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A Sustainable Delivery System

I. Background

E-commerce is transforming the retail landscape in the United States. According to the U.S. Census Bureau, online sales totaled $513.6 billion in 2018, representing a 14.2 percent increase over 2017. At the same time, e-commerce is capturing an ever-larger share of the *total* retail market. From 2010 to 2018, the percentage of total retail sales attributed to e-commerce more than doubled, from 4.3 percent of total sales to 9.7 percent. This rapid growth is expected to continue in the coming years.

Predictably, as e-commerce grows, so too does the parcel delivery industry. Recent figures estimate that the U.S. courier and parcel sector generates approximately $100 billion in annual revenue, with the global industry having annual revenues of about $250 billion. By 2020, Accenture, a leading professional services company, projects that the global courier and parcel market will exceed $343 billion.

II. Impact of E-Commerce on Energy Consumption and the Environment

Over the past few years, a number of studies have explored the environmental sustainability of e-commerce. Much of this research has focused on energy consumption and CO_2 emissions in the "last-mile" of delivery, defined broadly as the last stretch of distance between the consumer and the business, including local distribution centers. By all accounts, the last-mile is the most expensive, energy-intensive, and inefficient part of the supply chain, and can account for 13 to 75 percent of the total supply chain costs. (Gevaers, et al., 2009).

While the research is still evolving, there is growing evidence that e-commerce can lead to lower energy consumption and reduced CO_2 emissions. By some estimates, a typical delivery truck makes roughly 120 deliveries in a day. This number, however, can increase dramatically in urban areas with high drop densities and short delivery rounds. Thus, well-designed and efficient parcel delivery systems can supplant the need for countless car-based shopping trips and yield better environmental outcomes.

One frequently-cited study concludes that, on average, a single car-based shopping trip (for a non-food item) emits 4,274 grams of $C0_2$. By comparison, a single delivery truck making

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120 drops (and a 50-mile route) emits roughly 21,700 grams of $C0_2$. Importantly, when this figure is apportioned among the 120 drops, the truck-based delivery translates into only 181 grams of $C0_2$ per delivery. (J.B. Edwards, et al., 2009). As such, a car-based shopping trip emits nearly 24 times more CO_2 than a delivery truck to accomplish the same task.

Because the typical consumer travels a shorter distance to purchase groceries than non-food items, researchers have also explored the environmental tradeoffs between car-based shopping trips and truck-based deliveries associated with food purchases. The research suggests that the previously-discussed energy and environmental benefits related to non-food deliveries extend to the delivery of food items as well. Specifically, when customers are proximity-assigned, delivery trucks emit 80-90 percent less CO_2 per drop than the corresponding car-based trip to the grocery store. (Wygonik and Goodchild, 2012).

Notwithstanding these encouraging findings, the environmental sustainability of parcel delivery is greatly impacted by two factors: failed deliveries *and* the retrieval of items that consumers want to return. Failed deliveries can account for between 2-30 percent of all delivery attempts, and at the same time, between 25-30 percent of all online purchases (non-food items) are returned. (Nairn, 2003). Both circumstances require at least one additional trip by the delivery truck. Going forward, successfully tackling these twin challenges will be critical to capturing the energy efficiencies and environmental advantages of e-commerce.

Finally, even with efforts aimed at reducing the inefficiencies discussed above, there are limits to the sustainability of traditional delivery trucks given their size, delivery routes, and demand for infrastructure. For example, empty or nearly empty trucks represent an enormous environmental challenge and waste of energy. Consider that by some estimates, 16-30 percent of all delivery trucks on the roads in the United States and Europe are completely empty, and an even greater percentage is under capacity. Finding solutions to this reality, and keeping up with the additional demands for infrastructure, will further burden the long-term sustainability of e-commerce.

III. Starship Technologies' Personal Delivery Devices

In 2016, Starship Technologies launched its revolutionary personal delivery devices ("PDDs"), representing the next generation in logistics. These electrically-powered devices emit no CO_2 and have a delivery range of between 2-4 miles.

Activated by smartphone technology, consumers will be able initiate the delivery of their purchases when convenient for them, and can have items delivered directly to their doors

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within 15 to 60 minutes. Accordingly, this technology *eliminates* the inefficiencies associated with failed deliveries, and can be used to facilitate the return of unwanted goods.

Designed with advanced navigation and obstacle avoidance technologies, these devices can safely operate autonomously on sidewalks. Even so, an operator is always available to maneuver the devices remotely, if necessary. Weighing approximately 50-60 lbs., Starship's PDDs can carry three shopping bags full of items. Incredibly, these devices are capable of delivering items at a fraction of the cost of traditional delivery options.

At the same time, Starship's PDD represents a giant step in the evolution of delivery systems by facilitating the use of centralized drop-off and pick-up points. Thus, rather than make 120 individual drops a day, a delivery truck will instead make a hand-full of stops at central locations or delivery the PDDs to automated hubs, which will house the PDDs until requested by the customer.

The energy savings and environmental benefits associated with a centralized system, as described above, are staggering! Recent research indicates that such a system could reduce energy consumption by 25 times when compared to car-based shopping, and 12 times when compared to traditional delivery services. Similarly, the same study found that central delivery points can reduce CO_2 emissions by 32 times when compared to car-based shopping and 7 times when compared to traditional delivery services. (Zhang and Zhang, 2008).

Conclusion

E-commerce is far more environmentally sustainable than car-based shopping trips. Still, enormous inefficiencies remain within the existing truck-centered logistics system, and these inefficiencies will persist as e-commerce grows. Starship's PDDs offer a powerful solution to the environmental challenges associated with the "last mile" of deliver, by eliminating failed deliveries, facilitating returns, and dramatically lowering the cost, energy usage, and CO_2 emissions associated with this portion of the delivery system.

Starship Technologies is currently commercially available in the US, UK, Germany, and Estonia with partners like Sodexo, Daimler AG, Intuit, Tesco, Coop, Volkswagen, Novo Nordisk, Bayer, a, and others offering PDD delivery for the food, grocery, and parcel industries. PDDs, developed by Starship Technologies, have now covered over 350,000 miles in 16 countries and over 100 cities, and have encountered more than 15 million people.