Access to Affordable Bicycles: Summary of Findings from Literature Review and Key Informant Interviews

MIT D-Lab
Comprehensive Initiative on Technology Evaluation
Massachusetts Institute of Technology

Dan Frey, Megha Hegde, Gwyn Jones, Kendra Leith, Dan Sweeney, and Jonars Spielberg

January 2021

USAID FROM THE AMERICAN PEOPLE
MIT D-Lab designing for a more equitable world
CITE

About USAID

The United States Agency for International Development (USAID) is a leading international development agency and a catalytic actor driving development results.

The USAID Innovation, Technology, and Research Hub (ITR) (formerly the USAID Center for Digital Development) works to address gaps in digital access and affordability and to advance the use of technology and advanced data analysis in development. ITR's Technology Division pursues this mission by: 1) supporting the enabling environment that serves as a foundation for inclusive digital infrastructure and services and 2) building Agency capacity via technical trainings, toolkits, and guidance documents, and by building a network of Mission-based specialists. ITR/T works to foster market-led innovation and integrate digital technology, advanced data, and geographic analysis, and to align digital development best practices with the strategic planning and design of enterprise-driven programs across the Agency and with partners.

About MIT D-Lab | CITE

MIT D-Lab works with people around the world to develop and advance collaborative approaches and practical solutions to global poverty challenges. The program's mission is pursued through an academics program of more than 20 MIT courses and student research and fieldwork opportunities; research groups spanning a variety of sectors and approaches; and a group of participatory innovation programs called innovation practice.

This document is part of a series of reports produced by MIT CITE. Launched at the Massachusetts Institute of Technology (MIT) in 2012 with a consortium of MIT partners, CITE was the first-ever program dedicated to developing methods for product evaluation in global development. Located at MIT D-Lab since 2017, CITE is led by an interdisciplinary team and has expanded its research focus to include studies that explore the barriers to, and enablers of, effective innovation processes and technology adoption; the outcomes of capacity building programs and technology interventions; and the contexts in which technologies and innovation processes operate. This includes a portfolio of research studies on digital financial services programs, capacity for local innovation, internet of things for agriculture, inclusive systems innovation, fairness in machine learning, and evaporative cooling technologies. CITE also develops the capacity of researchers to conduct evaluations by providing resources and tools on its methods.

This report is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of this report are the sole responsibility of MIT D-Lab and do not necessarily reflect the views of USAID or the United States Government.

Table of Contents

Introduction and Key Findings

As part of a USAID-funded project, Access to Affordable Bicycles, an MIT D-Lab CITE team has been conducting research to understand the background, current state, and opportunities for bicycles to benefit underserved communities, particularly in Africa. In the initial phase of the project, the team conducted a literature review and key informant interviews. This paper outlines the key findings from the initial phase of the research. The team has also identified some gaps that could be addressed in the next phase of the research.

Although the literature on bicycles is limited and some of the sources are older, the team was able to identify a number of opportunities and challenges related to bicycles. The benefits include improved gender norms, improved access to education, increased productivity and income, and improved efficiency and time savings. Although there are several benefits, there are also a variety of challenges and barriers to adoption, which include affordability and access to credit to pay for bicycles; high transportation costs, tariffs, and taxes; government regulations that restrict access to bicycles; social and gender norms; difficult terrain, weather and inadequate infrastructure; design of bicycles often not suited to use case or user; safety concerns; spare parts and aftermarket services may be limited and repair costs can be expensive; and organizational capacity to implement and evaluate programs may be limited.

Methods

The team conducted a literature review and nine interviews in preparation for this report. In the literature review, they explored academic and popular literature through search engines such as Google Scholar, Science Direct, Scopus, MIT Libraries, and Google. The team looked at topics such as gender and social dynamics, education, barriers to adoption, opportunities to improve poverty outcomes, challenges related to access to bicycles, legal and policy frameworks, current bicycle designs/solutions and gaps, local production to improve access, urban/rural, the impacts of Covid-19, bicycles for education, supply chains, and manufacturing. The team identified key informants through the literature search and the D-Lab network and targeted individual informants that the team believed had the most relevant information. The initial list of key informants included actors such as staff at local NGOs, researchers, staff at international NGOs, manufacturers, policy makers and government officials, donors, and local bicycle shops. This preliminary list was combined with snowball sampling from the interviews while trying to ensure a diversity of points of view.

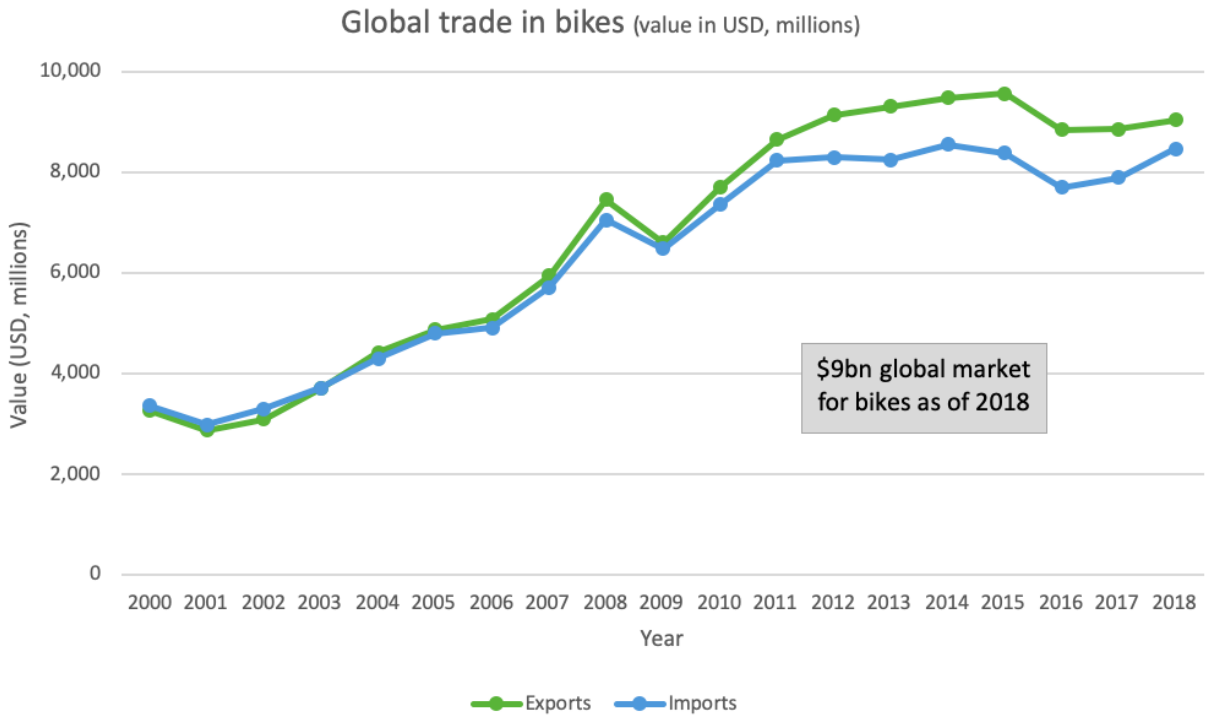
Bicycle Production, Exports, and Imports

Worldwide, over 150 million bicycles are produced each year (Comtrade, 2019). To place this number in context, this number is more than double the number of automobiles manufactured in a typical year.

There is a wide variety of bicycle types produced, but a small number of basic design types comprise the majority of the production. The five most common bicycle types (in order from most to least) are

mountain, hybrid, road, comfort, and youth (U.S. Department of Commerce, 2004). These five basic types comprise more than 90% of worldwide production. The most common bicycle type in Africa is the "roadster" type, which is an affordable and durable utility bicycle imported predominantly from India, China and Taiwan. It is important to note that bicycle manufacturing according to the U.S. Economic Census is presented from the Western market lens and may not accurately represent the supply of bicycles to countries in Africa.

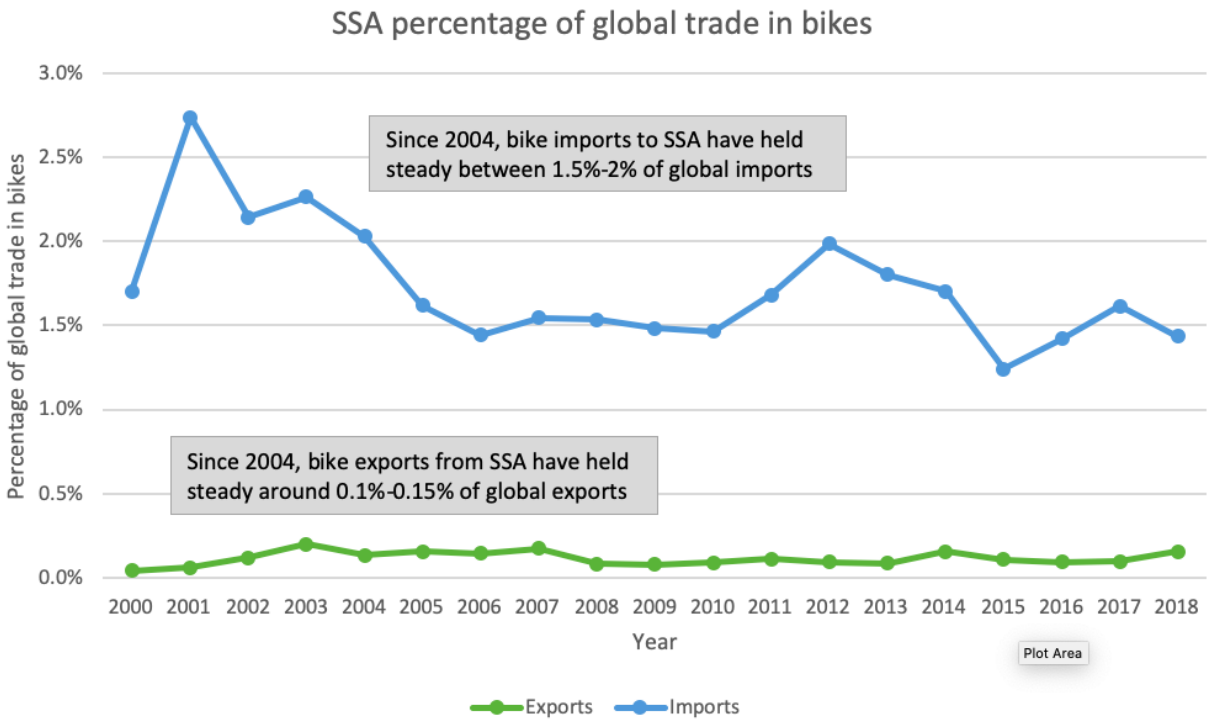
Sub-Saharan Africa (SSA) represents a very small portion of total bicycle exports. In 2018, the global market for bicycles was $9 billion. From 2000 to 2018, Sub-Saharan Africa represented only 0.1% to 0.15% of global exports. In 2018, the last year for which complete trade data is available, the largest exporters were China ($3.285 billion), Taiwan ($1.497 billion), the Netherlands ($740 million), Germany ($609 million) and Cambodia ($376 million). In contrast, Sub-Saharan Africa exported about $14 million in bicycles (United Nations, 2019). It important to that the gap between import and export data are due to incomplete reporting. It is also important to note that the second-hand bicycle market in Africa is large and is not captured in the official trade statistics in the figures here.



Source: United Nations Comtrade, 2019

The region also imports only a small percentage of bicycles globally, though imports far exceed exports and local manufacture remains low. From 2000 to 2018, Sub-Saharan Africa represented about 1.5% to 2% of the global imports. The largest importers worldwide included the United States ($1.6 billion), Germany ($769 million), Japan ($669 million), the Netherlands ($590 million) and France ($490 million). In 2018 in Sub-Saharan Africa, bicycle imports represented about $120 million. Within Sub-Saharan

Africa, the largest importers were South Africa, Ghana, Mozambique, Nigeria, and Tanzania and the largest exporters to Africa were China, India, Japan, and Taiwan. Interestingly, South Africa and Tanzania also were in the top ten list of exporters to Sub-Saharan countries, indicating that there is some local production occurring on the continent (United Nations, 2019).



Source: United Nations Comtrade, 2019

Dependence on Imported Bicycles and Limited Local Manufacturing Capacity

Although bicycles have been produced on the continent, African countries remain largely dependent on the supply of inexpensive imported and donated bicycles supported by decentralized maintenance and repair networks (Baker, 2018). A survey in rural Kenya reported approximately 65% of bicycles were purchased second-hand (Khayesi, 1993).

The supply of second-hand bicycles through philanthropic and development interventions has often resulted in a mismatch between the mobility needs of Africans and intended uses of low-end, discarded bicycles. Communities, with the support of local mechanics, often subscribe to and adapt, or reject, the bicycle design to meet their diverse needs (Baker, 2019, 2020). This is compounded by the fact that in many locations, there is limited capacity to manufacture bicycles locally (two respondents).

However, there are interesting cases from both Japan and India on how to develop such manufacturing experience. During the late 19th century in Tokyo, foreign visitors introduced European bicycles, which required repair and maintenance. Mechanics in Japanese rifle repair shops responded to this need and learned to repair and manufacture replacement parts for imported bicycles. With increasing popularity, the small manufacturers evolved into dedicated bicycle component companies and bicycle manufacturers by the end of the century. The expansion of the bicycle industry throughout Japan subsequently led to similar industrial evolution in smaller cities beyond Tokyo. By the 1970s, Japan was a major supplier of bicycles and components in the global market (Jacobs, 1995; Kotha & Fried, 1993). Similarly, in India, the import of British bicycles during the colonial period drove the establishment of small repair shops across the country. Subsequently, this led to a thriving ecosystem of distributed manufacturers in small towns, eventually consolidating in Ludhiana with the support from skilled refugees from West Punjab, Pakistan after independence. The spectrum of small and large manufacturing units comprising the modern Indian bicycle industry is one of the largest in the world (Singh, 1994; one respondent). Thus, there may be opportunities for African countries to learn from historical examples in Japan and India.

Opportunities to Leverage Bicycles

Based on the literature and key informant interviews, a number of benefits to using bicycles emerged, including improved gender norms, increased access to education, increased productivity and income, and time savings.

Improved gender equity

In interventions that focused on bicycle access to women and girls, it was reported that access to bicycles improved gender equity in the community and led to female empowerment (Fiala et al., 2019; Muralidharan & Prakash, 2017). This finding has been reported in several newspaper articles and blogs (for example, in Iran, Saudi Arabia, and Tajikistan). Studies have also shown that women often use bicycles for productive purposes such as taking advantage of income-generating opportunities and improving access to education for their children (one respondent). One recent study from Indonesia noted that women also use bicycles for social purposes such as shopping, recreation, and visiting family and friends more so than for economic purposes (L. Song et al., 2019).

Improved access to education

There is also evidence that bicycles have a positive impact on educational outcomes. Studies have found that bicycles are a cost effective way to increase access to education by reducing travel time in rural areas (Fiala et al., 2019; Girls Not Brides & Janaki Women Awareness Society, 2017; Muralidharan & Prakash, 2017; Räber, 2014; L. K. Song, 2003). In addition, studies demonstrate evidence of increased enrollment, decreased dropout rates, better performance in tests, decreased absenteeism, and improved punctuality (Fiala et al., 2019; Girls Not Brides & Janaki Women Awareness Society, 2017; Muralidharan & Prakash, 2017; Savage, 2020). Girls with access to bicycles and education have also reported feeling more empowered (Fiala et al., 2019; Girls Not Brides & Janaki Women Awareness Society, 2017;

Muralidharan & Prakash, 2017; Savage, 2020). Some of the key informant interviews also supported this evidence. Although there is some strong evidence of bicycles having a positive impact on education, one respondent indicated there is also a need for more research.

However, information uncovered in literature review and key informant interviews indicated that, when interventions don't have a specific education focus, children may not use bikes to access schools, but rather use them for recreational purposes and to run errands.

Increased productivity and income

There are also a number of documented benefits related to improving productivity and increasing income. Bicycle use for income-generating activities is common between urban and rural riders (e.g. goods and materials delivery, courier, passenger transport, knife sharpening) (Shirazi, 2020). There is evidence that bicycles can increase agricultural productivity in rural areas (Hine & Rutter, 2000). For a household engaged in agriculture, one study estimated that farmers would gain 3,000 additional working hours if bicycles were available for community members (Peier, 2015). In addition, bicycles can also increase farmer access to agricultural extension agents and valuable agricultural information, as demonstrated in Malawi (World Bicycle Relief, 2019c). Bicycles can also be used to create a passenger and small goods transport service, generating additional income, such as in Kampala (Bryceson et al., 2003). Some interventions targeting women have shown improvements in income because bicycles enable women to go to multiple markets for economic purposes, which was not possible previously (one respondent). Another study in Kenya found that for female business groups, women with bicycles experienced more positive business outcomes as compared to a control group that did not receive bicycles (World Bicycle Relief, 2019b). Thus, there is evidence of potential benefits related to productivity and income.

Improved efficiency and time savings

There are many reasons why the modern bicycle design is so popular. From an energy efficiency perspective, bicycles rank first among traveling animals and machines with the average rider requiring just 0.15 calorie per kg per kilometer, one-fifth of the average walking human (0.75 calorie per kg per kilometer), and one-fortieth of an automobile (7 calorie per kg per kilometer) (Wilson, 1973).

Given that riding a bicycle comes with additional efficiency, there are associated benefits of time savings, as people can accomplish tasks more efficiently including carrying more goods a farther distance at a quicker pace. This means that the users can increase the number and diversity of activities, which can lead to increases in both earnings and savings (Peier, 2015).

Bicycle Organizations

Given the potential benefits of using bicycles, there are a number of organizations working to improve access to bicycles, including Bicycles for the World, Wheels 4 Life, Bicycles Not Bombs, Village Bicycle Project, and Velafrica, among others in Africa. Many of these organizations ship second-hand bicycles

from the US or Europe. In an attempt to overcome challenges with second-hand bicycles, several non-profit initiatives filter only bicycles that are in good condition and provide tailored maintenance training and tools to local mechanics and riders. The Village Bicycle Project in West Africa is an example of a successful organization that has provided access and maintenance support in low-income communities totaling more than 100,000 second-hand bicycles since 1999 (Appropriate Technology, 2017).

Other initiatives by startup manufacturers have attempted to introduce a "made in Africa for African needs" bicycle. World Bicycle Relief's Buffalo Bicycle is designed for rugged use and easy repair, with coaster brakes, heavy-gauge steel tubing and spokes, and a cargo carrier capacity of 100kg. Buffalo Bicycles are assembled at workshops in Africa (Zambia, Zimbabwe, Kenya, and Malawi (Buffalo Bicycle, n.d.)) from parts manufactured in Asia and the US, and distributed across entrepreneur-technician and NGO networks across Africa. Approximately 500,000 bicycles have been distributed through Buffalo Bicycles and other WBR initiatives (World Bicycle Relief, 2019a). Similarly, the Institute for Transportation and Development Policy (ITDP) and Afribicycle in South Africa partnered to develop the "Africa Bicycle", a $65 bicycle designed for durability, ease-of-maintenance and appealing aesthetics compared to the more common "Black Roadster" found across Africa (White & Budnick, 2001). Accurate numbers for the volume of bicycles made in Africa in the African market have not been located; however, they are likely a small fraction of overall supply.

Due to the high cost of steel and low capacity for domestic manufacturing, several designers are constructing bicycle frames from locally available materials, including bamboo. Bamboo has a similar tensile strength compared to steel, but is 20% to 30% lighter and requires less specialized tools to cut, form and join (Ukoba et al., 2011). Booomers Bamboo Bicycles and Ghana Bamboo Bicycles are producing bicycle frames locally in Ghana from bamboo and importing the remaining components. While small-scale, local manufacturing of bamboo bicycles is achievable with low-investment, due to the low volumes, they are unable to achieve the scale and production cost of large, Asian bicycle suppliers (one respondent).

Challenges

Despite the potential benefits of bicycles, there are also challenges that limit access and use. Challenges include, affordability, lack of access to credit, high transportation costs, high tariffs and taxes, government regulations, social and gender norms, safety concerns, the design of bicycles, difficult terrain, availability and affordability of spare parts and aftermarket service, and organizational capacity, among others.

Affordability and access to credit to pay for bicycles

One of the biggest barriers is the affordability of a bicycle (one respondent). Bicycles range widely in price based on type, material, and country but can be as low as around $40 for ones imported from India, and as high as $150 for a Buffalo Bicycle (England & Manson, 2012). Community members often have limited income and purchasing power for this type of product, which means that financing is often

required (Ardizzi, 2018). However, access to credit is also a challenge (Peier, 2015). These two issues combined often make bicycles unaffordable to many community members in low- and middle-income countries.

High transportation costs, tariffs, and taxes

In addition, there can be high transportation and shipping costs and it can be difficult to import bicycles, especially to landlocked countries (Ardizzi, 2018). In cases where bicycles have been donated, partner organizations that are receiving the bicycles may not be able to pay for the high cost of shipping (one respondent). Once the bicycles arrive in country, they may also be subject to high taxes and import tariffs. In places like Ethiopia, Ghana, and Tanzania import taxes can be as high as 200% to 500%, making it very expensive to import the bicycles (Sieber, 1999). Thus, even if the shipping costs are reasonable, tariffs and taxes can present major challenges.

Government regulations and policies

Other restrictions include government regulations on imported bicycles (Gauthier & Hook, 2005; Sieber, 1999). In East Africa, one informant indicated that it has been harder to ship bicycles to the region due to stricter and evolving regulations on importing used goods, as governments do not want second-hand goods arriving in their countries. There is often uncertainty at the port of entry/customs since agents have discretion over the extent to which containers and manifests are scrutinized. It is generally an opaque, bureaucratic process that is confusing and unpredictable (one respondent).

In terms of mobility and transportation policy, bicycles generally receive little attention or consideration. This occurs at both the global and national level. Globally, mobility is not considered a top priority on the international development agenda. Investments in non-motorized transport receive very little support from international lenders (Pojani & Stead, 2015). A 2007 World Bank report that reflects on a decade of its assistance to the transport sector "makes virtually no concrete recommendations for improving non-motorized transportation infrastructure or policies worldwide" (Furness, 2010, p. 189-190). Mobility's absence in the Sustainable Development Goals, or SDGs, is further evidence of neglect (one respondent), despite the fact that access to bicycles can contribute directly to at least nine of the 17 SDGs (World Bicycle Relief, 2018).

At the national level, governments tend to promote mobility and transportation policies that favor motorized vehicles, especially cars, to the point where other modes of mobility operate within a "policy and planning vacuum" (Sietchiping et al., 2012, p. 185). In Ghana, for example, the National Transport Policy includes a target to increase the modal share of non-motorized travel by 10%. In practice, however, virtually no effort has been taken to achieve this target, even in areas where bicycling is prevalent (Acheampong & Siiba, 2018). Broadly speaking, the car is seen as a "modern" technology, whereas the bicycle is often seen as a "backward" technology, one associated with low-income or rural communities (Pojani & Stead, 2015; one respondent).

Social and gender norms can limit bicycle adoption

Social norms and preferences also have an effect on adoption. People often prefer motorized vehicles and often think of bicycles as a "poor person's" transportation option, which means that people may be less likely to adopt the bicycle (Nkurunziza et al., 2012). Urban dwellers are more likely to forego bicycle ownership for the convenience of using public transportation or purchasing a motorized vehicle (World Bank, 2008; one respondent). In addition, there is often the expectation that bicycles will be shared amongst household members, which creates the potential for sowing division, since people are often competing for this scarce resource to carry out their activities, with men's activities and needs often prioritized over those of women (Adom-Asamoah et al., 2020); one respondent).

Women are often responsible for gathering fuel, water and crop harvest, activities for which a bicycle could be helpful and at the same time, gender issues and social norms also prevent women from adopting bicycles (Acheampong & Siiba, 2018; Calvo, 1994; Porter, 2014). For instance, there is the belief that women may lose virginity if they ride a bicycle (one respondent) or girls might be spoiled or independent if given a bicycle (one respondent). There is also the belief that bicycles are predominantly men's equipment such that girls' and women's use is discouraged (Porter, 2014). Similarly, if there is a bicycle in the household, the man is more likely to use it, which could limit opportunities for women (Adom-Asamoah et al., 2020; Calvo, 1994; L. Song et al., 2019). Men also did not like programs that targeted only women (two respondents). Men were not happy that they were not included, and some bicycles were stolen/destroyed (one respondent). Thus, even though there are a number of potential benefits for women, there are gender norms and other risks that could limit adoption of bicycles by women.

Though they present difficulties, these challenges to improved gender equity are not necessarily intractable. Strategies for addressing these difficulties have included engaging local leaders and community members broadly, providing bicycles to boys and men in addition to girls and women, providing bicycles at scale to encourage mass participation, and repeated sensitization and training programs (two respondents).

Difficult terrain and weather and inadequate infrastructure

Terrain, weather, and infrastructure may also present a challenge for using bicycles. Mountainous or hilly regions can be difficult to traverse. Similarly, travel can also be difficult on muddy roads during the rainy season. (McSweeney et al., 2020; three respondents).

When the topographical and weather challenges are combined with inadequate infrastructure, this can make it even more difficult for users to adopt and continue to use bicycles (Hine & Rutter, 2000; McSweeney et al., 2020). Similarly, informal transport systems that are neglected by formal development/planning projects can also present challenges, making cycling a less desirable form of transportation (Bryceson, et, al., 2003). In addition, many of the bicycles currently available are poor quality and not rugged enough for rural roads and areas where there is inadequate infrastructure (Hamilton, 2012; The Economist, 2008).

Road infrastructure, motorized vehicle ownership and access to public transportation are more limited in rural areas (Hine & Rutter, 2000). Urban road infrastructure is generally better, but higher incomes, better access to public transportation, vehicle traffic congestion and poor infrastructure contribute to lower bicycle ownership and use compared to rural communities in some countries (Amoako-Sakyi & Owusu, 2012; Sietchiping et al., 2012).

Design of bicycles often not suited to use case or user

The design of the bicycle can also have an impact on adoption. For instance, the bicycle may not be created with the appropriate use case in mind including a low-load carrying capacity (Peier, 2015). In addition, many of the bicycles are designed for adult male bodies, which means that women and children may face discomfort and be less likely to adopt the solution (Calvo, 1994; L. Song et al., 2019).

Safety concerns

There are also safety concerns related to accidents with motorized vehicles, a lack of helmets, poor maintenance, and reliance on under-trained mechanics for repair (Bryceson et al., 2003). Safety concerns are also linked to gender, where women fear harassment and crime, or limit their bicycle use to times (daylight hours) and places (closer to home) they feel safer (L. Song et al., 2019)

Spare parts and aftermarket services may be limited and repair costs can be expensive

There is also evidence that spare parts to repair bicycles are not readily available and the after-market support is limited, which could lead to disadoption (World Bicycle Relief, 2019b). Similarly, there is also evidence that repairs and maintenance are not always accessible and can be expensive, leading to disadoption of bicycles (Mahapa, 2003). This was also confirmed in interviews (two respondents). One informant further noted that bicycles are typically sourced from one or two primary countries, which limits the kinds of spare parts that are available locally (one respondent).

Organizational capacity to implement and evaluate programs

Another challenge is organizational capacity to implement and evaluate bicycle programs (one respondent). Most organizations have weak capacity for monitoring, evaluation, and learning and therefore have little insight on what programs work or not, and why (two respondents). The fact that many organizations rely on volunteers and on managing numerous partner relationships further adds to the logistical complexity of providing bicycles (one respondent). However, organizations are beginning to think more critically and more long-term regarding programming. For example, World Bicycle Relief and Bicycles Not Bombs have both completed strategic planning processes in order to guide decision-making and to allocate organizational resources based on strategic priorities (two respondents).

Conclusion of Findings

Bicycles are an efficient way of getting around and there are a number of benefits of using bicycles including improved gender norms, access to education, and income-generating opportunities, as well as time savings. However, there are also a variety of challenges and factors that limit adoption of bicycles including affordability, access to financing, government regulations, high tariffs and taxes, limited spare parts and after-market service, high transportation and shipping costs, inadequate infrastructure, safety concerns, and social norms that prevent women and girls from using bicycles. Currently, there is limited recent literature on bicycles for development (two respondents). There is a need to dig deeper into these areas and identify critical research questions in specific geographic locations. In the next phase of the study, the team will do just that.

Gaps and Areas to Explore through the Research

The team has identified an initial list of gaps that could be addressed in subsequent research. They include:

1. Understanding bicycle supply chains, especially to rural areas, where supply chains often do not reach. Locations and quantities of bicycles (one respondent)
2. Most research/policy has suggested/advocated for supply-side interventions, such as more bicycles, more bicycle paths in urban areas, and improved roads and infrastructure. Demand-side research on people's perceptions, attitudes, and preferences concerning bicycles, which are strongly associated with cycling behavior, receives far less policy and research attention (Nkurunziza et al., 2012).
3. Pricing bicycles appropriately and the economics behind it (one respondent)
4. Unintended consequences of distributing bicycles, such as saving time for women, but that means having more time for housework; or, making it easier to get to bars for men (alcoholism issue); or the idea that bicycles often go to people who are well-connected to local elites/powerful people (one respondent)
5. Impact of bicycle on livelihoods broadly (focused a lot of research on education; want to branch out to impact of household more generally) (one respondent)
6. Additional research on girls' empowerment and power and decision-making for adults at the household level (one respondent)
7. Effects of transportation on the community including whether and how mobility can uplift a community at large (one respondent)
8. Understanding the extent to which mobility can build social networks/capital (people ride bicycles to church, kids can go to after-school activities, study groups) (one respondent)
9. Understanding how to scale bicycle mobility programs and how the government can support such programs (one respondent)?

10. Understanding how different players in the supply chain can work together to create a more robust bicycle ecosystem (one respondent)
11. Unit economics comparison of Asian manufactured (e.g. Hero) and African manufactured (e.g. Buffalo) bicycles (one respondent)
12. User behavior, consumption habits and trends in adoption for different types of bicycles e.g. second-hand vs. utility roadster
13. Enabling local bicycle production potential in Africa (one respondent)
14. Bicycle design adaptations to meet the diverse needs of riders (Baker, 2018)
15. Existence and/or evolution of bicycle repair, maintenance and manufacturing ecosystems in Africa

Next Steps

Although the team has conducted an initial literature review and key informant interviews, there still work to be done before the next phase of the study:

1. **Complete key informant interviews-** There is still information to uncover through subsequent key informant interviews, so the team will continue that work over the next few weeks.
2. **Finalize list of criteria for location selection and narrow the list of locations-** The team has created a preliminary list of criteria for selecting the scoping study location which include items like field partner engagement (enthusiasm, capacity, commitment, previous engagements), potential for impact, population density and how easy it would be to reach the population, scope of the research and research questions, existing bicycle ecosystem, existing bicycle infrastructure, topography, and proxies for the bicycle ecosystem (such as vehicle ownership rates, gas price, availability of public transportation). The team will finalize this list and then apply it to select a subset of geographies to explore as part of the scoping study. The team will then meet with the CDR team and Missions at USAID to prioritize the list further.
3. **Prepare the methodology for the scoping study-** The team has started to map out the research plan for the scoping study, which will include additional key informant interviews, literature review for the selected country(s), and data collection in country. They will share the methodology with USAID at the end of September.

In October, the team will begin the next phase of the research, the scoping study, which will help focus the research and narrow down on the most relevant research questions.

Appendix on Bicycle Designs

The precursor to bicycles were velocipedes which were a simpler device that look quite similar to a modern bicycle but are propelled by the rider pushing aft against the ground with their feet. These became available by 1813. This configuration still has some relevance today as a device for children to learn the skill of balancing a two-wheeled conveyance.

By 1840, the use of pedals was introduced. In the earliest instantiations of this innovation, the pedals were directly connected to the front wheel. This arrangement is still used today in children's models such as tricycles and "big wheels".

Having the direct drive of the front wheel caps the top speed to a rather low rate, so there was some pressure in the market to grow the front wheel. This eventually led to the configuration we know as a "penny-farthing" bicycle whose whole design is dominated by the front wheel. These larger front wheels both enabled higher speeds and also elevated the rider's body necessitating a means for stopping other than dragging feet on the ground or pushing back against the pedals. Therefore, by 1845 bicycle braking systems began to appear in the patent literature.

A much better way to attain higher top speeds (as compared to large front wheels) is via mechanical amplification of speed through a chain transmission. Having a larger sprocket in front and a smaller sprocket in back enables the designer to choose an appropriate rate of rotation of the crank to match a chosen top speed of the bicycle. This innovation appeared in 1884 due to the improvements in cost-effectiveness, precision, and interchangeability in component manufacture emerging during the industrial revolution. As soon as chains enabled higher speeds and comfortable rider position, pneumatic tires for bicycles appeared (circa 1890). The direct drive of the chain is quite hazardous, especially in downhill parts of the ride, so the overrunning clutch quickly appeared around 1897. By the end of the 19th century, the bicycle appeared almost exactly in its modern form (Clausing, 2003).

Manufacturing

Bicycle manufacturing generally requires the steps of making a diamond shaped frame, assembling bearings for the head and crank, assembling the steering, crank, pedals, derailleurs, chain, wheels, and brakes (Watson & Gray, 1978). Fabricating the frame is the most capital and skill intensive step requiring cutting tubes (usually seamless), fixturing or jigging, and joining (usually by welding). The main tube materials used are mild steel or Chromium Molybdenum steel. Aluminum or composite frames are used for higher-end models. A high-quality paint job is generally required to attain sufficient durability and weather resistance and usually involves electrostatic spraying equipment. The steps subsequent to fabricating the frame are ones that could be carried out by a bicycle repair shop or individual consumer with a good tool set (Wiley, 1980). Therefore, bicycles are often shipped in various states of disassembly so that they can be packed in flat boxes and finally assembled closer to the point of sale or by the consumer.

References

Acheampong, R. A., & Siiba, A. (2018). Examining the determinants of utility bicycling using a socio-ecological framework: An exploratory study of the Tamale Metropolis in Northern Ghana. *Journal of Transport Geography*, *69*(April), 1–10. https://doi.org/10.1016/j.jtrangeo.2018.04.004

Adom-Asamoah, G., Amoako, C., & Adarkwa, K. K. (2020). Gender disparities in rural accessibility and mobility in Ghana. *Case Studies on Transport Policy*, *8*(1), 49–58. https://doi.org/10.1016/j.cstp.2019.12.006

Amoako-Sakyi, R., & Owusu, S. A. (2012). BICYCLES : AN ANSWER TO MOBILITY NEEDS OF RURAL Authors. *2nd African Community Access Programme (AFCAP) Practitioners Conference*, 1–11. https://doi.org/10.13140/2.1.3676.3525

Appropriate Technology. (2017). Village bicycle project transforms lives. *Appropriate Technology*, *44*(1), 60–61.

Ardizzi, M. (2018). *Bicycles for development in Uganda : a study of perceptions, organizations and globalization* [The University of British Columbia]. https://doi.org/10.14288/1.0375880

Baker, L. (2018). *Scripting Mobilities in sub-Saharan Africa: a Case Study of Second-Hand Bicycle Networks* [Cardiff University]. http://orca.cf.ac.uk/114557/

Baker, L. (2019). Scripting the mobile development subject: a case study of shipping second-hand bicycles to Africa. *Social & Cultural Geography*, 1–19. https://doi.org/10.1080/14649365.2019.1652930

Baker, L. (2020). Constructing sub-Saharan African mobilities through the flow of second-hand objects: Scripting bicycles for Namibian users. *Journal of Transport Geography*, *83*(January), 102656. https://doi.org/10.1016/j.jtrangeo.2020.102656

Bryceson, D. F., Mbara, T. C., & Maunder, D. (2003). Livelihoods, daily mobility and poverty in sub-saharan Africa. *Transport Reviews*, *23*(2), 177–196. https://doi.org/10.1080/01441640309891

Calvo, C. M. (1994). Case Study on Intermediate Means of Transport Bicycles and Rural Women in Uganda. In *Sub–Saharan Africa Transport Policy Program* (No. 12). https://www.ssatp.org/publication/case-study-intermediate-means-transport-bicycles-and-rural-women-uganda-part-three

Clausing, D. (2003). *Effective Innovation*.

The Economist. (2008). On your bicycle. *Economist*, 389 p. 61. *The Economist Historical Archive*, http://tinyurl.gale.com/tinyurl/CMq3A8 Accessed 27 Nov. 2019.

England, A., & Manson, K. (n.d.). *Steering a path to making bicycles in Africa | Financial Times*. Retrieved September 10, 2020, from https://www.ft.com/content/3520c62e-e9bc-11e0-bb3e-00144feab49a

Fiala, N., Garcia-Hernandez, A., Narula, K., & Prakash, N. (2019). *Wheels of Change: The Impact of Bicycle Access on Girls' Education and Empowerment Outcomes in Rural Zambia*. Innovations for

Poverty Action (IPA). https://www.poverty-action.org/study/wheels-change-impact-bicycle-access-girls'-education-and-empowerment-outcomes-rural-zambia

Furness, Z. (2010). *One Less Car*. Temple University Press.

Gauthier, A., & Hook, W. (2005). Tapping the Market for Quality Bicycles in Africa. *Sustainable Transport*, 8–12. https://www.itdp.org/publication/seoul-and-sustainable-transport-leading-by-example-issue-17-2005/

Girls Not Brides, & Janaki Women Awareness Society. (2017). *Keeping girls in secondary school with bicycles* (Issue April). https://www.girlsnotbrides.org/resource-centre/keeping-girls-secondary-school-bicycles/

Hamilton, R. (2012). *Can the Buffalo change Africa's bicycle culture? - BBC News*. Can the Buffalo Change Africa's Bicycle Culture? Retrieved September 10, 2020, from http://www.bbc.com/news/world-africa-17115923

Hine, J., & Rutter, J. (2000). Roads, Personal Mobility, and Poverty: The Challenge. *Transport and Poverty Alleviation Workshop*, 1–12. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.523.8897

International Bicycle Fund. (2003). *Bicycle Statistics: Usage, Production, Sales, Import, Export*. Retrieved September 2, 2020, from http://www.ibicycle.org/library/statistics-data.htm

Jacobs, J. (1995). Bicycles and the wealth of nations. *Ceres*, *154*, 5–6. http://www.fao.org/3/v6640e00.htm#Contents

Khayesi, M. (1993). Rural household travel characteristics: The case of Kakamega District. *Journal of Eastern African Research & Development*, 23, 88–105 https://www.jstor.org/stable/24326291

Kotha, S., & Fried, A. (1993). *THE NATIONAL BICYCLE INDUSTRIAL COMPANY: Implementing a Strategy of Mass Customization* (No. 395-040–1). https://sureshkotha.files.wordpress.com/2018/05/nbic1.pdf

Mahapa, S. (2003). *Integrating Gender Into World Bank Financed Transport Programs- Case Study South Africa*.

McSweeney, M., Millington, B., Hayhurst, L., Wilson, B., Ardizzi, M., & Otte, J. (2020). 'The bicycle breaks down. What are they going to do?' Actor-networks and the Bicycles for Development movement. *International Review for the Sociology of Sport*. https://doi.org/10.1177/1012690220904921

Muralidharan, K., & Prakash, N. (2017). Cycling to School: Increasing Secondary School Enrollment for Girls in India. *American Economic Journal: Applied Economics*, *9*(3), 321–350. https://doi.org/10.1257/app.20160004

Nkurunziza, A., Zuidgeest, M., Brussel, M., & van Maarseveen, M. F. A. M. (2012). Exploring factors affecting the potential of bicycle commuting in Dar-es-Salaam. *Conference CODATU XV: The Role of Urban Mobility in (Re)Shaping Cities*.

Peier, J. (2015). *Access to transport for the base of the pyramid: Measuring the Impact of Bicycles in*

Burkina Faso [University of St. Gallen]. https://www.poverty.ch/wp-content/uploads/2017/10/VeloBurkinaPeier.pdf

Pojani, D., & Stead, D. (2015). Sustainable urban transport in the developing world: Beyond megacities. *Sustainability (Switzerland)*, *7*(6), 7784–7805. https://doi.org/10.3390/su7067784

Porter, G. (2014). Transport Services and Their Impact on Poverty and Growth in Rural Sub-Saharan Africa: A Review of Recent Research and Future Research Needs. *Transport Reviews*, *34*(1), 25–45. https://doi.org/10.1080/01441647.2013.865148

Räber, N. (2014). *Access to transport for the base of the pyramid: Measuring the impact of bicycles in Tanzania*. https://velafrica.ch/media/archive1/PDF_Deutsch/Wirkungsstudie/Measuring_the_impact_of_bicycles.pdf

Savage, S. (2020, July 25). "I can pedal faster than a man can run" - how bicycles are changing the dynamic on Africa's roads. *The Guardian*, 1–8. https://www.theguardian.com/global-development/2017/jul/25/i-can-pedal-faster-than-a-man-can-run-how-bicycles-are-changing-the-dynamic-on-africas-roads

Shirazi, Q. (2020, July 8). Business of knife sharpeners booms. *The Express Tribune*. https://tribune.com.pk/story/2253857/business-of-knife-sharpeners-booms

Sieber, N. (1999). Transporting the yield: Appropriate transport for agricultural production and marketing in Sub-Saharan Africa. *Transport Reviews*, *19*(3), 205–220. https://doi.org/10.1080/014416499295493

Sietchiping, R., Permezel, M. J., & Ngomsi, C. (2012). Transport and mobility in sub-Saharan African cities: An overview of practices, lessons and options for improvements. *Cities*, *29*(3), 183–189. https://doi.org/10.1016/j.cities.2011.11.005

Singh, S. (1994). Refugees as Entrepreneurs: The Case of the Indian Bicycle Industry. *The Journal of Entrepreneurship*, *3*(1), 81–96. https://doi.org/10.1177/097135579400300105

Song, L. K. (2003). The Potential of Bicycles As a Means of Transport for Learners in Rural South Africa. *Proceedings of the 22nd Southern African Transport Conference (SATC2003)*. https://repository.up.ac.za/bitstream/handle/2263/6831/LieuwKieSong_Potential%282003%29.pdf?sequence=1

Song, L., Kirschen, M., & Taylor, J. (2019). Women on wheels: Gender and cycling in Solo, Indonesia. *Singapore Journal of Tropical Geography*, *40*(1), 140–157. https://doi.org/10.1111/sjtg.12257

U.S. Department of Commerce. (2004). *2002 Economic Census: Motorcycle, Bicycle, and Parts Manufacturing* (Vols. EC02-31I-3). https://www.census.gov/prod/ec02/ec0231i336991.pdf

Ukoba, O. K., Ogunkoya, A. K., & Soboyejo, W. (2011). Development of an Eco-Friendly Bamboo Bicycle. *The Pacific Journal of Science and Technology*, *12*(1), 102–108. http://www.akamaiuniversity.us/PJST12_1_102

United Nations. (2019). *United Nations Commodity Trade Statistics Database*. comtrade.un.org

Watson, R., & Gray, M. (1978). *The Penguin Book of the Bicycle*. Allen Lane Publishing.

White, P. S., & Budnick, N. (2001). A New Bicycle for Africa. *Sustainable Transport*, *12*, 26–29. https://www.itdp.org/publication/cuenca-gets-on-the-bus-issue-12-2001/

Wiley, J. (1980). *The Bicycle Builder's Bible*. Tab Books.

Wilson, S. S. (1973). Bicycle Technology. *Scientific American*, *228*(3), 81–91. https://www.jstor.org/stable/10.2307/24923004

World Bank. (2008). *Safe, Clean, and Affordable. Transport for Development. The World Bank Group's Transport Business Strategy 2008-2012.* The World Bank.

World Bicycle Relief. (2018). *Mobility and the Sustainable Development Goals*. https://geographica.com/en/blog/what-is-smart-mobility/

World Bicycle Relief. (2019a). *2019 Impact Report*. https://worldbicyclerelief.org/wp-content/uploads/2020/05/WBR_2019-Impact-Report-3.pdf

World Bicycle Relief. (2019b). *2019 Kenya Impact Report*. https://worldbicyclerelief.org/wp-content/uploads/2020/05/2019-Kenya-Impact-Report_FINAL-051320.pdf

World Bicycle Relief. (2019c). *Malawi Impact Report*.