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## Sustainably Manufacturing a Bamboo Bicycle in a Container Factory

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### Abstract

In order for manufacturing suppliers to stay competitive in the global market, innovative and resource efficient process chains need to be a part of the manufacturing strategy. Secondary manufacturing process steps entail the assembly and surface treatment manufacturing steps, after the primary cutting and shaping of the components. Bicycles have an enormous effect on society, both in terms of socio-economics and of advancing modern industrial processes. In order to manufacture bamboo bicycle frames in South Africa, innovative designs and process chains need to be developed. Container factories could be the answer to reduce costs and increase resource efficiency. In this study, the feasibility of manufacturing bamboo bicycle in shipping containers is investigated. These results are then used to evaluate the sustainability of manufacturing bamboo bicycles in container factories.

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### 1. Introduction

Transportation issues in the rural parts of Sub-Saharan Africa has been a pressing matter over the years, yet the high poverty rate and declining road conditions impose a challenging environment to address these issues. The livelihood of an individual is directly affected by his/her ability to access their jobs and indirectly in terms of access to healthcare, education and social networks where future job opportunities may emerge [1]. Economic growth is a

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necessary condition for the alleviation of poverty in South Africa, but it should be reinforced with the development of the skills of the population in order to sustain the growth and reduce poverty and inequality. Human development and economic growth are thus linked and are mutually reinforcing [2]. This provides a challenge to find a way to address the transportation issues, while at the same time reducing unemployment and poverty through human development. Manufacturing and selling bicycle frames made mainly from bamboo could be a sustainable method to provide rural Africans with a method of transportation, while facilitating skills development and job creation.

Bicycles have an enormous effect on society, both in terms of socio-economics and of advancing modern industrial processes. Bamboo bicycles are more sustainable and a less expensive alternative when compared to typical steel, aluminum and carbon fibre bicycles [3]. The popularity of bamboo bicycles have increased over the past few years. In order to expand the market even more in developing countries, it has become important to find the best way of mass producing bamboo bicycles while keeping costs to a minimum [3]. Bamboo is the most versatile and fastest growing plant on the earth. It has played an integral part in millions of lives for the past millenniums. In the last few decades it is being exploited with renewed interest to serve as a substitute for timber [4].

There is a paradigm shift occurring in the past years with regard to manufacturing. Manufacturing needs to be more flexible, resource efficient and cost effective. One solution to fulfill these needs could be mini-modular container factories. Container factories is a new way of providing manufacturing solutions close to the market, while proving to be more flexible and inexpensive. Considerations for these factories include the required energy and water to perform the manufacturing steps, as well as the waste produced by the factory [5].

The CassaMobile project is one of the few projects that make use of shipping containers to create a factory on the go. The main goal of the CassaMobile project is to develop a new kind of local, flexible and environmentally friendly production system for highly customized parts based on a combination of different manufacturing processes like 3D printing, CNC-milling and 3D assembly technologies inside an enclosed unit such as a container [6]. This project is just one example showing the possibility of manufacturing a bamboo bicycle in a container factory.

Therefore the research objectives are to:

- Understand shipping containers and container capabilities
- Manufacture a bamboo bicycle
- Evaluate the sustainability of manufacturing bamboo bicycles in container factories

## 2. Shipping Containers

A shipping container is a container with strength suitable to withstand shipment, storage and handling. Freight containers are a reusable transport and storage unit for moving products and raw materials between locations or countries. In addition, for the design use of shipping, the possible applications for shipping containers are almost limitless [7]. Two local South African container companies, Container World and Topshell, are investigated to gain an understanding about these applications and the dimensions which need to be considered for the factory design.

As the market leader in the African container industry, Container World has pioneered the development of the container industry in Africa and continues to maintain their position as the market leader [8]. Their primary activities include the sales, conversions and transport of new and pre-owned marine shipping containers.

Container World has the capability to convert containers into any type of converted unit as requested by its customers. They have provided the sub-Saharan market with specialized container conversions since 1983. Converted containers throughout the world have shown great versatility in solving space requirements. According to Container World [8] these include, but are not limited to:

- Clinics
- Banks
- Mobile Workshops

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