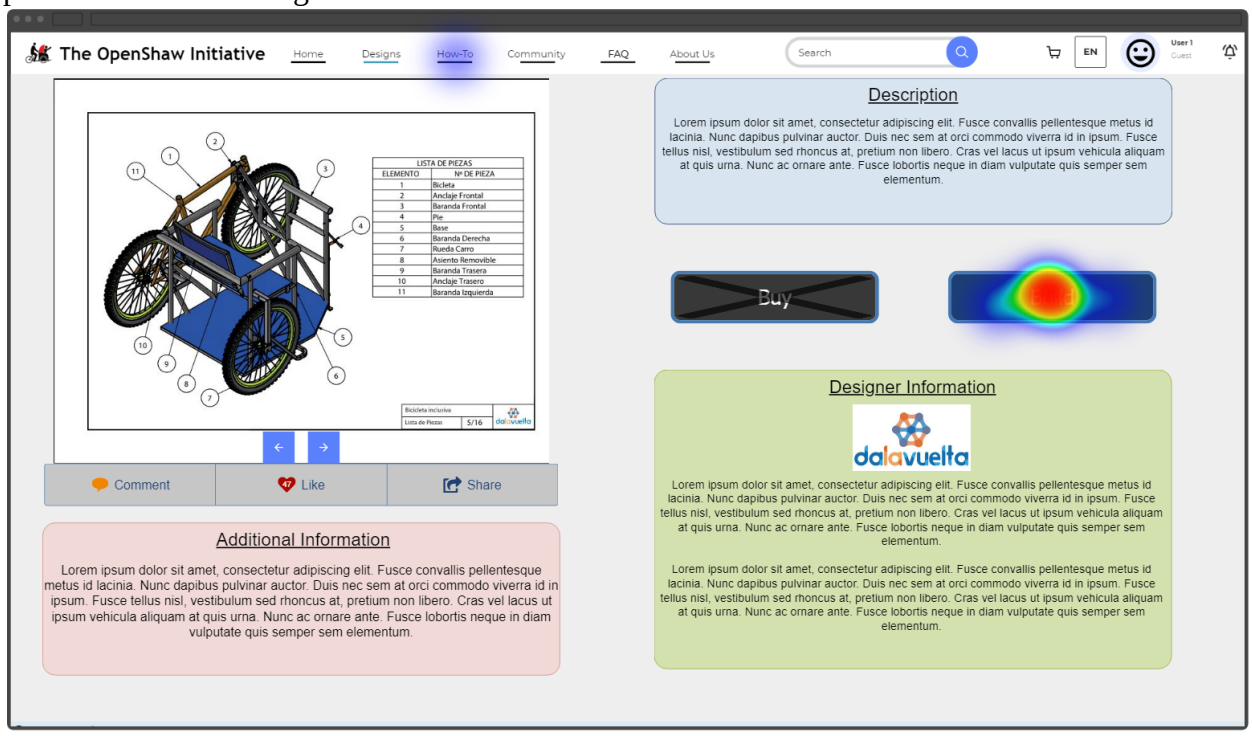
Appendix G is focused on the data collected from the user evaluations. These evaluations were done with non-CWA-affiliated users. The data in this appendix is specific to the online version of the user evaluation created in Qualtrics. Each task that the user had to accomplish has a corresponding heat map as shown below. The heat maps display the frequency that participants clicked on locations of the image. These results were shown to be generally consistent among all the heat maps. The last question of the Qualtrics user evaluation asked about user impressions, so there is a bar graph displaying those results.

Question 1: From this screen, where would you navigate to in order to create your account on the OpenShaw website? Click the image.'

Question 2: If you are considering uploading your own custom trishaw design, but are concerned about how you should license it because you don't want people selling a copy of your design, which resource would you use to learn about possible licenses? Click the image.

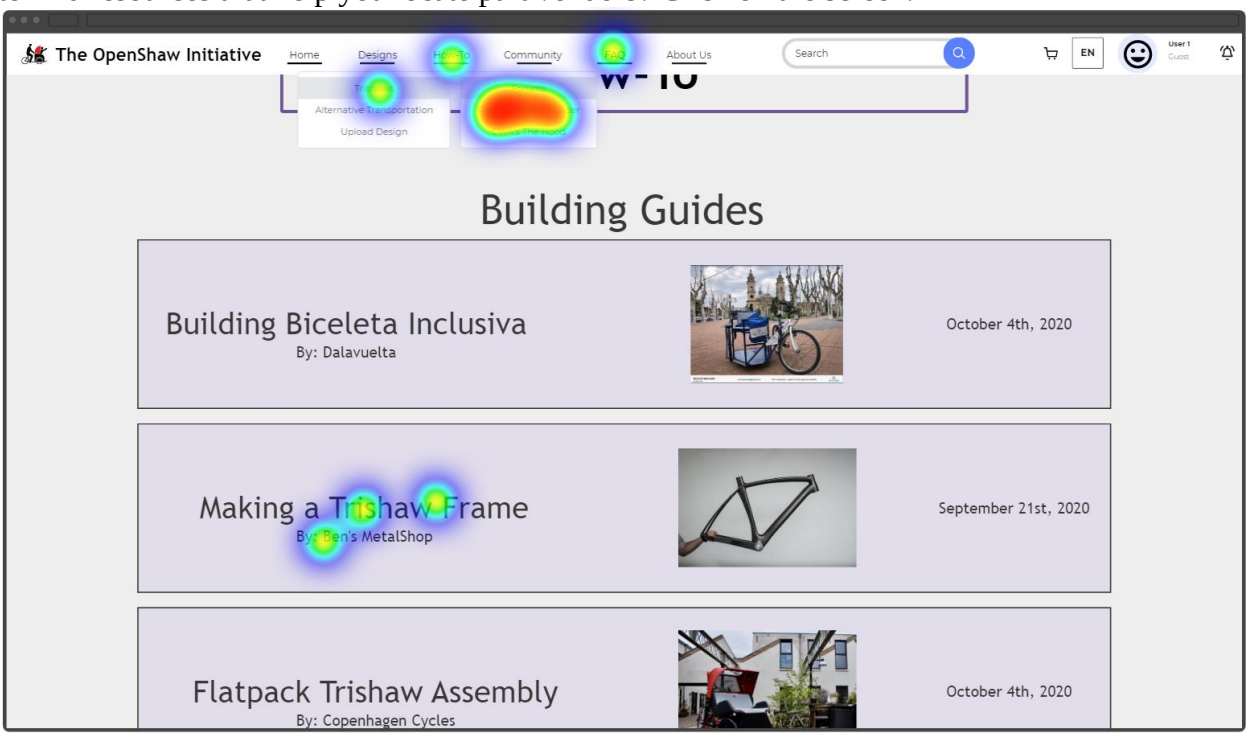


Question 3: You found the following sidecar bike on the OpenShaw website and downloaded the plans so you can build the bike from scratch, but have never built a bike before and don't know where to start. Where would you navigate to on the website to learn about the bike building process? Click the image.



Question 4: After stumbling across this website, you become interested in the organization of Cycling Without Age and want to look into starting your own chapter. Where would you navigate to in order to learn more about this? Note: There are multiple options, so click which one is most intuitive to you.

Question 5: You download the bill of materials and schematics required to build an open source trishaw, but do not have any of the parts on hand to begin. Where on this screen would you click to find resources that help you locate part vendors? Click on the screen.



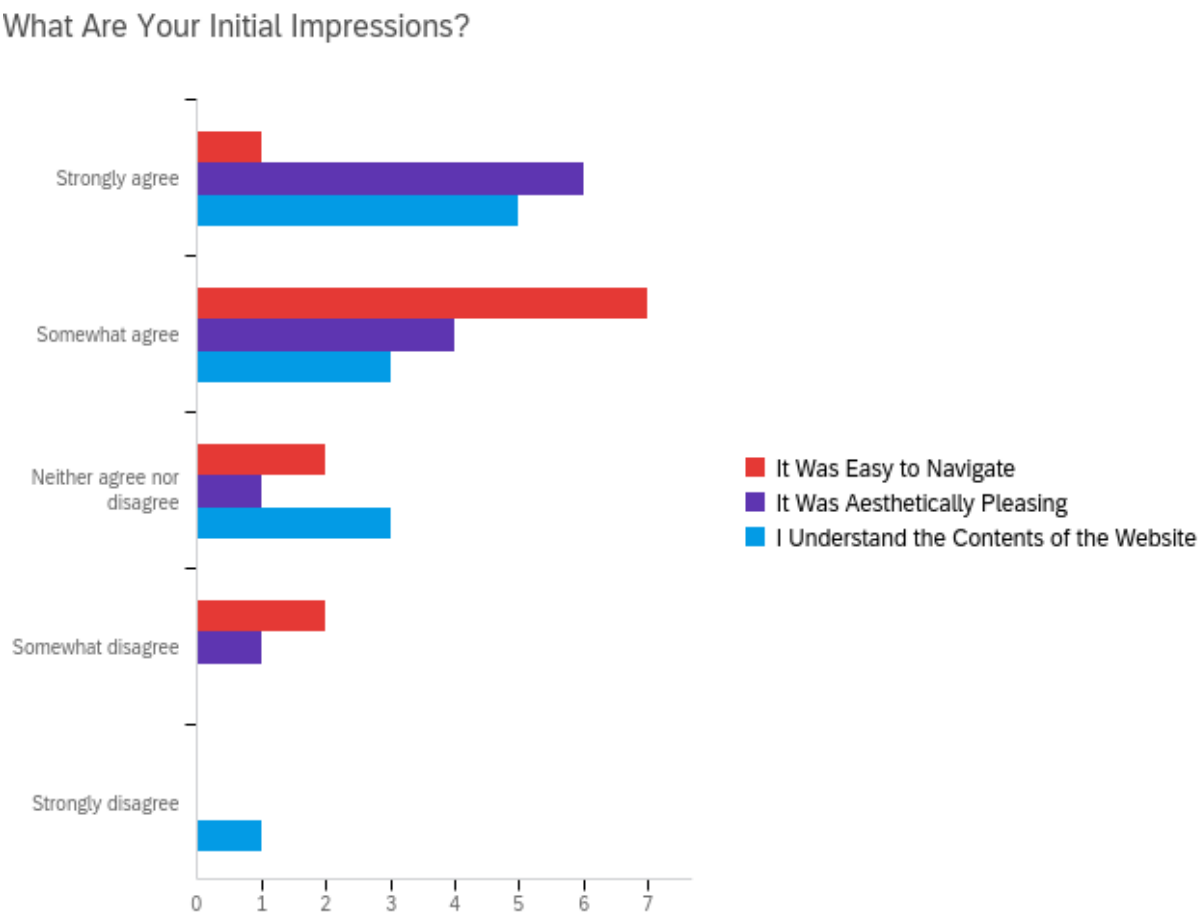
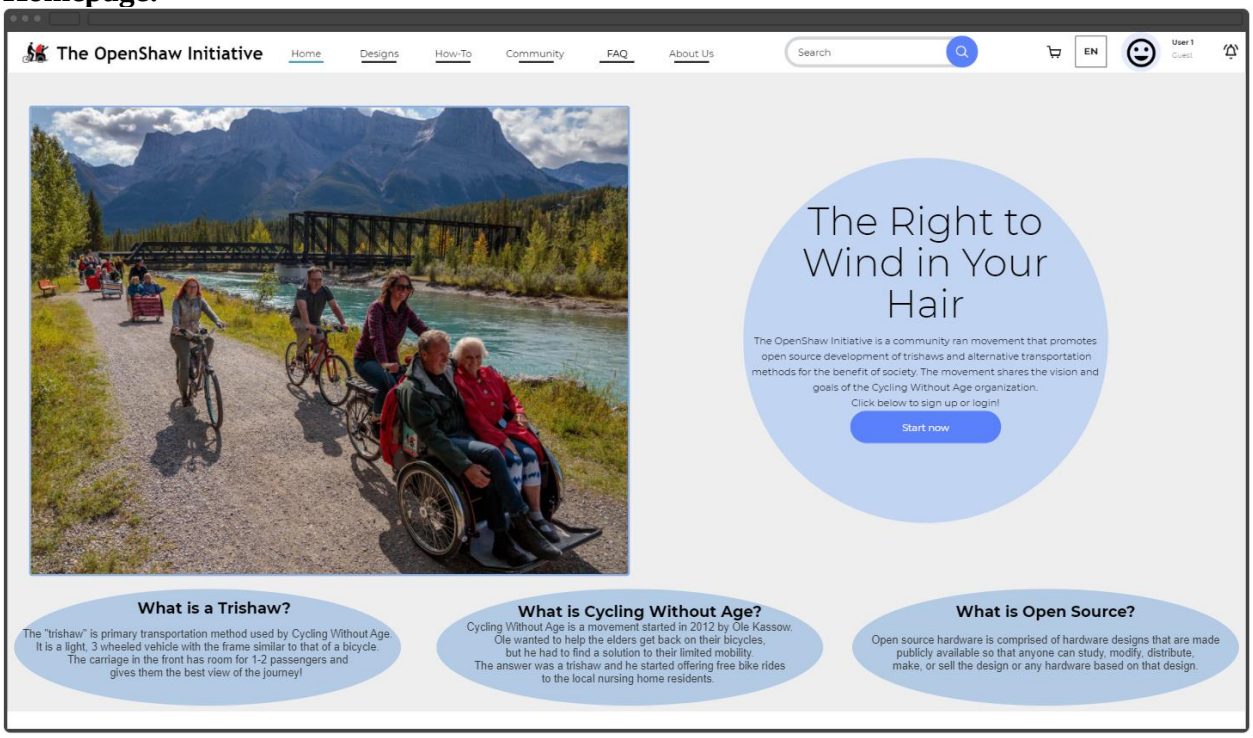


Figure G1 - Platform Initial Impressions

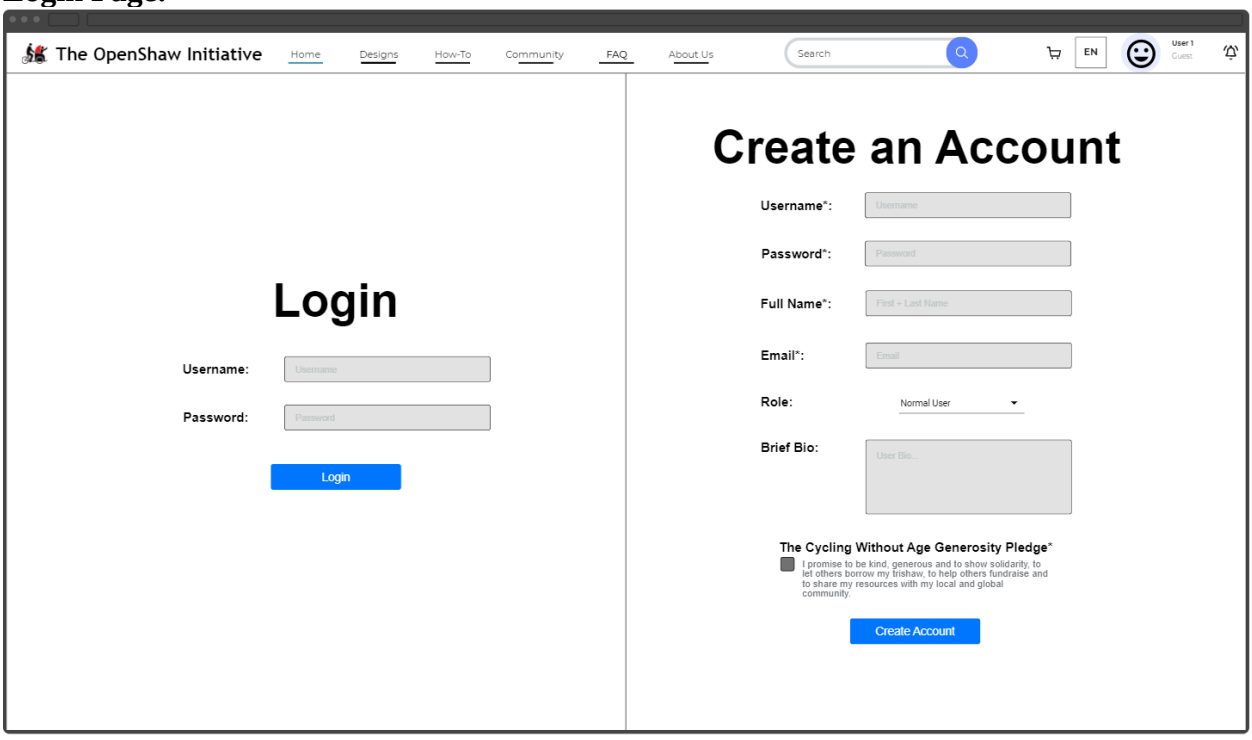
Appendix H: Platform Prototype

Appendix H exhibits the platform prototype that was created with Proto.io based on the data and analysis collected. Each figure below displays a page of the platform prototype, and all of the features present on it. For more detailed screenshots or more information on the prototype, refer to the supplementary files.

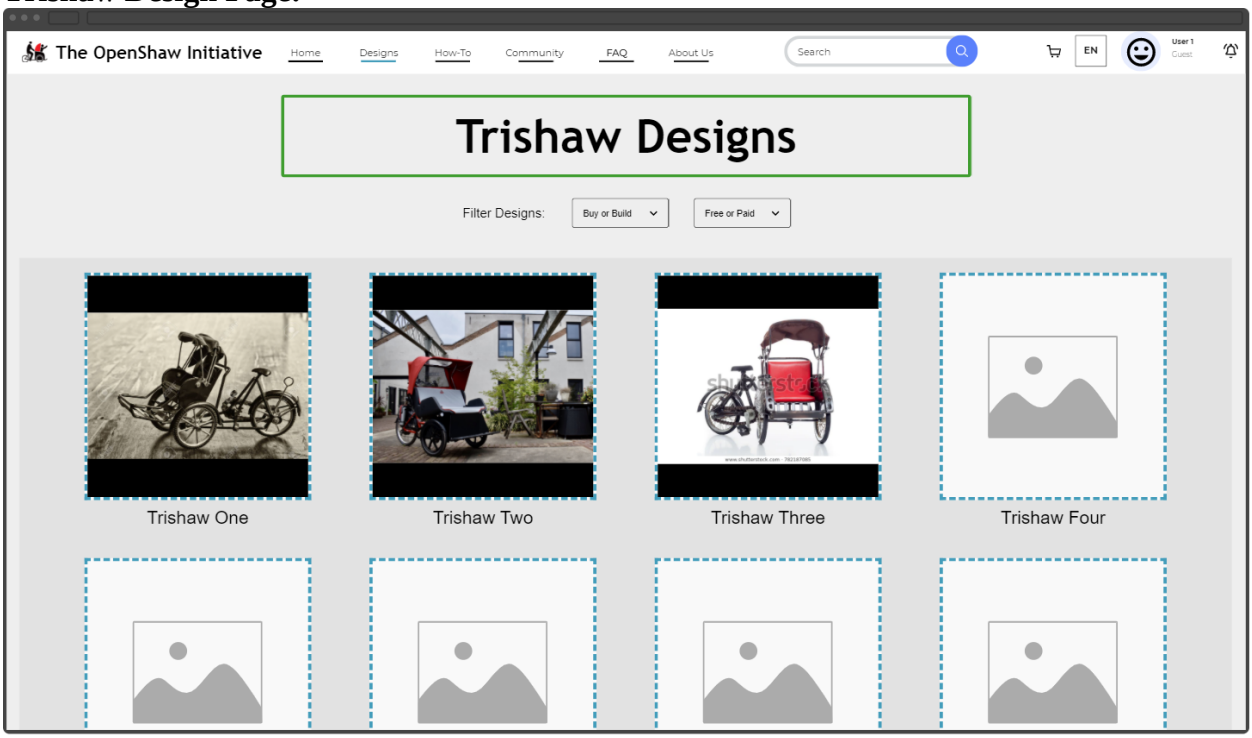
Homepage:



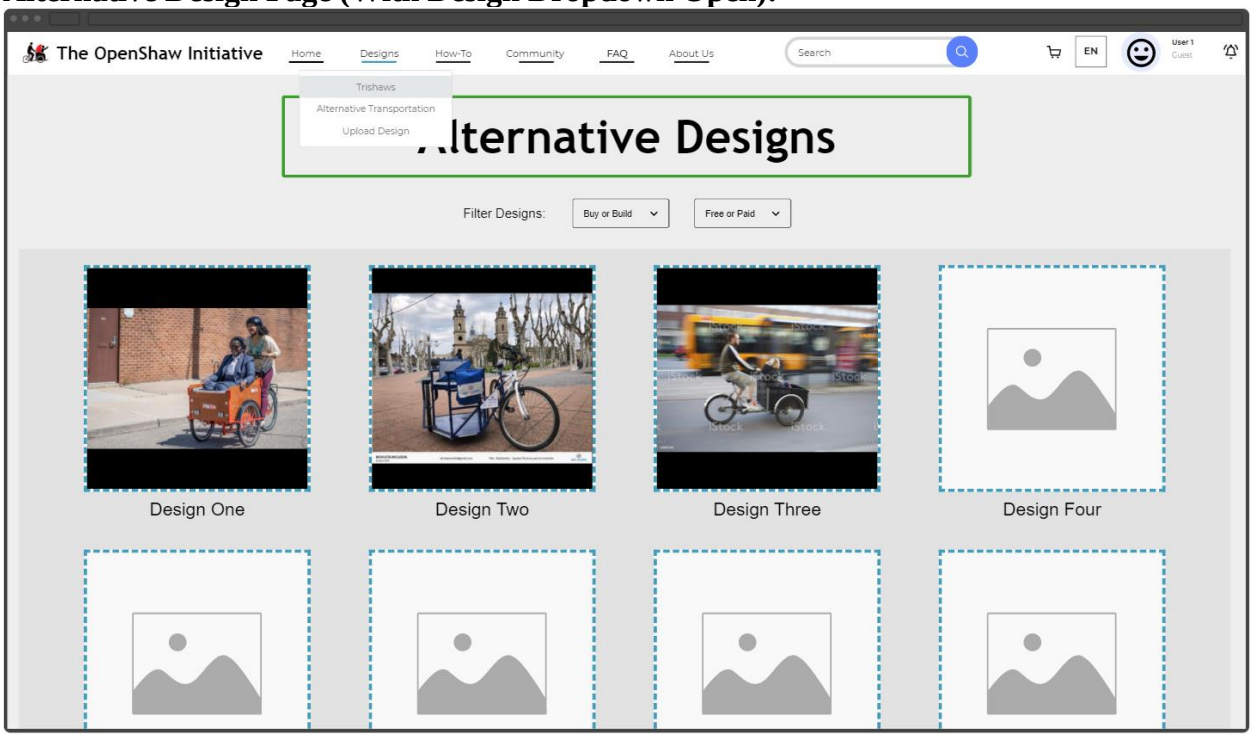
Login Page:



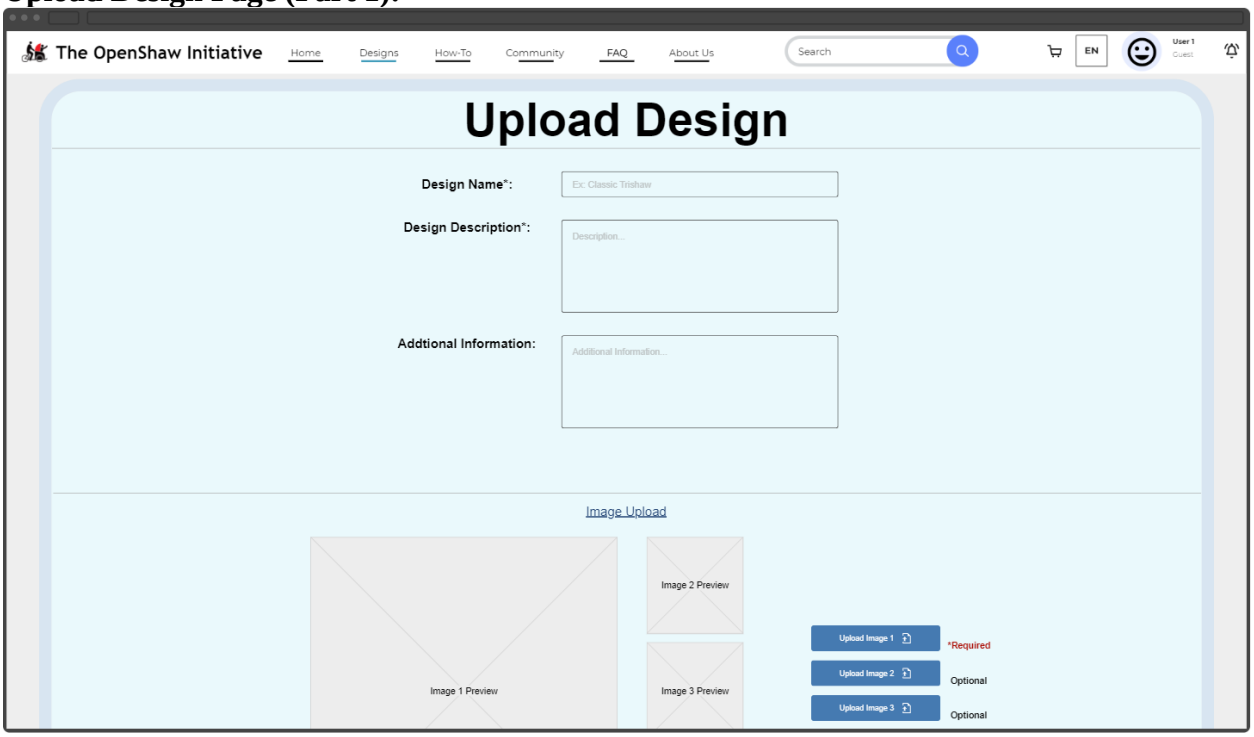
Trishaw Design Page:



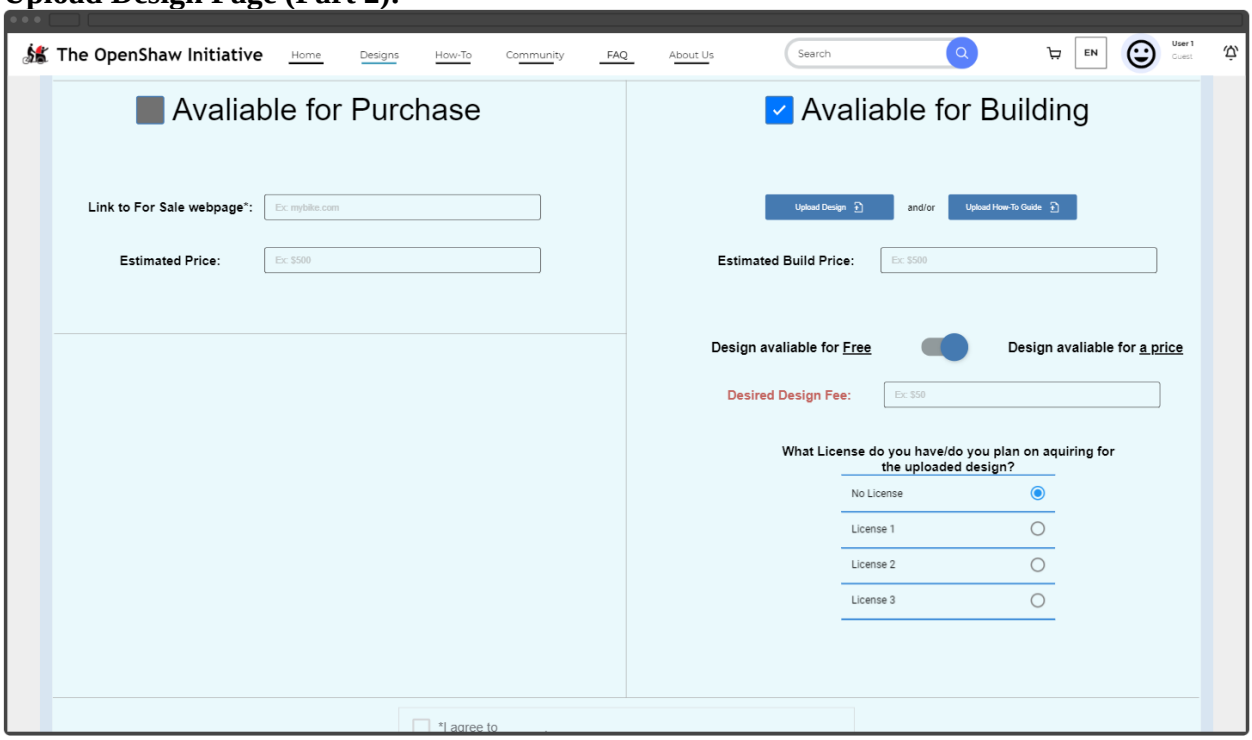
Alternative Design Page (With Design Dropdown Open):



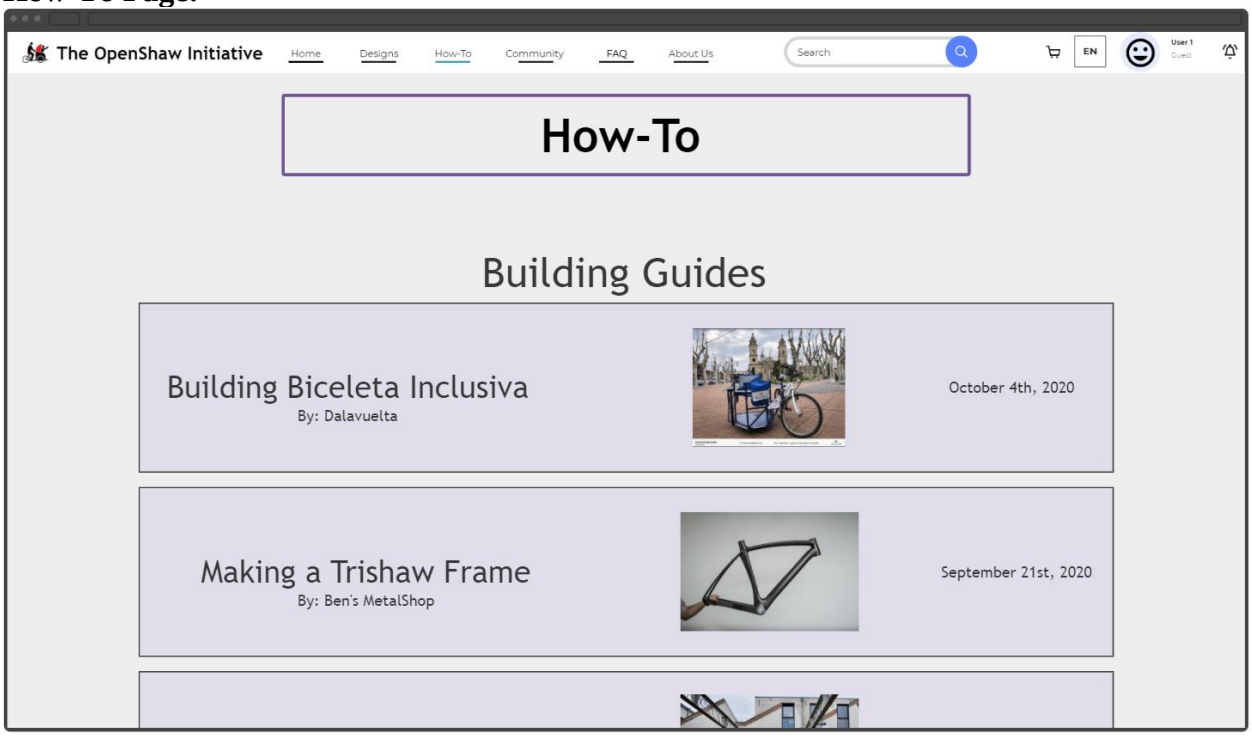
Upload Design Page (Part 1):



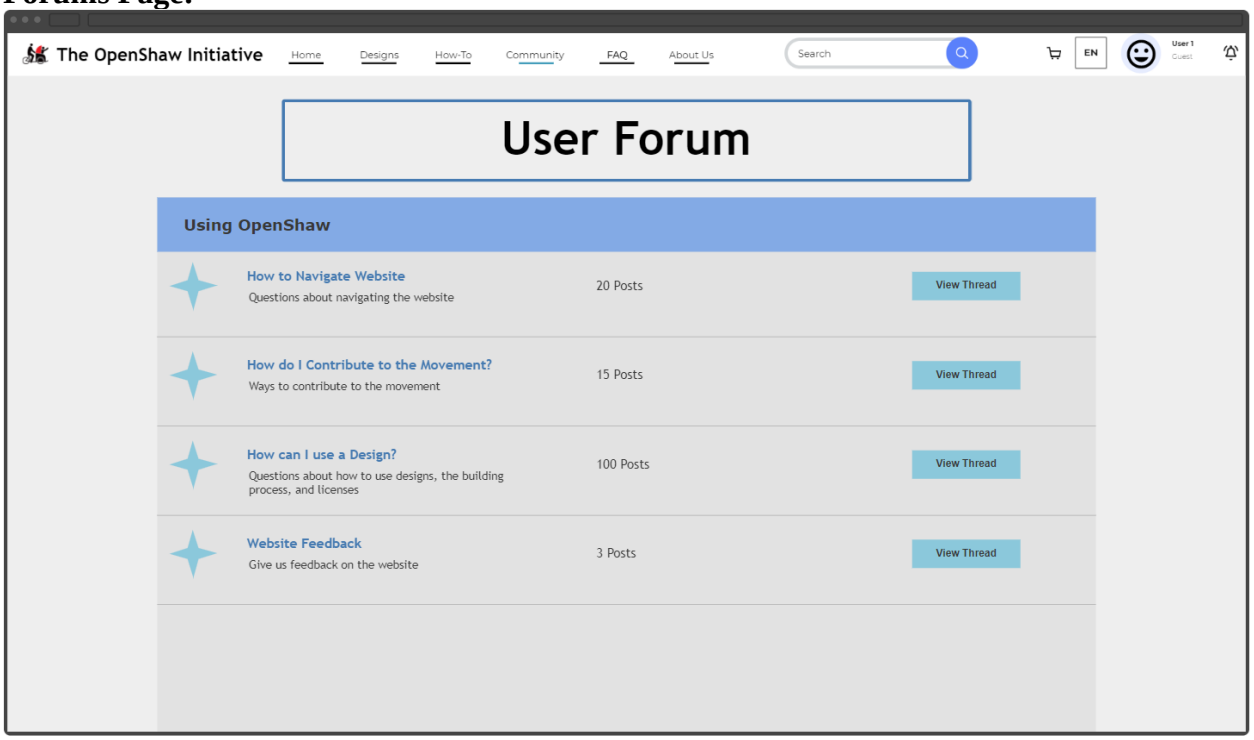
Upload Design Page (Part 2):



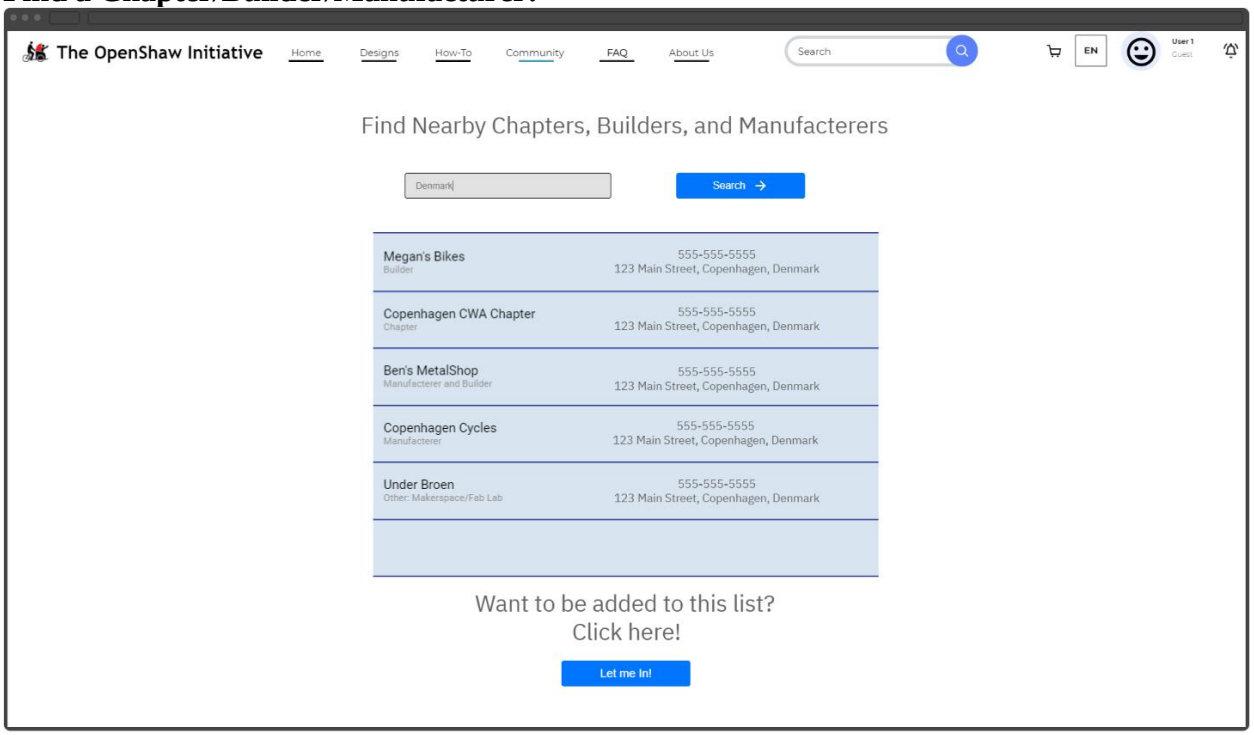
How-To Page:



Forums Page:



Find a Chapter/Builder/Manufacturer:



Appendix I: Open Source Trishaw Platform Guidelines

Introduction

The goal of these guidelines is to streamline the process of establishing a collaborative community for the creation, replication, and modification of open source trishaw and alternative bike designs. Ideally, Cycling Without Age will be able to utilize these guidelines and bypass most of the research and decision-making processes that are usually necessary in this endeavor. Using these guidelines, Cycling Without Age will implement this platform at their earliest convenience. The contents of these guidelines include information regarding licensing, security, community, collaboration, website features, and vending. To see the data and findings to support these guidelines, please refer to the full "Developing Guidelines for a Collaborative Open Source Trishaw Platform" report. To see the guidelines in action, refer to the prototype deliverables that are included in supplemental files.

Making the Prototype a Reality

Intended Readers: CWA Administration

The prototype our team built was designed to be used as a template and can be used as much or as little as Cycling Without Age sees fit. Its objective was to include and visualize the functional components that the stakeholders desired. The aesthetics and things like names and tab organization may be changed to create an attractive platform when it is built.

Preliminary Action: Further Researching Stakeholder Interest

We recommend that further research be done with stakeholders we were unable to get in contact with to gain a better understanding of their interests regarding the platform. Local trishaw and bike manufacturers, trishaw designers, trishaw part sellers, and chapter representatives are a few that will be a vital part in making the open-source platform and its community thrive. Before building the platform, a critical step is determining manufacturer, designer, and part seller interest. A positive response from most or all stakeholder groups is necessary to ensure the success of the platform.

Open-Source Implementation

There are three primary options for implementing the final website:

1. Completely independent site, not related to CWA
2. Independent site linked to current CWA site
3. Integrated into current CWA site

Option one will require a new website built from scratch, via WordPress or whatever website platform CWA chooses. Creating the website will take funding and it will cost more depending on how many advanced features are included. For example, something like ecommerce would require a lot of back-end work and maintenance. Without this feature, users would not be able to purchase directly from the website, but instead, the platform could take them to a third-party website (such as Christiania Bikes) for purchasing. We recommend that CWA starts with only the simple features, such as directing users to third party sites for purchasing.

Option two would involve building the platform on a different website but would have an obvious connection to CWA's site. This could be through a tab or prominent link on the main CWA website. There would also be links to CWA's main website on the OpenShaw website to link it back as well. It would work similarly to how cyclingwithoutage.com branches off of cyclingwithoutage.org when navigating to USA chapters.

The third option involves renovating the current CWA website and regrouping some of the website tabs. For example, "Getting Started" could include Starting a Chapter, Joining a Chapter, Finding a Chapter, and Becoming a Designer or Manufacturer. While this is the most complex to implement, it would keep everything in one place and make it easily accessible to anyone interested in Cycling Without Age. The following list shows a possible CWA website restructure that focuses on regrouping sections for easy implementation of open source features.

Recommended CWA Website Structure:

- **Home**
- **About Us**
  - SDG
- **Getting Started**
  - Starting a Chapter
  - *Joining a Chapter**
  - *Finding a Chapter**
  - *Becoming and Designer or Builder**
- ***Trishaws****
  - Trishaw Designs
  - *Alternative Trishaws**
  - *Upload a Trishaw**
- ***Community****
  - *User Forums**
  - The Hood
  - Social Media
  - Blog
  - *Find a Designer or Manufacturer**
- **Resources**
  - *How-To Guides**
  - *Video Tutorials**
    - Pilot tutorials
  - *Find a Designer or Manufacturer**
  - Fundraising
  - FAQ

* Tabs and features that are not currently in the CWA website

Prototype Features

Intended Readers: All

Through our data and analysis, we created a concise list of features that we believe will fulfill the stakeholders' expectations of the platform. These prototype features are categorized by different areas of the platform including security, community, and design/build features.

Security Features

Account Creation/Login

Research and interviews have proven that a simple login can deter negative actions like the abuse of free designs or inappropriate usage of community features. Linking an email, full name, and other information about themselves to their public account encourages positive interactions, especially after accepting the CWA Generosity Pledge. This login could be connected to The Hood login process -if feasible- or something else altogether. A link to the login page should be included on both the homepage and the navigation bar so it is always accessible. If the user is logged in when accessing the login page, it should instead route to a profile page where they can edit their information.

A user should be required to create an account or login before using the community forums, commenting on any designs, and before uploading or downloading designs. We recommend that a small profile biography be required to allow for individuals to identify as a member of a specific chapter, as a designer, or a manufacturer. During account creation, downloads, and uploads of designs, users should be required to accept certain user agreements to further encourage positive use of the website.

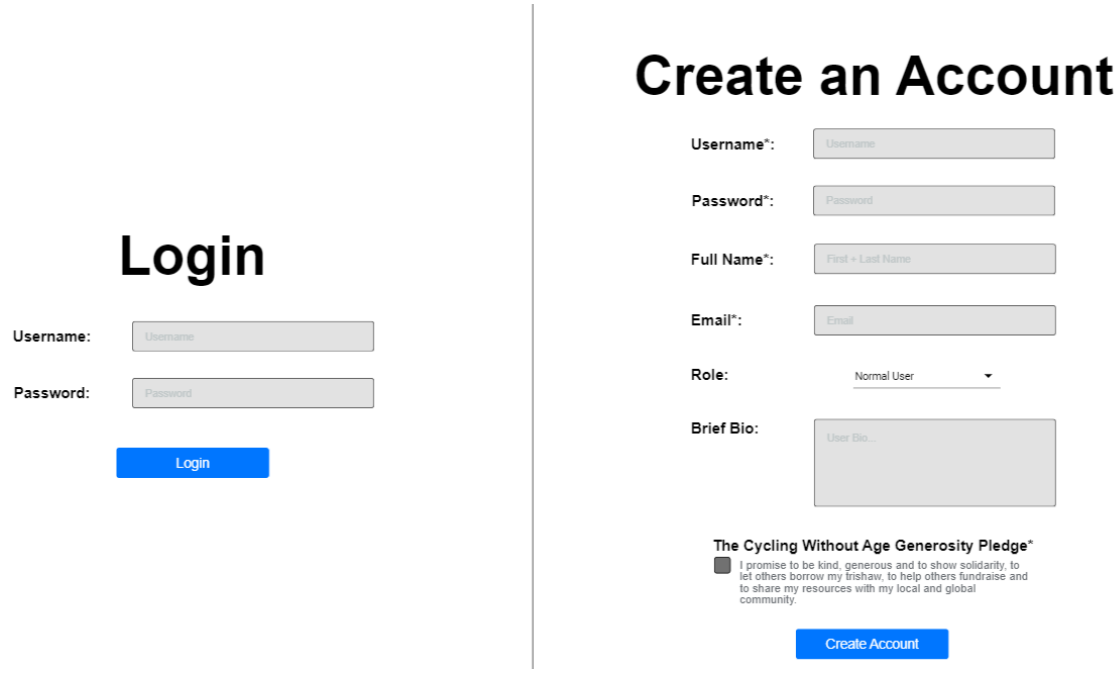


Figure I1 - Platform Prototype Account Creation Page

Community Features

User forums

User forums are the most community-driven feature on the website and will be the source of a lot of useful information. Found on almost all community driven websites we researched, user forums are an integral part of community building and information sharing. This forum would follow standard Internet forum formatting in order to be a well-organized place users can collaborate and share new information with people from all over the world. To make it easier to navigate, several "boards" will be grouped together under a "topic." Within each board, there are individual threads. All logged-in users will be able to start or reply to any thread.

The forum should start with multiple default threads that would encourage collaboration and continuous conversation. Open-ended topics, for instance, are much more successful at producing very active forums. There should also be an option to suggest a topic. Before these suggested topics are actually added to the forums, they would need to be approved by the moderators to ensure they are appropriate and unique. We understand that this feature may be difficult to implement, so we think that incorporating it with the Hood could be used as a temporary or even permanent solution.

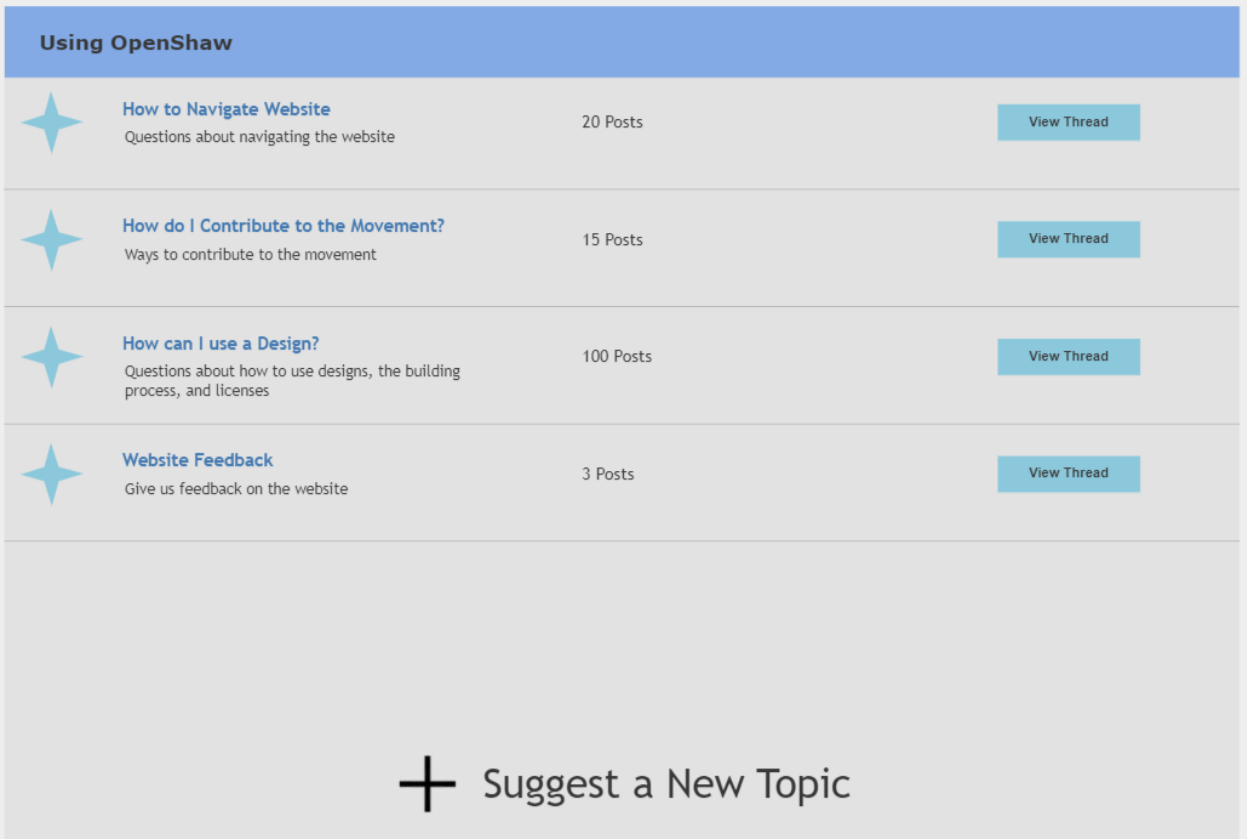


Figure I2 - Platform Prototype User Forum Page

Direct Messaging

One feature that chapters highly requested was the ability to direct message other chapters, builders, or designers. This feature would obviously require some kind of account, whether that be

an OpenShaw Initiative login or The Hood login. While private messaging seems straightforward, implementation can be complicated. We think that the Hood's direct messaging abilities could be used as an easier way to make this feature come alive. A possible issue with this method is that The Hood would need to be expanded to account for designers, manufacturers, and others that would be joining through the website.

Chapter, Builder, and Designer Finder

The ability to find nearby chapters, builders, and designers would allow a user to type in their location to get a list of nearby organizations involved with the OpenShaw Initiative. Each list entry would include the organization name, their phone number, and their address. A helpful map with pins in each location could also be an optional way to implement this kind of feature. Optimally, if a list entry was clicked on, it would lead to the organization's website. The "Find A chapter/builder/designer" page would also include a button on the bottom or side that encourages new organizations to sign up to be on the list.

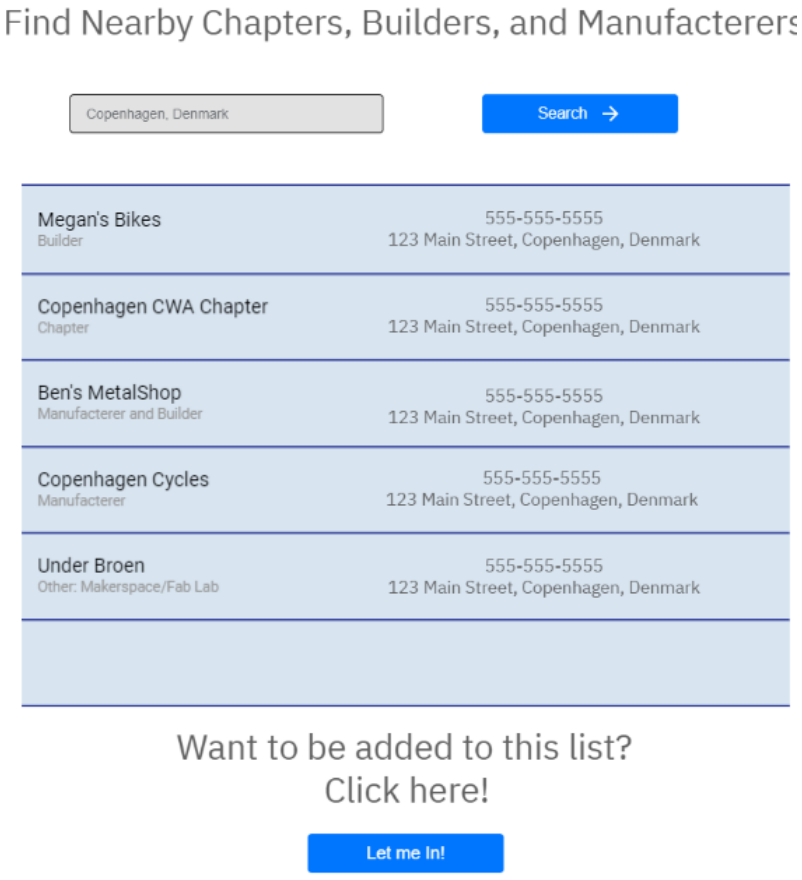


Figure I3 - Platform Prototype Nearby Chapter, Builder, and Manufacturer Search Page

Design/Build Features

Main Trishaw/Alternative Design Pages

With the possibility of many future designs, there will need to be a dedicated page to display them all in an organized way. One option is to have all the designs, whether trishaws or

alternative bike designs, on one page. This would keep everything in one place but would also put all designs on the same level, regardless of quality or type. This may lead to confusion for the users as they try and decipher the differences between designs. Another option would be to separate all trishaw designs onto one page and any other alternative bike designs onto another. This option was favored by Cycling Without Age because it can be used as a method to isolate and draw attention to trishaws, the preferred design of the organization.

In either of these cases, there are a few necessary features that should be included in the main design page(s). When displaying each design on the main page, each should be accompanied by a preview image and the name of the design. This way, users can easily find what they may or may not be interested in. When the user clicks on one of the preview images or names, it should send them to the individual design page for more information (these design pages are described in detail in the next section). Another necessary feature of the main page is the ability to sort or filter results. For example, there could be an option to filter designs by ones that can be built and bought, only built, or only bought. Another example would be the ability to filter designs by ones that are free or ones that have fees associated with them.

The visual design of this main page is essentially up to the creator and CWA preferences. What is seen in the prototype is just one way to display the information, but almost anything could work to effectively contain everything in one place.

Individual Trishaw/Alternative Design Pages

Each trishaw or alternative bike design should have its own page that includes a design description, designer information, build or buy options, easy sharing links, a user-sourced rating function, and user-sourced comments.

The design description should be provided by the designer in the upload process (described in the Design Upload Process section). Similarly, the designer information will be provided by the designer via their website profile. This information will help users decide which design to purchase to best suit their needs.

The build and buy options should be different buttons. The buy option would bring them to the designers website, and the build would bring them to a build page, which would hold how advanced the trishaw assembly is, detailed build instructions, a materials and tools list, and a list of parts that can be bought. Like the descriptions, these buttons are part of the core of the platform's purpose and are non-negotiable.

The user rating function could be a "like" function with a number of likes (maximum one per user), or an average rating out of a number of stars. Ultimately, one of these functions should be able to be used as a filter for finding bikes. Comments can either be formatted like Amazon reviews or YouTube comments, depending on which is found to be most suitable. The ability to comment will give users the ability to leave helpful information for each other and feedback for designers.

The "share" link should automatically copy the design URL to the user's clipboard - alternatively, a popup with various sharing methods (e.g. Facebook, LinkedIn, Twitter) would also be acceptable. This function is less important than the others by far, as it is primarily to make it easier for users to send designs to others.

In terms of the actual trishaw content, we recommend that designers primarily upload designs with parts that are:

A. able to be shipped together in a flatpack
B. pre-assembled
C. simple and easily obtainable through a third-party bike shop or otherwise

The results of the preliminary survey and interviews showed that chapters do not have access to trishaw or bike building equipment, do not have the skillset to build trishaws, and are primarily interested in assembly only trishaws. As such, chapters will mostly be interested in designs that have the necessary parts either on the OpenShaw website, a third-party website, or easily accessible through local bike building. While we do not recommend that CWA restrict their trishaw designs to explicitly easy assembly or flatpacks, we do recommend having advanced bike building separate from the higher-demand bikes.

How-To Section

The How-To section of the website should include how-to articles or videos created by CWA, designers, and/or builders. Ideally, this page will have some way to sort, filter, or search through the how-to materials. When a designer submits a bike design that has the option to be built, they should be encouraged to create a how-to article or video to accompany their design. These how-to materials could include assembly videos, videos showing how to use the bike, or text-based assembly guides. If created, the how-to page(s) will be included in the individual design page. This will make the build process more straightforward for users.

Design Upload Process

Uploading a design will require three pages. First, several fields regarding the design will need to be filled in. We identified that the most important ones include name, type of design (i.e. trishaw versus alternative bike), description, image(s), and whether the design is bought or built. Then, depending on the final choice, other fields will be required. For designs that are purchased directly, they will simply require a link to the buy page and an estimated price before shipping. For designs that are built, they will require design files, a how-to guide upload, an estimated build price, a price for the design (with "free" being an option), and a choice of license.

After these fields have been submitted, the site should bring the designer to an agreements page. It will reiterate the values of Cycling Without Age and any other legal documentation required. The designer will simply need to check off a box and click a button go to the next page.

The final page will simply contain confirmation of submission. Once that has been clicked, the designer will be thanked and returned to the platform's home page.

Miscellaneous Features

While the specific features above are fundamental for the platform, we cannot forget about the miscellaneous features that are essential for any website to function properly.

A home page is the first impression a user will get of the platform, and it is important that this page is aesthetically pleasing, and also provides the necessary information for the user to understand the purpose of the website. As shown in the prototype, this page can be formatted in a plethora of different ways, but we suggest that information about Cycling Without Age, trishaws, and how to get involved in the community be present. Pictures of different trishaws and a definition explaining what a trishaw is would be helpful to new users. We also recommend linking all of Cycling Without Age's social media at the bottom of this page to further publicize the organization.

Components that allow for a smoother user experience should also be prioritized. One important feature to consider implementing is a cart, usually found in the upper right corner of the page. A cart would be helpful for users to keep track of what items they are thinking of purchasing or downloading. The cart would also provide the option for users to purchase or download multiple items at once, instead of checking out one at a time. The difficult part would be implementing the vending through the Cycling Without Age platform. Another option is incorporating a bookmarking method instead. This way users can still bookmark designs they like, but there would be no need for CWA to commit to an ecommerce platform.

Another important interaction is a search feature to make navigating the website faster and easier. This search bar should bring them to a page that shows a list of various tabs that will show them the desired information.

Additionally, offering the users the ability to have notifications allows them to save time when looking for things that pertain to them. Users could customize what notifications they want, whether it be for updates of trishaw parts/designs availability, or direct messages/community forums.

To create better global accessibility, the website and guides should allow for translations, both automatic and sourced by users.

Lastly, having dedicated places for users to go to if they have questions will help diminish any frustrations that may occur. We suggest having both an About Us and Frequently Asked Questions (FAQ) pages. The about us page will go in depth on Cycling Without Age as an organization, why trishaw accessibility is important, and any other important information such as how to contact CWA. The FAQ page will focus on common questions that arose during the first stages of the platform as well as questions that CWA experiences over time. Somewhere on this page we also recommend having a help section where users can write their question if it is not already answered.

Licensing and I.P. Protection

Intended Readers: CWA Administration

When creating an open source initiative, the topic of licensing often arises. Due to the variety of licensing options and the varying open source philosophy, it is in the best interest of Cycling Without Age to give the designers the option to choose their own license. Many people in the open source community believe that any significant restrictions on open source projects invalidates the project even being considered open source. As such, these people generally use licenses that guarantee restriction-free use of their work or any derivative of the work. On the other hand, some designers post their content in open source communities with the intention that people can modify their work to suit their own needs and share their modifications with the community so that it may help someone else. The challenge is that these same designers may want to restrict iterators from commercializing their content or any derivative of it. Although this method does not exactly fit the definition of open source, existing licenses do accommodate for it. The following is a non-exhaustive list of licenses we recommend to give as options to designers.

Creative Commons

Creative Commons licenses are a category of licenses. When choosing a Creative Commons license, the licensor can choose as many or as few of the terms listed on the right to build the license they want. The most commonly used Creative Commons license in the open source community that still follows the terms of the official open source hardware definition would be the Creative Commons Attribution Share Alike License. Anyone that acquires content under this license has the right to modify, build upon, and redistribute a product for commercial or non-commercial purposes. The only requirements are that any derivative content credits the original designer, indicates if/what changes are made, and is licensed under the same terms as the original design.

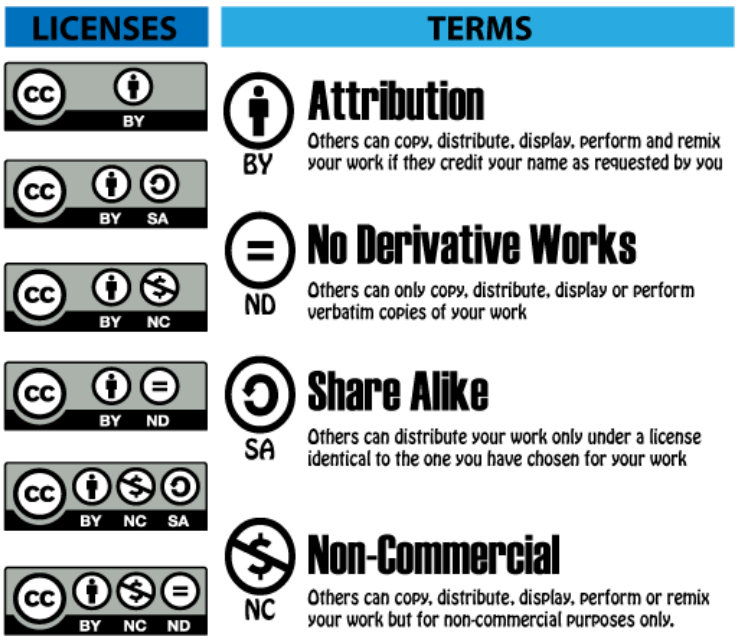


Figure I4 - Creative Commons Licensing Quick Reference (Creative Commons, 2020)

TAPR Hardware License

The TAPR Hardware License is specific to open source hardware. This license guarantees the freedom to share and create with the source hardware and its supplemental materials. More specifically, this license "forbids anyone who receives rights under the OHL to deny any other licensee those same rights to copy, modify, and distribute documentation, and to make, use and distribute products based on that documentation"(TAPR, 2007). It also addresses patent issues that may be a concern when publishing open source hardware by enforcing that "those who benefit from an OHL design may not bring lawsuits claiming that design infringes their patents or other intellectual property" (TAPR, 2007).

Solderpad Hardware License

The Solderpad Hardware license is another open source hardware-specific license. It grants almost identical permissions as the TAPR license but is "permissive", meaning that any derivatives of the hardware can be licensed with a different license.

Note: There are hundreds of open source hardware licenses that are available to designers. The ones listed above happen to be the most popular licenses and as such we would recommend these licenses to designers when they upload content but would not mandate them so that designers can still have control over their intellectual property. If we were to make a more specific recommendation that protected the property of the designer while complying with the official definition of open source hardware, we would recommend the Creative Commons Attribution Share-Alike License.

Website/Community Moderation

Intended Readers: CWA Administration

The final aspect that we believe is key to the success and longevity of the platform is the inclusion of some form of moderating. From the data analysis discussed in depth in our report, we found that all of the stakeholders considered some form of moderating essential, and that community moderating was common among other open source platforms.

Platform moderation gives the platform owner more control. Moderators can oversee user interactions, design submissions, platform updates, and so much more. Moderators prevent the platform from being static and outdated by having the ability to consistently update and change with the community. On a collaborative platform such as this, staying dynamic is more important than ever to accommodate new users or designs and keep current users intrigued.

The responsibilities of the moderators are essentially dependent on the desired level of supervision for the platform. For this platform we recommend that the moderators regulate overall community discussion at the minimum. Whether this be on forums or direct comments, the moderator would ensure that all conversation public on the platform was appropriate and relevant. Improper conduct such as inappropriate language, self-promotion, or posting unrelated content will be addressed in order to keep the platform centralized on its main purpose. Moderators will also discourage any of that behavior as the users will understand there are consequences if they use the platform incorrectly. We believe this will help build a community of dedicated users, as well as keep the platform free from any spam.

Another duty we suggest the moderators have is reviewing the trishaw or alternative bike design uploads. This would ensure that designs meet the safety and quality standards of Cycling Without Age. We recommend Cycling Without Age create a list of the basic requirements a design needs to have to be considered acceptable that the moderators can base their reviews on. Other aspects such as price, materials, and building difficulty should also be reviewed to make sure all the information being published is correct.

One final recommendation we have for moderators is updating the forums regularly. This could be with information of new designs, updates from Cycling Without Age, or anything else applicable to users. This will help support the community aspect of the platform by keeping the users engaged and wanting to come back to see new updates. This can also be a great opportunity to stimulate community discussion and gain feedback on what users want to see next.

Moderating a platform can come in many forms, such as a team of moderators or pre-programmed settings. At this point in time, we believe either option would perform well. However, after researching more about Cycling Without Age's website "The Hood", we found that it was moderated through volunteers and had great success. Looking forward, this may also be a viable option for recruiting a team of moderators. Overall, we believe that in future stages of this platform, some form of moderation would be essential to its longevity.

Closing Remarks

Based on our findings, we investigated what areas of the project could be expanded upon to further enhance the final product. The next few sections detail a set of recommendations for Cycling Without Age's next iterations of the platform.

Refining Guidelines

Although our guidelines and wireframe prototype showcase several recommended interactions for the final open source platform, they are by no means exhaustive. As such, more features will likely be needed, and what we created will need to be continuously iterated on. While our team cannot predict or provide the specifics of what may be added, we fully understand the likelihood of the entirety of our prototype being changed in the future.

It is also crucial to continue improving upon the platform based on any further feedback from stakeholders - especially manufacturers, designers, and consumers. We recommend that Cycling Without Age keep an open line of communication between themselves and all users of the platform. Using their thoughts and opinions to improve the platform past our guidelines and recommendations is essential to its success.

Expanding Community Reach

Finally, it would be prudent for Cycling Without Age to expand their social media presence in order to gain more platform traction. In a FarmBot interview, it was stressed that much of FarmBot's success was due to an active social media presence across many mediums. By posting on various other places frequented by others, Cycling Without Age can both expand in general as well as spread the use of the open source platform. This expansion will allow the community to grow even faster, further increasing trishaw accessibility around the world.