DESIGN OF A SUSTAINABLE MANUFACTURING PROCESS TO PRODUCE PENICILLIN V USING WASTE PAPER AS A GLUCOSE FEEDSTOCK

A LIFESAVING PILL: AN ANALYSIS OF THE GLOBAL PHARMACEUTICAL MARKET'S IMPACTS ON SUB-SAHARAN AFRICA

An Undergraduate Thesis Portfolio
Presented to the Faculty of the
School of Engineering and Applied Science
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Chemical Engineering

By

Patrick Bruns

May 9, 2022

EXECUTIVE SUMMARY: A SOCIOTECHNICAL SYNTHESIS

Healthcare is one of the largest industries in the world, and it impacts each of us every day in the pills we take, the taxes we pay, and the headlines we see. Often, access to the necessary drugs to treat any condition is often overlooked in the Western world where supply chains and distribution networks are fully established and secure. For those who live in sub-Saharan Africa however, consistent access to quality antibiotics is nonexistent, a fact which can prove detrimental to public health. The science, technology, and society (STS) topic serves to explore the global pharmaceutical market and its impact on sub-Saharan Africa. Through the design and analysis of an antibiotic production facility, the technical project addresses the antibiotic need in the region. The tightly coupled technical and STS topics describe the situations that gave rise to the current antibiotic crisis in Africa, as well as the social considerations of such a facility being placed in the region.

Bacterial infections, such as pertussis, pneumonia, and urinary tract infections, plague the world. Fortunately, treatments do exist with a wide away of antibiotics available on the market. One of the most widely used antibiotics is Penicillin V, which can either be administered as is or undergo further processing to produce penicillin derivatives like Amoxicillin and Ampicillin. The technical report outlines a proposed manufacturing facility to produce Penicillin V and to supply the sub-Saharan Africa region. In order to reduce the environmental impact of this facility, it is also proposed that waste paper be used as a feedstock to produce the glucose required for fermentation, eliminating some strain on local waste management systems.

The final plant design demonstrated that 330,000 kg of pharmaceutical-grade penicillin V could be produced annually, over double the initial estimate of 150,000 kg. Based on prescriber data from South Africa, an annual production scheme of this scale would supply the majority of

antibiotic needs in the region. An economic analysis of the proposed process indicated that initial capital investment costs amount to $29.2 million and annual operating costs $5 million. For this process, with annual revenue of $11.5 million, the facility is profitable with an estimated annual net profit of $6.7 million before taxes.

The aim of the STS paper was to determine the factors that contributed to the current antibiotic crisis in Africa. Using the STS methodology of Law and Callon's Actor-Network Theory, the global pharmaceutical industry was framed in a sociotechnical context. The initial inspiration for investigating the crisis stemmed from a desire to understand the social, political, and economic influences on the global pharmaceutical industry. The research conducted then evolved to using this knowledge to propose potential solutions and better establish the pharmaceutical trade in sub-Saharan Africa. This was accomplished using published medical data, regulatory reports from government agencies, and case studies.

The STS paper proposes 4 main factors that have shaped the landscape of the antibiotic market in Africa: Ununified regulatory bodies, low government spending on healthcare subsidies, aging or non-existent infrastructure, and antibiotic overuse, leading to drug resistance. By addressing and recognizing these issues, solutions can be implemented to address each one. Ultimately, it was determined that a unified regulatory authority, perhaps under the African Union, with jurisdiction over healthcare spending would best bolster the African market and provide an environment for investment.

Access to quality healthcare is a growing global healthcare concern. To better ensure a more equitable distribution of resources, and thus, more equitable distribution of healthcare, public health officials, legislators, private healthcare companies, and non-governmental organizations must make a coordinated effort to solve the issue.

TABLE OF CONTENTS