

Undergraduate Thesis Prospectus

The Socially Distanced Dispenser: A Contactless Food Vending System

(technical research project in Computer Engineering)

Plastic Bag Bans in the United States

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## **General Research Problem**

*How can producers provide consumers with safe and sustainable options?*

The United States is by far the largest producer of plastic waste in the world. In 2016, the country generated 42 million metric tons of plastic trash. Less than 10 percent of this trash was likely to be recycled (Parker, 2020). But in recent years, there has been a push toward reducing the prevalence of single-use plastics in the food and grocery industries. A poll conducted in 2019 by PBS NewsHour and Marist Poll found that 68 percent of adults in the United States would be willing to pay at least one percent more for everyday items made of sustainable materials rather than plastic, and around a quarter of adults support a total ban of single-use plastics (Santhanam, 2019).

Many producers wish to provide customers with environmentally-friendly shopping options. Some prominent vendors are making massive changes. Grocery chain Trader Joe's (2020a) announced in January that over the course of 2019, they reduced their use of plastic packaging by almost 6 million pounds. In 2018, the coffee chain Starbucks committed to eliminating the use of plastic straws in its stores after introducing a new straw-less lid for cold beverages (Rochman, 2018). Despite these initiatives, the COVID-19 pandemic has complicated both companies' efforts to reduce waste. In an attempt to protect their workers, Trader Joe's (2020b) has disallowed customers from bringing reusable grocery bags into their stores. Starbucks has suspended the use of reusable cups (Williams, 2020). These necessary measures come at a cost: more trash.

Grocers and food vendors need solutions to help them reduce their waste production while maintaining the health of their workers and patrons. Two approaches that may help solve this problem are explored here.

## **The Socially Distanced Dispenser: A Contactless Food Vending System**

*How can food vendors use technology to safely provide self-serve options during the COVID-19 pandemic?*

My team's answer is through a contactless, Bluetooth-enabled bulk dry food dispenser. The project is for the capstone course in the Department of Electrical and Computer Engineering, advised by Professor Harry Powell. I will complete the project with fellow students Jon Burkher, Jake Moses, and Justin Nguyen-Galante.

Due to the COVID-19 pandemic, the Centers for Disease Control and Prevention (2020) has advised customers to avoid purchasing foods and beverages from self-serve stations, and the U.S. Food and Drug Administration has recommended that stores suspend services that require the customer to touch a common utensil or dispenser (Center for Food Safety, 2020). Our goal is to provide a machine that will allow vendors to continue providing self-serve options by eliminating the need for direct contact with a common surface. This system will also allow consumers to bring their own containers to the store to fill with dry goods, reducing the need for plastic packaging.

The system will consist of a mobile application, a printed circuit board, and a motor attached to a dry food dispenser with a turning knob. The mobile application will contain a user interface in which the customer can select the product and quantity that they wish to purchase. The user will open the application and select their desired product, which will connect them via Bluetooth to the corresponding dispenser (Bluetooth, 2020). The Bluetooth signal will be processed by a MSP430FR2311 microcontroller on the PCB to determine how much to move the motor in order to dispense the requested amount. The microcontroller will output a signal to control the stepper motor, which will be attached to a rotating blade inside of the dispenser

canister using a 3D-printed shaft. All electronic and mechanical components will be housed in an enclosure to protect consumers. A Hall Effect sensor will be used to detect jams in the dispenser and other mechanical failures.

A number of constraints have informed the design of the product. The project must be completed by the end of the Fall semester, and the budget cap is \$500. We will also be conforming to standards set forth by the Food and Drug Administration, which regulate vending machines to ensure food safety (FDA, 2017). Additionally, the Occupational Safety and Health Administration requires that all machinery containing moving parts, such as a rotating motor, contain safeguards to prevent employee injury (OSHA, 2020).

One existing product that is similar to the Socially Distanced Dispenser is the Coca-Cola Freestyle beverage dispenser. Coca-Cola's dispenser allows users to choose from a variety of drinks by scanning a QR code on their smartphones, which directs them to a web application where they can select their beverage (Magloff, 2020). We are extending this idea to vend food rather than beverage, and we also hope that our mobile application will reduce the large overhead required by a web application. In addition, the price of a single module of the Freestyle Beverage Dispenser can be prohibitively expensive, ranging from \$2,000 to \$11,500 (Cost Aide, 2020). We are aiming to produce a more accessible final product costing less than \$200.

The end goal of the project is to produce a working prototype of a single dispenser, which will serve as a proof of concept for a module containing several dispensers, all of which would be controlled through the mobile app. A number of additional features could later be added to improve the product, such as weight sensing to ensure that the customer has placed a container beneath the dispenser before vending. If successful, the Socially Distanced Dispenser could aid

grocery stores and dining halls in providing sustainable options for consumers while reducing the spread of the novel coronavirus and other pathogens.

## **Plastic Bag Bans in the United States**

*How have the proponents and opponents of single-use plastic bag advanced their agendas?*

In 2019, the New York State Senate passed Bill S1508C banning carryout plastic bags, making New York the third state to enact such a ban. Since then, five additional states have enacted similar legislation (National Conference, 2020). The New York ban was first suggested by a task force created to address plastic bag litter. The task force was headed by the commissioner of the state's Department of Environmental Conservation (DEC), and consisted of several New York state politicians, as well as a representative from the New York League of Conservation Voters (NYLCV) and a representative from the Food Industry Alliance of New York State (New York State, 2020). In a 2018 report, the task force presented eight different legislative approaches to reducing plastic bag waste, one of which outlined a plastic bag ban that would eventually become law (New York State, 2018).

Several participant groups are in favor of the New York bag ban. One such group is the DEC, which is governing body responsible for enforcing the law. The DEC (2020) justifies the ban by citing the harm bags can inflict on wildlife if littered. A second participant group is organizations advocating for environmental protection. One example is Riverkeeper (2018), whose mission is to protect waterways in New York. Before the recent ban, Riverkeeper organized events to promote a bag ban, such as a day in 2018 for citizens to call the New York governor's office requesting the policy. A large number of similar advocacy groups exist. The

NYLCV (2020), which had a voice in the state task force on plastic bags, shares similar goals to Riverkeeper, but achieves them through different means. The group operates two political action committees aimed at electing state and local officials who will prioritize environmental policy. The NYLCV is pleased with the bag ban, and appreciates the freedom the bill provides to local government officials who want to enact stricter policies in their own municipalities (Sharon, 2019).

Trade associations representing the plastics industry oppose plastics bans. The American Recyclable Plastic Bag Alliance (ARPBA, 2018), which represents the plastic bag manufacturing and recycling industry, outspokenly fights these bans, claiming that plastic bags are sustainable. The association has argued that New York's ban will lead to market disruptions due to paper bag shortages, a loss of plastic manufacturing jobs in the United States, and increased carbon emissions (ARPBA, 2020).

Further opposition comes from store owners and grocers. The New York Association of Convenience Stores (2020) has advocated for increased exceptions for plastic bags use to benefit food vendors. The NYCAS identifies the higher cost of alternative paper bags as a primary concern for store owners. The Food Industry Alliance of New York State (FIA), which is a trade association representing the grocery industry, raises similar concerns. The FIA believes that the bag ban will fail to achieve the desired environmental results while increasing grocery stores' expenses, which the group asserts may inhibit grocers' efforts to open new stores in underserved communities. Instead, the FIA favors implementing fees on paper and plastic bags (Durant, 2019). A per-bag fee was among the eight solutions proposed by the 2018 plastic bag task force, on which the FIA had a representative member. The idea of a fee was ultimately dismissed, with

opposition coming from advocates for low-income communities which could be adversely affected by the extra cost (New York State, 2018).

The impact of a shift away from plastic bag use extends beyond the environment. Researchers Karmarkar and Bollinger (2015) explored the impact of using reusable bags on a customer's shopping behavior. They found that for a shopping trip in which a reusable bag is used, a customer is more likely to purchase organic produce and indulgent items such as desserts. Furthermore, there is a question of why it is necessary to ban single-use plastic bags in grocery stores in order to shift consumer behavior toward the use of reusable plastic bags. In their research, Yeow and Tucker (2014) evaluate the barriers that keep consumers from adopting reusable bags. Upon further research, it will be interesting to see whether participant groups exploit these psychological phenomena to inform and advance their agendas.

Finally, it is important to note that the COVID-19 pandemic has encouraged an increased use of single-use plastics. In their research, Silva et. al. (2020) offer policy suggestions for reducing and managing plastic waste in the era of the coronavirus. New York delayed enforcement of its bag ban from March until October, due in part to COVID-19 (NBC New York, 2020). Silva's research aligns with the actions the state has taken to ramp up the ban during an unprecedented time.

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