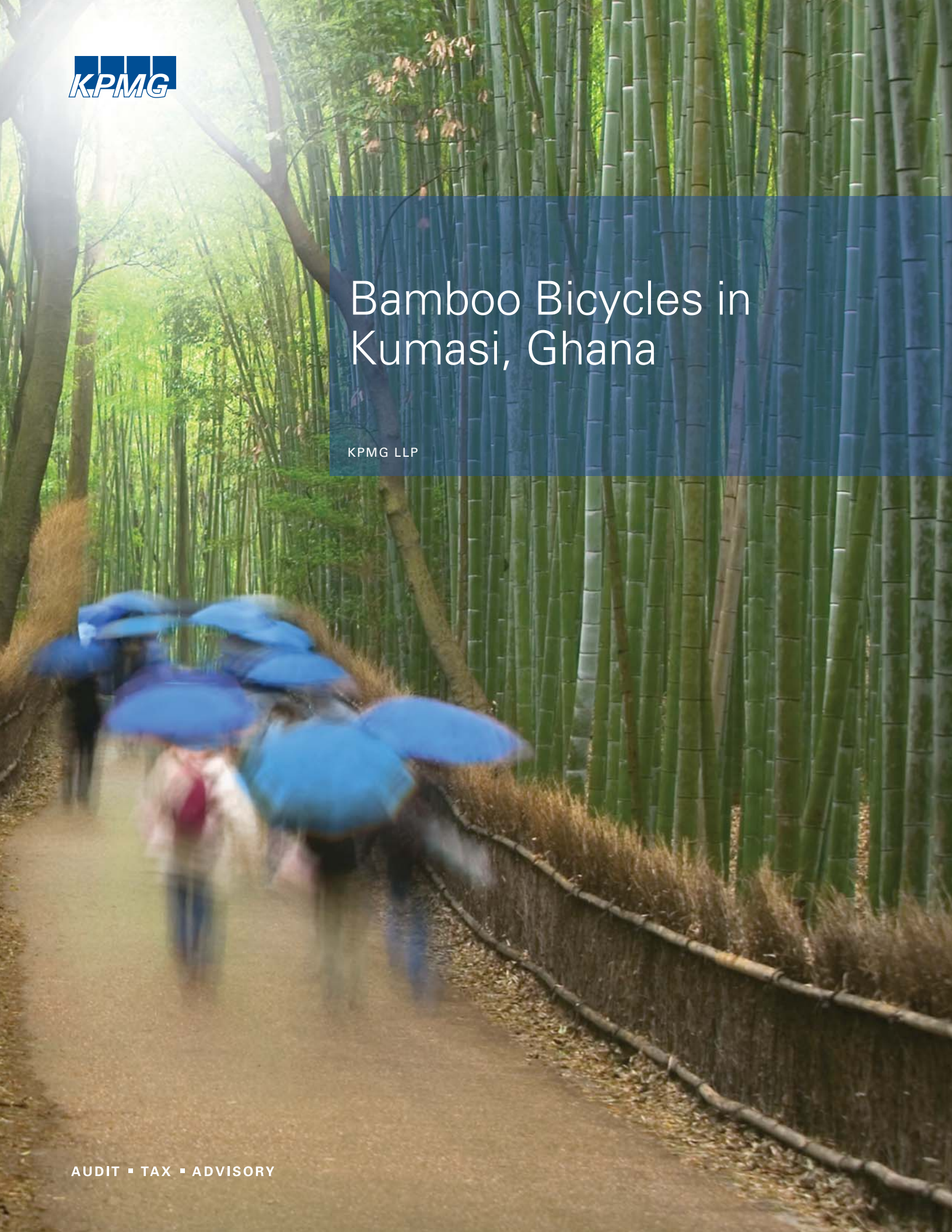

Bamboo Bicycles in Kumasi, Ghana

KPMG LLP

AUDIT ▪ TAX ▪ ADVISORY

MILLENNIUM CITIES INITIATIVE (MCI)
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

VALE COLUMBIA CENTER
ON SUSTAINABLE INTERNATIONAL INVESTMENT
A JOINT CENTER OF COLUMBIA LAW SCHOOL AND
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

MCI and VCC Working Paper Series on Investment in the Millennium Cities Nº 04/2008

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The Millennium Cities Initiative (MCI) is a project of The Earth Institute at Columbia University, directed by Professor Jeffrey D. Sachs. It was established in early 2006 to help sub-Saharan African cities achieve the Millennium Development Goals (MDGs).

As part of this effort, MCI helps the Cities to create employment, stimulate enterprise development and foster economic growth, especially by stimulating domestic and foreign investment, to eradicate extreme poverty – the first and most fundamental MDG. This effort rests on three pillars: (i) the preparation of various materials to inform foreign investors about the regulatory framework for investment and commercially viable investment opportunities; (ii) the dissemination of the various materials to potential investors, such as through investors' missions and roundtables, and Millennium Cities Investors' Guides; and (iii) capacity building in the Cities to attract and work with investors.

The Vale Columbia Center on Sustainable International Investment promotes learning, teaching, policy-oriented research, and practical work within the area of foreign direct investment, paying special attention to the sustainable development dimension of this investment. It is a joint program of Columbia Law School and The Earth Institute at Columbia University.

For more information, please refer to the MCI website at: http://www.earth.columbia.edu/mci/ and the VCC website at: http://www.vcc.columbia.edu/.

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Executive summary

Introduction

Background and objectives

The primary objective of this study was to assess the feasibility and investment opportunity of implementing a bamboo bicycle production facility in Kumasi, Ghana, in conjunction with the Millennium Cities Initiative (MCI) at Columbia University. For this assessment, desk-based research and interviews with industry and regional subject matter specialists were completed to assist with the following objectives:

- Understand the current transportation modes and bicycle market in Ghana
- Assess customer needs in Ghana to determine the suitability of a bamboo bicycle for rural use
- Identify the potential market size and demand
- Understand the operational considerations and costs associated with implementing a production facility
- Estimate the financial returns from investing in this opportunity

Methodology

To meet the objectives, KPMG LLP (KPMG) and MCI conducted desk-based research and interviews with industry participants, academics, government officials, NGO representatives, manufacturers, importers, subject matter specialists, and other industry participants. All analyses and findings in this report were generated by KPMG and MCI and were based on third-party data sources and responses obtained from industry participants as part of the interview program. These findings have been presented in a manner to illustrate possible risks and opportunities to consider.

Key findings

Market opportunity

According to sources, bicycles generally represent the best mode of transport for rural Ghanaians. However, it is reported that the bicycles currently available to rural Ghanaians are often of poor quality and unsuitable for local needs (Gauthier and Hook 2005, pp. 8–11). Bamboo bicycles may be comparable or superior to current bicycles both in terms of quality and suitability for local needs (Industry participant interview 2008). The annual bicycle market size in Ghana appears to be approximately $11.3 million. However, the total potential annual bicycle market size in rural Ghana appears to be closer to $33.3 million, when including the unpenetrated portion of the market.

Operational considerations

It appears the cost of producing one bamboo bicycle is approximately $47 (based on assumed production of 20,000 bicycles per year) (Snapshot Africa 2007). Sources in Ghana suggest that bamboo bicycles should be initially priced at roughly $55 to be competitive and affordable for rural customers (Industry participant interview 2008). The venture appears to be scalable, with adequate sources of material and labor available (GIPC: Cost of Doing Business in Ghana (accessed July 2008)).

Financial case study

The potential profitability of a bamboo bicycle facility appears to depend on the scale. As an illustration, sources suggest the five-year net present value (NPV) of a scenario of capturing approximately seven percent of the actual current market, or three percent of the total addressable market (i.e., the annual production and sale of 20,000 bamboo bicycles), is approximately $50,000. A more aggressive scenario of capturing 50 percent of the total addressable market (i.e., the annual production and sale of 333,333 bamboo bicycles) would yield a five-year NPV of nearly $4 million. A potential limitation may be the rate of adoption of bamboo bicycles by the target market (Ghana Country Report 2008, pp. 14–15).

Social impact

According to sources, the bamboo bicycles venture also appears to be attractive from a social impact standpoint (Litman and Burwell 2006, pp. 341–347). Better and more useful bicycles could improve the standard of living for rural Ghanaians and could create jobs for inhabitants of the rural areas near Kumasi (Mozer 1989, pp. 8–18).

Project overview

Historical and projected sustained economic growth in Ghana appear to make it an attractive market for the bamboo bicycle new market entry. Bamboo bicycles could offer a reliable mode of transportation and a potentially sustainable business opportunity for the people of Ghana. Due to its strength and other positive attributes, the bamboo that grows abundantly in the rural areas near Kumasi appears to be an appropriate material for building bicycle frames.

Overview of Ghana and Kumasi

Key facts about Ghana

Ghana is a country located in western Sub-Saharan Africa covering 230,940 km^2 of land. The population of Ghana is 23.9 million, which is 54 percent rural and 46 percent urban. The literacy rate in Ghana is 57.9 percent. The labor force represents 46.9 percent of the population of Ghana. The national currency is the Ghana cedi: USD 1 = GH¢ 0.98.

Ghana key statistics[1]

Overview
- Capital: Accra
- Form of government: Multiparty democracy
- Currency: Ghana cedi (GH¢)
- Exchange rate: USD 1 = GH¢ 0.98

People
- Population: 23.9 million
- Urban: 46%; Rural: 54%
- Median age: 20.4 years
- Population growth rate: 1.9%
- Literacy rate: 57.9%

Economy
- GDP (PPP): $31.3 billion
- GDP per capita (PPP): $1,400
- Labor force as a percentage of population: 46.9%
- Unemployment rate: 11% (2000)

Land use
- Total land: 230,940 sq km
- Arable land: 17.5% (40,415 sq km)

Infrastructure
- Railroads: 953 km
- Roads: 62,221 km (16% unpaved)
- Airports: 12 (7 with paved runways)

Kumasi key statistics[2]

People
- Population: 1.6 million

Economy
- GDP: 71% services, 24% industrial, 5% agriculture
- Labor force as a percent of population: 71.4%
- Unemployment rate: 16%

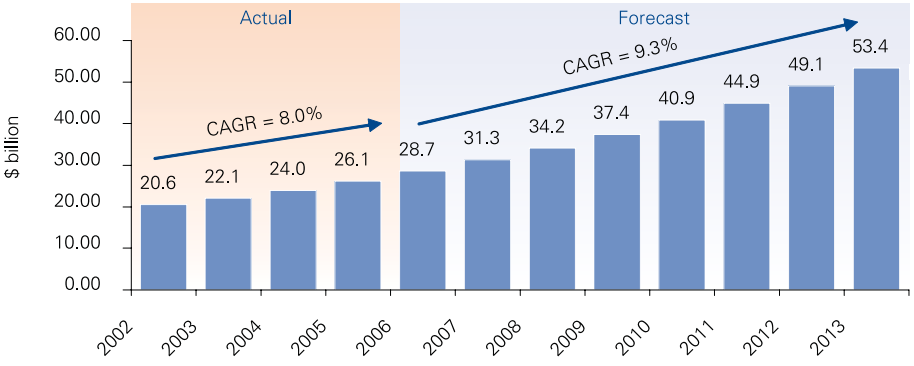
Infrastructure
- Airports: One (Kumasi Airport)
- Roads: 846 km (68% unpaved)

Sources: (1) IMF: World Economic Outlook Database 2008 (accessed July 2008); (2) Ghana Districts (accessed 2008).

Historical and projected GDP growth

With a GDP of $31.3 billion in 2007, Ghana has the 13th-largest economy in Africa. The GDP per capita in Ghana is $1,400 (compared to the GDP per capita in the United States of $44,000). After 2007, Ghana's GDP is projected to grow with a compound annual growth rate (CAGR) of 9.3 percent until 2013 (IMF: World Economic Outlook Database 2008 (accessed July 2008)). The projected sustained growth can be attributed to improvements in agricultural practices and increased efficacy of governmental macroeconomic management initiatives (Industry participant interview 2008).

Ghana is the 13th-largest economy in Africa with a GDP of $31 billion in 2007. GDP has grown at a CAGR of 8 percent from 2002 to 2007 and is projected to grow at 9 percent through 2013.



Source: IMF: World Economic Outlook Database 2008 (accessed July 2008).

Key facts about Kumasi

Kumasi is the second-largest city in Ghana (second only to Accra, the nation's capital). Kumasi, the capital city of the Ashanti region, has a population of 1.6 million. The labor force in Kumasi represents 71.4 percent of the city's total population (Ghana Districts (accessed 2008)).

Actual – CAGR = 8.0%

Average GDP growth in sub-Saharan Africa was 8.3 percent during this period.

Forecast – CAGR = 9.3%

The 9.3 percent CAGR is driven by current improvements in agriculture and stability in macroeconomic management.

Bamboo bicycles project

Bamboo bicycles could offer a reliable mode of transportation and a potentially sustainable business opportunity for the people of Ghana.

Source: www.bamboobicycle.org (accessed July 2008).

Background information – Bamboo bicycles

Dr. David Ho and Dr. John Mutter at the Columbia University Earth Institute and Craig Calfee at Calfee Design collaborated on the original concept and design of the bamboo bicycle and traveled to Ghana during the summer of 2007 with funding provided from the Earth Institute (Industry participant interview 2008). The team received positive feedback on a prototype of the bamboo bicycle, which was made in the United States and left in Ghana for three months for rural inhabitants to try out. Based on this experience, the team hopes to stimulate the production of bamboo bicycles using the local work force and the bamboo that is currently grown in and around Kumasi (Ho 2007–2008, pp. 1–11).

Advantages of bamboo bicycles

Rural Ghanaians could gain several benefits from a bamboo bicycles venture. These include the jobs created from stimulating a nonexistent bicycle production industry in the country and a potentially better transportation alternative. The bicycle is designed to carry large loads, which appears to be one of the most important decision criteria for rural Ghanaians when choosing a bicycle to purchase, since farmers need to transport their goods from the villages to the cities (Industry participant interview 2008). The bamboo bicycle may potentially have a longer life span, since there is likely to be local knowledge of repair techniques, and since the bamboo bicycle's frame could be easily replaced using locally available bamboo. These bicycles could be better than the bicycles that are currently imported into the country, which are not suited for the hilly terrains or to carry large loads. In addition, the bamboo bicycles are lighter and easier to handle.

Background information – Bamboo

Bamboo appears to be an appropriate material to build bicycle frames in Kumasi due to its strength and its abundance in the area. Bamboo was chosen for the bicycle project due to its widespread availability in Ghana.

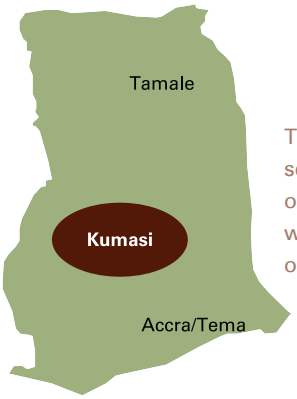
Key facts about bamboo

The tensile strength of bamboo is 28,000 Newtons per square inch, which is greater than that of steel (23,000 Newtons per square inch). Around the world, bamboo is used to build furniture and is commonly used as a construction material. Bamboo can grow up to three to four feet per day in both temperate and tropical climates. The Ashanti region has more than 57 bamboo forest reserves, and there are several clusters within a 60-mile radius of Kumasi. These bamboo clusters are located in areas such as Lake Bosumtwi, Juaso, Nyinahin, and New Edubiase (Akuamoa-Boateng 2008, pp. 1–2).

Bamboo and Rattan Development Program

The Bamboo and Rattan Development Program (BARADEP), an initiative administered by the Ghana Ministry of Forestry, has a mandate to preserve bamboo while finding practical, sustainable uses for it. BARADEP's objectives include promoting sustainable uses of bamboo to contribute to people's livelihoods, reversing the trend of people treating bamboo as a weed by destroying it, and training rural Ghanaians to cultivate bamboo efficiently. With the price of wood increasing, bamboo and rattan have proven to be attractive substitutes. It is important to note, however, that the Ghana Ministry of Forestry, which heads BARADEP, has passed legislation that would increase the price of bamboo from 70¢ per 8-meter culm to $2 per 8-meter culm (Industry participant interview 2008). The price increase would further the BARADEP objective of protecting and increasing the value of bamboo.

Bamboo clusters in and around Kumasi



There are several clusters of bamboo within 60 miles of Kumasi.

Source: Akuamoa-Boateng 2008, pp. 1–2.

Market opportunity

According to sources, the current market for the bamboo bicycles market in Ghana appears to be approximately $14 million annually with growth potential in the unpenetrated market. Current market penetration appears to be approximately 42 percent, leaving a market gap of approximately $19.5 million. The introduction of the bamboo bicycle may help to close the existing market gap, since the bamboo bicycle may be relatively high-quality and better suited to the needs of rural Ghanaians.

Modes of transportation

In rural Ghana, bicycles appear to offer cost and mobility advantages over alternative modes of transportation.

Comparison of common modes of transit in Ghana

Car

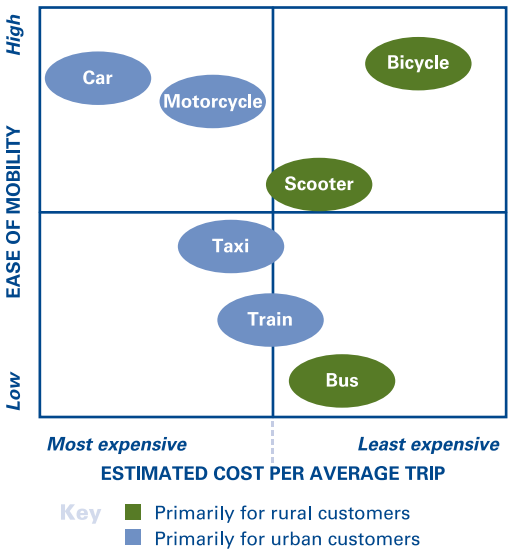
The infrastructure of roads and highways in Ghana is reported to be congested, lengthening average travel time, which leads to increased petrol and maintenance costs for cars.[1]

Motorcycle and Scooter

Despite their high cargo loads and flexibility, the high up-front and ongoing maintenance costs for motorcycles and scooters are significant drawbacks for average customers.[3]

Taxi

Industry experts suggest that the road network around Kumasi is only 32 percent paved, causing taxis to be unreliable, in addition to the long wait times that passengers often face when searching for a cab.[4]



Bicycle

Taking into account the up-front and ongoing maintenance costs of the modes of transit that offer independence, industry experts say that bicycles are a highly cost-effective way to transport people and goods in a flexible, independent manner.[3]

Train

Railroads in the Kumasi area are widely reported to be in poor condition and in urgent need of extensive repairs.[3]

Bus

Industry participants indicate that buses may be less appealing than bicycles for customers and employers due to slowness, frequent lateness, and inflexible routing; the ensuing widespread problem of employees arriving at work late by bus reduces overall economic productivity.[2]

Sources: (1) Ghana Districts (accessed 2008); (2) Project Africa Interview Program 2008; (3) Gauthier and Hook 2005, pp. 8–11; (4) Dorsey (accessed 2008).

While walking represents an inexpensive alternative to all of these modes of transportation, carrying large loads of goods from the villages is a very labor-intensive task. Thus, the high time and labor inputs required for foot transportation outweigh its evident low cost.

Current bicycle market – Competitive landscape

The current market in Ghana is characterized by low-quality imported bicycles that often are unsuitable for use in rural areas (Industry participant interview 2008).

Donated used bicycles imported from Western countries

Suppliers

Some of the main suppliers of donated used bicycles that are imported from Western countries and sold in Ghana include NGOs such as the Village Bicycle Project, Hayley's Bicycles for Africa, and Recycling Bicycles for Africa (Industry participant interview 2008).

Competitive advantages

It appears the main competitive advantage of donated used bicycles from Western countries is that they are usually sold at discounted rates ($30–70) in comparison to the prices of new and used bicycles imported from developing countries (Gauthier and Hook 2005, pp. 8–11). Additional advantages of used donated bicycles from Western countries include the lack of tariffs on imported bicycles and the bicycles' generally relative high quality compared to other new and used bicycles on the market (Industry participant interview 2008).

Competitive disadvantages

Since these bicycles are used, they may be prone to mechanical failure. This tendency to break down can lead to high maintenance and repair costs. Additional disadvantages of donated used bicycles from Western countries include the lack of availability of spare parts needed to repair them. Finally, since these bicycles generally are not designed for load carrying, they may be less attractive to customers in rural Ghana, who tend to favor bicycles with higher load carrying capacity (Industry participant interview 2008).

New and used bicycles imported from developing countries

Suppliers

Some of the main suppliers of new and used bicycles that are imported from developing countries and sold in Ghana include manufacturers from India and China that produce old-fashioned "Roadster"-style bicycles (Gauthier and Hook 2005, pp. 8–11).

Competitive advantages

According to sources, the new and used bicycles from developing countries have a strong existing distribution network and spare parts availability. In addition, these bicycles benefit from Ghanaians' familiarity with them. Like donated used bicycles from Western countries, the new and used bicycles from developing countries benefit from the lack of tariffs on imported bicycles. Finally, as members of the Chinese middle class grow in number, they may increasingly choose to purchase cars rather than bicycles. The resulting potential excess inventory of Chinese bicycle manufacturers may lead to another competitive advantage for these bicycles in the Ghanaian market: lower prices than Ghanaians are currently paying for them (Gauthier and Hook 2005, pp. 8–11).

Competitive disadvantages

The new and used bicycles from developing countries are generally designed for recreational use rather than load carrying, making these bicycles less attractive to rural customers. Additional disadvantages include their relatively poor quality; it is not unusual for components to break within two weeks of use (Industry participant interview 2008). Lastly, they are often heavy and hard to handle making them unsuitable for carrying cargo on rural terrain.

Customer selection criteria

Along with a number of customer selection criteria, bamboo bicycles may have an advantage over the metal bicycles that are currently available in Ghana. Metal and bamboo bicycles are comparably priced for the rural market, and bamboo bicycles can carry a much heavier load due to better design and greater strength. Although current bicycles have an established network of independent bicycle dealers and are widely available, bamboo bicycles are estimated to have a better replacement rate of approximately once every five years. Furthermore, bamboo bicycles may be easier to repair, since the replacement material is locally grown, and the knowledge and tools needed for repairs are often locally available (Industry participant interview 2008).

Bicycle market – Demand drivers

Economic, demographic, and social drivers are likely to increase bicycle sales to rural customers.

Economic drivers

Inefficiency of alternative modes of transit
The relative dearth of paved roads in the rural areas around Kumasi means that biking and walking are often the only viable means of transit (Mozer 1989, pp. 8–18). To many rural customers, bicycles present a more efficient, less labor-intensive alternative to carrying goods on foot.

Rising GDP
Ghana's sustained GDP growth suggests that an increasing number of rural Ghanaians may be able to spend more on transportation. Since bicycles are the primary mode of transport for rural customers, rising GDP is likely to lead to an increase in bicycle sales (Industry participant interview 2008).

Cost of alternative modes of transit
Rising fuel costs may cause customers to increasingly choose bicycles over motorized vehicles for basic transit needs (Industry participant interview 2008).

Demographic and social drivers

Migration from urban to rural areas
Due to the surge in agriculture, the Ghanaian Government is giving subsidies to the urban population to move to rural areas; this could cause an increase in bicycle sales (Industry participant interview 2008).

Government initiatives encouraging school attendance
Ghanaian Government initiatives encouraging parents in rural areas to ensure that their children attend school may drive demand for bicycles, which parents often use to transport their children to school (Industry participant interview 2008).

Increasing social acceptance of bicycle ridership
While riding bicycles is more common in the north (where the majority of the rural areas are located), social acceptance of bicycle ridership appears to be spreading to the south as well (Industry participant interview 2008).

Current rural bicycle market size

According to sources, the current rural bicycle market in Ghana is estimated to be approximately $14 million per year. This translates into an estimated sales volume of 277,240 bicycles sold per year. To illustrate the possible current rural market size, we multiply the 174 bicycles per thousand households by the 4 million households (with an average of six people per household) in Ghana, yielding a total current market size of approximately 693,100. We multiply this number by the 80 percent of all Ghanaian bicycle sales that are estimated to be attributable to rural consumers and divide it by the two-year estimated replacement rate for bicycles, yielding a number of bicycles sold each year to the rural Ghanaian market of approximately 277,240. Multiplying this number by the $50 average price per bicycle in the rural Ghanaian market yields an estimated rural bicycle market size of approximately $13.9 million per year.

Estimated annual volume of bicycle sales

1

Bicycles owned per thousand households	X	Households in Ghana	X	Percent of bicycle sales attributable to rural consumers	/	Estimated replacement rate	=	Estimated number of bicycles sold each year to rural market
174 bicycles per thousand households[1]	X	4 million households[2]	X	80%[3]	/	2 years[3]	=	277,240 bicycles sold per year

Current rural bicycle market size

2

Estimated number of bicycles sold each year to rural market	X	Average price per bicycle in rural market	=	Estimated rural bicycle market size
277,240 bicycles sold per year	X	$50 per bicycle[3]	=	$13.9 million per year

Note: Average household size in Ghana is 6 people.
Sources: (1) Dorsey (accessed 2008); (2) Ghana Country Report 2008, pp. 14–15; (3) Project Africa Interview Program 2008.

Addressable market size for bamboo bicycles

According to sources, it seems the annual addressable market size for bamboo bicycles may be 670,000 households. To illustrate this scenario, we used the following methodology.

According to the interviews that we conducted, bamboo bikes appear to be more suitable for rural consumers. An estimated 54 percent of Ghana's total population of 24 million people live in rural areas, which translates into a rural Ghanaian population of approximately 13 million.

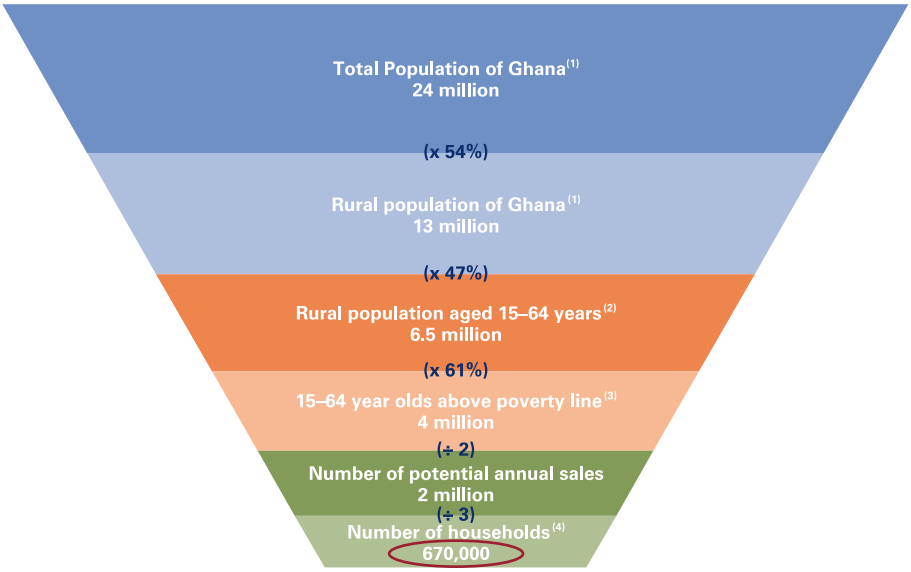
Industry subject matter specialists have suggested that people between the ages of 15 and 64 would ride bikes. This 15- to 64-year-old age range is consistent with the age range of the labor force, which is estimated to be 47 percent of the total population. Therefore, the rural population of working-age Ghanaians is approximately 6.5 million.

It is assumed that those above the poverty line equivalent to $403 per year (approximately 61 percent of Ghanaians) could potentially afford a bicycle. Multiplying the 61 percent of Ghanaians above the poverty line by the 6.5 million working-age rural Ghanaians yields approximately 4 million working-age rural Ghanaians above the poverty line.

Dividing this 4 million by the estimated bicycle replacement rate of two years yields an estimated 2 million potential annual sales to rural Ghanaians.

Finally, dividing the 2 million potential annual sales to rural Ghanaians by the three working-age individuals per average household yields an annual addressable market size for bamboo bicycles of approximately 670,000.

Current rural bicycle market size



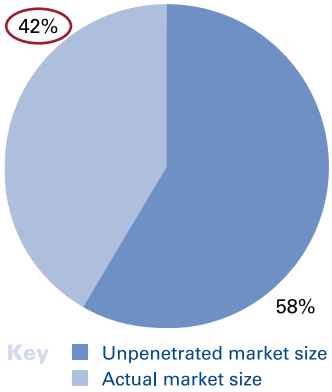
Sources: (1) United Nations 2008, p. 1; (2) Project Africa Interview Program 2008; (3) Ghana Country Report 2008, pp. 14–15; (4) Ghana Districts (accessed 2008).

Market penetration rate and market gap

Based on sources, the current market penetration appears to be approximately 42 percent, leaving a market gap of approximately $19.5 million. The market gap may be due to the existing bicycles' relatively low quality and poor fit with the needs of rural Ghanaians (Gauthier and Hook 2005, pp. 8–11). The introduction of the bamboo bicycle may help to close this gap (Industry participant interview 2008).

Potential and addressable market sizes

Market	Number of bicycles sold per year [1] [2] [3] [4] [5]
Actual market	277,240
Potential unpenetrated market	389,760
Total potential market size	667,000



Market	Annual market value ($)
Actual market	14,000,000
Potential unpenetrated market	19,500,000
Total potential market size	33,350,000

Sources: (1) Dorsey (accessed 2008); (2) United Nations 2008, p. 1; (3) Project Africa Interview Program 2008; (4) Snapshot Africa 2007; (5) Ghana Districts (accessed 2008).

Operational considerations

Key findings

A bamboo bicycle can be made in approximately one hour at a cost of approximately $47 per bicycle. Total costs to start a bamboo bicycle facility capable of producing 20,000 bicycles per year are approximately $1,019,000, with setup costs totaling to approximately $79,000.

Bamboo bicycle assembly

It is estimated the total assembly time required to build one bamboo bicycle by a two-person team using power tools is approximately one hour. Assembly time with hand tools is approximately two hours (Industry participant interview 2008).

Production format

Two production formats were considered for the construction of bamboo bicycles. The first was teams of two people working in tandem at each stage of the production process, and the second was assembly lines consisting of 12 workers, each responsible for a specific task along the assembly line. The two-person format was chosen because, based on estimated build times supplied by sources at the Earth Institute, it is more productive—it provides an output of four bicycles per person per eight-hour working day compared to an assembly line's output of approximately two and a half bicycles per person per day.

A cost benefit analysis was also performed as to whether or not it would be preferable to use power tools instead of hand tools. While hand tools can be used throughout the process, and indeed must be used at certain points, the increased productivity and efficiency realized through the use of power tools appears to outweigh their higher cost.

Construction process

The construction of a bamboo bicycle can be broken down into three steps. First, the bamboo is cut to size and treated with chemicals to prevent splitting. Second, the bamboo tubes are mitered, drilled, and bound together with glue, resin, and fiber, and then left in a jig to dry overnight. Finally, the manufactured components such as the seat, chain, and handle bars are attached to the frame (Industry participant interview 2008).

Costs of the venture

Base-case scenario

The base-case scenario used to illustrate costs is the production of 20,000 bicycles per year. This is the number of bicycles that can be produced in one year by 20 assemblers, which is the number of assemblers initially expected to be trained by volunteers from Columbia University's Earth Institute.

Total cost of first-year operations

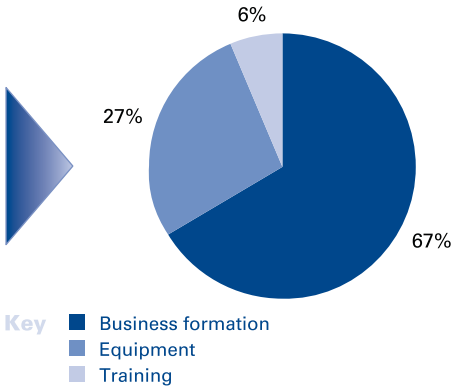
Sources suggest the cost to set up the venture will be approximately $79,000. The operational costs of producing the 20,000 bicycles will be approximately $940,000, or approximately $47 per bicycle. The total first-year cost of forming and operating a bamboo bicycle plant that produces 20,000 bicycles per year is therefore approximately $1,019,000.

Setup costs

Sources suggest the total cost to set up an assembly plant capable of producing 20,000 bicycles per year is estimated to be approximately $79,000.

Estimated setup costs for a plant designed to produce 20,000 bicycles per year

Category	Cost ($)
Business formation[1][2]	52,325
Equipment[1][3]	21,360
Training[1]	5,000
Total cost	78,685



Sources: (1) Industry participant interview 2008; (2) GIPC: Cost of Doing Business in Ghana (accessed 2008); (3) Snapshot Africa 2007

Business formation – $52,325

Ghanaian law requires that wholly owned foreign entities must have a minimum equity capitalization of $50,000. However, if a suitable local joint venture partner could be found, for example an importer of bicycles or bicycle parts, the equity capitalization requirement would be reduced to $10,000. In addition to the capitalization requirement, foreign entities must pay registration and licensing fees of approximately $2,325.

Equipment – $21,360

Equipment costs are comprised of the tools required to make the bicycles, the jigs to make the bicycles on, and the importation costs of bringing the equipment from the United States to Kumasi. In order to meet production estimates, it is estimated a two-person team receives a complete set of tools. The specific equipment needed is as follows: band saws, chop saws, saw blades, drill presses, assorted end mills, hand tools, bicycle jigs, and seat jigs.

Training – $5,000

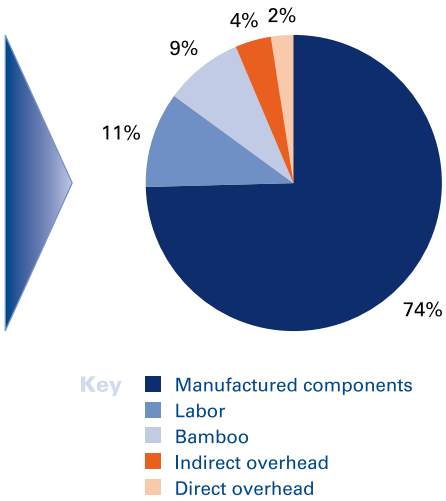
The Earth Institute expects training to be conducted over the course of ten days in Ghana by two volunteers from the Institute. However, the expected training regime could be modified in order to increase the number of assemblers trained and thus increase the plant's output and revenue. The cost to train one worker appears to be outweighed by the corresponding increase in production, and thus revenue, that the worker produces. Therefore, in practice, bicycle production should and would not be constrained by the cost of training assemblers, but rather by demand.

Operational costs

The cost to produce one bicycle is approximately $47. The total cost of goods sold is approximately $45 per bicycle. Indirect annual overhead of nearly $41,000 can be allocated on a per bicycle basis at approximately $2 per bicycle.

Estimated operational costs for the production of 20,000 bicycles per year

Cost Category	Cost per bicycle ($)
Manufactured components [1][2]	35
Labor [1][3]	5
Bamboo [1]	4
Indirect overhead [1][2][3]	2
Direct overhead [1][2]	1
Total cost of production	47



Sources: (1) Industry participant interview 2008; (2) Snapshot Africa 2007; (3) GIPC: Cost of Doing Business in Ghana, (accessed 2008)

Manufactured components – $35

Manufactured components account for approximately 74 percent of the total cost of producing a bicycle. In addition to the cost of the manufactured components themselves, this cost category includes the binding materials needed for frame assembly, and the transport and tariff costs of importing the components and materials from China and South Africa, respectively.

Ghana generally imposes additional tariffs on imported bicycle parts that, if imposed in this case, would likely make the bicycle too expensive for the target market. However, according to an investment official at the GIPC, it appears that the bicycle parts can be exempted from these tariffs if they are registered with the Ghanaian Government for use in the manufacturing of bicycles.

Labor – $5

The legally mandated minimum wage in Ghana is $2.25/hour. While reports were received that assemblers could be hired for approximately $0.80/hour, the labor cost estimates in this analysis are properly based on the legal minimum wage.

Bamboo – $4

Bamboo costs include not only the cost of the bamboo itself, but also transport of the bamboo from the fields to the assembly site, and the cost of the chemicals to treat the bamboo. As previously stated, the cost of bamboo is expected to rise at the end of 2008 due to initiatives that the Government of Ghana has designed to encourage bamboo cultivation in Ghana. It is this expected cost of bamboo that has been used in these calculations.

Indirect costs – $2

Indirect costs are comprised of the salaries for a manager and a foreman at market rates, and the costs of leasing, insurance, electricity, marketing, and license renewal.

The marketing cost was calculated as the cost of giving away 20 bicycles to the target market. Given that the biggest impediment to bicycle sales may be with initial acceptance, a method by which to convey the expected value proposition embedded in the bamboo bicycle is to give bicycles away as promotional items. In addition to the promotional bicycles, advertising emphasizing that these bicycles are adopted for use in rural Ghana from a high-tech design developed in the United States may help gain initial consumer acceptance. It is important for an investor to consider that, depending on how easily the bicycle is accepted by the general public, this venture may require a more extensive marketing program, requiring costs that are not considered here.

Direct overhead – $1

Direct overhead consists of the cost of electricity for the power tools and the depreciation of the tools through use.

Financial case study

In the base-case scenario, it appears the bamboo bicycles venture in Kumasi, Ghana could yield a positive return. Profitability of the business is dependent on the size of the operations and the number of bicycles that are able to be sold in the market.

Key assumptions

Key assumptions that drive revenue projections in the financial model were based on input received from industry sources and include:

- Bicycle builders employed (20 in base case; variable in demand sensitivity analysis)
- Bicycles produced per year (20,000 in base case; variable in demand sensitivity analysis)
- Percentage of bicycles produced that are sold (100 percent)
- Average price per bicycle ($50)
- Tax rate on businesses located outside of Kumasi city limits (zero percent)
- Growth rate (zero percent)
- Discount rate (12.5 percent)

Sources suggested using a 12.5 percent discount rate because it is the average discount rate for foreign direct investments in Ghana (Ghana Country Report 2008, p. 15). Since the bamboo bicycles venture is a new market entry, the appropriate discount rate for this venture may actually be above the average discount rate for foreign direct investments in Ghana. Revenue, cost, and financial assumptions for the bamboo bicycles analysis are obtained from interviews with industry participants and analysis of data in industry reports (Industry participant interview 2008).

Assumptions – Bamboo bicycles

Category	Assumptions	Comments
Revenue assumptions		
Number of bicycle builders	20	The 20 bicycle builders hired at the start of the project will work full-time (40 hrs/wk for 50 wks/yr).
Bicycles produced per year	20,000	Working in teams of two, the 20 bicycle builders will produce approximately one bicycle per team per hour, totaling 20,000 bicycles per year.[1]
Average price per bicycle	$50	Industry experts indicate that rural Ghanaians currently pay $45–70 for bicycles (the most commonly cited price is $50); since the bamboo bicycle is a novel product, it will be priced at the low end of the range.
Bicycles sold per year	20,000	Due to the relatively large current Ghana bicycle market demand, it is assumed that all bicycles produced will be sold.
Cost assumptions[a]		
Capital expenditures: initial outlay	$78,685	The required capitalization cost for a wholly owned foreign entity in Ghana accounts for $50,000 of the initial outlay; the remainder is comprised of equipment and transport costs.
Direct materials cost per bicycle	$40	The direct materials costs include the cost of bamboo and the cost of manufactured components.
Direct labor per bicycle	$4.50	The bamboo bicycle factory will employ 20 bicycle builders at the minimum wage of $2.25 per hour; two hours of labor are needed to make each bicycle.
Overhead costs per year	$13,352	Overhead costs include the land lease, equipment depreciation, marketing, manager salary, foreman salary, insurance, and license renewal with the Ghana Free Zones Board.[2]
Tax rate	0%	Locating the factory outside of Kumasi city limits allows the company to pay no income taxes.
Financial assumptions		
Discount rate	12.5%	The average discount rate for foreign direct investments in Ghana was 12.5 percent (as of 2Q07).[3]
Growth rate	0%	In accordance with the conservatism principle, the cash flow model assumes no annual growth in revenue.

Note: (a) Cost assumptions are based on a production rate of 20,000 bicycles per year.
Sources: (1) Industry participant interviews 2008; (2) Ibid; (3) Ibid; (4) Ghana Country Report 2008, pp. 14–15.

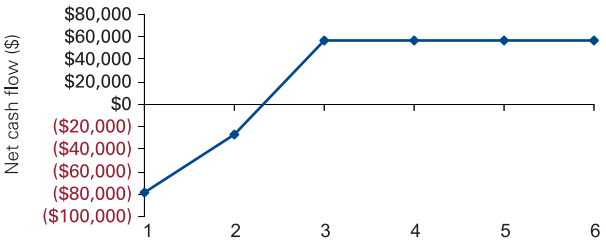
Financial case study – Base case

According to the base-case illustration, the bamboo bicycles venture in Kumasi, Ghana could be an attractive investment opportunity for an investor. The base-case financial analysis could result in a net present value of approximately $49,000, a payback period of roughly four years, and an internal rate of return of approximately 28 percent.

Expected cash flow for a five-year period

Year	0	1	2	3	4	5
Revenue						
Number of bikes		18,333	20,000	20,000	20,000	20,000
Price per bike		$50	$50	$50	$50	$50
Total revenue		$916,667	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Operational costs						
Direct material		$795,807	$795,807	$795,807	$795,807	$795,807
Direct labor		$90,000	$90,000	$90,000	$90,000	$90,000
Overhead		$55,186	$55,186	$55,186	$55,186	$55,186
Less: Depreciation		$2,045	$2,045	$2,045	$2,045	$2,045
Less: Total operational costs		$938,948	$938,948	$938,948	$938,948	$938,948
Less: Capital expenditures	$78,685	$4,281	$4,281	$4,281	$4,281	$4,281
Total cash flow	($78,685)	($26,562)	$56,771	$56,771	$56,771	$56,771

Expected cash flow over a five-year period shows flat rate revenue after the second year



Estimated financial benefits	
NPV	$49,378
Payback period	<4 years
IRR	28%

Sources: (1) Industry participant interviews 2008; (2) Ghana Country Report 2008, pp. 14–15.

Revenue – Number of bikes = 18,333

Assuming only bikes made during 11 months out of the first year are sellable due to ramp-up time.

Operational costs – Overhead

Includes direct and indirect overhead.

Demand sensitivity analysis

According to the demand sensitivity analysis, the bamboo bicycles venture appears to be a scalable business; the rise in net present value increases as the size of the business increases.

Current bamboo bicycles market – Demand sensitivity analysis

The demand sensitivity for bamboo bicycles is affected by the adoption rates for addressable customers who currently own bicycles. A key definition in the demand sensitivity analysis is that the "current market" is comprised of the 227,240 rural Ghanaians who currently own bicycles. The demand sensitivity analysis for the current bamboo bicycles market includes the assumption that none of the currently untapped potential rural bicycle market would be captured.

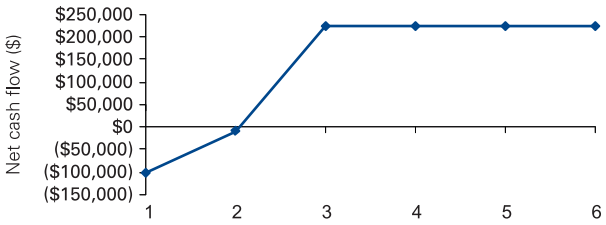
20 percent penetration of the current market

If bamboo bicycles penetrated 20 percent of the current rural bicycle market in Ghana (i.e., if 20 percent of the 227,240 bicycles currently sold to rural Ghanaians per year were bamboo bicycles), the result would be a net present value of $484,620, a payback period of fewer than two years, and an internal rate of return of 101 percent. At 20 percent penetration of the current market, 55 bicycle builders would be employed, and 55,448 bicycles would be produced per year.

50 percent penetration of the current market

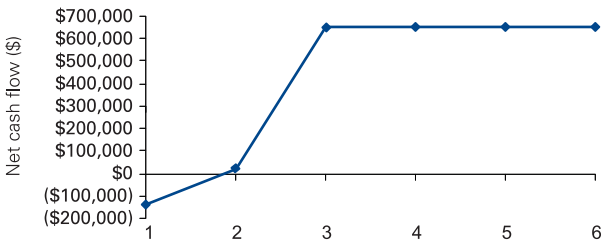
If bamboo bicycles penetrated 50 percent of the current rural bicycle market in Ghana, the result would be a net present value of $1,505,833, a payback period of fewer than two years, and an internal rate of return of 171 percent. At 50 percent penetration of the current market, 139 bicycle builders would be employed, and 138,620 bicycles would be produced per year.

20 percent penetration of the current market



Estimated financial benefits	
NPV	$484,620
Payback period	<2 years
IRR	101%

50 percent penetration of the current market



Estimated financial benefits	
NPV	$1,505,833
Payback period	<2 years
IRR	171%

Current and potential bamboo bicycles market – Demand sensitivity analysis

The demand sensitivity for bamboo bicycles is affected by the adoption rates for the total addressable market. A key definition in the demand sensitivity analysis is that the "total addressable market" is comprised of the 670,000 Ghanaians in the addressable market for bamboo bicycles. Some of these potential customers currently own bicycles, and some of them do not; all of them are included in the analysis.

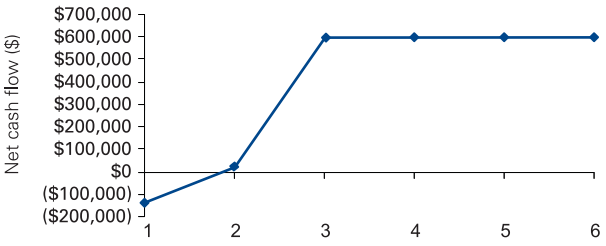
20 percent penetration of the total addressable market

If bamboo bicycles penetrated 20 percent of the total addressable bicycle market in Ghana (i.e., if 20 percent of the 670,000 Ghanaians in the addressable market for bamboo bicycles purchased bamboo bicycles), the result would be a net present value of $1,444,255, a payback period of fewer than two years, and an internal rate of return of 171 percent. At 20 percent penetration of the total addressable market, 133 bicycle builders would be employed, and 133,333 bicycles would be produced per year.

50 percent penetration of the total addressable market

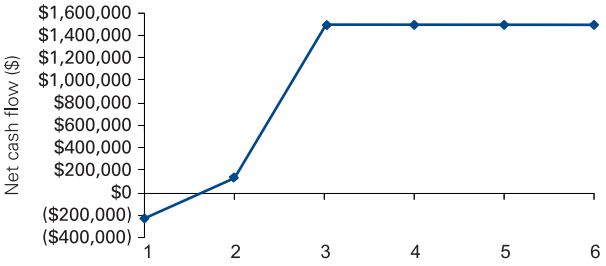
If bamboo bicycles penetrated 50 percent of the total addressable bicycle market in Ghana, the result would be a net present value of $3,896,587, a payback period of fewer than two years, and an internal rate of return of 227 percent. At 50 percent penetration of the total addressable market, 333 bicycle builders would be employed, and 333,333 bicycles would be produced per year.

20 percent penetration of the total addressable market



Estimated financial benefits	
NPV	$1,444,255
Payback period	<2 years
IRR	171%

50 percent penetration of the total addressable market



Estimated financial benefits	
NPV	$3,896,587
Payback period	<2 years
IRR	227%

Ease of execution

While there are various factors that could affect the success of the production, distribution, and adoption of bamboo bicycles in Ghana, there are measures that can be taken to mitigate those risks.

Demand

Current condition

An accurate depiction of the demand for bamboo bicycles is difficult to ascertain due to their novelty and uniqueness. However, there appear to be no cultural impediments to the adoption of bamboo bicycles by rural Ghanaians, and indeed the few bamboo bicycles that were shown to and used by rural Ghanaians have received positive feedback (Industry participant interview 2008).

Demand for bicycles in Kumasi itself appears to be limited (Industry participant interview 2008). The rural residents of the areas surrounding Kumasi do not appear to be the nation's highest consumers of bicycles (Industry participant interview 2008). The city of Tamale, in northern Ghana, and northern Ghana in general, appear to be the highest consumers of bicycles (Industry participant interview 2008).

Potential risks

Demand could be less than the demand for metal bicycles indicates owing to the fact that it is difficult to accurately estimate the demand for bamboo bicycles. It is also difficult to project demand as commercial production of bamboo bicycles has not yet occurred.

Potential solutions

Before launching the full-scale operation envisioned herein, it might be advisable to undertake a trial run with production on a much smaller scale. Additionally, the initial concentration of distribution in Tamale and the surrounding regions might lead to higher initial demand and a more accurate understanding of the market's potential. These actions, combined with marketing efforts, may help mitigate the risk posed by an unexpected shortfall in demand.

Finally, there also exists the potential for exportation. Ghana is the only country in the region that does not impose tariffs on completed bicycles imported from China and India (Industry participant interview 2008). Consequently, approximately 300,000 bicycles per year are imported into Ghana to be immediately transported to neighboring countries (Industry participant interview 2008). This indicates that there is a significant demand for bicycles in these countries, and that the infrastructure to distribute bicycles from Ghana to surrounding countries exists. While a detailed analysis of export potential from a regional, as well as Western and Asian, perspective is beyond the scope of this study, export does present a possible opportunity that could further hedge against disappointing demand in Ghana.

Bamboo

Current condition

There is currently a plentiful supply of native bamboo growing wild in Ghana, with the Ashanti region being a major growing area (Industry participant interview 2008; Akuamoa-Boateng 2008, pp. 1–2). However, bamboo is not currently cultivated in Ghana (Industry participant interview 2008). Indeed, it has generally been used by the local population as housing material, and increasingly for commercial construction and decorative arts (Industry participant interview 2008). However, the Ghanaian Government recently formed BARADEP to develop an industry around this natural resource and to protect the country's dwindling forests (Industry participant interview 2008). One step BARADEP has taken relevant to the production of bamboo bicycles was the introduction of legislation to set a minimum price for bamboo destined for use in commercial activity (Industry participant interview 2008).

Potential risks

With no existing bamboo industry, the principal bamboo related risk may be the inability to secure a reliable and consistent supply of the requisite quality bamboo. An additional risk is an increase in the price of bamboo due to growing demand and further intervention by the Government of Ghana.

Potential solutions

By collaborating closely with owners of the bamboo producing land, or by vertically integrating the bamboo cultivation process into the supply chain, the venture could mitigate the risks posed to the supply of bamboo and its price.

Imported supplies

Current condition

Manufactured components can be imported from China in containers that hold enough parts to make approximately 600 bicycles (Industry participant interview 2008). The epoxy resin can be sourced and shipped from South Africa in an amount sufficient to meet production (Industry participant interview 2008). The tools and jigs can be purchased in the United States and shipped to Ghana (Industry participant interview 2008).

Potential risks

Spare parts for bicycles in Ghana are often of low quality (Industry participant interview 2008). This poses a danger to the reputation for quality that bamboo bicycles hope to develop.

Potential solutions

In order to ensure the quality of the bicycles, some of the imported components could be designated specifically for use as spare parts, or alternatively, separate additional spare part kits could be imported. Local repairmen could then be supplied with the parts and instructed that they only use these parts to repair bamboo bicycles.

Labor

Labor will likely pose no risks to execution. There is significant unemployment and underemployment in and around Kumasi (Industry participant interview 2008). There is also a large contingent of bicycle repairmen, woodworkers, and craftsmen with transferable skills and a preference for steady employment at the relatively high wage of $2.25/hour over their current occupations (Industry participant interview 2008).

Assembly plant

Current condition

Leasing is affordable (approximately $10/m^2/year) and, given a 60 percent vacancy rate, readily available (Industry participant interview 2008; Snapshot Africa 2007). A plant size of approximately 740 m^2 should be sufficient to fit ten work stations, an office for the manager, and areas for drying and storage (Industry participant interview 2008).

Potential risks

Equipment, materials for much of the year, works in progress, and a certain number of completed but unsold bicycles will be stored on-site, presenting a significant risk of loss from fire or theft. Workers also face the risk of injury, a potentially significant risk considering the heavy use of power tools. Injuries could result in potentially employer liability for lost wages as well as for pain and suffering (Industry participant interview 2008).

Potential solutions

Insurance is available in Ghana to cover fire, theft, and injury. The annual cost to insure this venture against these risks would be approximately $4,500 (Industry participant interview 2008).

Materials delivery

Current condition

Transporting the required manufacturing inputs from China, South Africa, the United States, and the fields around Kumasi should not pose a significant problem. There are major ports in Accra and Tema, and there is a reliable road link between Accra and Kumasi (Industry participant interview 2008). Bamboo can be placed on trucks at pickup points in rural areas and then delivered to Kumasi (Industry participant interview 2008).

Potential risks

There have been reports of instances of corruption in customs processing and a lack of reliability in the timing of imported supplies from China (Industry participant interview 2008). Rising fuel and related transportation costs may increase the cost of materials needed to produce bicycles. (Industry participant interview 2008). Additionally, importing these materials may expose the investor to risk associated with potential fluctuations in foreign exchange rates. (Industry participant interview 2008). There were also reports that during the wet season, some of the roads in rural areas may become difficult to pass (Industry participant interview 2008).

Potential solutions

To hedge against delivery risks, shipments from China could be stacked to account for expected delays, and bamboo could be purchased during the dry season to the greatest extent possible.

Distribution

Current condition

Bicycles are currently distributed to end users in Ghana through a network of independent bike dealers (IBDs) (Industry participant interview 2008). IBDs purchase bicycles from the importers or larger IBDs in their areas and then resell the bicycles to the end user (Industry participant interview 2008). Rural IBDs often buy a bicycle for resale only when they have an order placed by a customer (Industry participant interview 2008).

While there is no standard markup used by the IBDs, they generally charge the end user approximately ten percent more than they bought it for (Industry participant interview 2008). Accordingly, the expected cost of a bamboo bicycle to the consumer would be approximately $55.

Potential risks

The operation is heavily reliant on IBDs as its sole purchaser and distribution channel. Also, due to the lack of direct consumer contact, feedback on the bicycles from the end user will be slow and unreliable.

Potential solutions

In order to mitigate these risks, the bicycles could be sold directly to end consumers through the venture's own distribution network. A distribution network could be created by hiring existing IBDs that currently serve the target segment as exclusive distributors of bamboo bicycles. Also, sales could be made directly to companies operating in Ghana for use by their employees, and to the Ghanaian Government.

Regular customer visits performed by the manager and foreman would also help ensure better feedback, and would be especially useful in the initial project phases.

Electricity

Current condition

Ghana is reliant on hydroelectric dams for 70 percent of its electricity (EIU 2007, p.24). The electricity supply is currently considered to be relatively dependable, but as recently as 2007, there was power rationing caused by the grid's inability to handle increasing demand and urbanization (Industry participant interview 2008).

Potential risks

Under current conditions, blackouts and brownouts can be expected for up to five days every month (Industry participant interview 2008). Furthermore, a drought severe enough to hamper Ghana's hydroelectric supply or the failure of supply to keep up with demand, could lead to further shortages and production interruptions.

Potential solutions

In order to hedge against temporary loss of power, a diesel generator could be purchased. A generator large enough to handle production needs could be purchased new in the United States for approximately $3,000–$6,000. Furthermore, any scheduled brownouts could be worked around since much of the assembly is done by hand.

Taxes and incentives

Current condition

Income tax is levied at a rate of ten percent on businesses located in Kumasi (Industry participant interview 2008; GIPC (accessed 2008)). However, income is not taxed if a business is located just outside of Kumasi's city limits.

The government provides incentive fees at a rate of two to eight percent of revenue for the transfer of technology to a local business (Board of the Ghana Investments Center 1992, pp. 5–6).

Potential risks

By being located in Kumasi, profits will be taxed at ten percent. It also appears that incentive fees are only paid when technology is transferred to a Ghanaian entity.

Potential solutions

The business should be located just beyond the city limits in order to minimize its tax liability. The technology embodied in the bamboo bicycle appears likely to qualify under the technology transfer law, but transfer of the technology to a wholly owned foreign entity may not. Therefore, to benefit from the incentive fees, the technology could be transferred to a local joint venture partner.

Social impact

Social benefits

Bamboo bicycles appear to have the potential to make a significant positive impact on the social and economic welfare of Ghana.

Job creation

The venture may not only create employment for assemblers at a higher wage than most other Ghanaians, it may also create jobs and income along the value chain for the suppliers of bamboo and the distributors of the bicycles. It may also assist in the Ghanaian Government's efforts to develop the bamboo industry.

Increased productivity and efficiency

The end users of the bicycles, rural Ghanaians employed mostly within the agricultural sector, may increase their productivity and efficiency. Rural inhabitants may be able to transport more goods over longer distances and in a shorter time. The decrease in travel times may also allow for more time to be spent working the fields and selling produce.

Healthcare delivery

It appears the delivery of rural health services is currently limited in Ghana (Industry participant interview 2008). However, because bamboo bicycles are light and can handle rough terrain while carrying large loads, they can be used in emergency and nonemergency situations for the transport of medical professionals, medical supplies, and patients. Indeed, case studies in Tanzania have shown that investing in bicycles for healthcare delivery may be a cost-effective way of lowering mortality rates (Gauthier 2005, pp. 23–25).

Environmental benefits

The increased cultivation and use of bamboo as an alternative to traditional wood could help the preservation and rehabilitation of Ghana's dwindling forests (Industry participant interview 2008).

Education transit

Parents in rural areas often take their children to school on bicycles. By increasing bicycle use and availability in rural areas, school attendance by rural children could increase (Industry participant interview 2008).

Conclusion

The production and sale of bamboo bicycles in Ghana could be a financially viable, scalable, and socially responsible venture. The potential annual market for bicycles in rural Ghana and the gap left open by the insufficiencies of imported metal bicycles may present a promising opportunity. Additionally, according to sources, the cost of producing the bicycles could allow for a profit margin of approximately six percent on each bicycle sold, and perhaps more importantly, the expected final cost to the end consumer of approximately $55 puts the bicycle within reach of many rural Ghanaians.

There are risks related to the production and scalability of the enterprise, although an investor may be able to mitigate some of these to a degree. The investor and reader should be aware that the actual demand for these bicycles is not known and cannot be accurately estimated with a high degree of certainty. Customer perception of the bicycles could be a significant impediment to an investor's success in the market. Starting with a small-scale operation in northern Ghana might be advisable in order to more precisely ascertain demand levels and the appropriate scale and production capacity of the operation.

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