OTCO

Pioneering Pharmaceutical Circularity

Johnson & Johnson

ME 310 Spring Documentation

Antoni Soledad
Ashwinkumaran Senthilkumar
Ben Randoing
Ghadi Nehme
Juan Jimenez

Anthea Kuczewska
Patrick Allgeier
Péter Bázsa
Stephen Primeau

Anna Dietrich
Ece Akillioglu
Nico Frei
Patrick Bier

1 Executive Summary

In recent years, the concept of a circular economy has emerged as a groundbreaking approach to address the challenges of resource depletion and environmental degradation. This innovative model has been gaining significant traction among companies worldwide, revolutionizing traditional linear production and consumption practices. In a circular economy, the prevailing notion of waste is fundamentally challenged, as materials are not merely recycled or disposed of properly but instead circulate within closed-loop systems. The primary objective is to eliminate waste generation altogether by ensuring that all materials are reused, repaired, or repurposed whenever possible. This paradigm shift has sparked a transformative wave, compelling businesses to rethink their strategies, products, and processes.

Janssen Pharmaceutical Companies of Johnson & Johnson (J&J) has expressed its strong commitment to achieving significant progress in climate action by enhancing the environmental sustainability of its products, operations, and supply chain. In 2021, J&J established ambitious sustainability goals, including its aspiration to achieve carbon neutrality by 2030 [1]. To accomplish these objectives, the company is proactively exploring innovative and sustainable strategies to create solutions for its packaging and drug delivery systems that encourage circularity in their material streams. The project featured three subteams: a team of engineering students from Stanford University in the United States, and two teams of business students from the ZHAW International Business Master's program in Switzerland. Janssen challenged the team to explore circular solutions for self-injectable drug delivery and pharmaceutical packaging material streams.

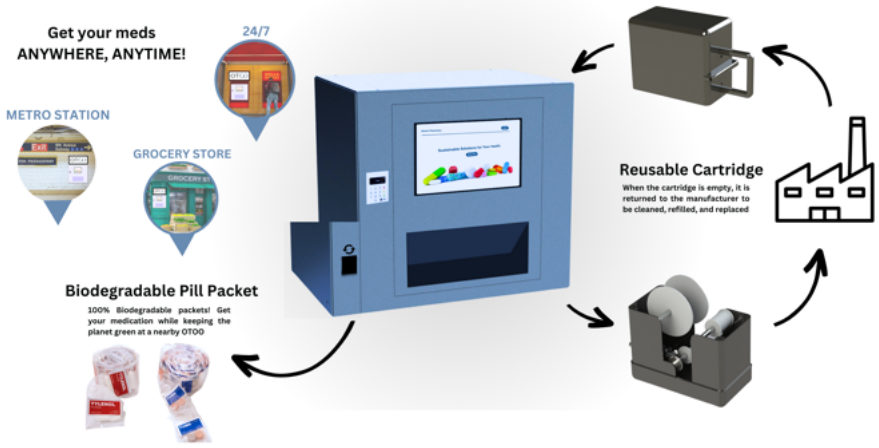

Figure 1.1: *A closed-loop of materials for dispensing medication: A vending machine provides users with just as much medicine as they need, when they need it. A disposal bin adjacent to the machine encourages users to recycle empty packets and pill bottles. Reusable cartridges are refilled by the supplier with rolls of pill packets.*

Pharmaceutical drug usage globally is widespread. For individuals aged 60 and above, nearly

90% used prescription drugs, and more than 35% used five or more medications. However, many concerns in the industry exist, including a scarcity of packaging take-back programs, insufficient material tracking, and significant waste of expired medications. Notably, 98% of individuals report not finishing their medication prior to its expiration [2]. Storage of unused medications can lead to inappropriate disposal and result in adverse ecological and environmental health effects. For medications that have expired or that were unused, as many as 90% are disposed [2].

We identified the primary obstacle limiting circular practices in the pharmaceutical supply chain to be the shared material streams between manufacturers and customers. Current pill bottles are crated and filled at a manufacturing facility and ultimately end up in the hands of users. As a result, we explored new models of delivering medications that support separate material streams between the manufacturers and users. Initial efforts attempted to leverage existing familiarity of consumers with pill bottles to develop a vending apparatus that distributes medicine into a reusable pill bottle from a bulk container provided by pharmaceutical companies. A consumer would be able to purchase the exact quantity of medicine when they need it due to the high density and 24/7 hours of the vending machines. Through user testing and needfinding, however, we recognized that convenience for consumers was crucial. Notwithstanding the practicality of a bulk container for manufacturers, returning packaging or carrying a bulky pill bottle did not fit the specific needs of consumers. As a result, we now implement a system to provide a single dose to users that they may dispose of immediately after consumption at the new vending machine.

OTOO serves to reduce expired pill waste by and subsequent environmental contamination by providing a single dose of medication to users in convenient locations when they need it. This new model of vending is suitable for medication for sudden onset ailments such as Tylenol and allergy medications. The bulk cartridge in Figure 1.1 is filled and returned to the manufacturer while the biodegradable medication packets are immediately returned after use in the OTOO adjacent medication disposal bin for appropriate cleaning and and recycling by the manufacturer. This new model not only reduces expired pill waste but minimizes the environmental impact of improperly discarded pill bottles by facilitating seamless material return immediately after purchase.

We recognize an essential aspect of new circular solutions is widespread adoption by consumers. To encourage the use of OTOO machines, we require that the process of purchasing be quick and convenient. We propose that OTOO machines will be developed for dense placement in areas with high traffic such as metro stations and busy streets. In particular, there exist communities – even in generally well equipped cities like Zurich – that are not well represented by pharmacies. Figure 1.2 illustrates the placement of pharmacies in Zurich and indicates empty regions where OTOO machines my be placed to ensure purchasing medication from OTOO is convenient and possible for a large population of consumers.

Figure 1.2: *A map of OTOO locations in Zurich to maximize convenience and coverage. Green dots indicate existing pharmacy locations open after 8PM. Red dots indicate pharmacy locations that close prior to 8PM and indicates the regions with less representation of extended hour pharmacies.*