



Creating a Sustainable Business Model for Open-Source Trishaw Designs

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Abstract

Cycling Without Age (CWA), a non-profit organization with the goal of aiding the elderly, sells and distributes trishaws to their community and customers/chapters. Trishaws are cycles with a carriage in the front for passengers to sit. A challenge to CWA is that trishaws are not affordable in the Global South. A sustainable, open-source business model and a test of that business model were created to help CWA address this problem. These outline how CWA locations can choose available trishaw designs to build locally through different open-source options, based on the resources available to them.

Executive Summary

Cycling Without Age (CWA) is a non-profit organization that helps the elderly community get out and enjoy their surroundings through trishaw rides. A **trishaw** is a cycle that has one wheel in the back, and two wheels in the front, as well as a two-person carriage in front for the elderly to sit and enjoy the view while a volunteer pedals the bike around. Cycling Without Age's mission is to create happiness among elderly citizens by providing them with an opportunity to remain an active part of society and the local community.

At present, **most trishaw models are made in Europe** and sold by vendors to CWA chapters. CWA works with some vendors and receives a small stipend from trishaw sales. These funds help to support the mission of the organization. This process works well for chapters in **more developed countries or regions that can typically raise the \$7,000-\$12,000 cost** of popular trishaw models. In developing countries, costs at this level represent a significant barrier in acquiring a trishaw. The cost of shipping trishaws from northern Europe to other parts of the world remains a substantial component in the overall cost of trishaws.

Currently, Cycling Without Age has 2,200 chapter locations, and **about 730 chapters, or one-third of the total, are inactive, meaning they do not have a trishaw**. Our team surveyed inactive affiliates, mostly in the **Global South**, and found that the cost of commercial trishaws was prohibitive, when they **could afford to pay \$350-\$3,000 for a trishaw**. The map below in Fig. 1 shows the locations of affiliates that we surveyed. **We want to make trishaws more accessible to these locations and others in the Global South, by developing and implementing an open-source manufacturing plan.**



Figure 1: Map of Potential Open-Source Customers

Open-source manufacturing is when a design can be shared online for those all over the world who have access to download and build the design themselves, with local materials, tools, and workers. This process of **sending blueprints or components, rather than the finished**

product itself, promotes sustainability and local economic development in these developing countries. It also typically has the added benefit of a decrease in cost as compared to shipping the fully assembled product. Our team also determined that **an open-source approach could make trishaws available to these chapters at a cost closer to \$600-\$2,500**, rather than the current \$7,000-\$12,000. **An open-source approach could ultimately increase the number of active chapters in the Global South.**

Our goal was to make trishaws more accessible in developing countries and regions to promote happiness, sustainability, and local economic development. In order to improve the lives of older adults who can no longer cycle on their own, we worked with Cycling Without Age to **develop a business plan for open-source designs for trishaws** (called “openshaws”) that will enable CWA chapters to utilize the talents of local designers, builders and maker spaces to produce a trishaw that is both affordable and sustainable. To achieve this goal, we focused on four objectives:

1. Identify key principles and success factors of current open-source initiatives for trishaw designs
2. Research and analyze the process of making a trishaw
3. Research and design a successful sustainable plan, following an open-source initiative, for trishaw design, manufacturing, and distribution
4. Design a test of our sustainable business plan with perspective designers, manufacturers, and maker spaces for trishaws

Through researching and networking, we found several **open-source manufacturing initiatives** and reached out to all of them. We interviewed Opendesk, FarmBot and Open Robotics to find out about their initiatives and determine which factors helped their organizations in becoming more successful and which inhibited success. From there, we compiled and ranked all reported **success factors** in order to incorporate them into our open-source plan. We also considered overall success factors of existing business models (listed in Appendix H), the difficulties we could face when trying to integrate the open-source plan with many different countries, and the integration of certain aspects of CWA’s current processes. Additionally, we created a list of key principles for the business model in order to account for the organization’s hopes and goals for the project.

Incorporated into the business model were key factors such as royalties, the CWA mission, and key partners and the benefits of this project for them. We hope for there to be royalties involved with the downloading of designs, in order to increase design security and also provide revenue for the designers, as well as some profit for Cycling Without Age in order to help them sustain their mission. As stated in the principles, this project will strive to promote sustainability and local economic growth. Through this and through increase of accessibility and cost efficiency of trishaws in the Global South, Cycling Without Age’s mission will be shared in as many locations as they can reach. This not only helps the potential chapter locations and the

new open-source designers, but also helps the current manufacturers and chapters by promoting trishaw sales and involvement with Cycling Without Age as a whole. This full business model is shown in Appendix J.

While brainstorming the limitations of our project and the difficulties we could face when applying the plan to different countries, we realized that not every country is going to want to take part in this plan and, for those countries that do, not all will have the resources to be involved in a full open-source plan. To address these challenges, **we decided to gauge the levels of open source on a spectrum, with four different open-source options.** These different options chosen to be analyzed are: **completely** open sourced, **partially** open sourced, open sourced through **hubs sending in flat packs**, and open sourced through **hubs sending fully assembled trishaws**.

These options would be tested with chapters depending on their resources and the feasibility of the option in their location. The first option, manufacturing a completely open-sourced trishaw, consists of a chapter only being sent a trishaw design, a list of parts, and an instructional aid explaining how to build a trishaw. Completely open sourcing entails that chapters will need to work with local professionals to build frames, carriages, and other components that they wouldn't be able to make themselves in their own space. Partial open sourcing is similar to the previous option explained, except certain components that couldn't be locally sourced would be sent along with the design and the instructional aid.

The next options, **open sourced by sending trishaws in flat packs and open sourced by sending fully assembled trishaws, make use of localized manufacturing hubs** that will send trishaw models to nearby chapter locations. A hub would be a location or two on each continent that would ship the needed parts to other open-source chapters on that continent or within a close proximity to that continent. Chapters would have the choice to receive their trishaw models either in flat packs, which consists of a number of separate pieces being sent in boxes needing local assembly with the help of an instructional aide, or they can receive their trishaw fully assembled, which would require little to no aid at all. We also made an informative pamphlet for potential customers, explaining why this would be a good option for them and how they can be a part of the initiative. This pamphlet is shown in Appendix K.

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Figure 2: Test Parameter Selection

To test this business model and the four open-source options previously mentioned, we decided to run **two beta tests**. Due to the broad scope of the project, we chose to focus on areas that had an interest in the project. The **areas selected for the test are South America and Central America**, as shown in the circled area of Fig. 2, above. These areas were chosen for a few major reasons. First, we checked which areas had potential chapters in developing countries that were interested in getting more affordable trishaws. Second, we looked for **potential designers and manufacturers located in the area that had an interest in the project, such as Lester Bikes in Argentina who agreed to work as a hub location** (teal pin). Third, we looked for potential chapters in the chosen area that were interested in participating in a test, such as the **potential chapters in Peru and Panama** (white pins). South America and Central America were chosen due to interest and the resources needed for the test.

Through interviews and surveys, we compiled a list of **ten factors to consider when a chapter is choosing which test option is best** for them. These factors were rated against each option as shown in the first matrix in Appendix L. For the current tests, two main factors were considered. The first factor considered was the resources available, such availability of local bike manufacturers or similar who could help with the process and the accessibility of materials and parts needing to be bought locally. A second factor considered was the level of experience those in the chosen potential chapters have and how much time they are looking to put into creating their trishaw.

Through the knowledge we gained from our interviews with affiliates in Peru and Panama (interview summaries in Appendix B), we were able to **determine which test options worked best for the potential chapters in Peru and Panama**. Because Jose Rey Sanchez from **Peru** expressed his interest in manufacturing parts, yet is not currently living there, it was recommended that he start with the open-source **option of “Partially Open Sourced.”** This option would give him the opportunity to manufacture the parts that can be sourced and made locally and also have the flexibility of getting the rest of the parts from Lester Bikes.

From the **Panama** potential chapter heads, Allen Candanedo and Federico Herrera, we learned that there are no manufactures or bike shops in the area where they would be able to get parts locally. So, for their test location, we recommended the open-source **option of “Open Sourced Through Hubs Sending in Flat Packs.”** This option would allow them to get all the parts needed shipped to them, and, although the trishaw parts would not be manufactured in their country, it would still be assembled locally and the parts would be manufactured more locally than the ones manufactured with the current CWA process.

Looking forward, there is still much that can be done before the beta tests occur. Some steps include creating a bill of materials, planning the structure and a timeline for completing the tests, determining the success factors for the tests, and designing a safety check to deem that the beta test open-source trishaws are safe to use. Once these prior steps are completed, the tests may begin. While the tests are proceeding, the test locations should record their progress and processes and have biweekly meetings with Cycling Without Age to update them.

Once these beta tests are concluded, the open-source business model can be refined based on the results of the tests. While the beta test is conducted and the business model is refined, it would be best if an online platform could be created for accessing open-source designs. Using this platform, affiliates of the open-source project can download and build designs locally that were posted by future Cycling Without Age open-source designers.

Once the platform and refined business model are finalized, more tests should be run in proximity to the current testing locations to ensure the functionality of the model and platform. Once everything is confirmed to be successful in these areas, it will enable CWA to expand its program and will provide a potential model that can be replicated in other parts of the Global South.

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Reviewed by all team members

1. Introduction

Cycling Without Age (CWA) is an international non-profit that helps older adults thrive, both mentally and physically. The organization was founded in 2012 by Ole Kassow in Copenhagen with the help of Dorthe Pedersen (Comai, 2014). CWA provides opportunities for residents in nursing homes to be social and feel the joy of “wind in their hair,” through free rides (The right to wind in your hair - Cycling Without Age, 2015). Cycling with others creates a strong connection between generations and an overwhelming sense of fulfillment and understanding. Cycling Without Age tries to nurture these connections through the interactions of the pilots (those who drive the trishaws) and the trishaw passengers. Trishaws are cycles with a carriage in the front for passengers to sit. After the United Nations (UN) created the Sustainable Development Goals (SDGs) in 2015, Cycling Without Age identified three SDGs as particularly important for their mission—Health and Well-Being, Reduced Inequalities, and Sustainable Cities and Communities. CWA implements these SDGs in each of their guiding principles: generosity, slowness, storytelling, relationships, and “without age”, meaning that age is not a factor in participation (How CWA works with the Sustainable Development Goals – Cycling Without Age, 2019).

At present, most trishaw models are made in Europe and sold by vendors to CWA chapters. CWA works with some vendors and receives a small stipend from trishaw sales. These funds help to support the mission of the organization. This process works well for chapters in more developed countries or regions that can typically raise the \$7,000-\$12,000 cost of popular trishaw models. Locations in Northern Europe remain the place of manufacturing for most trishaws. The cost of shipping from this area remains a substantial component in the overall cost of trishaws. However, for developing countries, costs at this level represent a significant barrier in acquiring a trishaw due to funds being less readily available. About 730 CWA chapters are still fundraising for a trishaw (Kassow, 2020c).

Previously, CWA has tried to improve their process by enlisting designers to create more sustainable designs, however, most of these designers had difficulties with the scope of the project (Kassow, 2020c). Other methods, such as implementing sustainable protocols, communicating with manufacturers, or simplifying distribution processes, are steps that CWA could investigate to reduce the gap between these countries and accessible trishaws (Mueller, 2011). CWA is working to make additional models which would be more accessible, and the organization has proposed making trishaws with open-source designs, so that chapters in developing countries can make trishaws locally. With the help of a sustainable business model, open-source trishaw designs, and collaborative maker spaces, Cycling Without Age can make large strides in providing greater access to trishaws. Due to the COVID-19 global pandemic, some of our process and results had to be adapted due to the current climate of the world in order to achieve our goal. Our goal is to make trishaws more accessible in developing countries and regions to promote happiness, sustainability, and local economic development. In order to improve the lives of older adults who can no longer cycle on their own, we worked with Cycling

Without Age to develop a business plan for open-source designs for trishaws that will enable CWA chapters to utilize the talents of local designers, builders and maker spaces to produce a trishaw that is both affordable and sustainable. To achieve this goal, we focused on four objectives:

1. To identify key principles and success factors of current open-source initiatives for trishaw designs
2. To research and analyze the process of making a trishaw
3. To research and design a successful sustainable plan, following an open-source initiative, for trishaw design, manufacturing, and distribution
4. To design a test of our sustainable business plan with perspective designers, manufacturers, and maker spaces for trishaws

2. Background

As people age, health and wellbeing become more important. Often elderly people with the poorest health will end up in nursing homes (Russel, Cutrona, de la Mora, & Wallace, 1997, pp. 574-589). In efforts to improve mental and physical health, many nursing homes will give their residents options of different programs and activities to engage in, in order to be social and build relationships (Diane, 2018). Some nursing homes even collaborate with outside organizations, such as Cycling Without Age, to help host these activities. Cycling Without Age has created a volunteer program that provides trishaw rides to residents while striving to keep them integrated with their communities. These trishaws are unique, because they provide a tailored experience to both the resident passengers and the drivers. They are built through companies scattered around the world, utilizing a variety of manufacturing processes. As part of this process, materials and parts are shipped from company to company.

A common solution to helping businesses run smoothly is to implement a business plan. Business plans help to keep companies and organizations on track and ensure that everything runs smoothly. There are several different structures of integrating an open-source initiative into a business model. An open-source initiative allows designers from around the world to share their designs with those to whom they give access, so that the designs can be made anywhere with local parts. CWA is working to make its processes more sustainable and inclusive.

2.1 Cycling Without Age

In nursing homes, residents who are unable to build and keep up with meaningful relationships can end up feeling very lonely (Paque, Bastiaens, Van Bogaert, & Dilles, 2018, pp. 1477-1484). Feelings of isolation creates greater risk of cognitive impairment, physical illness, and a shorter lifespan (Reach out! socializing improves health, mood, and mental acuity: Interaction with others helps ward off cognitive decline and depression and promotes physical and mental wellbeing, 2014, p. 3). However, going outside and spending time in nature can decrease this risk, possibly because the outdoors can decrease stress, promote the restoration of attention, and evoke positive emotions (Sommerhalder, Abel, & Abraham, 2009 and Wells, 2000). Magnitude of social relationships can also improve health (Fiorillo & Sabatini, 2011, pp. 1644-1652). Overall, mental health of older adults can be improved when they are able to have time outdoors and create relationships

Cycling Without Age was created to give older adults in nursing homes the opportunity to experience cycling without the dangers of doing so themselves (Comai, 2014). CWA dreams to help older adults become happier and more active members of society as passengers on trishaw rides. Trishaws give them options to get out of their nursing homes and experience the city in a similar way to when they were young. Most passengers' moods become more positive after each ride. In turn, these rides often have a positive effect on the volunteer cyclers known as

pilots; giving them new perspectives of the cities they cycle through and life in general. Relationships often will form between passengers and pilots, who can be a generation or two younger (*The right to wind in your hair - Cycling Without Age, 2015*).

CWA's message has been established in 2,200 chapters, local volunteer groups of CWA members, in 47 countries. Of those 2,200 chapters, two thirds are "active," which means they currently possess a trishaw; the remaining third of chapters (730 chapter) is currently fundraising for a trishaw (Kassow, 2020c). This is demonstrated in Fig. 3 where the turquoise represents chapters with trishaws, the gray represents a chapter fundraising for trishaws, and the red "cups" represent coffee shops that are affiliated with CWA.

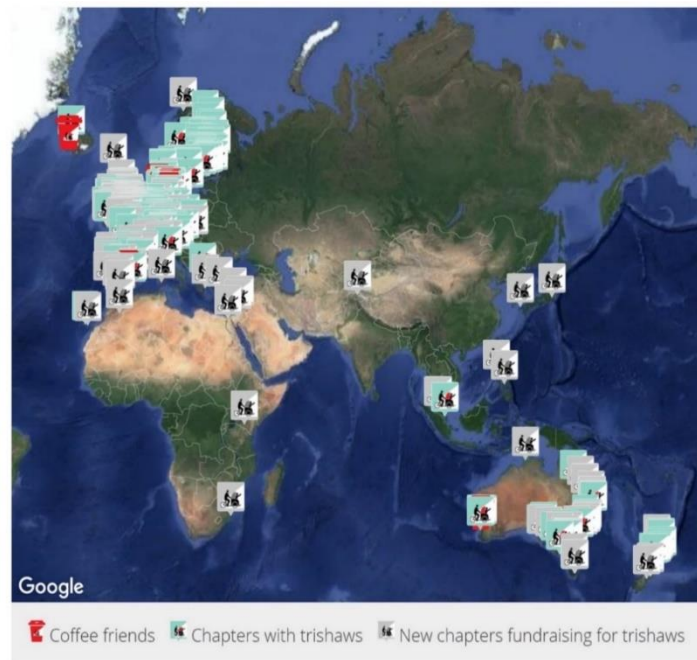


Figure 3: Partial Map of CWA Chapters (The right to wind in your hair – Cycling Without Age, 2015)

Although there are many chapters all over the world, they are predominantly located in North America and Europe in countries with larger economies. As shown in Fig. 12 in Appendix D, there are not many chapter locations in South America, Africa, and parts of Asia, and the few chapters in those regions tend to still be funding for trishaws. The low number of trishaw sales in these developing countries is most commonly due to a lack of funding, resources, and awareness of the organization.

2.2 Trishaw Designers and Manufacturers

The trishaw originated from the becak, an Indonesian incarnation of the ubiquitous pedicab, or cycle-rickshaw. The becak is a pedal powered bike with three wheels and a passenger

seat. It is the descendant of the original hand pulled rickshaws that originated in 19th Century Japan (Admintih, 2016). Trishaws are very similar to the commonly known bike, which is a human or motor powered, pedal driven, single track vehicle, having two wheels attached to a frame, one behind the other, whereas a trishaw can be human powered or motor assisted and has three wheels attached to a frame, with one in the back and two in the front (Definition of bicycle | dictionary.com and CYCLE RICKSHAW | definition in the Cambridge English dictionary). A trishaw requires a driver that pushes along a carriage attached to the front which seats one or two people. One model is shown below in Figure 4.



Figure 4: Mode T by Christiania Bikes, Ridden by CWA Founder, Ole Kassow (Velojoy, 2015)

CWA is synonymous with trishaws, being the only international non-profit organization, we have identified, after thorough search of scholarly and non-scholarly resources, that provides trishaws all around the world. Van Raam, Niels Holme Larsen, Christiania, Triobike, and Cycles Toussaint are designers and manufacturers of the current five models of trishaws that CWA provides. Their models are respectively The Chat, Nihola Taxi, Model T, Triobike Taxi, and Ami (Trishaws for Cycling Without Age - Cycling Without Age, 2018). Trishaw parts are made by partner manufacturers with either local or foreign parts from other companies in different parts of the world.

Assembly of the Ami trishaw model is similar to a building kit. All the parts are already manufactured and shipped together in flat packs. It is then assembled on site or by a mechanic with the help of an instruction manual. Based on destination of a shipment, the Triobike is shipped as one part or two parts. When shipped as two parts, it is first sent to a bike mechanic to be assembled before the final delivery. All other trishaw models are manufactured and completely assembled before shipping. Also depending on the location, shipping costs vary (Copenhagen cycles, n.d.). For developing countries, this cost of shipping can mean the

difference between becoming an active chapter or not. One solution to this high cost is assembly in local bike shops or maker spaces.

A maker space is a collaborative workspace that can be inside a library, university, or a separate public or private facility for learning, exploring, creating and sharing (What is a makerspace?, n.d). They can have a variety of maker equipment including laser cutters, 3D printers, computers with design software, soldering irons, computer numerical control (CNC) machines, and even sewing machines. Despite the advantages of having high end maker equipment, a maker space does not need to include all these machines or even any of them to be considered a makerspace. Maker spaces can utilize hand tools, wood working machines, metal & forging tools, and other hands on methods. There are academic maker spaces such as the Georgia Institute of Technology Innovation Studio that focus more on student and research projects and community makerspaces such as Fab Lab El Paso that allows the local community access to fabrication tools and other resources for creative collaboration, product manufacturing, and learning new skills.

2.3 Open Source

An open-source initiative means that a resource is available for anyone with access to use. Open-source manufacturing is done with the purpose of increasing sustainability and local economic development. In most cases, when an idea is open sourced for manufacturing, it means that the idea can be implemented anywhere, rather than just in the location of its design. This means fewer shipments need to occur, making the earth greener. Many organizations pride themselves on taking part in this initiative, as their processes can help to improve the whole world.

Many organizations following open-source manufacturing initiatives have very similar processes. The typical process starts with the sharing of designs. Some designs are put online to be downloaded for free, many have a price for download, others are request only, and a handful are only shared with a specific group. Independent of the retrieval process, once the manufacturer has the design, they can use their own tools and materials to make the hardware item. The saying, “It is easier to ship recipes than cakes and biscuits”, has been attributed to John Maynard Keynes (It is easier to ship recipes than cakes and biscuits, 2017). This process, not involving any shipping, is much more sustainable. The local making of hardware also promotes local economic growth and local jobs.

If CWA were to successfully implement an open-source initiative, not only would they be more accessible, but the organization would be more sustainable. Designers all over the world working with CWA would post their designs to the CWA site for chapters everywhere to build. For them, this might mean that anyone on the internet can use the designs or it may mean that just CWA affiliates could view them. Once a chapter selects a design that they like, they can

obtain the needed parts locally, rather than getting the parts shipped in from across the world, as it is happening right now (Kassow, 2020c). This would greatly reduce the cost of each trishaw, because the chapter would not need to pay for nearly as much shipping. Each chapter's manufacturers could then build the trishaw design themselves. With the reduction of shipping and the use of materials and manpower all over the world, sustainability and local economic growth would be greatly increased.

2.4 CWA's Current Business Model

A business model is designed to help make a business operate more successfully. This design is made to help them identify sources of revenue, clientele, products, and details of financial matters (Rouse, 2013). CWA is a nonprofit organization and self-funds through their operations and soliciting donations (What does CWA do with the money it raises? - Cycling Without Age, 2016).

For volunteers to start a chapter, they must sign an affiliate form. For the chapter to become active, it must buy a trishaw, which the volunteers do through fundraising. CWA not only profits from fundraising, but also from getting a fair portion of trishaw sales and membership fees. There are different membership fees for different country chapters, in which some of these membership fees are mandatory. Chapters are also able to join other memberships to be able to get specific local benefits. The membership fees cover aspects such as insurance for the chapter in respect to factors such as trishaw rides (Kassow, 2020b).

CWA also receives revenue from approved trishaw manufacturers that sell trishaws through their websites. A small portion from every bike they sell goes to CWA as a donation. As part of CWA's current process, there are two main types of donors which are the all-profit contributors and regular contributors. An all-profit contributor, for example, would be Copenhagen cycles because all their profits they make go toward CWA. A regular contributor would be a seller that donates a certain percentage of the money per every trishaw sold to CWA. There are also distributors that sell trishaws, but they do not give any percentage of their profit back to CWA (Trishaws for Cycling Without Age – Cycling Without Age, 2018).

In order to open source CWA's business model, licensing must be considered. There are different levels of open sourcing that consist of open-source licensing and open-source dual licensing. Open-source licensing, or approved software copyright licensing, permits developers to rearrange and share the original code it is made from. The open-source dual licensing allows vendors to make their software under an open-source license as well as under a different model involving a fee (Comparing open source vs. licensing vs. Open-source dual licensing models, 2016). These are all options that CWA could explore while creating their open-source initiative.

3. General Methodology

The ultimate goal of Cycling Without Age is to improve the lives of older adults around the world who can no longer cycle on their own. In order to accomplish this, trishaws need to be more accessible by decreasing the price and increasing the locality of their production. We worked with Cycling Without Age to develop and implement an open-source plan through local maker spaces, designers, and builders to reduce the price and production time for trishaws, as well as increase sustainability and local economic development. To help us achieve this goal, we created the following four objectives:

1. To identify key principles and success factors of current open-source initiatives for trishaw designs
2. To research and analyze the process of making a trishaw
3. To research and design a successful sustainable plan, following an open-source initiative, for trishaw design, manufacturing, and distribution
4. To design a test of our sustainable business plan with perspective designers, manufacturers, and maker spaces for trishaws

CWA is based in Copenhagen but has chapters all around the world. Our research was conducted through interviews and analysis of CWA affiliates to understand opportunities, needs, and challenges regarding trishaws. We looked at potential chapters in developing countries who were interested in possibly taking part in this open-source initiative. The main difficulty of our project was the presence of the COVID-19 pandemic during the time of research and implementation. The occurrence of this pandemic meant that the entirety of the project had to be done remotely. This was especially difficult when trying to contact different organizations and resources, as the majority of people were more focused on their health and safety than this.

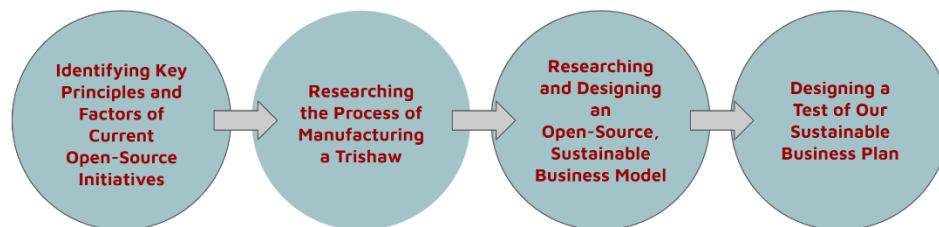


Figure 5: Sequence of Objective Implementation

The following sections describe the methods we adopted to achieve each of the objectives listed above in Fig. 5.

4. Identifying Key Principles and Factors of Current Open-Source Initiatives

Open-source initiatives can be applied to software, as well as manufacturing. When it comes to software, the Open Source Initiative (OSI) non-profit corporation gives a good sense of what open-source software is all about. OSI “enables a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is higher quality, better reliability, greater flexibility, lower cost, and an end to predatory vendor lock-in” (Opensource.org, n.d.). While some of the key principles of open-source software do appear in open-source manufacturing, the processes are not quite the same. The difference between open-source software and open-source hardware is that software is digital, typically free, and easily available, while hardware is physical and requires time, effort, and money to provide to others (Villum, 2020).

4.1 Methodology

In order to identify key principles and factors of open-source initiatives, we interviewed many different organizations with this initiative. All available information on each organization was used to assess their levels of success. This was done in order to assess which factors contribute to creating a successful open-source initiative and which restrict this from happening.

4.1.1 Identified and Interviewed Open-Source Initiatives

One open-source manufacturing initiative that had been recommended to review was Opendesk. We got into contact with this organization to ask if they knew of any similar organizations and researched other open-source manufacturing organizations. We interviewed as many open-source manufacturing organizations as possible over video calls. We asked the questions in Appendix A in order to get their perception on how successful they are and what factors make them successful. These interviews were semi-structured, rather than structured or unstructured. While structured interviews leave little room for follow-up questions and unstructured interviews do not typically consist of preset questions, semi-structured interviews consist of a list of general questions to ask that have the freedom to branch into other questions. We believed that semi-structured was best for us, because while talking to these organizations, we had some specific information that we wanted to obtain, but we also wanted to be able to hear about specific examples and for the subjects to be able to expand on their answers. In general, an interview was preferable over other methods, such as surveys, because we wanted to talk to a select group of organizations to get their expert responses.

4.1.2 Analyzed Organizations' Websites and Public Information

For each organization interviewed, we looked at factors such as their social media presence and web traffic in order to assess ourselves how successful they are. Social media platforms that were used to assess success were Facebook, Instagram, Twitter, and YouTube. We recorded how many followers or subscribers each organization's account had for each platform. Web traffic was assessed by looking at how many monthly visitors each organization's website had using a software called "SimilarWeb" provided by the Crunchbase website. This website also gave values for how money much a few of the organizations raised through crowdfunding.

4.1.3 Analyzed Interview and Research Results

With the results from both our online research of public information about each organization and the information organizations gave us during our video interview, we had enough information to form conclusions on what makes a successful open-source manufacturing company successful. We were able to assess how successful each company is by comparing the results of our online, public information research and their perception of their success. From there, we analyzed which factors contributed to each organizations' success and which factors halted their successes. We finally analyzed the interview results to see if there were any common success factors reported among multiple organizations. We considered the reported success factors of all seemingly successful organizations.

4.2 Results and Analysis

4.2.1 Shortlist of Initiatives

Through email conversations with Opendesk, several other open-source hardware initiatives were brought to attention. Online searches using keywords, such as "open-source hardware" and "open-source manufacturing" resulted in us discovering several other organizations following an open-source manufacturing initiative. Through researching the website of each organization found and looking at their processes, we confirmed which organizations were in fact using an open-source initiative for their hardware products:

- Opendesk
- Open Source Beehives
- Farm Bot
- Open Source Ecology
- RepRap
- Turtle Bot

- Fritzing Labs
- Local Motors
- Sensorica
- Medtronics
- BMW Innovation Lab
- MIT Emergency Ventilator (E-Vent) Project

We reached out to each of these organizations to see who would be willing to be interviewed by us in order to determine the success factors of their open-source manufacturing initiative, and the following agreed: Opendesk, FarmBot, and Open Source Beehives. Turtlebot referred us to Open Robotics, an open-source software organization, who also agreed to be interviewed. While the Open Source Beehives organization also agreed to be interviewed, an interview never occurred due to a drop in communication, possibly due to world conditions. Interviews were held with Opendesk, FarmBot, and Open Robotics.

4.2.2 Analysis of Success Results

Through following methods described in Section 4.2.2, we were able to determine the success of each organization interviewed for the purpose of supporting their reported success factors. Based on social media presence, it appeared that Opendesk and FarmBot were both extremely successful, while Open Robotics was not as seemingly successful. While looking at web traffic statistics, it seemed as though Opendesk and Open Robotics were both very successful, yet it did not seem FarmBot was as successful in this aspect. In regard to crowdfunding, it seemed that FarmBot was the most successful, with Opendesk following behind, and Open Robotics being the least successful as compared to the other two organizations. Results of the analysis of success based on social media presence, web traffic, and crowdfunding values are shown in Tbl. 1 below.

Table 1: Quantitative Open-Source Success Analysis

Organization	Instagram (number of followers)	Facebook (number of followers)	Twitter (number of followers)	YouTube (number of subscribers)	Web Traffic (number of monthly web visitors)	Value Raised in Crowdfunding (USD)
Opendesk	16,800	13,306	8,560	1,880	24,193	381,000
FarmBot	17,200	118,000	3,735	11,900	628	813,000
Open Robotics	N/A	N/A	9,500	N/A	11,002	N/A

Sources: Opendesk.cc.; Open Robotics; FarmBot | Crunchbase; [@farm.bot], n.d.; FarmBot, n.d.a; FarmBot, n.d.b; FarmBot [@farmbotio], n.d.; Open Robotics [@OpenRoboticsOrg], n.d.;

Opendesk, n.d.a; Opendesk [@open_desk], n.d.a; Opendesk [@open_desk], n.d.b; Opendesk Info, n.d.

(FarmBot and Opendesk social media numbers retrieved April 1, 2020; FarmBot and Opendesk web traffic and crowdfunding numbers retrieved April 3, 2020; Open Robotics data retrieved April 9, 2020)

Based on these results, it appears that all three organizations are successful in different areas, so each of their success factors will be considered. However, due to Open Robotics being an open-source software organization, rather than hardware, the reported factors from Opendesk and FarmBot were considered first.

4.2.3 Success Factors of Open-Source Initiatives

After interviews with Opendesk, FarmBot, and Open Robotics (summaries of outcomes shown in Appendix B), many success factors were determined. Overall, if a factor was reported by more than one organization or seemed to have a greater impact on an organization, it was considered more important. The goals of the project were also considered while ranking success factors, in terms of what seemed to pertain most to the project. Using these considerations, the following list of success factors were compiled from most to least important:

1. Ensure design security
2. Make the project feasible
3. Have the right people behind everything (motivated potential chapters, designers, manufacturers, and affiliates)
4. Have the right opportunity and market
5. Network and continuously give updates
6. Always have designs available and engage with community about them
7. Consider how many people working in each location and overall range of coverage
8. Have investors
9. Have experience with the product
10. Stay more focused on the impact and quality of the project, rather than the amount of revenue

These open-source initiative success factors seem to be extremely relevant to the project. We believe that though considering each of them in the business model and the future of the project, they will ensure the highest amount of success for this initiative.

4.2.4 Evaluation of Success for Cycling Without Age's Open-Source Plan

Through discussions with Opendesk, FarmBot, and Open Robotics and analysis of our ranked success factors for open-source initiatives, we compiled a list of factors for Cycling

Without Age to take into account while analyzing their own success of their open-source initiative in the future. These factors are as follows:

- Number of open-source customers
- Conversations and relationships with customers
- Social media impact
- Amount of profit made for Cycling Without Age
- Overall open-source trishaw sales

We believe that a good goal in terms of open-source trishaw sales would be to have five completely open-sourced trishaws manufactured within a year from the time the first design is sent. Hopefully, these trishaws will be made in a variety of countries. We believe that if Cycling Without Age is able to determine their goals for each of the other factors, they will be good measures to look back at and keep track of their analysis of their own success.

5. Researching the Process of Manufacturing a Trishaw

Trishaws are very similar to a pedicab that are bike drawn carriages found around the world. Unlike the pedicab, the trishaw carriage is in front of the bike allowing the passenger to experience a ride without their view blocked by their driver. Trishaws also allow a closer proximity of the driver and passenger to have more personal conversations and relationships.

5.1 Methodology

We analyzed the processes and factors that would be necessary for building an open-source trishaw for Cycling Without Age and designed and tested an open-source, sustainable business model specifically for trishaw designs. In order to best create a business model that incorporated the typical process of trishaw distribution, we researched how the designs are created and submitted, how these designs are approved, how CWA manufactures and others make trishaw parts, and the tools and methods needed to assemble a trishaw.

5.1.1 Researched How Trishaw Designs are Created

First, we contacted the current designers that are partnered with CWA. These designers are the creators of CWA's current five models: The Chat, Nihola Taxi, Model T, Triobike Taxi, and Ami (trishaw models shown in Fig. 7–Fig. 11 in Appendix C). We reached out to all available CWA and independent designers with predetermined questions about the tools they use to create their designs, the process of designing a trishaw, any difficulties they experienced, and specifications for their designs (as shown in the questions in Appendix A). Then, after we interviewed these designers, we analyzed the creative engineering process that each designer used for their specific trishaw. With this information, we determined the key elements of a trishaw for its users and the trishaw's important functions.

5.1.2 Analyzed the Process of Approval of a Trishaw Design for CWA

Most organizations, when they need to approve a design for mass production, have certain criteria, safety regulations, and guidelines to follow. We were unsure of the exact procedures CWA follows when approving trishaw designs, so we the organization with questions about necessary processes for design approval. These questions ranged from “How universal can a design be in terms of safety regulations?” to “What format should designers submit designs such as file type and notation?”

5.1.3 Determined How Manufacturers Make Trishaw Parts

For both a cost efficient and sustainable business model, it was necessary to research how CWA manufacturers and other trishaw manufacturers created their models. We reached out to all available manufacturers with predetermined questions concerning the materials for trishaw parts, their distribution process, and their manufacturing processes (shown in Appendix A). With the results we collected from the manufacturers, we compiled a list of important trishaw aspects that all current manufacturing partners collectively focus on. With this information, we analyzed the manufacturing processes and necessary methods to build trishaw parts.

5.1.4 Researched the Tools and Methods Needed to Assemble an Open-Source Trishaw

Finally, we researched the process that chapters and organizations go through when assembling their trishaws. When anyone receives an Ami trishaw, it is in a set of flat packs supplied with an instruction manual with all the necessary steps to build that specific trishaw. It provided more contextual information for us to look at the available trishaw manual to understand all the steps it takes to construct a trishaw. We created a survey to contact current CWA chapters to ask if the manual provided was accurate and what are the necessary tools needed to assemble their trishaws (questions shown in Appendix A). From this, we investigated the qualifications on what equipment maker spaces would need to produce trishaws for local chapters and overall understand what CWA chapters must do to create a fully functional trishaw.

5.2 Results and Analysis

5.2.1 Analysis of How Trishaws Designs are Made

Interviews with current CWA partner manufacturers Van Raam, Nihola, and Cycles Toussaint were conducted in order to ask them about certain processes and software they use for designing. We also interviewed a non-affiliated manufacturer, Lester Bikes, about these same aspects (questions in Appendix A). When deciding on features of the design they wanted to make, each manufacturer had their own principles or process (interview summaries in Appendix B). Some manufacturers gauge the needs and desires of CWA affiliates and then make a list of aspects to incorporate into the design. The other manufactures either chose a specific design that satisfies their own requirements or a design that was requested by customers.

In regard to creating designs, the overall consensus was that all manufacturers use some type of computer aided design, or CAD, software (interview summaries in Appendix B). Some used AutoCAD for their initial designs and sketches and then refined them using other modeling software programs, such as SketchUp. Other manufacturers primarily use Solidworks for their designing. From this research, we are aware of certain abilities and experiences we should be

reviewing when searching for potential designers/manufacturers. Then we can work with our potential contacts with what aspects to incorporate with their designs if necessary.

5.2.2 Criteria of Trishaw Design Approval

It is crucial that both designers and CWA agree on certain restrictions and aspects that will be implemented with incoming designs for potential future models. We learned of CWA's current approval process for trishaw designs called the Trishaw Development List. CWA is very open to any potential design that comes from an accreditable source and moderately complies with their list. The most important topics discussed in the list are easy entry and exit without tipping forward, adult-sized seat belts with an option for removable body harnesses, specific canopy requirements, integrated crank motor assist, and overall quality brakes and construction (Trishaw Development List in Appendix E).

5.2.3 Analysis of How Trishaws Parts are Made

Along with our interviews with Van Raam, Nihola, Cycles Toussaint, and Lester Bikes about their design processes, we also inquired about their manufacturing processes. Amongst all the manufacturers we talked to, all of them seem to follow manufacturing processes similar to normal bike designers (interview summaries in Appendix B). The main difference is the modifications to the bike frame and the construction of the carriage. Most manufacturers use machines that perform different kinds of tube processing and welding robots/personnel to construct their bike frames. These frames are then blasted and coated before assembly. There are also specific assembly stations for wheels, brakes, et cetera. Next, all the components come together in a final bike assembly to finally be tested and inspected before distribution.

5.2.4 Important Aspects of a Trishaw Model

Throughout our interviews with manufacturers, and technical informants, we determined that certain aspects of a trishaw model are more important than others. With this information, we can analyze the benefits of not including certain unnecessary aspects in some of the current trishaw models when developing the new open-source designs. The most important aspects are the bike frame, carriage, brake system, durability, overall quality construction, safety options, and some type of pedaling assistance either through gearing or motors (interview summaries in Appendix B). We determined that for successful open-source designs, the potential designers should focus less on aesthetics and additional components such as storage, canopies, or even electric assistance, and focus more on a simple but strong frame that has a safe and comfortable carriage for passengers.

5.2.5 Tools and Methods Needed to Assemble a CWA Trishaw

Initially, we sent a survey to a random sample of CWA chapters around the world asking about their experiences with assembling trishaws. Although the survey did get a few responses, they were not used, because we determined that the majority of chapters did not have experience in assembling any trishaw models, except for some in Canada. After discovering that the Cycles Toussaint Ami Trishaw model is the only CWA trishaw that is consistently shipped and assembled as multiple parts, we analyzed the assembly manual and interviewed the founder of the model and company, Jane Hu. We also interviewed two CWA affiliates, Blaine Nester and Risenga Manghezi, about technical information they had on the concepts of trishaws and how to assemble them. Using all of these sources, we determined that open-source trishaws that would be assembled by chapters or makerspaces would need normal bike maintenance tools, such as Allen keys, wrenches, screwdrivers, mallets, et cetera (Cycles Toussaint Team, 2019; interview summaries in Appendix B). However, with the construction and assembly of certain parts, certain additional tools and machines would be necessary (list of tools and methods needed for trishaws in Fig. 13 and Appendix F).

6. Researching and Designing an Open-Source, Sustainable Business Model

Sustainability is typically a main factor for open-source business models. Sustainability in a business usually refers to a change that best benefits the company through helping the surrounding environment. The ability to adopt a more sustainable stance is a very important capability for businesses. When creating a sustainable business model, you must have a systemic view that has the global perspective and networking in consideration. A network is a group of organizations that work to achieve both individual goals and the common goal they set (Evans & Vladimirova, 2017).

This is the goal moving forward in relation to CWA's current model. Due to CWA's difficulties in reaching developing parts of the world, they would benefit from utilizing a sustainable business model. This model would be tailored to their needs in order to make progress toward reaching their overarching goals of increasing sustainability and local economic development in these areas (Kassow, 2020c).

We were able to reach out to a contact in CWA's network, Sebastian Brachetta. Brachetta is the CEO of Lester Bikes in Rosario Argentina and was named the entrepreneur of the year in Argentina in 2018. Lester Bikes was started in 2017, and the factory makes multiple modes of transportation, such as cargo bikes, electric scooters and trishaws. Brachetta employs people that are handicapped to make his company more inclusive in matters regarding labor and his customers. His bikes each cost roughly 500 euros. The designs of the models were made to accommodate those with physical disabilities and those with mental disabilities. For example, there are models that accommodate those in wheelchairs by allowing it so that they do not have to get out of their wheelchair to ride. (Brachetta, 2020).

6.1 Methodology

We researched CWA's current plan and financial goals, identified what an open-source sustainable business model is, found potential designers and manufacturers, looked at potential makerspaces, found out the best way to open-source trishaws with the best success factors and least limitations, looked at the price restraints of potential customers, and found ways to integrate open-source factors into our model. To improve how CWA's process runs and increase the number of trishaws and chapters around the world, it was important that every aspect of these open-source factors was considered when designing the open-source model.

6.1.1 Researched CWA's Financial Goals and Current Business Model

The first step we took to create a new model is that we researched and analyzed several aspects of CWA. We talked with the organization and also researched their current processes. We also spoke with current manufacturers about their distribution processes (questions listed in Appendix A) in order to have a good sense of the current CWA model. Additionally, we spoke with Ole Kassow about his financial goals for CWA after the open-source initiatives are integrated. These questions will allow us to get a better understanding of the revenue he hopes to gain for the organization in the upcoming years. We did this in order to design a business plan that will work best for him and his goals, specifically.

6.1.2 Identified Existing Open-Source, Sustainable Business Models

For designing the new model, in general, we identified what an open-source sustainable business model is. We started with different types of business models like open-source, non-profit, sustainable, and successful and non-successful models. After we researched a variety of business models, we looked more specifically at the aspects we needed and started making a list of what made these other models successful and how we could integrate these factors into our model.

6.1.3 Determined Designers and Manufacturers

To determine potential designers and manufacturers we started by reaching out and interviewing the contacts we got through Cycling Without Age's network, based on questions listed in Appendix A. We then compiled a shortlist of the designers and manufacturers that we thought were qualified, based off factors such as their past experiences and willingness to work with an open-source business plan and open-source trishaw designs for chapters in developing countries.

6.1.4 Examined Potential Maker Spaces

Next, we looked for possible maker spaces for the future. Since CWA has chapters all over the world, we wanted to have makerspaces in regions near the chapters. We determined what would make a good maker space, by finding maker spaces that already exist and are in use in the United States. Once we found an existing maker space, we made a list of materials and tools they have and then determined what tools are needed for the maker spaces that we were looking for. We also needed to find out what resources these specific areas have, and then used the information we gathered to look for potential maker spaces to determine if it would be a

feasible area for maker spaces.

6.1.5 Integrating Factors of Successful Organizations' Business Models into Our Open-Source Plan

To successfully open-source trishaws, we brainstormed and made a list of limitations our project could face, as well as the difficulties that could arise with our plan being applied to different countries. We also looked at success factors for open sourcing, such as how people are to be informed of open sourcing in the future. This led to our final step we took when we researched and designed this new open-source sustainable business model, which integrated open-source factors into it, as listed in Section 4.2.3. We looked at current non-profit, sustainable, and open-source business models and picked out the success factors that could be best applied to CWA. These success factors were those that seemed to make nonprofit companies the most profit through open sourcing, while also promoting sustainability. We also determined if those open-source factors fit into CWA's organization and current process or not, and then looked how we could work these open-source initiatives into CWA's plan.

6.2 Results and Analysis

6.2.1 Success Factors of Business Models

Through researching different business models, we came up with multiple factors that caused both success and failure for businesses that were either open source, sustainable, or non-profit. We used keywords such as "successful sustainable business models", "success factors and limitations for business models", "success factors for non-profits", and "success factors for open-source business models." When using these keywords, we found multiple websites that listed success factors and limitations for these business models. After looking through these websites and getting a better understanding of what helped businesses be successful and what led them to failure, we thought about which aspects we wanted to include in the business model we created and came up with a shortlist of success factors. This list consists of:

- Having the main outlines of how that company operates be clear
- Pursuing specific sources of funding
- Models cannot be too general or too specific
- Sustainable business models should be flexible over the course of time, to guarantee mission effectiveness and desired financial performance
- More individuals are interested in working for non-profits or organizations that make a positive impact

- Business models need to have the capacity and strategic plan to ally with other enterprises, organizations, and government agencies.
- To enhance local buy-in and ownership it is necessary to involve local communities as partners and co-designers of new models
- Results from different sustainable development goals (i.e. economic, social, environmental) need to be acknowledged and discussed.
- Consistent monitoring and reviewing are necessary in a business model.

Sources: (*Anatomy of the nonprofit business model: A key driver of organizational performance.*; Business models for sustainable development, 2010; Emprechtinger, 2018; Foster, Kim, & Christiansen, 2009; Miller, 2017)

The full list of success factors can be found in Appendix H, along with the list of limitations to keep in mind while using the business model.

6.2.2 Shortlist of Manufactures and Designers

Through interviews with Cycling Without Age's current manufacturers and researching open-source initiatives, we were able to come up with a certain criterion for the potential manufacturers and designers. We used CWA's network to find potential manufacturers and designers and came up with a list of contacts. We contacted two manufacturers/designers, one in Poland and the other in Argentina. Unfortunately, while the Poland contact may be a potential designer for the future, he was not able to go through the interview process at this time. We interviewed the contact from Argentina, Sebastian Brachetta from Lester Bikes, and determined that he not only was qualified for the project, but also was very interested. Thus, we decided he was a perfect fit for the first run of the business model. After further consideration of the initiative, it became clear that the other potential manufacturers would be the chapters who choose to build the trishaws themselves, with their own tools and resources.

6.2.3 Shortlist of Makerspaces Around the World

By looking through CWA's network, specifically of those who may be good candidates for participating in the open-source initiative, we determined that many different makerspace locations may be needed in the future of this project. Through research, we compiled a list of makerspaces in many different countries, mostly in the Global South. This list is shown in Appendix G. As described in Section 7.2.1, the specific potential manufacturers for our beta test of this business model are located in Peru and Panama. While we were not able to find any makerspaces in Panama, we were able to find two potential spaces in Peru, as listed in Tbl. 2 in Appendix G. However, the contact in Peru, Jose Rey Sanchez, would like to see if he can find a

makerspace of his own, and the contacts in Panama, Allen Candanedo and Federico Herrera, seem to have their own mechanics team.

6.2.4 Compiling Our Open-Source Business Model

There were many considerations when compiling our business model. We took into account the difficulties we could face when trying to integrate the open-source plan with many different countries, the limitations of our project, how we were going to inform others about open source, and how we were going to integrate some aspects of the current CWA process into our model, as well as determination of key open-source factors of the business model. While brainstorming the limitations of our project and the difficulties we could face when applying the plan to different countries, we realized that not every country is going to want to take part in this plan and, for those countries that do, not all will have the resources to be involved in a full open-source plan. To combat this, we decided to have the levels of open source exist on a spectrum, with four different open-source options, all explained in Section 7.2.2. We also made an informative pamphlet for potential customers, explaining why this would be a good option for them and how they can be a part of the initiative. This pamphlet is shown in Appendix K. For figuring out how to inform others about open source, we decided to use the forms of communications CWA already uses such as their platform called “The Hood” and newsletters. As for the aspects of CWA’s current process and key factors of open sourcing, we came up with the following principles:

- Increase interest and development in sustainability
- Provide opportunities for local manufacturing and economic growth
- Stay more focused on the impact and quality of the project, rather than the amount of revenue
- Even if at first a chapter is at a lower level of open sourcing, the ultimate goal should be to be continue moving up in levels of open sourcing (as defined by the Rating Matrix for Levels of Open Source in Appendix A)
- Always be striving to spread Cycling Without Age to more parts of the world
- Always have designs available and engage with community about them
- Continuously update the network and reach out to new and interested contacts
- At least 50% of a trishaw should be open sourced
- Strive to increase trishaw sales, with more openshaw sales each year

We also implemented factors such as royalties, the CWA mission, and key partners and the benefits of this project for them. We hope for there to be royalties involved with the downloading of designs, in order to increase design security and also provide revenue for the designers, as well as some profit for Cycling Without Age. As stated in the principles, this project will strive to promote sustainability and local economic growth. Through this and

through increase of accessibility and cost efficiency of trishaws in the global south, Cycling Without Age's mission will be shared in as many places as they can reach. This not only helps the potential chapter locations and the new open-source designers, but also helps the current manufacturers and chapters by promoting trishaw sales and involvement with Cycling Without Age as a whole. This full business model is shown in Appendix J.

6.3 Conclusions

This business model is meant to be used as a framework of how Cycling Without Age can open-source trishaws for chapters all over the world. It is also meant to be used as a foundation of this new open-source initiative that CWA is adding to their current processes. This model can be built upon through the results of multiple iterations of testing.

Different key factors of the business model can also be highlighted and put into informative pamphlets for different stakeholder groups. These stakeholders are the Key Partners, as described in the business model in Appendix J. These informative pamphlets would be used to answer any questions the respective stakeholder may have regarding this open-source initiative. For example, the informational pamphlet we created, as described in Section 6.3.4 and shown in Appendix K, is meant to be used by potential open-source customers to answer any questions they may have about why open sourcing is the best option for them and about key resources and contacts they would need in order to take part in this initiative.

7. Designing a Test of Our Sustainable Business Plan

7.1 Methodology

While we created our business model, we began to create our test of the viability of an open-source initiative. These were done in tandem of one another to help create a model that considered factors that would appear while testing. These factors were evaluated when planning the different open-source options and picking the continents, affiliates, and beta test options in the end.

7.1.1 Chose a Specific Area and Affiliates

Due to the broad scope of the project, we chose to focus on areas that had an interest in the project. The areas that were selected for the test are South America and Central America. These areas were picked for a few major reasons. First, we checked which areas had potential chapters in developing countries that were interested in getting more affordable trishaws. Second, we looked for potential designers and manufacturers located in the area that had an interest in the project, such as Lester Bikes in Argentina who agreed to work as a hub location. Third, we looked for potential chapters in the chosen area that were interested in participating in a test, such as the potential chapters in Peru and Panama. This area of South America and Central America was picked due to it having the interest and the resources needed for the test.

7.1.2 Designed Open-Source Options

Due to no two places being identical to one another, it was decided to make different test options based off how feasible it would be to open source in different locations. The open-source options were created based off different tiers of open source. These different options chosen to be analyzed are: completely open sourced, partially open sourced, open sourced through hubs sending in flat packs, and open sourced through hubs sending fully assembled trishaws. These options would be tested with chapters depending on their resources and the feasibility of the option in their location. The first option, manufacturing a completely open-sourced trishaw, consists of a chapter only being sent a trishaw design, a list of parts, and an instructional aid explaining how to build a trishaw. Completely open sourcing entails that chapters will need to work with local professionals to build frames, carriages, and other components that they wouldn't be able to make themselves in their own space. Partially open sourcing is similar to the previous option explained, except certain components that couldn't be locally sourced would be sent along with the design and the instructional aid. The next options, open sourced by sending trishaws in flat packs and open sourced by sending fully assembled trishaws, make use of localized manufacturing hubs that will send trishaw models to nearby chapter locations. Chapters

would have the choice to receive their trishaw models either in flat packs, which consists of a number of separate pieces being sent in boxes needing local assembly with the help of an instructional aide, or they can receive their trishaw fully assembled, which would require little to no aid at all. A hub would be a location or two on each continent that would ship the needed parts to other open-source chapters on that continent or within a close proximity to that continent. For South America and Central America, Lester Bikes would be the hub. These options were carefully analyzed by creating a list factors and rating them for each option in order to compare them.

7.1.3 Chose Test Options

We surveyed potential customers asking questions such as price point, geographical features, materials available, and manufacturing skills to determine universal factor to consider. These results, shown in Tbl. 3 in Appendix I, were helpful with determining the main factors that a chapter should consider when picking a test option. These factors are shown in Fig. 6. However, for the current tests, two main factors were considered. The first factor considered was the resources available, such availability of local bike manufacturers or similar who could help with the process and the accessibility of materials and parts needing to be bought locally. A second factor considered was the level of experience those in the chosen potential chapters have and how much time they are looking to put into creating their trishaw.

7.2 Plans for Test

7.2.1 Rating Factors for Test Options

When coming up with the four test options, completely open sourced, partially open sourced, open sourced through hubs sending in flat packs, and open source through hubs sending fully assembled trishaws, a set of ten factors were created that go along with these four test options. Each stakeholder would rank the level of importance of each factor differently. For CWA, the ten factors as rated from most important to least important are show in Fig. 6: The most important being in the top left and corner Transportation Carbon Footprint and the least important being in the bottom right hand corner Time Needed to Make Product.

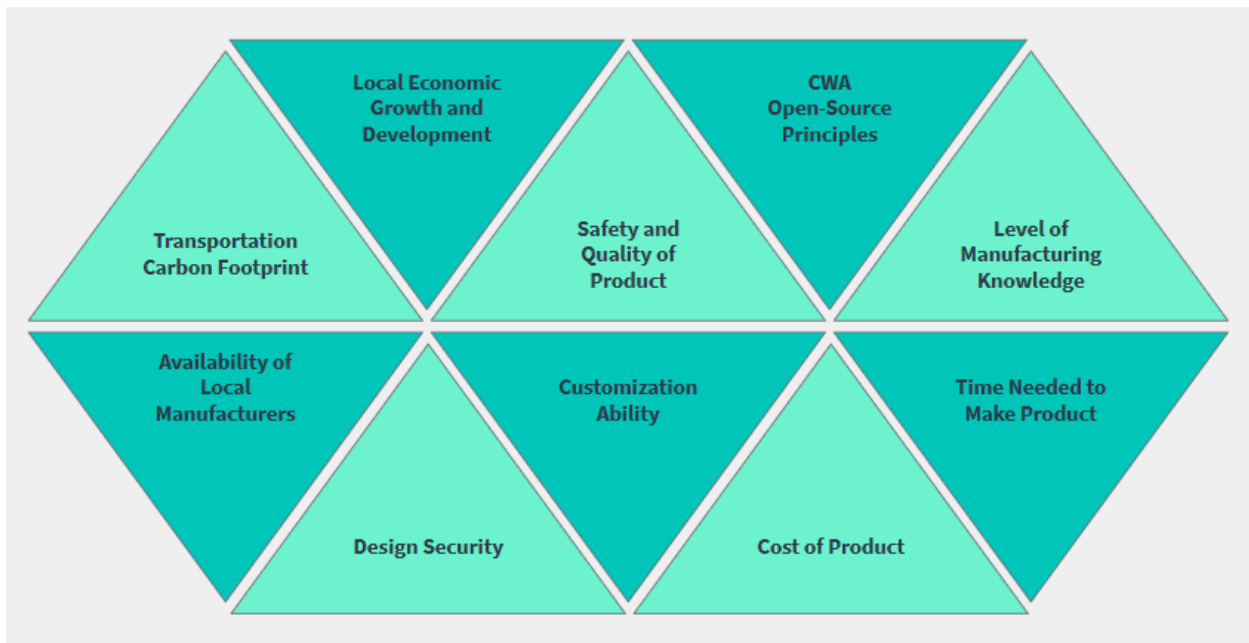


Figure 6: Ten Factors for Stakeholders to Consider

Based on input from our interviews and potential customers survey results, the Rating Matrices for Comparison of Relevant Factors Among Different Open-Source Levels and Rating of Relevant Factors Among Different Distribution Processes were created, as shown in Appendix L. These matrices rate each of the factors in Fig. 6 for each open-source option, as described in Section 7.2.2.

The first rating matrix was created for the purpose of helping a chapter interested in open sourcing a trishaw determine, based on their current situation, which option would work best for them. The second matrix compares the open-source options to the current process for those chapters that would like to see clearly the pros of this approach. The first matrix rates the ten factors on a scale of “Most” to “Least” for incorporating each individual factor into each open-source test option. However, this does not mean that the range will always follow the same pattern from “Least” to “Most” or vice versa or that no two test options will receive the same rating for a certain factor. For example, the options of “Open Sourced Through Hubs Sending in Flat Packs” and “Open Sourced Through Hubs Sending Fully Assembled Trishaws” have the same rating for customization ability, because, in both cases, the parts are premade and would therefore have the same amount of leeway for a chapter to add unique items to their trishaw. This rating matrix was used to help determine what test options would be the most feasible for each test location. The second matrix rates the factors of each option from “Little/Few” to “None” in relation to overall rating, as shown through our research.

It is important to note that the coloring for completely open source might portray this test option a bit inaccurately. This is because the matrices account for this option not being feasible in all location, as shown in our survey results in Tbl. 3 in Appendix I, because many of the

potentially customers do not have access to the resources or skills currently needed for completely open sourcing. This does not mean that it can never be accomplished—it will just be more of a challenge.

7.2.2 Chose Tests

Through the knowledge we gained from our interviews with Peru and Panama (interview summaries in Appendix B), the factors we came up with from our other interviews and potential customers survey, and the Comparison of Relevant Factors Among Different Open-Source Levels ratings matrix located in Appendix L, we were able to determine which test options worked best for the potential chapters in Peru and Panama. Because Jose Rey Sanchez from Peru expressed his interest in manufacturing parts, yet is not currently located in Peru, it was recommended that he start with the open-source option of “Partially Open Sourced.” This option would give him the opportunity to manufacture the parts that can be sourced and made locally and also have the flexibility of getting the rest of the parts from Lester Bikes. From the Panama potential chapter heads, Allen Candanedo and Federico Herrera, we learned that there are no manufactures or bike shops in the area that they would be able to get parts locally. So, for their test location, we recommended the open-source option of “Open Sourced Through Hubs Sending in Flat Packs.” This option would allow them to get all the parts needed shipped to them, and, although the trishaw parts would not be manufactured in their country, it would still be assembled locally and the parts would be manufactured more locally than the ones manufactured with the current CWA process.

7.3 Test Recommendations

Moving forward, once the pandemic ends and social distancing is no longer occurring, the tests can commence. However, there is still much that can be done before the beta tests occur. First, the test locations will need to receive a bill of materials, estimated prices of each item, and the cost for the frame, if needed, from Lester Bikes so the locations can confirm the open-source test option chosen was the most feasible for them. Second, before the test is started, the timeline for completing the test and the structure of the test must be decided. Lastly before the test starts, the success factors for the test must be determined and a safety test must be created to deem that the open-source trishaws are safe to use. While the tests are occurring, the test location should record their progress and processes and have biweekly meetings with CWA to give their updates and feedback on the test.

In the future, after multiple iterations of the tests are completed, it is believed that chapters might be able to move from one level of open source to a higher level, such as from partially to completely open sourced. Even if it is not possible for a location to move to a higher

level of open source, there are still ways for both the chapter and CWA to increase the ratings of the factors rated the lowest in the open-source option chosen for their location. For example, a chapter starting off with the flatpack test option that is unable to move up to partially open source or completely open source could improve the rating of the “Local Economic Growth and Development” factor by putting local business advertisements on their trishaws and having tune ups and safety checks done by local bike shops. CWA could also improve the ratings of some factor such as “Decreasing Transportation Carbon Footprint” by encouraging the hubs to ship their parts or assembled trishaws using the most environmentally friendly options of transportation. The full list of ways for ratings of factors to be increased are shown in Tbl. 4 in Appendix M.

8. Overall Recommendations

This project has quite a lot of potential in the near future. Once the beta tests described in Section 7.3.2 are complete, our open-source business model can be refined and even broken up into sub-business models for different stakeholders, similar to the informative pamphlet in Section K, based on the results of the tests.

While the beta test is conducted and the business model is refined, we recommend that an online platform be created for accessing open-source designs. Here, affiliates of the open-source project can download and build designs locally that were posted by future Cycling Without Age open-source designers in order to promote designer collaboration, as well as ease of participation in the open-source plan. With this, legal aspects of open sourcing, such as ensuring intellectual property security through patents or otherwise, should be talked through with a lawyer in order to account for the most important open-source initiative success factor, ensuring design security, as described in Section 4.3.3.

Once the platform and refined business model are finalized, more tests should be run in South America and Central America, possibly with new countries, to ensure the functionality of the online platform and business model. Once everything is confirmed to be successful in these areas, it will ensure the success of future use of the Cycling Without Age open-source initiative, and, therefore, the initiative can be expanded to Africa, and eventually the entirety of the Global South, especially those potential customers surveyed, as described in Section 7.2.3.

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Appendix A: Interview/Survey Consent Statements and Questions

Used for All Interviews Prior to Delivery:

We are working with Cycling Without Age in Copenhagen, Denmark, which is an international non-profit organization that helps promote the inclusiveness of all members of the community. This is done through volunteers giving trishaw rides to nursing home residents. One major issue with the organization is the inaccessibility of trishaws for developing countries. In order to increase overall trishaw sales in these lower-income locations, our project is working on creating an open-source business model. This project is of particular importance, because it will allow Cycling Without Age affiliates to make trishaws locally and promote sustainability. Do you consent to participating in this interview?

If interviewee consents...

Thank you for agreeing to be interviewed, all of this information will help us with our research. It is important to note you do not have to answer all of the questions and you can stop the interview at any time. With the understanding that this recording would only be used for our research purposes, do you consent to allowing us to: record the interview, paraphrase your words, quote your words, and use your name and location?

Please understand that if you would like to change your permission status, revoke your interview, or if you have any questions, you may contact any of our email addresses.

*Note: Due to interviews being held over video call, consent was given verbally, rather than on a form.

Pre-Survey Information That Will Be on All Surveys Prior to Questions:

We are working with Cycling Without Age in Copenhagen, Denmark, which is an international non-profit organization that helps promote the inclusiveness of all members of the community. This is done through volunteers giving trishaw rides to nursing home residents. The major issue with this organization growing, is the cost of trishaws. The stages of design and manufacturing of these trishaws happen in different locations from each other and then are distributed across the world, thus creating large shipping expenses. To combat this our project is working on creating an open-source business model that will hopefully alleviate some of the cost. Thank you for participating in the survey, you may stop the survey at any time.

Note: The following are general questions chosen to be asked on a case-by-case basis.

Interview Questions for Business Model Experts

- What do you perceive to be key factors of open-source initiatives?
- What challenges do you foresee with open sourcing trishaw designs?
- What key pointers would you give for creating a new open-source business model?
- What limitations are there to making our open-source business model successful?

Survey Questions for Current Chapters

- Which country is your chapter located in?
- How long have you been a chapter?
- How many trishaws do you currently have?
- How many pilots do you currently have?
- How many nursing homes do you currently work with?
- Did your chapter have difficulties fundraising?
 - What struggles did you face while fundraising?
 - What made this a struggle?
- What factors contribute to your success as a chapter?
- Has your chapter ever had to assemble a trishaw?
- Have you assembled the Triobike Trishaw model?
- Have you assembled the Cycles Toussaint Ami Trishaw model?
- How accurate do you think the instruction manual was?
- Are steps missing from the instruction manual?
- Are all tools that you used listed in a section of the instruction manual?
- What tools did you use to assemble the trishaw?
- How long did it take to assemble a trishaw?
- Did the tools required for assembly come with the shipped trishaw parts?
- Did you have to get any tools needed for assembly on your own?
- Where did the assembly of the trishaw commence?
- Have you assembled your own custom trishaw model?
- Do you think making a video tutorial of assembling the CWA trishaw models would be helpful?
- Is there anything else you would like to share?

Interview Questions for Current Designers/Manufacturers

Background

- How long have you been designing and working on manufacturing trishaws?
- How did you get into designing trishaws?
- Had you ever designed or manufactured a bicycle before working with trishaws?

Design Process

- What is the process of designing a trishaw like?
- What were the specifications for the design you created?
- What software do you use to create your designs?
- Do you follow any country-to-country safety regulations?
- Were there any difficulties that you experienced while creating a design?

Manufacturing Process

- Where do you get materials for making trishaw parts?
- What is your process of making trishaw parts?
- What kind of challenges did you face while manufacturing the designs?
- What is your distribution process?

Your thoughts

- What do you think the ideal process would be of making, sending, and building open-source trishaws?
- Is there anything else you would like to share?

Interview Questions for Open-Source Initiatives

Background

- How did this organization form and when?
- Has it been open source the whole time?
 - If not, when did you transition?
- What made your organization want to be open sourced or transition to an open-source initiative?

Open-Source Model

- Does your organization use any of the following open-source business models: support and services, advertisement partnerships, paid additional features, or Software as a Service (SaaS)?
- Does your organization use single licensing or dual licensing?
- Is there any part of your open-source model that you think needs improvement?

- How did you spread the word about your organization being open source and getting people to use your products?
- Do you have business in any developing country?
 - If yes, which?

Results of Your Open-Source Initiative

- Approximately, how many sales of your open-source products do you have per year?
- How do you measure success?
- How successful would you consider your initiative to be?
- What factors contributed to your organization's success?
- What mistakes were made while working to develop your open-source initiative?
 - What did you learn from these mistakes?
- What benefits and drawbacks has your organization experienced from being open source?

Your Thoughts

- Is there anything else you would like to share?

Interview Questions for Potential Customers

General

- What is the current state of your country due to the pandemic?
 - Is everyone in lockdown?
 - Could you work on assembling the trishaw now if the frame was shipped?
 - When do you think your country will be back up and running?

Capabilities and Cooperation

- Do any of you have experience with bike/trishaw manufacturing or assembly?
 - Do you know anyone who does?
- What is a reasonable price you would be able to pay for the trishaw frame?
- Have you been able to find maker spaces or bike builders near you?
 - If no: Would you like us to do anything to help, or are you okay continuing on searching yourselves?
- Is there a bike shop near you that you could buy parts from?
- What are common materials you would have access to?
- Also, what are some materials you have no/limited access to?
- Would you be comfortable filming the process as you go through building the design?

Interview Questions for Potential Designers/Manufacturers

About You

- Tell us a little bit about yourself and your interests.
- What is your profession?
- Where are you located?

Our Organization

- Do you know what Cycling Without Age is?
- Have you heard of a becak or a trishaw?

Experience

- What past experience do you have in this field (either designing or manufacturing)?
- What is your greatest accomplishment?
- Have you ever designed a bike or similar?
 - What is your design process if so?
- Have you had any previous work with designing/manufacturing for a different country?
- Have you had any previous work with a non-profit organization?
- Have you had any previous work with freely accessible designs?

Capabilities and Participation

- Do you know anything about the safety regulations for bikes/cycling in your country or others?
- Are you able to create designs that can be easily mass produced?
- Would you be willing to create designs that are freely available?
- What are your other commitments/ what is your availability?
- What certain safety regulations does your bike follow?

Your thoughts

- Do you have any questions for us?
- Is there anything else you would like to share?

Testing

- Are you planning to open source your current trishaw design or would you like to create a new one?
- When do you think it would be feasible for you to send your design to the beta testing locations?
- Would it be possible to make a design that wouldn't need a frame manufacturer?

- Could you try to create a new design that is capable of having attachments, such as something like the Copenhagen Wheel?
- If creating a new design, would you be comfortable filming some of your design process?
- How much money would you hope to get from each design you send?
- What software/program do you use for your designs?
- What percentage of your current design do you believe can be safely open sourced?
- What are your thoughts on making the frames and having the customers make the rest of the bike?
- What do you think the price would be for shipping one of your bikes in the following ways: fully assembled and shipped, shipped in flat packs, and shipping just the frame?

Interview Questions for Potential Manufacturers

About you

- Tell us a little bit about yourself and your interests.
- What is your profession?
- Where are you located?
- Would you be willing to relocate?

Our Organization

- Do you know what Cycling Without Age is?
- Have you heard of a becak or a trishaw?

Experience

- What past experience do you have in this field (either designing or manufacturing)?
- What is your greatest accomplishment?
- Have you ever designed a bike or similar?
 - If so, what is your design process?
- Have you had any previous work with designing/manufacturing for a different country?
- Have you had any previous work with a non-profit organization?

Capability

- Do you know anything about the safety regulations for bikes/cycling in your country or others?
- Are you able to build designs that are easily mass produced?
- What are your other commitments/ what is your availability?

Your Thoughts

- Do you have any questions for us?
- Is there anything else you would like to share?

Interview Questions for Technical Experts/Chapter Leaders

About you

- Which chapter are you in association with?
- What is your role in that chapter?
- How long have you been working with this chapter?
- How many trishaws does your chapter have?

Your insight

- Would you be interested in using an open-sourced trishaw?
- What would you expect if you were to get your next trishaws the open source way?
- What are some factors you would like to see considered in an open-source trishaw design?
- What trishaws parts do you think would be difficult to open source?
- Do you think open sourcing trishaws would be successful?
- What challenges do you foresee with open sourcing trishaw designs?
- What level of knowledge of bike manufacturing do you think would be necessary in order to build a trishaw using an open-source design?
- What kind of tools do you feel would be necessary for building an open-source trishaw?
- Do you think it would be feasible for developing countries to open-source trishaws?
- Is there anything else you would like to share?

Survey Questions for Potential Customers

- (Q1) Do you consent to participating in this survey?
- (Q2) What is your name (First Last)?
- (Q3) Where are you located?
- (Q4) What is a reasonable price you would be able to pay for a trishaw design? (0 – 10,000 USD)
 - (Q4_1) Preferred Price \$USD
 - (Q4_2) Maximum Price \$USD
- (Q5) What is the terrain of your location (i.e. hills, flatland, wetland, oceanfront, etc.)?

- (Q6) What are common materials you would have access to (i.e. aluminum, wood, steel, etc.)?
- (Q7) Also, what are some materials you have limited or no access to?
- (Q8) Do you have any experience with designing or manufacturing or assembling?
- (Q9) Do you know anyone who does?
- (Q10) What is their contact information?
- (Q11) Which do you have experience with? (check all that apply)
 - (Q11_1) Designing
 - (Q11_2) Manufacturing
 - (Q11_3) Assembling
- (Q12) Have you ever worked on trishaws or bikes before? (check all that apply)
 - (Q12_1) Bikes
 - (Q12_2) Trishaws
 - (Q12_3) Neither
- (Q13) What manufacturing or designing software programs are you able to access?
- (Q14) Do you know of any maker spaces, bike manufacturers, or frame makers near you?
- (Q15) What is the name, contact information, and category (maker space, bike manufacturer, or frame maker) of the location?
- (Q16) Is there anything else you would like to share?

Appendix B: Interview Summaries

Current Designers/Manufacturers

Jan-Willem Boezel from Van Raam (March 31, 2020) - Jan-Willem Boezel is a member of the Van Raam team. Van Raam is one of Cycling Without Age's current manufacturers, and they were willing to give us information on their processes. Van Raam's design process includes talking to customers to see what they would like. For designing, the company uses Solidworks. Their trishaw parts come from different areas of Asia and Europe. These parts get bent, welded, laser cut, painted, sand blasted, and maintained. They distribute their trishaws through a dealer that goes to the chapter. Jan-Willem Boezel, our interviewee, recommends the open-source trishaw designs be adaptable in order for the seat to have the ability to be replaced by a box to make it a cargo bike.

Jane Hu from Cycles Toussaint (April 15, 2020) - Jane Hu is the founder of Cycle Toussaint, which is the major trishaw producer for Canada. She worked with manufacturers in China to produce her product and is very knowledgeable about the process of manufacturing trishaws. We learned from Jane that when creating a trishaw model and distributing, it is very difficult, especially if you have foreign/unfamiliar manufacturers and partners working with you to create and ship the model. There are some issues that we may run into when designing a quality bike at a cheap price, but as long as we are flexible with some of our criteria, we should be able to successfully open source a trishaw design. We should also have the right platform and assess restrictions for the designs and where to build them. We also learned the general process of chapters deciding to build the models themselves or have a professional build it, however in any scenario it is highly requested that customers see a bike mechanic to test it before usage. Jane was concerned that open sourcing trishaw designs would not be successful in developed countries.

Niels Larsen from Nihola (April 1, 2020) - Niels Larsen is the founder of Nihola. Nihola is one of Cycling Without Age's current trishaw manufacturers. They were willing to speak with us to give us information on their current processes. Niels Larsen has 20 years of experience with manufacturing trishaws. The first prototype he made for CWA came out three years ago. Niels has had experience manufacturing bikes before making the trishaw. For the design process, Nihola talks to the customers to make sure they get what they need, do their drawings on Autocad, and make edits to the prototypes through multiple tests. For the designs, they have to follow the European safety regulations and have an EN 15194 certification. For the manufacturing process, most parts are produced in Denmark and Asia. Their distribution process includes having 300 dealers. The ideal process for manufacturing open-source trishaws, in Niels' opinion, is to make them very simple, very solid, and to not add the electric assist, because they are hard to maintain. He also commented that most people tend to not read the manuals for the electronics.

Risenga Manghezi from Christiania Bikes (April 6, 2020) - Risenga Manghezi is part of the team at Christiania Bikes. We spoke with him to ask about certain technicalities and possibilities for trishaws with our project. We learned from Risenga that there are some factors we have to consider as we open-source trishaw designs. One possible obstacle was that some countries may not approve or need the service that CWA provides due to differences in cultures. Another note was that the electrical assist may not be necessary or may be too expensive. When open sourcing the design and manufacturing the bike, he said only basic assembly and mechanical skills would be needed if electric assist is not added. Overall, he said we should be able to open-source designs, but we will have to focus on our mission and have the right people supporting us. He recommends we start by just focusing on one location.

Open-Source Initiatives

Joni Steiner from Opendesk (April 6, 2020) - Joni Steiner is a co-founder of Opendesk and was willing to share with us his experiences and advice about open sourcing. Opendesk is an open-source organization started by architects when the opportunity was sprung on them. This organization was very big on their ethos and very proud of them. Some of their reported success factors are investors, as well as considering how many people are working for the organization and the range of coverage. A mistake that Opendesk made was making their designs open and available freely. This led to their designs being taken and used for personal success without giving Opendesk credit.

Katherine Scott from Open Robotics (April 8, 2020) - Katherine is from Open Robotics and is a board member of the Open Source Hardware Association. Open Robotics is an open-source software company. She recommends that the open source makers try to get certified to be open source (hardware in general should). She also recommends that Cycling Without Age does not mention how their open-source process works to investors unless they ask for it. Additionally, Cycling Without Age should make sure to have a good social media presence, so people are aware of the organization's product. She reports that the organization's success is due to staying humble about the project and being strategic when going forward and expanding. Also, they consistently make software.

Marc Roland from FarmBot (April 6, 2020) - Marc Roland works at FarmBot, an open-source hardware organization that distributes open-source robotic farming designs and promotes open-source agricultural processes. FarmBot recommends Cycling Without Age makes sure to monitor who can see the open-source designs to ensure people do not steal them and cut the original designer and company out of the profit. The company measures their success by their social media pages and sales. Some of the factors that lead to their success were having the right idea, people, and opportunity/market.

Potential Customers

Allen Candanedo and Federico Herrera from Panama (April 27, 2020) - Allen Candanedo and Federico Herrera are the heads of a potential chapter of Cycling Without Age in Peru. We learned from Allen and Federico that they both are interested in participating in our test, and that they have moderate knowledge of assembling bikes and sourcing bike parts. However, in Panama, there are few-to-no bike manufacturers or shops for recreational bike parts. In Panama, the cycling community is not very popular and most of the community is made of people using cycling as exercise or competitive cycling. Due to lack of parts and possible aid available in Panama, we suggested that Allen and Federico receive a trishaw model through flat packs, in which they can have their mechanic teams assemble the model. They agreed this open-source option would be feasible in Panama.

Jose Rey Sanchez from Peru (April 27, 2020) - Jose Rey Sanchez is the head of a potential chapter in Peru. We learned that Jose is moving back to Peru sometime in the near future, after the pandemic is over, and has experience in manufacturing. He plans to travel to Argentina to meet with Sebastian to learn the process of making the trishaw model that Sebastian designed. He will most likely be building the trishaw himself and wants to look for makerspaces and bike shops in Peru by himself initially, because he thinks it will be easier for him to find places. We believe Jose may need parts from Sebastian, such as the frame, to make sure it is done correctly. However, he will hopefully be able to source the rest of the parts locally for this run of the test. For future test iterations, he may be able to make the whole trishaw locally in Peru, including the frame.

Potential Designers/Manufacturers

Sebastian Brachetta from Lester Bikes (April 2, 2020) - Sebastian from Lester Bikes in Argentina has experience with bike and trishaw manufacturing and designing. He is interested in helping us with our project and would be willing to relocate, if needed. His bikes are similar to CWA's but without the electronics. They are cheap, sturdy, and follow safety regulations. His major takeaway was that manufacturing trishaws would not be too difficult, but we must make sure they meet safety factors. He is very interested in being a part of this project.

Sebastian Brachetta from Lester Bikes (April 20, 2020) - Sebastian is still very much interested in collaborating with CWA to open-source trishaw designs, however there were many concerns brought up about the general feasibility of the project at this stage. A main concern was the lack of available or willingness of companies that would manufacture only a small amount of trishaws for our initial test. Although, if done more independently, the concerns of safety and liabilities for CWA become an issue and we would not want to risk CWA's reputation. The aspect of providing designs and/or creating new ones, if needed, will not be an issue for Sebastian. He'll give his designs to the Peru and Panama contacts and isn't looking for much in

terms of compensation. He, himself, is unsure of how to move forward and is concerned about the level of success this will have but will help in any way he can after a possible in depth talk with CWA and our group about the future of our project testing.

Sebastian Brachetta from Lester Bikes with Ole Kassow and Pernille Bussone from Cycling Without Age (April 24, 2020) - Sebastian is still collaborating with CWA to open-source trishaw designs, however, there were many concerns about the general feasibility of the project at this stage which were discussed between him and CWA. He stated that the project will be difficult in certain markets and that it is very important that the frames of the trishaw be professionally built or quality assured. CWA stated that they understand why it is not realistic in some locations to fully open source in the beginning. CWA and Sebastian agreed that even just sending the frame with a list of parts to be locally sourced would be doable and still satisfy CWA's desire to promote local economic development. We will see if this works or not, and if it's successful the process can be simplified to collapsible parts or more hardware connection for possible future tests. For the collapsible design, Sebastian is thinking about having a tutorial video explaining how to assemble the bike. This design will overall be easier to ship and build.

Technical Information

Blaine Nester from Cycling Without Age British Columbia Chapter (April 1, 2020) - Blaine Nester is an affiliate of Cycling Without Age who we asked about technical aspects of trishaws and his insights on our project. We learned from Blaine that there are many physical aspects of a trishaw we want to make sure are at a certain quality to ensure the project is safe and successful. There were a lot of concerns brought up about making sure the open-sourced trishaw designs are quality assured and checked, due to the ease of hiding faulty parts and the importance of the passengers' safety. Also, he reported that there is not much complexity with assembling/building a trishaw or bike, so only simple tools and some basic knowledge would be needed for future customers to build our designs. He also brought up some factors to consider, such as the need for power assist in hilly areas.

Christain Villum from Danish Design Center (April 21, 2020) - Christain Villum works for the Danish Design Center and is knowledgeable about open-source hardware business models. Through talking with him a few things became apparent. The business model should be done very early on into the project and be open to change and suggestions that the community might have. Before any hardware is worked on, a lawyer should look over the licensing plans to avoid issues down the road. In addition, it is important to note that not all open-source hardware products might be completely open source due to some parts being considered proprietary to protect the designers. This is something to further consider with our design.

Craig MacAulay from Ottawa, Canada (April 9, 2020) - Craig is a brother of a CWA affiliate who has knowledge about self-made bike-taxis. He also helped his brother make modifications to

current trishaws they had. He, himself, is not a designer, nor a manufacturer. He had a friend make a bike-taxi for him to bike his mother around in, and now he gives rides to several people in his area. Craig's brother is the lead of his local chapter, so Craig brought up how, from his experience, trishaw pilots can become stressed, because they cannot see with passengers in the front of the trishaw sometimes. He notes that his brother had to make many modifications to the trishaw models once received.

Appendix C: Current Cycling Without Age Trishaw Models



Figure 7: The Chat Trishaw by Van Raam (Trishaws for Cycling Without Age - Cycling Without Age, 2018)



Figure 8: The Nihola Taxi Trishaw by Niels Holme Larsen and Team (Taxi.)



Figure 9: The Model T Trishaw by Christiania Bikes (Model T.)



Figure 10: The Ami Trishaw by Cycles Toussaint (Ruhnke, 2019)



Figure 11: The Triobike Taxi by Triobike (Hole, 2018)

Appendix D: Cycling Without Age Current Chapters Map



Figure 12: CWA World Map (*The right to wind in your hair – Cycling Without Age, 2015*)

Appendix E: Cycling Without Age Trishaw Development List



TRISHAW DEVELOPMENT LIST

General features:

- Easy entry and exit, without tipping forward. Ideally without the pilot having to hold down the rear of the trishaw. (This allows elderly to be helped in and out of the trishaw by the pilot, without needing the help of anyone else.). Christiania Bikes (CB) has devised a front footrest that can be lowered to the ground that prevents tipping. Trio has a small removable panel in its footrest that is replaced when the passengers are in the seats. But neither of these solutions prevent tipping forward under certain circumstances when the trishaw is loaded. The pilot should be able to leave the seat and not have to worry that the trishaw will tip forward.*
- Turning without tipping when loaded. Every three-wheeled trishaw we have tested can be tipped when turning. The Nihola is harder hard to tip than the CB or Trio, the main difference being that the Nihola's front wheels turn, versus the entire box and wheels turning on both the CB and the Trio.
- Electric assist, keeping in mind we distribute worldwide. Ideally top assist speed is no more than 10-12 mph. The ideal e-assist system adjusts to stop assisting at our lower top speed. It should also have a remote diagnostic feature for servicing.

For the passenger box:

-- sufficient seat width and depth and backrest height, good cushioning. The Trio is generally acceptable dimension-wise. CB is too narrow for fat Americans.

-- an aesthetically-pleasing passenger box design. Again, the Trio is one example, but by no means the only version. We have seen a number of very 'boxy' designs that look rather home-made and not very elegant.

-- rounded edges, sufficient width on areas that will be gripped or touched by passengers so that doing so is comfortable and safe. Many seniors have very thin skin, and grabbing onto a narrow metal edge can cause cuts or abrasions.

-- no exposed bolts or other protrusions in the passenger compartment.

-- no exposed metal edges where one piece of metal meets another – again, the concern is for the fragile skin that many seniors have

-- include adult-sized seat belts, with an option for removable body harnesses (shoulder and waist) for passengers less able to hold themselves up in the seat.*

* these are items that are very important to CWA
V81618



- a footrest that can be lowered to ground level or otherwise moved from the pilot's position, to allow for easy entry and exit, then pulled back and locked in place for travel; or some other strategy to permit easy entry and exit. Even a very small (4-5 cm) step can be a serious challenge for many of our passengers.
- a closed-off storage space under the seat. We find that a small shelf that can hold a folded-up walker works well in the Christiania, with a box underneath that can hold passenger handbags, coats, etc. The Trio has underseat storage with a lid that pops out. Nihola has an open platform with no door, which is not as desirable as one that can be closed.
- on the pilot side of the passenger compartment, storage space accessible to the pilot, typically used for water bottles, raincoats, smaller items such as those. One affiliate has designed a pouch that attaches to the rear battery bracket; the pouch is large enough to hold a phone, wallet, keys, etc.
- a fitted blanket that covers the footrest and then pulls up to cover the lower torsos of the passengers and can be kept in place (currently we use elastic cords that clip around protruding knobs on the passenger box to hold the blanket in place up by the waists of the passengers)
- consider LED strip lighting attached to the front of the box, versus bulb-type lamps that can easily be knocked off
- a reasonably watertight compartment that can hold a booklet of instructions and emergency phone numbers.

For the canopy:

- the ideal is a canopy that does not have to be slotted into place, but one that folds down when not in use and easily opens up when needed without too much effort, like with a horse-drawn carriage. The Trio has a foldable canopy but it is a bit difficult to operate. The CB has one that detaches from holder clamps and inserts into mounting clamps; it's very cumbersome to operate but works well when it's in place. The Nihola is similar to the CB; workable but difficult to maneuver.
- if we must use a detachable canopy, the ribs and canopy should be integrated, so that all of it stays together as one unit.*
- the fabric should have windows on the sides and rear so passengers and pilots can see through.* This may mean a mesh rear window for the pilot to look through, so wind doesn't catch and stress the canopy, and also to make it easier for the pilot to communicate with the passengers.
- when installed, the canopy must be high enough at the front so that a normal-sized passenger can easily enter and exit the trishaw.*
- we may have a use for a sunshade-only version, but this is optional at present

* these are items that are very important to CWA
V81618



For the trishaw construction:

- quality brakes all around*
- integrated crank motor assist, preferably an intelligent one that has been programmed to CWA needs (high torque, low top speed).*
- internally-gearred vs derailleur
- high-quality construction all around*
- we are not afraid of an innovative design if it works

* these are items that are very important to CWA
V81618

Appendix F: Tools and Methods Needed to Assemble an Open-Source Trishaw

Ami Assembly Guide



5 Tools Required

5.1 Ami Tools Provided

1. 1 – Metric Allen Key set
2. 2 – 8mm / 10mm box wrench
3. 1 – 13mm / 15 mm box wrench
4. 1 – Phillips screw driver
5. 1 – Tool kit bag

We recommend the Ami tools provided be stored in the storage compartment once assembly is completed.

5.2 Additional Tools Required

1. Metric measuring tape/ruler
2. Box knife
3. Rubber mallet
4. Tray for small parts
5. Screw drivers
 - a. Flat head screw driver
 - b. Stubby philips screw driver
 - c. Large flat head screw driver
 - d. Torx T25 key
6. Wrenches / sockets
 - a. Metric wrench set 7mm – 24mm
 - b. Metric Socket set
 - c. Large adjustable wrench
7. Metal files
 - a. Large round metal file
 - b. Small round metal file
8. Sandpaper or Dremel with flapwheel sander
9. Bicycle tire pump
10. Teflon bearing grease

2019-06-15

Figure 13: Cycles Toussaint Ami Assembly Guide Tools (Cycles Toussaint Team, 2019)

Additional Tools Required

- Electric assist tools
- Measuring tools for battery cells
- Torque tools
- Cable cutters
- Chain tools
- Other standard bike tools

Makerspace Requirements

- Storage space and ability for housing trishaws
- Storage space and ability for housing trishaw motor batteries
- Laser cutting
- Wood working
- Electrical maintenance
- Textiles
- Welding

Source: Interview summaries in Appendix B

Appendix G: List of Global Makerspaces

Table 2: List of Global Makerspaces

Country	Makerspace/Bike Shop Name
Argentina	Impact Hub Buenos Aires
Brazil	Impact Hub São Paulo
China	Impact Hub Shanghai Serk (Bike Shop)
Colombia	Cuadrilla Espacio
Guatemala	TecLab
India	Workbench Projects
Israel	Makerlab Israel
Italy	Chrono (Bike Shop)
Mexico	Hacedores Makerspace
Nigeria	3D Africa
Peru	Lima Makers Makerspace
South Africa	The MakerSpace
Spain	The Workshop Madrid
Taiwan	M.Zone

Sources: Makerspace directory; Find your closest impact hub, 2018

Appendix H: Success Factors and Limitations of Business Models

Success Factors

- Having the main outlines of how that company operates be pretty clear
- Pursuing specific sources of funding
- Models cannot be too general or too specific
- Business modes should be characterized by clarity, logical validity and tangible evidence that supports the main components of their model such as:
 - Theory of Change
 - Programmatic Approach
 - Operational Framework
 - Multilateral Value Proposition
 - Revenue Structure
- Sustainable business models should be flexible over the course of time, to guarantee mission effectiveness and desired financial performance
- A strong business model displays soundness, sustainability and effective execution. It should have consistent desired results being accomplished along with a favorable financial bottom line
- More individuals are interested in working for non-profits or organizations that make a positive impact
- Business models need to have the capacity and strategic plan to ally with other enterprises, organizations, and government agencies.
- To enhance local buy-in and ownership it is necessary to involve local communities as partners and co-designers of new models
- It is important for business models for sustainable development to be self-sustaining in the long term. However, large investments of time and resources in the beginning is key for successful innovation and growth.
- Results from different sustainable development goals (ie. economic, social, environmental) need to be acknowledged and discussed.
- Consistent monitoring and reviewing are necessary in a business model.
- Outlook for company environment
 - The board should be knowledgeable, zealous, and active members
 - Board members should have a strong relationship with one another based on honesty, respect, and good communication
 - Staff leadership positions should be run by committed and well informed individuals
 - A strong relationship between board members and staff that is based on trust, honesty, respect, and good communication is important

Limitations

- Unchangeable processes, structures and company standards
- Indisputable convictions of the company
- Not doing self and team assessments that reflect on the current processes, company habits and values
- A team not willing to accept change or modify their process to become more successful

- Doing things based on getting the individual ahead rather than the whole company/personal gain
- Only sticking with a plan that worked in the past rather than modifying it based on the current situation
- Being boastful and too proud/arrogant
- Not taking in others ideas and not being open to different perspectives
- Being scared of losing profit and not willing to take chances on opportunities

Sources: *Anatomy of the nonprofit business model: A key driver of organizational performance.*; Business models for sustainable development, 2010; Emprehtinger, 2018; Foster, Kim, & Christiansen, 2009; Miller, 2017

Appendix I: Potential Customers Qualtrics Survey Results

Table 3: Potential Customers Qualtrics Survey Results

#	Questions	Responses				
Q1	Do you consent to participating in this survey?	Yes	Yes	Yes	Yes	Yes
Q2	What is your name (First Last)?	Responses Omitted from Document for Privacy	Responses Omitted from Document for Privacy	Responses Omitted from Document for Privacy	Responses Omitted from Document for Privacy	Responses Omitted from Document for Privacy
Q3	Where are you located?	Morocco	Asuncion, Paraguay, South America	Mérida Yucatán México	Maldonado , [Uruguay]	Pakistan
Q4_1	What is a reasonable price you would be able to pay for a trishaw design? - Preferred Price \$USD	99	1775	260	201	1390
Q4_2	What is a reasonable price you would be able to pay for a trishaw design? - Maximum Price \$USD	0	3070	407	344	1051
Q5	What is the terrain of your location (i.e. hills, flatland, wetland, oceanfront, etc.)?	flatland	hills	Flatland	Ocean front	Flatland
Q6	What are common materials you would have access to (i.e. aluminum, wood, steel, etc.)?	wood, steel	wood steel	Steel wood	[Aluminum] - all indeed	Wood

Q7	Also, what are some materials you have limited or no access to?		none, [it's] just price	Aluminum	Carbon	Steel
Q8	Do you have any experience with designing or manufacturing or assembling?	No	No	No	No	Yes
Q9	Do you know anyone who does?	Yes	No	No	Yes	
Q10	What is their contact information?	we have many mechanics and welders here			I know there must be but need to find out	
Q11 _1	Which do you have experience with? (check all that apply) - Designing					I have experience with ...
Q11 _2	Which do you have experience with? (check all that apply) - Manufacturing					I have experience with ...
Q11 _3	Which do you have experience with? (check all that apply) - Assembling					
Q12 _1	Have you ever worked on trishaws or bikes before? (check all that apply) - Bikes					
Q12 _2	Have you ever worked on trishaws or bikes before? (check all that apply) - Trishaws					

Q12_3	Have you ever worked on trishaws or bikes before? (check all that apply) - Neither					I have worked with ...
Q13	What manufacturing or designing software programs are you able to access?					Wood
Q14	Do you know of any maker spaces, bike manufacturers, or frame makers near you?	Yes	Yes	No	No	Yes
Q15	What is the name, contact information, and category (maker space, bike manufacturer, or frame maker) of the location?	Responses Omitted from Document for Privacy	Responses Omitted from Document for Privacy			Responses Omitted from Document for Privacy
Q16	Is there anything else you would like to share?	In fact, at the moment I can't pay any money for the project but I am very committed. When I became an affiliate with [CWA], I asked them to turn the project into a cause, and apply	[I'd] be happy to import one as you have them and start the project, then, maybe enroll these partners if possible. After the [quarantine] there will be enormous need for		Costs are [an] issue here due to import. We have no Bike manufacturer as far as I know.	No

		to world funding competitio ns to help create more branches in the world. I did that myself but it has ever been in vain .	elders to be outside			
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Appendix J: Cycling Without Age Open Source Trishaw Designs Business Model based on Bplan: The UC Berkeley Startup Competition Template

<u>Key Partners</u>	<u>Key Activities</u>	<u>Value Proposition</u>	<u>Customer Relationships</u>
<p>Who are Cycling Without Age's Key Partners? Cycling Without Age's Key Partners are current and potential chapters, current and potential manufactures, and Cycling Without Age investors. These people are important due to them playing a large part in how successful Cycling Without Age is in expanding to the global south.</p> <p>Who are Cycling Without Age's Key Suppliers? Cycling Without Age's Key Suppliers are designers, local manufactures, and local bike shops. These suppliers help with the expansion of the chapter by giving them the resources needed to create the trishaw from stages of design to fully assembled and ready for use.</p> <p>Which Key Resources are Cycling Without Age acquiring from partners? The expectations for the partners are to be interested, volunteer and give their time, help give their input when needed, and to overall help Cycling Without Age expand to new parts of the world.</p> <p>Which Key Activities do partners perform? Designers will distribute their designs and give some percentage of each design or parts sale to Cycling Without Age. Whereas current manufacturers sell their trishaws to chapters that can afford it and Cycling Without Age makes a profit off royalties with them. Chapters help spread Cycling Without Age's message and help raise money for the organization by buying trishaws from places the organization has deals with.</p> <p>How will the Key Partners benefit? The designers can receive some form of royalty for their designs, possibly a percentage per design if completely open</p>	<p>What Key Activities does Cycling Without Age's Value Propositions require? For Cycling Without Age to deliver on the ability to have trishaws in developing locations and to increase the local economic development and growth in these areas, the organization and its partners would need to design, source, manufacture, and assemble trishaw parts. Quality checking will also be highly recommended before the use of each open-sourced trishaw.</p> <p>Distribution Channels? For Cycling Without Age to continually reach its customers through its distribution channels, the organization needs to post open-source designs onto a platform and then maintain that specific platform along with all current platforms.</p> <p>Customer Relationships? To maintain customer relationships, Cycling Without Age must provide applications and opportunities to become affiliates. The organization also needs to maintain its social media presence to engage with and inform customers.</p> <p>Revenue streams? For Cycling Without Age to develop its future revenue streams, it will need to draft legal documents for certain</p>	<p>What value does Cycling Without Age deliver to their customers? Cycling Without Age wishes to provide its customers and the community with local economic development and growth, the ability to have trishaws, and assurance that their trishaws are safe.</p> <p>Which one of Cycling Without Age's customer's problems are they helping to solve? The goal of Cycling Without Age is assisting customers in getting trishaws so they can become active chapters.</p> <p>What bundles of products and services is Cycling Without Age offering to each Customer Segment? The bundle of products and services that Cycling Without Age are offering to each Customer Segment are affordable trishaws and the ability to establish a chapter.</p> <p>Which customer needs is Cycling Without Age satisfying? Cycling Without Age hopes to reach chapters in developing locations who are not able to fundraise enough to buy a European trishaw model. They hope to help them develop local economic growth.</p>	<p>What type of relationship does each of Cycling Without Age's Customer Segments expect the organization to establish and maintain with them? The type of relationship Cycling Without Age's Customer Segments expect the organization to establish and maintain with them is one where the organization outreaches, gives updates, and makes trishaws as available as possible for them.</p> <p>Which ones have Cycling Without Age established? For Cycling Without Age to develop its future revenue streams, it will need to draft legal documents for certain financial relationships between Cycling Without Age and other organizations, such as the providers of designs. These documents would outline factors such as royalties, licensing, etcetera. Also, to ensure continual incoming revenue, the organization should talk to customers about their preferences and limitations on prices.</p> <p>How are they integrated with the rest of Cycling Without Age's business model? For Cycling Without Age to be able to deliver the ability of having local economic growth and development and trishaws in developing locations, the resources needed consist of manufacturing opportunities, as well as the necessary materials for open-source parts, such as wood, plastic, and metal.</p> <p>How costly are they? It is always a pleasure for Cycling Without Age to maintain relationships with their customers and all that is needed is to dedicate their time to ensure that their customers are satisfied and feel that their needs were considered.</p>
		<p><u>Customer Segments</u></p> <p>For whom is Cycling Without Age creating value? Cycling Without Age is creating value for its Key Partners.</p> <p>Who are Cycling Without Age's most important customers?</p>	

<p>sourced, whenever the design is downloaded. When not completely open sourced, the designer will receive payment for the parts shipped, possible with added royalties if sending the design, too, for local parts to be sourced and added (i.e. if just the frame is sent and the rest is made locally). The current and potential chapters get the chance to be involved with the organization at a low cost. Current manufacturers and Cycling Without Age investors get the benefit of the free advertising of trishaws and an increase in overall trishaw sales.</p>	<p>financial relationships between Cycling Without Age and other organizations, such as the providers of designs. These documents would outline factors such as royalties, licensing, etcetera. Also, to ensure continual incoming revenue, the organization should talk to customers about their preferences and limitations on prices.</p>	<p>In respect to the open-source aspect of Cycling Without Age, the organization's most important customers, that they are trying to get trishaws to, are the chapters and potential affiliates in the global south.</p>
<p><u>Key Resources</u></p> <p>What Key Resources does Cycling Without Age's Value Propositions require? For Cycling Without Age to be able to deliver the ability of having trishaws in developing locations and local economic growth and development, the resources needed consist of: manufacturing opportunities, as well as the necessary materials for open-source parts, such as wood, plastic, and metal.</p> <p>Distribution Channels? To continually reach Cycling Without Age customers through the organization's distribution channels, Cycling Without Age needs to have access to the internet for online distribution of information and networking. The organization will also need to develop a controlled online platform so customers have access to designs.</p> <p>Customer Relationships? To maintain customer relationships, Cycling Without Age must have the time, personnel, and online social media platforms to publish information and reply to or collect responses from the community.</p> <p>Revenue Streams? The key resources needed to develop Cycling Without Age's future revenue streams are personnel like lawyers and accountants, as well as legal documentations for things such as royalties, clauses, funding, and licensing.</p>		<p><u>Cost Structure</u></p> <p>What are the most important costs inherent in Cycling Without Age's business model? The most important costs that are inherent in our business model are related to the manufacturing of parts for trishaws.</p> <p>Which Key Resources are most expensive? The most expensive Key Resources are the electric motor and the braking system.</p> <p><u>Channels</u></p> <p>Through which Channels does Cycling Without Age's Customer Segments want to be reached? There are multiple channels that Cycling Without Age's Customer Segments can be reached from and can communicate with each other on, but the channels they could possibly want to be reached by are the Hood or other platforms used for posting open-source designs.</p> <p>How is Cycling Without Age reaching them now? How are Cycling Without Age's Channels integrated? As of now, Cycling Without Age is able to reach out to its Customer Segments through newsletters in emails, the Hood, surveys, and the Cycling Without Age social media platforms. On the Hood, for example, Cycling Without Age affiliates can post questions and concerns that they may have.</p> <p>Which ones work best? In general, Cycling Without Age gets the highest response rates when individually emailing contacts, but, due to this being a very time-consuming approach, it is not very effective when a large number of people must be reached. When large groups are to be contacted, Newsletters are sent out in English. When reaching out to new open-source contacts where the predominant language is not English, newsletters will be sent in their native language.</p> <p>Which ones are most cost-efficient? All of Cycling Without Age's current channels are at similar levels of cost-efficiency and provide adequate access to customer concerns and input.</p> <p>How is Cycling Without Age integrating them with customer routines? Cycling Without Age will have scheduled newsletters and updates on all platforms so that customers can expect when they'll receive new information and be able to respond with their input.</p>

<u>Revenue Streams</u>	<u>Principles of This Open-Source Initiative</u>
<p>For what value are Cycling Without Age customers really willing to pay? For the potential chapters in locations Cycling Without Age is looking at, most can pay within a range of \$350-\$3,000.</p> <p>For what do they currently pay? The cost of a trishaw from one of the leading manufacturers ranges in cost from \$7,000-\$12,000.</p> <p>How are they currently paying? Currently, Cycling Without Age chapters can fundraise for their trishaws through many different recommended methods such as: municipalities, privately owned nursing homes, foundations, private companies, crowdfunding, and personal funding.</p> <p>How would they prefer to pay? Cycling Without Age assumes that its customers would prefer to pay for trishaws through donations, sponsorships, or crowdfunding.</p> <p>How much does each Revenue Stream contribute to overall revenues? All of the overall revenues are from the profit of operations and by soliciting donations. Cycling Without Age receives revenue whenever a customer or affiliate purchases a trishaw, pays to participate in a training class, or involves a Cycling Without Age staff member in a takeoff event.</p>	<ul style="list-style-type: none"> • Increase interest and development in sustainability • Provide opportunities for local manufacturing and economic growth • Stay more focused on the impact and quality of the project, rather than the amount of revenue • Even if at first a chapter is at a lower level of open sourcing, the ultimate goal should be to be continue moving up in levels of open sourcing (as defined by the Rating Matrix for Levels of Open Source in Appendix A) • Always be striving to spread Cycling Without Age to more parts of the world • Always have designs available and engage with community about them • Continuously update the network and reach out to new and interested contacts • At least 50% of a trishaw should be open sourced • Strive to increase trishaw sales, with more openshaw sales each year

Sources:

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Appendix K: Cycling Without Age Open Source Trishaw Business Model for Potential Open Source Customers based on Bplan: The UC Berkeley Startup Competition Template

<p><u>Overview</u></p> <p>We want to make trishaws more accessible to you, our current and potential affiliates, by developing and implementing an open-source plan. Open-source plans allow for customers to download designs and make the product locally or have the product shipped from a local designer who makes the product for the customer. The benefits of this approach are an increase in sustainability and local economic growth and development. This approach benefits you by making available a trishaw model that is closer to 350-3,000 USD, rather than the current 7,000-12,000 USD.</p>	<p><u>Key Resources</u></p> <p>Cycling Without Age strives to promote sustainability and local economic development. However, we understand that not everyone has the resources to create a completely open-sourced trishaw. For this reason, we provide the Rating Matrix for Levels of Open Source (in Appendix A) for you to assess your current situation and determine what option of open sourcing you would like to choose at this time. We do, however, have the “Principles of Cycling Without Age’s Open-Source Initiative”. One of these principles is that even if at first your chapter has to choose a lower level of open sourcing, the ultimate goal should be to continue moving up in levels of open sourcing once you get more acquainted with the processes. If fully open sourcing is not a realistic goal for your location, we hope that you can strive to get your trishaws to be at least 50% open sourced.</p>	<p><u>Customer Relationships and Channels</u></p> <p>The type of relationship we hope to establish and maintain with you is one where we outreach, give updates, and make trishaws as available as possible for you. We will use many different platforms for this, such as our social media accounts, the Hood, newsletters and other emails, and a new platform for design sharing and downloading open-source trishaw designs. Within this platform, some designs may require a small cost for access, in order to support our designers. However, these designs can allow your chapter to build your own open-source trishaw.</p>	<p><u>Costs</u></p> <p>Currently, chapters pay 7,000-12,000 USD for trishaws. With this open-source plan, you will be able to buy trishaws more local to you or download designs of these trishaws to make them locally for closer to 350-3,000 USD. This cost could be paid through use of municipalities, foundations, private companies or nursing homes, crowdfunding, and personal funding.</p>
<p><u>Your Key Activities</u></p> <p>As one of our key partners, what we need from you is your time and interest in our goals as an organization. To be as involved as we hope you would like to be, some fundraising and gaining sponsorship may be required in order to purchase an open-source trishaw or trishaw design and parts. Then, depending on your choice of open sourcing (as defined by the Rating Matrix for Levels of Open Source in Appendix A), you would have to collaborate with makerspaces or local manufacturers to obtain the parts and tools needed to make a trishaw. We feel this is a great chance for you to be involved for a much lower cost than previously offered.</p>	<p><u>Value Proposition</u></p> <p>Cycling Without Age wishes to provide its customers and the community with local economic development and growth, the ability to have trishaws, and assurance that their trishaws are safe. Our goal is to assist our current and potential customers in getting trishaws so they can become active. We would also like to provide our affiliates with the opportunity to promote sustainability and local economic development through creating jobs for the local manufacturers and bike shops in your area that can provide the manufacturing of the frames, assembly of more advanced parts, and frequent quality checks of the trishaws.</p>	<p><u>Principles of Cycling Without Age’s Open-Source Initiative</u></p> <ul style="list-style-type: none"> • Increase interest and development in sustainability • Provide opportunities for local manufacturing and economic growth • Stay more focused on the impact and quality of the project, rather than the amount of revenue • Even if at first a chapter is at a lower level of open sourcing, the ultimate goal should be to be continue moving up in levels of open sourcing (as defined by the Rating Matrix for Levels of Open Source in Appendix A) • Always be striving to spread Cycling Without Age to more parts of the world • Always have designs available and engage with community about them • Continuously update the network and reach out to new and interested contacts • At least 50% of a trishaw should be open sourced • Strive to increase trishaw sales, with more openshaw sales each year 	

<p><u>Cycling Without Age's Key Activities</u></p> <p>To maintain customer relationships, Cycling Without Age will provide applications and opportunities to become affiliates. We will also maintain social media presence to engage with and inform our affiliates.</p>		
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Sources:

- Becoming A Cycling Without Age affiliate - Cycling Without Age. (2016). Retrieved from <https://cyclingwithoutage.org/affiliate/>
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Appendix L: Open-Source Options Rating Matrices

Comparison of Relevant Factors Among Different Open-Source Levels				
Factors	Completely Open Sourced	Partially Open Sourced (External sourcing of selected components)	Open Sourced Through Hubs Sending in Flat Packs (Local assembly required)	Open Sourced Through Hubs Sending Fully Assembled Trishaws
Decreases Transportation Carbon Footprint				
Promotes Local Economic Growth and Development*				
Assurance of Safety Standards				
Follows CWA Principles for Open Source				
Facilitates Construction Without Prior Knowledge of Manufacturing and Assembly of Trishaws, Bikes, Scooters, or Similar				
Facilitates Construction Without Need of Finding a Bike Manufacturer or Frame Maker Willing to Make Small Scale				

<i>Scale:</i>
<i>Most</i>
<i>Least</i>

Assures Intellectual Property Security**				
Allows for Customization Based on Local Needs				

*This refers to local economic growth and development of any kind, including that of bike manufacturers, frame makers, and the local community, such as bike mechanics.

**These ratings are based on the assumption that there are no legal rights to the respective trishaw design.

Note: Cost and time were not taken into account at this stage of analysis due to lack of data, such as chapter location and resources. Once this information is acquired, these will be significant factors to consider.

Rating of Relevant Factors Among Different Distribution Processes

Factors	Completely Open Sourced	Partially Open Sourced (External sourcing of selected components)	Open Sourced Through Hubs Sending in Flat Packs (Local assembly required)	Open Sourced Through Hubs Sending Fully Assembled Trishaws	Current Process
Decreases Transportation Carbon Footprint					
Promotes Local Economic Growth and Development*					
Assurance of Safety Standards					
Follows CWA Principles for Open Source					
Facilitates Construction Without Prior Knowledge of Manufacturing and Assembly of Trishaws, Bikes, Scooters, or Similar					
Facilitates Construction Without Need of Finding a Bike Manufacturer or Frame Maker Willing to Make Small Scale					

Key:
<i>High</i>
<i>Moderate</i>
<i>Low</i>
<i>Little/Few -None</i>

Assures Intellectual Property Security**					
Allows for Customization Based on Local Needs					

*This refers to local economic growth and development of any kind, including that of bike manufacturers, frame makers, and the local community, such as bike mechanics.

**These ratings are based on the assumption that there are no legal rights to the respective trishaw design.

Note: Cost and time were not taken into account at this stage of analysis due to lack of data, such as chapter location and resources. Once this information is acquired, these will be significant factors to consider.

Appendix M: Ways to Increase Ratings of Open-Source Factors

Table 4: Ways to Increase Ratings of Open-Source Factors

Factors	Ways to Increase Rating
Decreases Transportation Carbon Footprint	<ul style="list-style-type: none"> • Get materials from places where the processes are environmentally friendly • Sourcing parts from locations that are environmentally friendly • Try to use more sustainable transportation methods for shipping
Promotes Local Economic Growth and Development	<ul style="list-style-type: none"> • If the potential customer is in the same city/area as the hub • Having to go to a bike mechanic for frequent inspections & tune ups • Getting as many people involved as possible • Have advertisements for local companies on the trishaw
Assurance of Safety Standards	<ul style="list-style-type: none"> • Have a chapter member focus on safety issues • Quality check each part • Have a safety test that they must pass before being used • Frequent inspections & tune ups
Follows CWA Principles for Open Source	<ul style="list-style-type: none"> • To be determined
Facilitates Construction Without Prior Knowledge of Manufacturing and Assembly of Trishaws, Bikes, Scooters, or Similar	<ul style="list-style-type: none"> • Provide tutorial videos • Provide in-depth manuals
Facilitates Construction Without Need of Finding a Bike Manufacturer or Frame Maker Willing to Make Small Scale	<ul style="list-style-type: none"> • Innovative designs specifications that doesn't require specific machines and tools
Assures Intellectual Property Security	<ul style="list-style-type: none"> • Take legal action to ensure this security (i.e. patents, licenses, etcetera) • Have special process of acquiring designs <ul style="list-style-type: none"> ○ Only people on the special platform can get them
Allows for Customization Based on Local Needs	<ul style="list-style-type: none"> • Have a collaborative forum for people to post different modifications they have made to their trishaws • Designs with interchangeable features