Investigating Sustainability Efforts of a Zero-Waste Grocery Delivery Service

An Interactive Qualifying Project submitted to the Faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Worcester Polytechnic Institute
Sponsored by Alpakas

D22 / Spring, 2022

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Abstract

With its quest for profit and its resistance to regulation, neoliberalism promotes a linear economy that follows a take-make-waste philosophy. Plastic waste in 2015 totaled 275 million tonnes and in 2020 global CO_2 emissions reached 34.81 billion tonnes. Businesses that wish to embrace a sustainable model, like the circular economy, need to find ways to develop and demonstrate viability. Our project team worked with Alpakas, a Berlin-based startup that offers zero-waste grocery delivery. We aimed to help prove Alpakas' sustainability metrics to be effective. By conducting key informant interviews, we identified plastic waste reduction as the central KPI around which we would organize our field work. To identify Alpakas' ability to reduce plastic waste, we presented our findings through a spreadsheet dashboard tool as well as an infographic. The spreadsheet tool quantifies conventional grocer plastic waste and directly compares it to the Alpakas inventory. To address a second KPI, we researched CO_2 emissions of gas and diesel cars and light commercial vehicles. We compared that with the small amount of CO_2 that Alpakas e-cargo bikes produce and represented our findings in another section of the dashboard. This section identifies the amount of CO_2 saved in transportation by shopping with Alpakas based on distance the distance the customer lives from the warehouse. We created the infographic with the intention of it being displayed on the company's website so as to explain the benefits of shopping with Alpakas. Ultimately, we found a way for Alpakas to demonstrate its sustainable practices, and exercise ideas of the circular economy.

Introduction

The environment is being destroyed due to the overuse of natural resources and waste production. Internationally, unsustainable business practices lead to the creation and sale of disposable, unrecyclable goods for profit. Businesses generate products, consumers use them and dispose of them, waste accumulates, and landfills fill up[1]. Eco-friendly alternatives to this model often require a higher upfront cost or are more costly overall, so businesses are hesitant to provide customers with options that allow them to be more environmentally friendly. Together, these factors compose a cradle-to-grave economy in which single-use disposables prevail[2]. The implementation of recycling has improved this condition, but not all materials are recyclable and many are often disposed of regardless of their recyclability. William McDonough, a theorist of circular economy, provides an example of purchasing a rug made from recycled polyester soda bottles: “The rug is still on its way to a landfill; it's just stopping off in your house en route”[3]. We must put in more work to create a society where products can be recycled more than just once or twice. Society must radically change its methods of production and consumption to implement effective change.

The circular economy constitutes an alternative means of production and consumption that aims to eliminate waste by design. A circular economy, in contrast to the cradle-to-grave model, is based on cradle-to-cradle principles that help to eliminate waste[4]. By ‘cradle-to-cradle’ principles, theorists of the circular economy, like William McDonough, refer to it as a method to minimize waste, regenerate resources, and extend the life cycle of products. The circular economy’s cradle-to-cradle principles not only aim to reduce waste but to regenerate resources through recycling and refurbishment. In other words, products are not converted to waste but are pulled back into the production cycle and the materials are reused to generate more products. In addition, they strive to extend the life cycles of products to reduce waste and production emissions.

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[1]Bocken, N. M. P., & Short, S. W. (2021). Unsustainable business models – Recognizing and resolving institutionalized social and environmental harm. Journal of Cleaner Production, 312, 127828. https://doi.org/10.1016/j.jclepro.2021.127828
[2]McDonough, William. (2002). Cradle to cradle: Remaking the way we make things. North Point Press.
[3]McDonough, William. (2002).
[4]McDonough, William. (2002).

The goal of this project was to help Alpakas, a zero-waste grocery delivery service, to demonstrate the efficacy of its sustainability practice. This was determined by identifying key performance indicators (KPIs) through key informant interviews with important stakeholders which included consumers and employees. One specific KPI we recorded was the amount of plastic waste saved with each Alpakas product order when compared to a conventional grocery store. These assessments will help measure Alpakas' impact on waste reduction.

Background

The Impact of Neoliberalism on Sustainability

Businesses in neoliberal political-economic conditions pursue profit maximization with minimal government regulation or social control. Neoliberalism is an ideology that emphasizes the free market and promotes competition between private businesses to develop a prospering economy[5]. From a neoliberal perspective, government influences on the market are almost always detrimental to profit maximization due to extra costs such as taxes[6]. This philosophy has allowed large corporations to dominate the market and define the requirements for being a successful business as maximizing total economic activity measured as Gross Domestic Product (GDP)[7]. This emphasis on profit "drives overconsumption, and exploitation of both nature and people"[8]. The market in a neoliberal environment is defined by large corporate entities, so all businesses, including those who aspire to be sustainable, must mimic their profit-driven business models to compete and survive.

In a free market, the biggest proponent of irresponsible corporate habits is deregulation. Deregulation has become a well-known aspect of neoliberalist governments since the 1970s. The term deregulation can be defined as a loosening of government influence on laws restricting business decisions. Under Reaganomics in the 1980s, deregulation allowed for businesses to increase their profits with cheaper resources, labor, and operating costs. Uniquely, neoliberalism

[5] Cousens, A. (2016). How Neoliberalism Puts Profit Over People. Critical Reflections: A Student Journal on Contemporary Sociological Issues. Retrieved April 6, 2022, from https://ojs.leedsbeckett.ac.uk/index.php/SOC/article/view/4425?msclkid=128f901db4c011ec9a22fb420d2a0f7d
[6] Cousens, A. (2016).
[7] Riedy, C. (2020). Discourse coalitions for sustainability transformations: Common ground and conflict beyond neoliberalism. Current Opinion in Environmental Sustainability, 45, 100–112. https://doi.org/10.1016/j.cosust.2020.09.014
[8] Riedy, C. (2020).

has damaging effects on the environment that are overlooked. In a leaked private memo, Lawrence Summers, the chief economist of the World Bank, justified the dumping of toxic waste into the environment because it was cheaper to dispose of it in poor countries rather than to dispose of it in rich countries or the country where it was produced[9]. Deregulation in this instance permits large, environmentally insensitive corporations to cut corners where they deem necessary to maximize profit which shapes the habits of the corporate sector to follow suit.

Businesses that aim to succeed are encouraged to ignore the environmental impacts of their actions in a neoliberal society. This is primarily due to the costs associated with increasing corporate sustainability, including an increased cost in operation and decreased profit margins. The push for maximizing profit in large corporations likewise incentivizes smaller businesses to ignore sustainability in the pursuit of profitability. Therefore, the conditions of the neoliberal economy compel businesses to pursue fewer sustainability efforts as sustainability will only decrease profit[10]. These trends are extremely detrimental to the longevity of our planet, so a change in corporate culture is needed to spread sustainability-based business models.

Increasing corporate focus on environmental sustainability requires a devaluation of profit maximization. Businesses are still able to make a profit in adjusted models, but with decreased repercussions on the environment. To do this, similar emphasis must be placed on sustainability-based metrics when making business decisions. This can be encouraged with regulation and governmental guidance, but neoliberal pressures avoid government influence. Businesses must be able to maintain a viable business model to survive in the marketplace, but in a deregulated environment this often means sacrificing morals for profit[11]. Current laws do not hold a high value on economic sustainability, so therefore it is not in a company's best financial interest to be sustainable[12]. Achieving a more sustainable world must then be driven by individuals who wish to change this culture for good.

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[9] Lee, W.J.Y. The Political Economy of Australia's Waste Crisis: From Neoliberalism to the Circular Economy Agenda. Circ.Econ.Sust. (2021). https://doi.org/10.1007/s43615-021-00097-y

[10]Alexander, J. (2007, February 14). Environmental sustainability versus profit maximization: Overcoming systemic constraints on implementing normatively preferable alternatives - journal of business ethics. SpringerLink. Retrieved April 8, 2022, from https://link.springer.com/article/10.1007/s10551-006-9264-5

[11]Alexander, J. (2007, February 14).

[12]Alexander, J. (2007, February 14).

Neoliberal business practices have led to a cradle-to-grave economy. “Cradle-to-grave” means that a product is produced and then converted to waste and never used again. At its core, cradle-to-grave ideologies are “focused on making a product and getting it to a customer quickly and cheaply without considering much else”[13]. Products do not last as long and become waste. Since in most cases it is cheaper to buy a new product than go through the effort of repairing an old one, roughly 90% of products made for use in the United States eventually become obsolete and are disposed of in landfills[14].

The adverse impacts of a cradle-to-grave economy are increased plastic waste and greenhouse gas emissions. Plastics constitute a special risk to the environment due to their long lifespan. Across the world’s oceans, researchers have documented the widespread presence of both macroplastics, which refer to plastics larger than 5mm in diameter, and microplastics, which refer to plastics smaller than 5mm in diameter[15]. A study published in 2022 has indicated that microplastics have moved their way from the environment into the human body. From that study, 80% of the participants' blood samples contained microplastics[16]. A similar study discovered plastic fragments within the placenta[17]. These studies were conducted due to concern over the health consequences of large amounts of waste produced each year. Microplastics in several studies have shown the potential to cause “metabolic disturbances, neurotoxicity, and increased cancer risk in humans”[18]. In 2015, global plastic waste reached 275 million tonnes[19]. At the current rate of waste production, the macroplastics on the ocean surface are expected to reach 2.65 million tonnes and microplastics are expected to increase to 3.97 million tonnes by 2050[20]. It is also expected that by 2050 the ocean will contain more plastic than fish by weight according to a report by the World Economic Forum and Ellen MacArthur Foundation[21]. However, if

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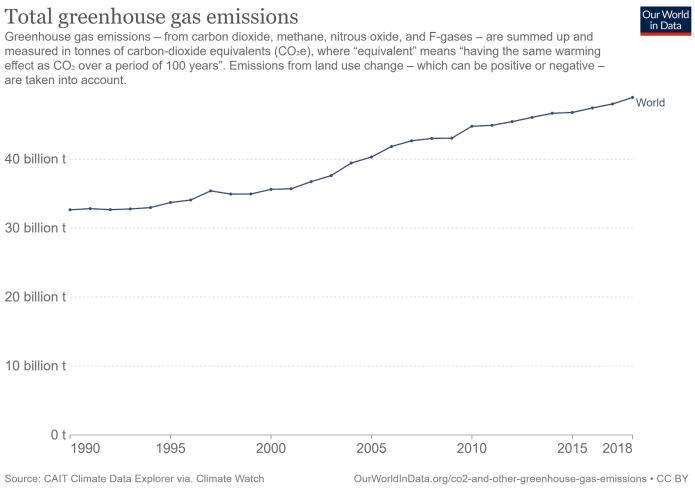
[13] McDonough, William. (2002).
[14] McDonough, William. (2002).
[15] Chang, M. (2013). Microplastics in facial exfoliating cleansers. Microplastics in Facial Exfoliating Cleansers. Retrieved April 12, 2022, from https://nature.berkeley.edu/classes/es196/projects/2013final/ChangM_2013.pdf
[16] Leslie, H. A., Velzen, M. J. M. van, Brandsma, S. H., Vethaak, A. D., Garcia-Vallejo, J. J., & Lamoree, M. H. (2022, March 24). Discovery and quantification of plastic particle pollution in human blood. Environment International. Retrieved April 6, 2022, from https://www.sciencedirect.com/science/article/pii/S0160412022001258
[17] Leslie, H. A., et. al (2022, March 24).
[18] Rahman, A., Sarkar, A., Yadav, O. P., Achari, G., & Slobodnik, J. (2020, December 3). Potential human health risks due to environmental exposure to nano- and microplastics and knowledge gaps: A scoping review. Science of The Total Environment. Retrieved April 12, 2022, from https://www.sciencedirect.com/science/article/pii/S0048969720374039?casa_token=spYtclbD8kcAAAAA%3ADFERnPGUaV8u3SWlQ_XjZsXk0yHy2RxOzDTuNF0c6GmSAK4DrnWynta9Ok4Fzi8JQBr1JjKC
[19] Ritchie, H., & Roser, M. (2018, September 1). Plastic pollution. Our World in Data. Retrieved April 7, 2022, from https://ourworldindata.org/plastic-pollution?msclkid=ba66a134b68211ec8d4b80ffdc0a1894
[20] Ritchie, H., & Roser, M. (2018, September 1).
[21] Macarthur, E. (n.d.). Circular economy principles: Circulate products and materials. Circular economy principle. Retrieved March 24, 2022, from https://ellenmacarthurfoundation.org/circulate-products-and-materials

plastic waste was eliminated in the year 2020, the waste in 2050 would decrease by millions of tonnes[22].

On top of the plastic leading to an increase in waste, the production of plastic is contributing to greenhouse gas emissions. Greenhouse gas emissions are a consequence of burning fossil fuels, such as oil. With current methods of production, plastic is responsible for 4-8% of oil consumption[23]. If action is not taken, it is predicted that plastic will be responsible for 20% of the world's oil consumption[24]. As shown in figure 1, in 2018 the total greenhouse gas emissions were 48.94 billion tonnes[25]. The most prominent greenhouse gas is CO_2, contributing to almost 75% of greenhouse gas emissions[26]. Global CO_2 emissions are continuously on the rise and have not yet reached their overall peak. As shown in figure 2, in 2020, the global CO_2 emissions were 34.81 billion tonnes. Over the past 20 years, CO_2 emissions have grown by 9.58 billion tonnes[27]. The food industry is responsible for about a third of all global emissions. This is due to the emissions associated with powering and heating food as well as equipment to transport, store, and cook food[28]. To achieve a more sustainable future it is imperative that the cradle-to-grave principles transition to the cradle-to-cradle principles.



[22] Ritchie, H., & Roser, M. (2018, September 1).
[23] Bauman, B. (2021, April 2). Why plastics can be garbage for the climate. Yale Climate Connections. Retrieved April 19, 2022, from https://yaleclimateconnections.org/2019/08/how-plastics-contribute-to-climate-change/
[24] Bauman, B. (2021, April 2).
[25] Ritchie, H., & Roser, M. (2020, May 11). Greenhouse gas emissions. Our World in Data. Retrieved April 6, 2022, from https://ourworldindata.org/greenhouse-gas-emissions#annual-greenhouse-gas-emissions-how-much-do-we-emit-each-year
[26] Ritchie, H., & Roser, M. (2020, May 11). CO2 emissions. Our World in Data. Retrieved April 6, 2022, from https://ourworldindata.org/co2-emissions?msclkid=2e1ad1feaf4011ec92110f800af245a0
[27] Ritchie, H., & Roser, M. (2020, May 11). CO2 emissions.
[28] Bocken, N. M. P., & Short, S. W. (2021).

Figure 1: This figure represents the global greenhouse gas emissions[29]

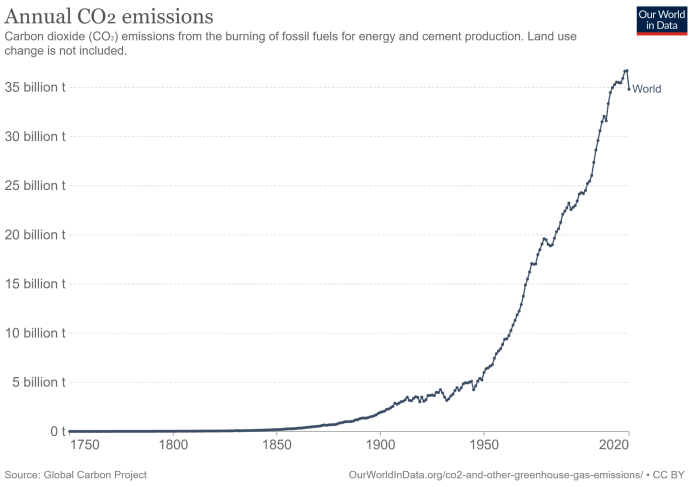


Figure 2: This figure represents the global annual CO_2 *emissions*[30]

The current linear economy is destroying the planet and requires intervention. As evident in the language of cradle-to-grave, the linear economy takes natural resources, creates something with them, and disposes of the product after it is no longer capable of fulfilling its initial purpose. This process depletes natural resources and builds up waste. It is often easier to buy a brand-new product than to fix or refurbish the old one, like a toaster[31]. The linear economy inspires a "take-make-dispose approach, where energy is lost through the process of creating objects and disposing of them[32]. Roughly 99% of manufactured products last six months after the "make" phase before they are permanently disposed of"[33]. The process of reusing and recycling can be as simple as returning bottles with deposits or as creative as making art with disposables. To achieve a circular economy, efforts must be made to encourage recycling and repurposing items at the end of their life and continuing the utilization of materials.

[29] Ritchie, H., & Roser, M. (2020, May 11). Greenhouse gas emissions.
[30] Ritchie, H., & Roser, M. (2020, May 11). CO2 emissions.
[31] McDonough, William. (2002).
[32] Bocken, N. M. P., & Short, S. W. (2021).
[33] Mostaghel, R., & Chirumalla, K. (2021). Role of customers in circular business models. Journal of Business Research, 127, 35–44. https://doi.org/10.1016/j.jbusres.2020.12.053

Figure 3: This figure represents the flow and aspects of the linear economy[34]

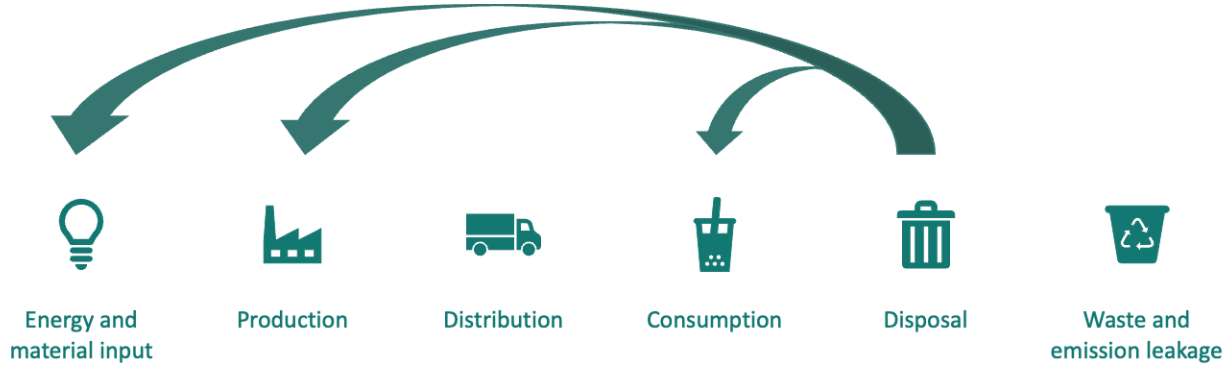


Figure 4: This figure represents the flow and aspects of the linear economy adjusted with arrows to represent the circular economy.[35]

The Role of the Circular Economy in Achieving a Sustainable Future

The circular economy provides solutions to the problems of the linear consumption model[36]. The circular economy uses sustainable business practices to advance economic development. In this model, materials are created, used, and returned to continue the cycle again. Waste reduction is promoted through recycling and refurbishment of materials between businesses and consumers.

In the cradle-to-cradle system, waste does not exist. In this sense, every product at the end of its life is not waste but is instead redefined as a new resource. As McDonough puts it, "If

[34] Wautelet, Thibaut. (2018). Exploring the role of independent retailers in the circular economy: a case study approach. 10.13140/RG.2.2.17085.15847.
[35] Wautelet, Thibaut. (2018).
[36] Urbinati, A., Chiaroni, D., & Chiesa, V. (2017). Towards a new taxonomy of circular economy business models. Journal of Cleaner Production, 168, 487–498. https://doi.org/10.1016/j.jclepro.2017.09.047

humans are truly going to prosper, we will have to learn to imitate nature's highly effective cradle-to-cradle system of nutrient flow and metabolism, in which the very concept of waste does not exist"[37]. Rather than being an end-of-life material to be discarded, waste is a new beginning for materials. Through the continued use of resources, this economic system can "do more with less", which emphasizes using fewer resources and recycling current resources for multiple purposes.

The reuse of materials generates economic value while avoiding exploitation of resources and waste accumulation[38]. Whereas recycling is based on the idea of changing the initial function of the material, circular economies encompass that concept as well as repairing and reusing materials for continued use[39]. Additionally, studies have proven that the adoption of the circular economy protects the climate and ecosystems. It was concluded that the adoption of a circular economy in seven European nations would result in a greenhouse gas emission reduction of up to 70% as well as grow the current workforce by 4%[40].

[37] McDonough, William. (2002).
[38] Urbinati, A., Chiaroni, D., & Chiesa, V. (2017).
[39] Auwalin, I., Rumayya, Rahma Sari, F., & Maulida, S. R. (2022). Applying the Pro-Circular change model to restaurant and retail businesses' preferences for circular economy: Evidence from Indonesia. Sustainability: Science, Practice and Policy, 18(1), 97–113. https://doi.org/10.1080/15487733.2022.2027121
[40] Stahel, W. R. (2016). The circular economy. Nature, 531(7595), 435–438. https://doi.org/10.1038/531435a

Principles of the Circular Economy

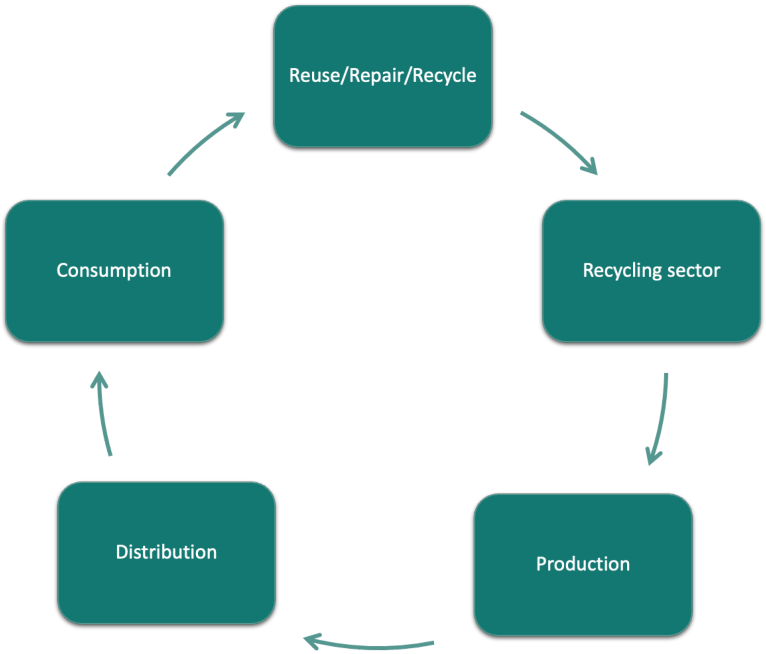


Figure 5: This figure represents the flow and aspects of the circular economy[41]

Circular economies are based upon three main principles: eliminate waste and pollution, circulate products and materials (at their highest value), and produce sustainably[42]. The first principle states that there is no such thing as waste within a truly circular economy[43]. The goal for all individuals striving to achieve this system is to eliminate all waste[44]. The second principle emphasizes the circulation of materials[45]. Through cycles, regeneration of energy and materials can occur[46]. The third principle explains that producing sustainably continues economic development[47].

A circular economy aims to redefine waste as a resource. On its own, the term "waste" suggests that materials have reached the "end of the line" and are not reusable. In Germany, the

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[41] Macarthur, E. (n.d.).
[42] Salonitis, K., & Stavropoulos, P. (2013). On the Integration of the CAx Systems Towards Sustainable Production. Procedia CIRP, 9, 115–120. https://doi.org/10.1016/j.procir.2013.06.178
[43] Circular economy - definition, principles, benefits and barriers. Youmatter. (2020, February 21). Retrieved March 24, 2022, from https://youmatter.world/en/definition/definitions-circular-economy-meaning-definition-benefits-barriers/
[44] Macarthur, E. (n.d.).
[45] Macarthur, E. (n.d.).
[46] "Circular economy…". Youmatter. https://youmatter.world/en/definition/definitions-circular-economy-meaning-definition-benefits-barriers/
[47] Macarthur, E. (n.d.).

approach to waste management has shown significant promise. Waste management is understood as resource management, which suggests the continued use of materials[48]. The German Closed Cycle Management Act is based on the Waste Hierarchy in Figure 6[49].

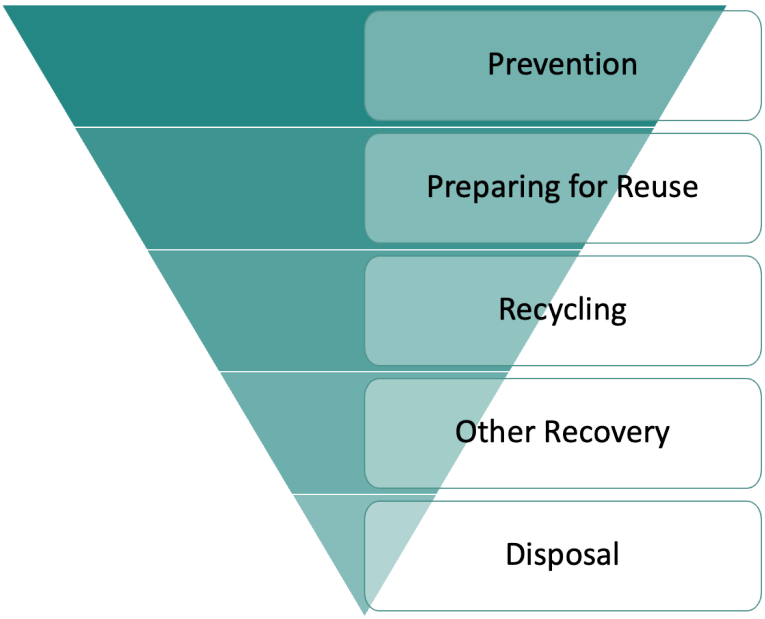

Figure 6: This figure pictures the waste hierarchy according to the German Law Archive[50]

As of 2015, Germany recycles over 40% of its municipal solid waste. When compared to most of western Europe, that's more than every other country. However, at the same time, Germany still incinerates nearly 40% of its municipal solid waste[51]. Though these statistics demonstrate that Germany has not yet achieved a perfectly circular economy, it suggests that Germany is leading the way in circular economy implementation. Additionally, the recovery of packaging waste over the past 30 years has significantly improved in every area, including plastic and aluminum as shown in figure 7.

[48] Nelles, M., Grünes, J., & Morscheck, G. (2016). Waste Management in Germany – Development to a Sustainable Circular Economy? Procedia Environmental Sciences, 35, 6–14. https://doi.org/10.1016/j.proenv.2016.07.001
[49] Nelles, M., Grünes, J., & Morscheck, G. (2016).
[50] Nelles, M., Grünes, J., & Morscheck, G. (2016).
[51] Nelles, M., Grünes, J., & Morscheck, G. (2016).

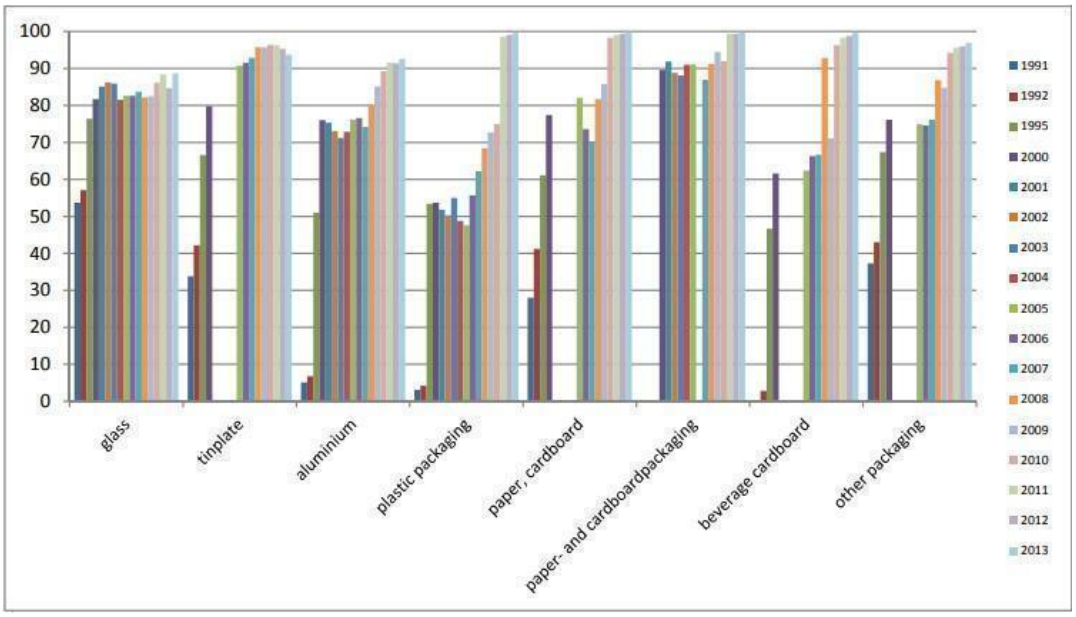

Figure 7: Development of recovery rates of packaging waste between 1991 and 2013[52]

The circular economy depends on a perpetual circulation of products and materials. The main goal is to keep using products regardless of their initial use or for repurposing, also known as "closing of the loop"[53]. To achieve a perfect circular economy, resources must find their way back to a central depot for redistribution[54]. Consumers must return resources rather than convert them to waste. An example of this is bottle deposits. Additional costs are applied to items such as beverage containers with a rebate when the product is returned for recycling or proper disposal[55]. Similarly, in the case of Alpakas, jarred products that come in an Alpakas jar are the customers to keep for the entirety of the product. When purchasing the product, they also put down a deposit on the cost of the jar. When the customer is done, they simply return the jar to an Alpakas delivery driver and get their deposit back. This method allows for resources to be returned for redistribution into the economy while incentivizing consumers to participate through the additional taxes applied. The deposit-refund system will effectively control pollution from the consumer side while returning materials to production lines. These methods do rely on the product's ability to survive many uses and multiple life cycles.

[52] Nelles, M., Grünes, J., & Morscheck, G. (2016).
[53] Macarthur, E. (n.d.). , Prendeville, S., & Sherry, J. (2014). Circular Economy. Is it Enough? https://doi.org/10.13140/RG.2.1.1473.1128
[54] Prendeville, S., & Sherry, J. (2014).
[55] Walls, M. (2011). Deposit-Refund Systems in Practice and Theory (SSRN Scholarly Paper ID 1980142). Social Science Research Network. https://doi.org/10.2139/ssrn.1980142

Finally, sustainable production is a key component of the circular economy as it contributes to continued economic development. Sustainable production methods are more environmentally friendly and cheaper than conventional production methods[56]. Sustainable development begins with extracting fewer resources from the environment. By extracting fewer resources, businesses can lower production costs, reduce material consumption, and minimize their environmental impact. The organic food movement, in particular, supports the economy through the high production of goods with a smaller environmental impact and less use of resources by promoting organically sourced foods[57]. Sustainable production also relies on responsible production by disposing of necessary waste in an environmentally conscious way[58].

Circular Economy in Practice

Many countries, including China, Singapore, France, and the Netherlands, have adopted circular economy principles. In 2002 China adopted a circular economy in the form of pilot programs across the country[59]. This implementation involved at 3 levels: micro, meso, and macro levels. At the micro-level, producers implemented cleaner production to address generic pollution. One form of this was eco-design, "a systematic incorporation of environmental aspects into the design of production process and the final product"[60]. At the meso level, the development of "resource recovery parks where environmental technology firms making "green products" coexist" also known as industrial parks, waste trading sites, and leisure parks are encouraged[61]. Industrial parks would be designed so that they did not have to rely on external sources to reduce their footprint[62]. At the macro level, the promotion of new infrastructure with the hope of phasing out old polluting enterprises and supplementing them with ones that would promote bio-farming and the tourism industry is encouraged. Following a pilot project in Dalian, one of China's biggest industrial centers, a study was done from 2005 to 2010 on the progress made. By using KPIs, experts were able to evaluate dimensions set at the micro, meso, and

[56] Salonitis, K., & Stavropoulos, P. (2013).
[57] Lebel, L., & Lorek, S. (2008). Enabling Sustainable Production-Consumption Systems. Annual Review of Environment and Resources, 33(1), 241–275. https://doi.org/10.1146/annurev.environ.33.022007.145734
[58] Lebel, L., & Lorek, S. (2008).
[59] Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China: Moving from rhetoric to implementation. Journal of Cleaner Production, 42, 215–227. https://doi.org/10.1016/j.jclepro.2012.11.020
[60] Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013).
[61] Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013).
[62] Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013).

macro levels to measure improvement. They found that Dalian had reduced waste and continued its economic development.[63].

In contrast, Singapore has implemented circular economy principles through a zero-waste master plan that emphasizes producer responsibility. Extended producer responsibility refers to the responsibility of producers for the environmental impact of products throughout their life cycle[64]. The Singapore plan focused its efforts to expand producer responsibilities in the areas of electronic waste as well as company packaging[65]. Along with efforts to reduce waste through recycling, Singapore also plans to reuse waste by converting it to jet fuel[66]. In sum, the zero-waste program in Singapore has used legislation and over 2 million dollars in grants for projects solely related to zero waste[67].

France and The Netherlands have operated more targeted programs fostering circular economic principles[68]. The French programs aimed to reduce resource consumption, reduce landfill waste, and recycle 100% of plastics while developing additional jobs to support the transition to the circular economy. The French Association of Private Enterprises (AFEP) took steps to mobilize private companies to adopt circular economic practices. Thirty-three French companies agreed publicly to annual monitoring of their contribution to the circular economy. A set of 100 standards was put forth for these companies to follow with the goal being to influence other companies to follow in their footsteps and achieve the public notoriety that the initial 33 received[69]. France encourages recycling through reduced taxes on recycled goods. From 2009 to 2017 the recycling rate increased by 7.6%[70].

The Netherlands, meanwhile, relies on the recovery and reuse of materials and energy due to a scarcity of resources. The country developed the Energy & Raw Materials Factory (ERMF), which recovers reusable resources from sewage. Not only is this process saving resources, but it also is estimated to be profitable. By the year 2030, the annual revenue will be

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[63] Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013).
[64] Sahay, S., & Gupt, Y. (n.d.). Waste Management and Extended Producer Responsibility - Lessons from the Past. ResearchGate. Retrieved April 20, 2022, from https://www.researchgate.net/publication/332859591_Waste_Management_and_Extended_Producer_Responsibility_-_Lessons_from_the_Past
[65] Rezvani Ghomi, E., Khosravi, F., Tahavori, M. A., & Ramakrishna, S. (2021). Circular economy: A comparison between the case of Singapore and France. Materials Circular Economy. Retrieved April 20, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7799405/
[66] Mawhood, R., Gazis, E., de Jong, S., Hoefnagels, R., & Slade, R. (2016). Production pathways for renewable jet fuel: A review of commercialization status and future prospects. Biofuels, Bioproducts and Biorefining, 10(4), 462–484. https://doi.org/10.1002/bbb.1644
[67] Rezvani Ghomi, E., Khosravi, F., Tahavori, M. A., & Ramakrishna, S. (2021).
[68] Rezvani Ghomi, E., Khosravi, F., Tahavori, M. A., & Ramakrishna, S. (2021).
[69] 50 measures for a 100% circular economy. Republique Francaise. (n.d.). Retrieved March 23, 2022, from https://circulareconomy.europa.eu/platform/sites/default/files/frec_anglais.pd
[70] Rezvani Ghomi, E., Khosravi, F., Tahavori, M. A., & Ramakrishna, S. (2021).

14 euros for each inhabitant of the Netherlands, which is around 17,000,000 people[71]. Additionally, markets were created to sell the recovered resources. This prevents competition between water authorities. This not only helps clean the water for the people who live around it but creates profit in the form of selling these resources, to support the creation of a circular economy[72].

The practice of providing evidence of company claims is much more effective at displaying sustainability efforts than claims alone. Companies may describe themselves as "sustainable" because they have reusable packaging, source their products locally, or mitigate waste. Through the implementation of KPI assessment, quantitative measures can strengthen a business' evidence of its sustainability efforts. KPIs, when focused on sustainability-related claims, can contribute to a sustainability performance measurement system (SPMS). Through this system, businesses are forced to "address issues associated with the ''triple bottom line'' of economic, environmental, and social performance" as they reveal themselves in the quantitative data collected[73].

As a young startup, Alpakas could profit from a form of statistical analysis that provides evidence of its practices of sustainability. Once on their feet, one of Alpakas' next steps is data analysis to improve overall performance. For Alpakas, the KPIs we implement will allow the company to attract a wider customer base with compelling statistics backing its sustainability. The implementation of a KPI system should not only save Alpakas time, energy, and money but also will help the company market itself as the zero-waste grocery delivery service to use.

Methods

The main goal of the project is to support Alpakas in demonstrating the efficacy of its sustainable business model. To do this we will follow our methods through four main objectives.

[71] Van Leeuwen, K., de Vries, E., Koop, S., & Roest, K. (2018). The Energy & Raw Materials Factory: Role and Potential Contribution to the Circular Economy of the Netherlands. Environmental Management, 61(5), 786–795. https://doi.org/10.1007/s00267-018-0995-8
[72] Van Leeuwen, K., de Vries, E., Koop, S., & Roest, K. (2018).
[73] Searcy, C. (2012). Corporate Sustainability Performance Measurement Systems: A Review and Research Agenda. Journal of Business Ethics, 107(3), 239–253. Scopus. https://doi.org/10.1007/s10551-011-1038-z

1. Define the current state of conventional German grocery waste and Alpakas' methods for sustainability
2. Understand the nature of KPIs
3. Determine which KPIs are most important to Alpakas' stakeholders
4. Establish a KPI measurement system related to Alpakas' sustainability efforts

To help visualize these objectives, Figure 8 demonstrates our methodological approach. The process of gradually refining our approach from the current state to desires for the future state will allow us to provide Alpakas with relevant data that they can use to act in the future.

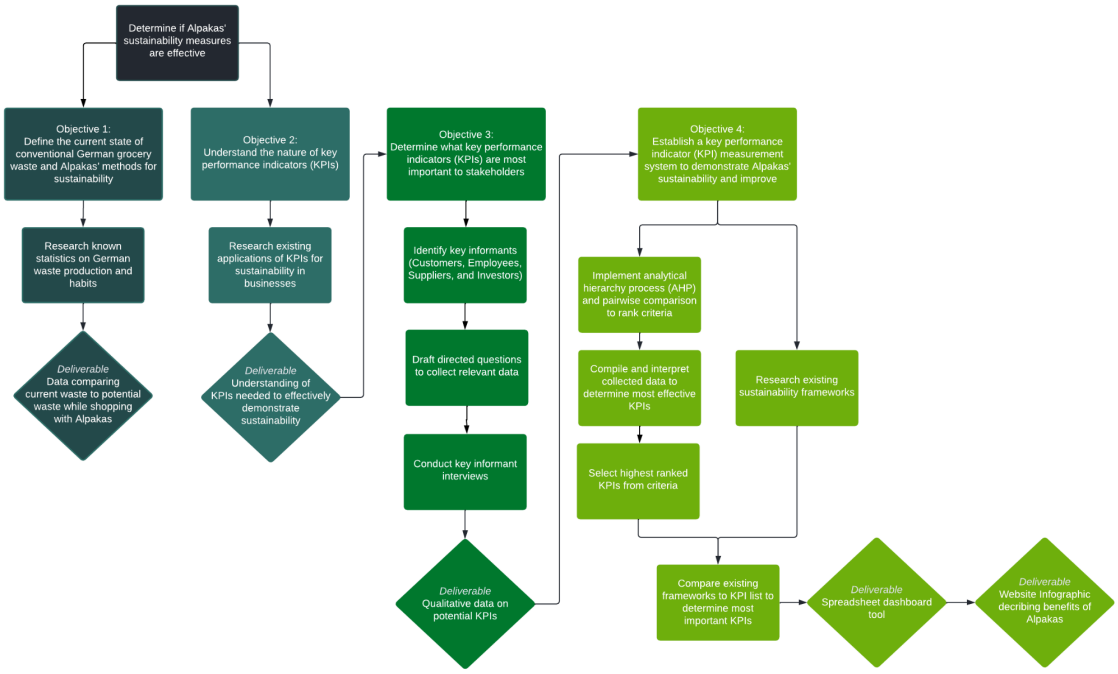


Figure 8: Methods graphic outlining our approaches to obtain our deliverables.

Defining Current State and Alpakas' Sustainability Approach

Making improvements to a company's business model begins with the definition of its achievements thus far. The term "current state" refers to the condition in which a company is currently operating and its status within the desired focus. For the scope of our project, the focus is sustainability efforts. Alpakas' current state is therefore described as its amount of plastic

waste production and ability to be sustainable with its current business model. The desired "future state" is where Alpakas sees itself in the future. This future state could be described with goals such as 100% plastic-free or zero emissions in production. Through the analysis of the current state of grocery store plastic waste, Alpakas can compare its approach and assess its positive impacts overall. In the case of major German grocery stores, the current state can be described as far from zero-waste. Their future state is yet to be determined and is not within the scope of this project. We are looking to compare Alpakas' current state to major German grocery stores' current state.

To provide evidence of the effectiveness of the Alpakas approach, we set out to compare the current state of grocery plastic waste to Alpakas plastic waste. We did this by assessing the plastic waste in conventional grocery stores and formulating Alpakas' savings from plastic waste. Along with this, we set out to compare the effectiveness of the e-cargo bikes in reducing CO_2 emissions when compared to cars or delivery trucks. We did this by assessing the CO_2 emissions from diesel trucks, diesel cars, petroleum cars, and e-cargo bikes.

Understand the Nature of Key Performance Indicators

"Key performance indicators", or KPIs, are metrics that provide insight into how a company performs in certain areas over time. To use KPIs in the context of Alpakas' efforts toward sustainability, we needed to understand how KPIs are identified and formulated. We did this by conducting a literature review on KPIs to better our understanding.

Determine Which Key Performance Indicators are Most Important to Alpakas' Stakeholders

To determine stakeholders' priorities regarding Alpakas sustainability measures, we conducted key informant interviews. A key informant interview is a qualitative research method that collects important information from "key informants"[74]. The initial key informant is WPI's point of contact with Alpakas, Charlotte Sollberger. From an interview with Ms. Sollberger, we developed a list of key informants to determine specific stakeholders of interest. While Alpakas'

[74] FAAN, M. D. C., PhD, RN, PMHCNS-BC. (2014). Nursing Research Using Data Analysis: Qualitative Designs and Methods in Nursing. Springer Publishing Company

interests are focused on cost benefits, other stakeholders, such as suppliers, employees, or customers, may have differing perspectives on what is important to measure[75]. From the list of stakeholders four interviews were conducted. The questions asked in the interview were based on the sustainability mission of Alpakas. Employees were asked their opinions on Alpakas and how they believe Alpakas can improve its business model. By keeping our questions open-ended and simple, employees could spin their responses to be tailored to their interests. In turn, our records of stakeholder interests better reflected the KPIs that stakeholders would truly like to see.

To understand which KPIs were important to the competitors of Alpakas, we conducted a SWOT analysis. A SWOT analysis examines the strengths, weaknesses, opportunities, and threats of a company. We analyzed three different types of Alpakas' competitors. To diversify our KPIs and understand a wider scope of the delivery market we looked at non-sustainable-oriented delivery services in Germany such as Flink, niche delivery services in Germany such as Biorena, and delivery services outside of Germany such as Pieter Pot. Each grocery delivery service highlighted different KPIs on its website that it thought were important to its customers and the company's values. Flink focuses on operation functions such as delivery speed, prices, and freshness of products[76]. Biorena, on the other hand, highlights its organic certifications, CO_2 emissions, and the three pillars of sustainability (economic, environmental, and social sustainability)[77]. Lastly, Pieter Pot concentrates on its sustainability measures such as packaging, CO_2 emissions, and life cycle assessments of their jars[78]. Overall, plastic packaging, CO_2 emissions, and organic certificates are some KPIs that other companies considered important and are applicable to Alpakas.

Establish a Key Performance Indicator Measurement System Related to Alpakas' Sustainability Efforts

By improving our understanding of KPIs and creating a list of KPIs, we developed a real-time measurement spreadsheet tool. To do this, we needed to determine the best platform to

[75] Professor Joseph Sarkis. (2022, February 17). Sustainable Supply Chain Interview [Personal communication].
[76] *Deine Lebensmittel Geliefert in Minuten*. Flink. (n.d.). Retrieved April 26, 2022, from https://www.goflink.com/de-DE/
[77] *Alles Liebe.* Biorena. (n.d.). Retrieved April 26, 2022, from https://biorena.shop/
[78] *Hoe Het Werkt*. Pieter Pot. (n.d.). Retrieved April 26, 2022, from https://www.pieter-pot.nl/pages/hoehetwerkt

develop the tool on. We did this through discussions with colleagues and determined the dashboard was to be developed within Google sheets.

Through these methods, we can to provide Alpakas with an assessment of their sustainability measures. With this Alpakas will be able to provide its customer base with a better understanding of how its mission and sustainability efforts are effective and justified. All stakeholders, whether it is potential customers, Alpakas employees, or suppliers of the company, will be able to see concrete evidence tracking the overall benefits of Alpakas' efforts to achieve a circular economy.

Results

Understand the Nature of Key Performance Indicators

Thoughtfully curated KPIs can communicate progress to relevant stakeholders while adhering to the standards of the Global Reporting Initiative (GRI). By reporting according to the GRI standard, companies can honor all stakeholders in their efforts to mitigate environmental effects. In the context of KPIs, every corporation is faced with different demands, stresses, and priorities that may shift the trajectory of data collected. For investors, it is typical that they would like to see concrete statistics, represented by KPIs, that support global standards. The GRI, for instance, has a defined set of standards for sustainability reporting that are widely accepted by organizations around the world. These standards apply to every organization, regardless of size or structure. With the GRI standards, organizations are able "to publicly report the impacts of their activities in a structured way that is transparent to stakeholders and other interested parties."[79] Statistics for various organizations can be compared to determine relative sustainability. It is necessary that all stakeholders maintain commitment and understand all aspects of the business model in order to maintain sustainability[80].

To be effective for analysis and implementation, KPIs must show unambiguous evidence of improvement toward set targets or goals; they must aid in decision making by measuring useful factors; they must allow for comparison of data over a duration of time; they must be able

[79] GRI - Standards. (n.d.). Retrieved February 9, 2022, from https://www.globalreporting.org/standards/
[80] Mostaghel, R., & Chirumalla, K. (2021). Role of customers in circular business models. Journal of Business Research, 127, 35–44. https://doi.org/10.1016/j.jbusres.2020.12.053

to track "efficiency, effectiveness, quality, timeliness, governance, compliance, behaviors, economics, project performance, personnel performance or resource utilization"[81]. In our case, we began our KPI characterization with interviews with our sponsor and other employees of Alpakas. The interviews conducted with all relevant stakeholders allowed us to identify what is most important to each type of stakeholder. As exemplified by the GRI set of sustainability standards, there are a plethora of different methods to demonstrate a company's sustainability [82].

Certain metrics can be chosen to display specific goals and successes that can be used as KPIs [associated with specific GRI standards] GRI 308: Supplier Environmental Assessment 2016 is an example of a standard emphasized by the Global Reporting Initiative. This standard requires due diligence of organizations to seek out suppliers that do not contribute to negative environmental impacts. This includes reporting material topics (topics that describe the impacts the organization's materials have on the economy, environment, and people), and disclosing the newly added suppliers that were screened using the environmental criteria required by the standard[83]. Organizations may have a wide variety of supplier environmental influences while still qualifying for the standard. Due to the nature of businesses, not all suppliers avoid large environmental impacts. The requirements, therefore, ask for a full disclosure of the number of suppliers they work with that have significant environmental impacts and actual impacts. It is important to note, however, that sustainability performance should not only be assessed from the focal firm and its supply chain, but also further into the supply chain network [84]. This network is all the interactions that the product has such as production, transport, and use. Following these guidelines ensures global credibility for company sustainability.

Determine Which KPIs Are Most Important Through Interviews

As a result of the key informant interviews conducted with the employees, we determined the most important KPI to be a plastic waste comparison between Alpakas and conventional grocery stores. Through an interview with Ms. Sollberger, the team determined that this measurement would be used as a significant marketing tactic for the Alpakas team. Through

[81] What is a Key Performance Indicator (KPI)? (n.d.). Retrieved February 10, 2022, from https://kpi.org/KPI-Basics
[82] GRI - Standards.
[83] GRI - Standards.
[84] Searcy, C. (2012). Corporate Sustainability Performance Measurement Systems: A Review and Research Agenda. Journal of Business Ethics, 107(3), 239–253. Scopus. https://doi.org/10.1007/s10551-011-1038-z

employee interviews, with a variety of employees including the Assistant Director of Marketing, the Social Media Associate, and the Director of Operations, we determined that a plastic waste measurement was still the most important, followed by quantifying the CO_2 emissions reduced through ordering with Alpakas. In the initial discussion with the marketing team, the fundamental aspect of Alpakas' approach to sustainability was reducing overall plastic waste. This led to the KPI of interest, quantifying this plastic waste reduction. As the category manager explained, however, it would be important to research CO_2 emissions, since shipping across borders is far more impactful than just the packaging itself. So we need to consider all aspects of CO_2 emissions, production, delivery, etc. The reason we chose plastic waste as our main KPI over CO_2 is because of how difficult CO_2 emissions would be to obtain. Due to the time constraint of seven weeks, we were not in a position to create a meaningful measurement system for tracking CO_2.

For customers, we analyzed data from 61 customers with the help of Ms. Charlotte Sollberger. Ms. Sollberger helped translate the customer responses from German to English. From then we provided questions to help facilitate a conversation that would give our team an idea of what a typical Alpakas customer thinks. The reason we chose to approach the customer perspective this way was due to our need for a relevant sample size. After contacting over a dozen customers, we were unable to have any interviews with them. Therefore, we analyzed data that had already been recorded by Alpakas. The three most occurring KPIs in the customers' responses were environmental impact, waste reduction, and social impact. We learned that sustainability is important to many people, however, they would rather outsource their sustainability efforts through Alpakas. By meeting these requirements, KPIs can be analyzed and modified to help further a business's progress.

Measuring the KPIs for Plastic Waste

To begin our assessment of Alpakas plastic waste reduction, we met with warehouse managers to garner information on the average amount of waste produced through the shipping, receiving, packaging, picking, and packing of their products. Alpakas' Senior Category Manager, James Lydall, emphasized the guidelines in the sourcing of Alpakas products and how he determines if a supplier is fit for collaboration. We learned that competing grocery stores often

use more than one layer of packaging made out of plastic. Multiple layers of packaging make shipping and moving products more convenient. Each set of products has a different size and type of plastic packaging for the second layer which would result in another set of measurements that is not open to the public. While we are unable to gather all the needed information in the scope of our project, we met with Nicholas James Lomax who is the Munich Operations Manager to start research on the second and third-layer packaging for future use for the Alpakas team. These initial findings on plastic usage in conventional grocery stores and competitors provide the group with key insights into how these businesses function. In our dashboard, since a concrete amount was not obtainable, we use the uncertainty of the amount of plastic used in the second and third layers of packaging to emphasize the potentially unknown amount of plastic used by other grocery stores.

To determine the average plastic waste produced by consumers, we determined the amount of plastic packaging of products. Based on the amount of plastic packaging, we generated metrics to track Alpakas' plastic waste reduction efforts. Our metric of focus, the amount of plastic waste, is best demonstrated through our dashboard calculation of the plastic waste reduced by purchasing individual products with Alpakas. To accomplish this, we visited four different grocery store chains in Berlin: Edeka, Lidl, REWE, and Alnatura. At each location, we recorded the mass of the product with plastic packaging as well as the advertised weight of the product displayed on the packaging. To determine the amount of plastic used per unit of the product, we entered this data into a spreadsheet, which subtracts the advertised weight of the product from the mass of the product with its plastic packaging and thereby generates a net mass of plastic reduction.

Generating a Spreadsheet Dashboard Tool

We developed a dashboard from the information collected to allow for real-time adjustments to be made to Alpakas' operations. We used a spreadsheet to serve as the database for all collected information about their products. As new products are added, employees input new lines of information with related criteria. The dashboard is designed to provide key snapshots of important KPIs, such as plastic waste and CO_2 emissions. Cells of importance will

be highlighted and emphasized to draw the attention of the user. Additionally, the strategic use of colors, tables, and diagrams allowed for easy interpretation of data from employees and customers[85]. The dashboard highlights information based on the KPIs of interest. The main KPIs of interest are quantifying plastic waste and CO_2 emissions, which are measured through the dashboard.

We organized plastic waste based on the specific types of plastic packaging used for products in grocery stores. This was used to assign all Alpakas products an equivalent local grocery packaging type. For products stored in multiple different types of packaging, the average plastic waste per unit of the product was averaged for all the specific types that the product is generally stored in. For example, we determined the average plastic waste of a "wrapped tray" by weighing 43 trays of differing shapes and sizes. In the case of packages that contained liquids, we could not determine the mass of plastic without first emptying the bottles of their contents, since differences in liquid density would have interfered with our measurements. To account for this factor, we collected and weighed empty containers from friends and colleagues.

Based on the data collected, we developed a dashboard to allow for real-time adjustments to be made to Alpakas' operations. We used a spreadsheet to serve as the database for all collected information about their products. As new products are added, employees input new lines of information with related criteria. The dashboard is designed to provide key snapshots of our KPIs, plastic waste, and CO_2 emissions. Cells of importance, the names of columns, and product names will be highlighted and pinned to draw the attention of the user.

			TYPES OF PACKAGING													
Product	SKU	Category	Bottle Squeeze	Bottle Twist	Box Resealable	Box Snap Closure	Cling Film	Netting	Plastic Foil Bag	Shrink Wrap	Thick Bag Resealable	Thick Bag Sealed	Thin Bag Sealed	Thin Bag Tied	Tray Wrapped	NOT PLASTIC
Basmati rice (brown)	1010193201	Rice & Grains	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☐
Brown rice (long grain)	1010193401	Rice & Grains	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☐
Potato Salad (Vinegar & Oil)	1010144801	Salads	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Farmer Salad	1010156101	Salads	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐
Coleslaw	1010156001	Salads	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cauliflower Kimchi	1010178401	Salads	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sauerkraut with Apple	1010178501	Salads	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
No-Egg Salad	1010145301	Salads	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lettuce, Green	1010146701	alads & Fresh Herb	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
Lamb's Lettuce	1010146901	alads & Fresh Herb	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
Spinach	1010147001	alads & Fresh Herb	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
Rocket Salad (Arugula)	1010150301	alads & Fresh Herb	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
Mini Pretzels (Spelt)	1010113901	Salty	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
Swiss Alpine Herb Chips	1010108301	Salty	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐
Sesame Crackers	1010112501	Salty	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☑	☐
Tomato & Herb Chips	1010108501	Salty	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

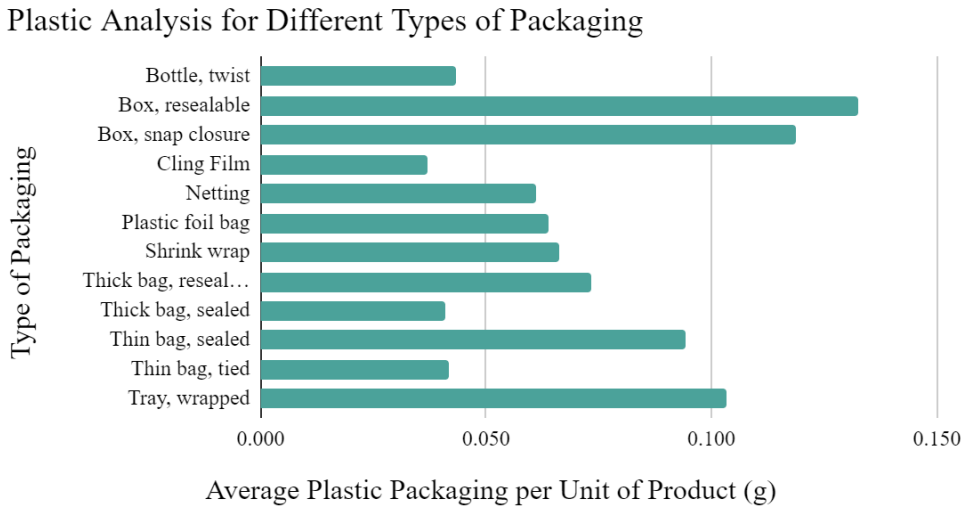
[85] Neemann, J., Roberts, D., Kenel, P., Chastain-Howley, A., & Stallard, S. (2013). Manager to Manager: Will Data Analytics Change the Way We Deliver Water? Journal (American Water Works Association), 105(11), 25–27.

Figure 9: The use of colors and pinning of the 1st column and 2nd row allows for easier use of the dashboard

Additionally, the strategic use of colors, tables, and diagrams allowed for easy interpretation of data from employees and customers[86]. Colors like red and green indicate which goals are being met and which are still lacking, similar to the Kanbans Japanese flagging tool used in production systems. Operators or employees are signaled to take action when a data point is red, so it is much easier to act quickly.

The dashboard then calculates all the product's plastic waste amounts and sums them up for the overall order to provide an order plastic reduction amount. Through analyzing current plastic packaging used in German grocery stores, the dashboard assigns a direct value to the amount of plastic waste reduced through using Alpakas grocery service.

This research demonstrated that by quantifying the plastic packaging waste and assigning Alpakas products a waste reduction amount, Alpakas can demonstrate its customers' ability to reduce consumer plastic waste. The overall plastic waste reduced through using Alpakas is quantified in our dashboard. The dashboard determined the amount of plastic packaging waste per unit of product for various types of packaging. The data for the types of packaging is shown in Figure 10.



[86] Neemann, J., Roberts, D., Kenel, P., Chastain-Howley, A., & Stallard, S. (2013).

Figure 10: The average amount of plastic packaging per unit of product for different packaging types was determined by defining the current state of grocery waste.

Based on the plastic packaging data, we developed an Alpakas order simulator. The simulator allows the user to input their Alpakas order and determines the amount of plastic waste reduced. This was completed by defining the types of packaging that the products would be stored in if they were in a local grocery store. The average of the plastic used per unit of product for all the packaging was then assigned to each product. This value estimated the amount of plastic per unit for each individual Alpakas product. The simulator then uses these values to determine how much plastic is reduced through purchasing an Alpakas product.

ORDER SIMULATION

SKU #	Products	Quantity	Amount	Unit	Average Plastic Packaging Waste	Unit
1010160701	Mountain Cheese (6 Months)	2	300	g	25.46	g
1010140201	Lammsbräu Edelhell	1	500	ml	0.00	g
1010140602	Quartiermeister Pils	1	330	ml	0.00	g
1010134801	Face Scrub (Apricot)	1	50	ml	4.96	g
1010153901	Beard Oil Argan	1	30	ml	2.98	g
1010200501	Dinkel-Laib	1	550	g	23.05	g
1010137201	Granola (Apple-Cinnamon)	1	380	g	31.25	g
1010172501	Aronia Berries	1	245	g	19.84	g
1010104601	Peppermint Leaves	1	30	g	2.83	g
1010111601	Strozzapreti (Red Lentil)	1	500	g	33.81	g
1010121001	Voelkel Oat Drink	1	0.75	l	32.41	g
	Plastic Waste Reduced				33.39	**g**

Figure 11: The dashboard developed in Google Sheets includes an order simulator to show Alpakas customers how much plastic waste they are reducing through each product

Measuring The KPIs for CO_2 Emissions

Another important KPI, as identified by the category manager at Alpakas, is the quantification of CO_2 produced through conventional delivery methods, such as cars and vans. Alpakas can show how much CO_2 its customers are saving through the company's use of e-cargo bikes. To evaluate this KPI, we researched statistics on the CO_2 emissions per kilometer of travel for different vehicles: e-cargo bikes, delivery trucks, and passenger cars.

A study completed by the Umweltbundesamt (The Federal Environmental Agency of Germany) examined CO_2 emissions. Since there were discrepancies between real-world

measurements and the measurements were done on a dynamometer, twelve different data sources were examined on a total of 1.4 million vehicles. The vehicles examined for this project adhered to the EURO 6b standards. This means they were legally compliant with the most recent emissions regulations put in place in 2014[87]. We examined the CO_2 emissions of both diesel and gasoline passenger cars and light commercial vehicles (LCVs), similar to what an Alpakas customer would interact with if they did not shop with them. By averaging the top three most prominent records of emissions we obtained the most accurate and fair data.

Vehicle	CO2 Emissions (g/km)
Diesel Passenger Car (gCO_2 /km)	165.1
Gas Passenger Car (gCO_2 /km)	159.6
Diesel LCV (gCO_2 /km)	218.5
Gas LCV (gCO_2 /km)	184.8

Table 1: The Average CO_2 Emissions of Euro class 6b in grams per kilometer[88]

Vehicle	CO2 Emissions (g/km)
E-Cargo Bike[89]	16
E-Cargo Bike[90]	22
Average	19

Table 2: The Average CO_2 emissions in grams per kilometer from using E-Cargo Delivery Bikes based on two sources of e-cargo bike emissions

The reduced emissions are determined by finding the difference in emissions between the delivery vehicle selected and the e-cargo bike. Using these values, the user of the spreadsheet can

[87] Tietge, U., Dornoff, J., Dias, S., Mock, P., Allekotte, M., Heidt, C., Knorr, W., Althaus, H.-J., Notter, B., Oberpriller, Q., Laderach, A., Hausberger, S., Matzer, C., Eisenman, C., & Kuhnimhof, T. (2020, December 10). Erarbeitung einer Methode zur Ermittlung und Modellierung der Co2-Emissionen des Kfz-Verkehrs. Umweltbundesamt. Retrieved April 22, 2022, from https://www.umweltbundesamt.de/en/publikationen/erarbeitung-einer-methode-zur-ermittlung

[88] Tietge et al. (2022)

[89] Llorca, C., & Moeckel, R. (2021, June 17). *Assessment of the potential of cargo bikes and electrification for last-mile parcel delivery by means of simulation of urban freight flows - European Transport Research Review*. SpringerLink. Retrieved April 22, 2022, from https://link.springer.com/article/10.1186/s12544-021-00491-5#Abs1

[90] *Cycling facts and figures*. ECF. (n.d.). Retrieved April 22, 2022, from https://ecf.com/resources/cycling-facts-and-figures

input the distance in kilometers they live from a delivery warehouse or a grocery store, and the spreadsheet will output the CO_2 emissions that are reduced by using the Alpakas e-cargo bikes. The user can input multiple delivery vehicle types and the average CO_2 emissions reduced through the e-cargo bikes is calculated. This method of analysis does have limitations since in Germany many people bike or walk to grocery stores, and this analysis method is only accurate for customers who would otherwise drive to the grocery store by car or get their groceries delivered through a delivery truck.

DELIVERY SIMULATION

Normal Grocery Transport Method	How do you normally get groceries?	Estimated Kilometers from Warehouse/Grocery Store from Warehouse	CO2 Emissions Reduced through Alpakas Delivery Service	Unit
Diesel Passenger Car (g/km)	☑	1	146.1	gCO2
Gas Passenger Car (g/km)	☑	1	140.6	gCO2
Diesel LCV (g/km)	☑	1	199.5	gCO2
Gas LCV (g/km)	☑	1	165.8	gCO2
CO2 Emissions Reduced through E-Cargo Bikes			**163**	gCO2

Figure 12: The dashboard developed in Google sheets includes a delivery simulator to show Alpakas customers the CO_2 emissions they reduce through ordering through Alpakas.

To identify which KPIs Alpakas should assess, we investigated competitors' frameworks through SWOT analyses. Just like Alpakas, other grocery delivery services are relatively new and in high demand due to Covid-19. As a result, these companies are still small, establishing themselves, and working to expand. By observing the successes and failures of other small businesses, Alpakas will be better able to target their marketing to the appropriate audience through KPIs. Both the SWOT analysis and the KPIs identified will help Alpakas stay competitive. Alpakas' competitors are classified into three categories: those in Germany that are not sustainability-oriented, those that are similar but not in direct competition with Alpakas, within Germany, and those that are outside of Germany and sustainability-oriented. To get a sample of successes and challenges for a range of Alpakas competitors, we decided to choose one company from each category, Flink, Biorena, and Pieter Pot respectively.

Each grocery delivery service highlighted different KPIs on its website that they thought were important to its customers and the company's values. Flink focused on operation functions

such as delivery speed, prices, and freshness of products[91]. Biorena, on the other hand, highlighted its organic certifications, CO_2emissions, and the three pillars of sustainability (economic, environmental, and social sustainability)[92]. Lastly, Pieter Pot concentrates on its sustainability measures such as packaging, CO_2 emissions, and life cycle assessments of its jars[93]. Overall, plastic packaging, CO_2 emissions, and organic certificates are some KPIs that other sustainable companies, like Pieter Pot, considered important and apply to Alpakas.

In our SWOT analysis, our team recognized overlapping challenges between the identified companies and Alpakas. Flying Emma and Pieter Pot, for example, are unable to service a full inventory due to their size. The sustainable business model is responsible for these companies' inability to provide customer convenience at a level that is comparable to traditional grocery stores. In an attempt to avoid overstocking and larger inventories, environmentally friendly businesses must sacrifice some customer satisfaction, expectations, and profits. Sometimes with produce, it has more demand than inventory leaving some customers empty-handed. This is because produce products naturally have a short shelf life. Large grocery stores, on the other hand, normally buy surplus produce to guarantee customer satisfaction, even though it leads to increased waste during slower weeks. Customers are less likely to shop with these companies because they aren't able to fulfill all of their grocery store needs. If a customer has to shop at two different companies to fulfill their needs, it doubles the sources of emissions, which partially defeats the original point to shop sustainably. Also, it is difficult for companies to find suppliers that are organically certified or suppliers that are also focused on zero plastic waste. Businesses such as Alpakas and Biorena that source from suppliers that are organically certified have fewer options for suppliers when compared to non-organically certified grocers. This is due to the higher standards suppliers need for the organic certification. This means Alpakas and Biorena are more likely to run out of inventory and not have the same variety as their non-organically certified competitors. The process to attain these certifications is very regulated to ensure that proper measures were taken to make organic food. Alpakas and Biorena would rather know that suppliers took precautions while producing the product than increase their profit margins. This reduces their selection of suppliers and products. Many companies are

[91] *Deine Lebensmittel Geliefert in Minuten*. Flink. (n.d.). Retrieved April 26, 2022, from https://www.goflink.com/de-DE/
[92] *Alles Liebe.* Biorena. (n.d.). Retrieved April 26, 2022, from https://biorena.shop/
[93] *Hoe Het Werkt*. Pieter Pot. (n.d.). Retrieved April 26, 2022, from https://www.pieter-pot.nl/pages/hoehetwerkt

aiming to succeed without following the tenets of neoliberalism. Some examples of companies that are aiming to be successfully environmentally friendly are Pieter Pot and Alpakas.

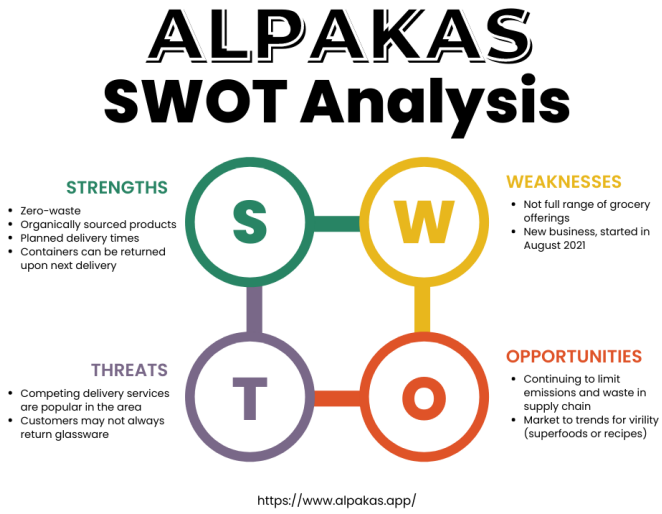


Figure 13: SWOT Analysis of Alpakas

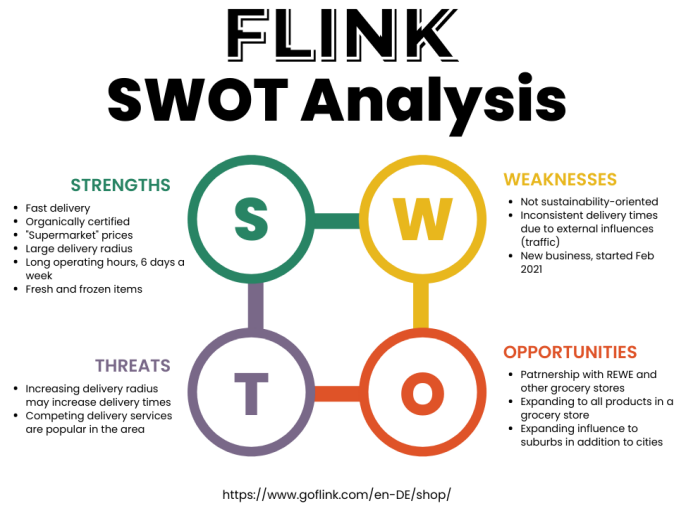


Figure 14: SWOT Analysis of Flink

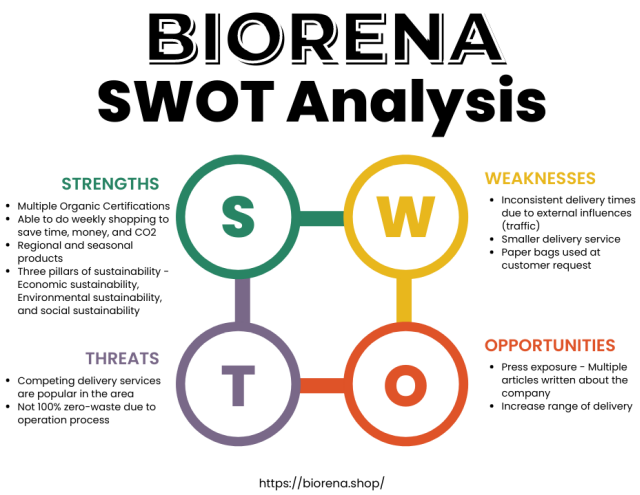


Figure 15: SWOT Analysis of Biorena

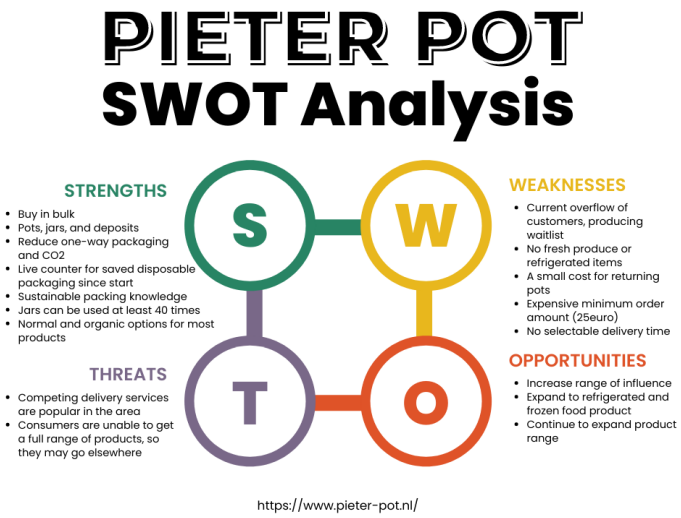


Figure 16: SWOT Analysis of Pieter Pot

Testing the Limits of Neoliberalism

Alpakas continues to focus on reducing plastic packaging waste while maintaining a sustainable business model. In the near future, the company plans to open another warehouse in Munich, Germany. Additionally, the company has been hiring many new employees over the past few months, which is a further sign of progress and growth. This ability to plan for expansion suggests that, despite the additional effort and cost included in choosing zero-waste

alternatives to plastic, Alpakas is finding success in its efforts to resist many companies' neoliberal tendencies. To the extent Alpakas finds success, it may show that sustainability and viability need not be diametrically opposed. Alpakas uses a system that strives for a circular economy, allowing profit and sustainability to coincide. As it works to carve out a space for itself in a neoliberal society, Alpakas adheres to the main principles of a circular economy: circulate products and materials, eliminate waste and pollution, and produce sustainably[94].

Unlike current societal norms that justify the disposal of materials rather than reusing them, Alpakas makes it easy for its customers to contribute to a circular economy[95]. The deposit system that Alpakas has implemented with their product delivery promotes the reuse of materials. For Alpakas, this requires a large upfront investment that is seen as a loss in profit from a neoliberal perspective. From our observations in collecting plastic packaging weights, standard grocery chains in Germany package their foods in disposable containers that are not always recycled but cost less per unit. Through recent successes of expansion, Alpakas has shown proof of concept that its material deposit system is both eco-friendly and profitable.

One of the ways Alpakas reduces its carbon footprint is through electric cargo delivery bikes. While bike deliveries may take longer than car deliveries, the mean cruising speeds only slightly differ. In a Berlin case study, the mean cruising speed for a car was 17.3 kph while the mean cruising speed for bike shipments was 15.9 kph[96]. This combined with the added benefits of less CO_2 emissions further shows a better carbon footprint when compared to conventional delivery methods. Thus, Alpakas can reduce its CO_2 emissions and maintain profitability without losing practicality.

In choosing a zero-waste company, the customer is preventing plastic from being wasted. Alpakas is beginning to demonstrate how a grocery service can embrace the principles of a circular economy without falling victim to the pressures of the neoliberal market.

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[94]Macarthur, E. (n.d.).; Salonitis, K., & Stavropoulos, P. (2013). On the Integration of the CAx Systems Towards Sustainable Production. Procedia CIRP, 9, 115–120. https://doi.org/10.1016/j.procir.2013.06.178

[95] McDonough, William. (2002).

[96]Gruber, J., Kihm, A., & Lenz, B. (2014, April 13). *A new vehicle for urban freight? an ex-ante evaluation of electric cargo bikes in Courier Services*. Research in Transportation Business & Management. Retrieved April 20, 2022, from https://www.sciencedirect.com/science/article/pii/S2210539514000091?casa_token=An-SaNva9LQAAAAA%3A2a1SyP2X1o7DwOOulJtdvwB0aFI4T1TJy8CN5_mWsU3f-XsS5x1yy_kes0ZFtXZLj7uiZJgV

Conclusion

Alpakas goal to quantify plastic waste expands beyond the first layer of packaging completed for this project. We decided to not include the second and third layer packaging in our metrics because it was too difficult to gather meaningful data on the current state of other grocers' second and third packaging layers. Also, for the scope of the project we examined CO_2 emissions of electric cargo bikes but were unable to complete a full analysis of CO_2 emissions of products. In our SWOT analysis and interviews, we determined that CO_2 emissions are a key performance indicator that is important to many stakeholders and should be examined further.

As Alpakas continues to grow as a company they are continuing to improve their environmental sustainability as well as their business sustainability. For future work at Alpakas an aspect we examined through the employee interviews was investigating rider satisfaction. Being a delivery rider is also the most physically demanding job at Alpakas. If conditions at Alpakas do not promote a healthy working environment for riders, the company as a whole will suffer as riders are crucial to customers receiving their groceries. While we did not specifically explore what Alpakas can do to ensure rider satisfaction we made them aware they should explore in the future.

Overall, through our dashboard, we were able to demonstrate the efficacy of Alpakas sustainable efforts by calculating the amount of plastic packaging waste saved through purchasing Alpaka's products. In proving Alpakas waste reduction amount, Alpakas can demonstrate their plastic waste reduction impact directly to their customers. Alpakas is an example of a successful sustainably oriented business. Businesses like Alpakas can help facilitate consumers to be environmentally friendly. This will lead to a positive change in ocean life, the quality of human life, and the environment.

Investigating Sustainability Efforts of a Zero-Waste Grocery Delivery Service

Supplemental Materials

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Advised by Professors Katherine Foo and Daniel DiMassa

Worcester Polytechnic Institute
Sponsored by Alpakas

D22 / March 30, 2022

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Booklet Design	Brianna
Presentation for Alpakas	Brianna (design), Eric (content)

Part B: Interview Email

English

Hello!

Thank you so much for choosing Alpakas as your grocery delivery service!

We are a group of college students from the United States who are working with the Alpakas team. As part of our studies, we are looking to interview current Alpakas' customers, such as you, about your stance on Alpakas' mission and overall sustainability within the food sector.

If you are interested in helping us to make alpakas more sustainable, we really appreciate your time. We would provide a 10 Eur voucher as a small gesture of our appreciation.

Depending on your preference, the interviews may be conducted in German or in English. As a participant, you will be asked a set of 8 questions lasting no longer than 15 minutes. If you are interested, please let us know the times you have available during the week of March 28th and we will be happy to set up an online-meeting :).

This interview is voluntary, but we would love to have the opportunity to speak with you!

Thank you,
Alpakas' Project Team

German

Hallo!

Vielen Dank, dass du Alpakas als Lebensmittel-Lieferdienst gewählt haben!

Wir sind eine Gruppe von College-Studenten aus den Vereinigten Staaten, die mit dem Alpakas-Team zusammenarbeiten. Im Rahmen unseres Studiums möchten wir aktuelle Alpakas-Kunden, wie dich, zu ihrer Einstellung zur Mission von Alpakas und zur allgemeinen Nachhaltigkeit im Lebensmittelsektor befragen.

Wenn du daran interessiert bist, uns dabei zu helfen, Alpakas nachhaltiger zu machen, würden wir uns sehr über deine Zeit freuen. Als kleine Geste unserer Wertschätzung würden wir einen 10 Eur-Gutschein zur Verfügung stellen.

Je nach Wunsch können die Interviews auf Deutsch oder auf Englisch geführt werden. Als Teilnehmer würden dir 8 Fragen gestellt werden, die nicht länger als 15 Minuten dauern. Diese Interviews werden virtuell über Zoom geführt. Wenn du Interesse hast, teil uns gerne mit, welche Zeiten in der Woche vom 28. März du zur Verfügung hast, und wir vereinbaren gerne einen Termin für ein Interview :).

Dieses Interview ist freiwillig, aber wir würden uns sehr freuen, mit dir zu sprechen!

Herzlichen Dank!
Dein Alpakas' Projektteam

Part C: Employee Interviews and Perspectives

These interviews helped us to identify KPIs for Alpakas. From the list of stakeholders 4 interviews were conducted. The questions asked in the interview were based on the sustainability mission of Alpakas. Employees were asked their opinions on Alpakas and how they believe Alpakas can improve its business model. By keeping our questions open-ended and simple, employees could spin their responses to be tailored to their personal interests. In turn, our records of stakeholder interests better reflected the KPIs that stakeholders would truly like to see.
The questions asked were as follows.

1. How would you define sustainability in the delivery industry?
2. Do you get your groceries from Alpakas? Why or why not?
3. What sustainability-related goals do you have while working at Alpakas?
4. In what ways have you seen Alpakas improve in their sustainability efforts?
5. Are there any issues you have observed in Alpakas functionality regarding their sustainability efforts?

Employee 1

1. How would you define sustainability in the delivery industry?
    - *Environmentally*
        - *Some business emphasis business sustainability*
        - *Minimize packaging and waste (plastic)*
    - *Socially*
        - *Employees happiness and satisfaction*
        - *Treat people with respect*
        - *Don't look at people as numbers*
2. Do you get your groceries from Alpakas? Why or why not?
    - *No, because they don't in their city at the moment*
    - *Order from their competitor BIORENA*
    - *Does not seek organic*

Employee 2

1. How would you define sustainability in the delivery industry?
    - *Packaging, what is vs isn't recyclable, not exactly returnability*
    - *CO2 footprint/emissions, shipping across borders is far more impactful than just the packaging itself*
2. Do you get your groceries from Alpakas? Why or why not?
    - *Some not all, not an organic shopper, alpakas is organic store so its more expensive for him*
3. What sustainability-related goals do you have while working at Alpakas?
    - *The more they can impact food companies can realize what their doing in terms of sustainability. Then bigger alpakas gets, the more influence they have*
4. In what ways have you seen Alpakas improve in their sustainability efforts?
    - *Not a defined packaging strategy, didn't know some suppliers were actually not sustainable. Packaging is a nightmare, they might not even be using glass in a year and instead go to plastic*
5. Are there any issues you have observed in Alpakas functionality regarding their sustainability efforts
    - *Want to see more "normal" non organic products*
    - *Flagship store would be nice, but not necessary or really that feasible*
    - *Original unverpackt, there are zero waste store, not super popular though. Not fresh goods, dry goods, oils and what not.*
    - *Some edekas offer refill on nuts.*

Employee 3

1. How would you define sustainability in the delivery industry?
    - *Riders should be treated fairly and kindly*
    - *Deliver effectively*
    - *Making things like uber eats and meals more sustainable*
2. Do you get your groceries from Alpakas? Why or why not?
    - *Sometimes*
        - *Only if youre going to get a meal or two*
        - *Bigger Weekly shops with alpakas because of price*
3. What are your personal goals while working at Alpakas?
    - *Their work contributes to a more sustainable future*
    - *Develop themselves*
    - *Sustainable entrepreneurship*
4. Are there any issues you have observed in Alpakas functionality regarding their sustainability efforts
    - *Alpakas orders samples in normal packaging for tasting purposes and will work out details for sustainable packaging at a later date.*

Employee 4

1. How would you define sustainability in the delivery industry?
    - *3 different aspects*
        - *Social*
            - *Stressful environment usally*
            - *Want worker friendly environment*
            - *Stressed or Fun?*
            - *Office Team- be together or team?*
            - *Alpakas is focused on value and change*
        - *Environmental*
            - *Environment when the delivery is occurring, there is no negative impact*
            - *Delivery specifually is wasteful*
        - *Economical*
            - *Needs to still be feasible*
            - *Profitable*
            - *Scalable*
2. Do you get your groceries from Alpakas? Why or why not?
    - *Partially*
        - *Dry ingredients*

    - *Musli*
    - *Fruits and Veggies*
    - *They don't have everything they need*
    - *Too expensive*
3. What are your personal goals while working at Alpakas?
    - *Develop myself to a leadership position*
    - *Learn so they can be a founder and give back*
    - *High Speed, Good founders*
    - *Values sustainability, and overconsumption*
    - *Not as much on delivery*
4. In what ways have you seen Alpakas improve in their sustainability efforts?
    - *Amount of waste they are reducing*
    - *Amount of products*
    - *70% of groceries come from alpakas*
    - *Scalability has improved*
5. Are there any issues you have observed in Alpakas functionality regarding their sustainability efforts
    - *More transparency with suppliers*
    - *Not an easy partnership with suppliers*
    - *Improve relationship so suppliers can be more transparent with alpakas*
    - *CO2 Tracking Improvement*
    - *How fair, socially, with riders and people in warehouse*
    - *Plastic Comparison*

Part D: Customer Perspective

For customers, the team took a different approach than with the employee interviews. After contacting over a dozen customers we were unable to have any interviews with them. The team agreed we didn't want to waste time attempting to schedule interviews with customers that may or may not show, and we wanted to work with a relevant sample size. Therefore we synthesized data that had already been recorded by Alpakas. We looked at data from 61 customers with the help of Ms. Charlotte Sollberger. In a conversation with Ms. Sollberger, she helped translate the customer responses, which were in German into English. From then we provided questions to help facilitate a conversation that would give our team an idea of what a typical Alpakas customer thinks. The questions used to help facilitate the conversation are below.

1. What criteria do customers take into consideration to decide how you decide where to purchase your groceries?

2. How important and why (from 1 to 5 with 1 not important at all) are the following criteria for customers purchasing and spending habits?
3. Why did customers initially choose Alpakas over other grocery services?
4. Do customers have any hesitations or issues with Alpakas? If so, what?
5. How can Alpakas exceed customer's expectations?
6. In what ways do customers think Alpakas can improve?

Customer Data Summarization

Based on conversations with Ms. Charlotte Sollberger

1. What criteria do customers take into consideration to decide how you decide where to purchase your groceries?
    - *Finally a sustainable option in grocery delivery*
    - *Speed*
    - *Plastic usage*
2. How important and why (from 1 to 5 with 1 not important at all) are the following criteria for customers purchasing and spending habits?
    - *Environmental Impact: 5*
    - *Waste Reduction: 5*
    - *Social Impact: 5*
    - *Price: 3*
    - *Convenience: 3*
    - *Speed: 4*
3. Why did customers initially choose Alpakas over other grocery services?
    - *Convenience*
    - *Transparency*
    - *They know if they shop with alpakas, there is no question about sustainability, they can trust alpakas (outsourcing sustainability)*
    - *Social Sustainability*
    - *Good prices*
    - *How punctual Alpakas is*
4. Do customers have any hesitations or issues with Alpakas? If so, what?
    - *Fresh produce isn't up to their expectations (ripe products)*
    - *Concerns with deposits*
    - *Concerns with sourcing locally, not enough, not stating where products are from*
    - *Website was not user friendly at first*
5. How can Alpakas exceed customers' expectations?

- *A larger assortment of products*
- *More flavors?*
- *Choosing the ripeness of the produce*
- *More slots on the weekends*
- *Launch App*
- *Seeing what impact the customer is having*
- *How nice the riders are*

6. In what ways do customers think Alpakas can improve?
    - *Cheaper if possible*

Part E: Defined Plastic Packaging Types

Packaging Types	Sample Picture
Box, snap closure	
Box, resealable	
Tray, wrapped	 

Thin bag, tied	
Thin bag, sealed	
Plastic foil bag	
Thick bag, sealed	
Thick bag, resealable	

Netting	
Shrink wrap	
Bottle, squeeze	
Bottle, twist	

Cling Film	

Part F: Dashboard Instruction Manual

Alpakas Sustainability Analysis Dashboard

Spreadsheet Dashboard to Quantify Alpakas Sustainability

Summary

The excel sheet utilizes data collected by WPI students at local grocery stores. The calculations determine the average amount of plastic packaging per unit of product for different types of food packaging.

Excel Sheet Tabs:

Data Collection

The data collection tab includes the data that was collected from conventional grocery stores in Berlin. The following is the name and description of each of the columns:

- **Name of Product:** the name of the product the data was collected on
- **Type of packaging:** the type of packaging the product was packaged in (refer to Packaging Types)
- **Name of Photo:** the file name of the photo within the data collection album
- **Product Number:** the number in which the product data collected
- **Labeled Weight of Product:** the weight that is advertised on the product
- **Weight w/ Packaging:** the weight of the product and packaging on the scale
- **Weight of Plastic:** the difference between the weight w/ packaging and the labeled weight of the product to determine the weight of just the plastic
- **Plastic Packaging Per Unit (g or mL) of Product:** the amount (g) of plastic packaging per unit of the product
- **Store:** the store in which the data was collected

Packaging Type Plastic Values

This tab references the Data Collection tab of the dashboard. Each conventional grocery product in the Data Collection tab was assigned a packaging type as well as a plastic packaging per unit (g or mL) of product. Utilizing spreadsheet pivot tables, the average amount of plastic packaging (in grams) per unit of product (g or mL) was assigned to each specific packaging type.

Packaging Types

The packaging types tab includes all of the types of plastic packaging we considered when defining the packaging types for the conventional grocery store products in the Data Collection tab.

The packaging types are as follows:

- Box, snap closure
- Box, resealable
- Tray, wrapped
- Thin bag, tied
- Thin bag, sealed
- Plastic Foil Bag
- Thick bag, sealed
- Thick bag, resealed
- Netting
- Shrink Wrap
- Bottle Squeeze
- Bottle Twist
- Cling Film

SKUs

The packaging types tab includes all of the Alpakas products. The following is the name and description of each of the columns:

- **Product:** The name of the Alpakas product
- **Alpakas Category:** The category that the product is within
- **Types of Packaging (columns B-AD):** each checkbox represents the type of packaging that the product is packaged within conventional grocery stores, the values for each packaging type are obtained from Packaging Type Plastic Values
    - Other: This column determines if a product is a vegetable or fruit that is sold in pieces rather than in grams
- **SKU:** the Alpakas product identification number
- **Alpakas Packaging Type:** the method of packaging Alpakas packages the product in
- **Amount:** the amount of product (g, mL, piece) that Alpakas sells per item unit

The function of this tab is to assign each Alpakas product a plastic packaging average. The columns hidden represent the individual average plastic amount for each type of packaging. When the box to the left of the hidden columns is checked, that individual packaging type is assigned to the product. Because certain products have multiple types of packaging, there are checkboxes to assign multiple types of packaging to one product. When boxes are checked, the average plastic packaging per unit (g or mL) of product for those packaging types is averaged together. If a product is a fruit or vegetable and is sold in pieces rather than grams, the product is assigned the amount of plastic that is in one produce bag. If a product is generally sold in glass or paper, the user will check off this option and the plastic waste will be

assigned the value of 0 grams. This assigns each Alpakas product its specific plastic packaging reduction amount.

Adding New Alpakas Products

As Alpakas adds products, the SKU sheet will need to be updated. The product name will be input, the category will be input, and the user will define the types of packaging the product is typically packaged in by clicking the checkboxes that apply. Once added to the SKU sheet, the product will become searchable on the Order Simulation tab.

Products Not Typically Sold in Plastic

Alpakas sells some products that in conventional grocery stores are stored in glass rather than plastic, for example, Beer. Because of this, the plastic waste for these products is 0. The product's packaging type would be glass or paper and this check box would be clicked. Therefore, products that are typically stored in glass are assigned a plastic waste value of 0 on the SKUs sheet.

Example:

Unassigned Packaging Types

The user has not yet assigned the Alpakas products a conventional grocery store packaging type, therefore, there is no plastic waste reduction value for this Alpakas product yet.

Product	Shrink Wrap	Shrink Wrap	Thick Bag Resealable	Thick Bag Resealable	Thick Bag Sealed	Thick Bag Sealed	Thin Bag Sealed	Thin Bag Sealed	Thin Bag Tied	Thin Bag Tied	Tray Wrapped	Tray Wrapped	PLASTIC PACKAGING AVERAGE
Dark Chocolate Drops (74%, Vegan)	☐	FALSE	☐	FALSE	☐	FALSE	☐	FALSE	☐	FALSE	☐	FALSE	#DIV/0!

Assigning Packaging Type

The user checked off the "thick bag resealable" packaging option and the "thick bag resealable" plastic packaging value was displayed in the hidden orange column.

Product	Shrink Wrap	Thick Bag Resealable	Thick Bag Resealable	Thick Bag Sealed	Thick Bag Sealed	Thin Bag Sealed	Thin Bag Sealed	Thin Bag Tied	Thin Bag Tied	Tray Wrapped	Tray Wrapped	PLASTIC PACKAGING AVERAGE
Dark Chocolate Drops (74%, Vegan)	FALSE	☑	0.07	☐	FALSE	☐	FALSE	☐	FALSE	☐	FALSE	0.0732

Assigning multiple packaging types

Product	Shrink Wrap	Shrink Wrap	Thick Bag Resealable	Thick Bag Resealable	Thick Bag Sealed	Thick Bag Sealed	Thin Bag Sealed	Thin Bag Sealed	Thin Bag Tied	Thin Bag Tied	Tray Wrapped	Tray Wrapped	PLASTIC PACKAGING AVERAGE
Dark Chocolate Drops (74%, Vegan)	☐	FALSE	☑	0.07	☑	0.04	☑	0.09	☑	0.04	☐	FALSE	0.0626

The user checked off the "thick bag resealable", "thick bag sealed", "thin bag sealed", and "thin bag tied" packaging options. The plastic packaging average references all the values in the hidden columns and averages them together to assign the product a plastic reduction amount.

Functions by Column:

Packaging Types:

This function only calculates when the checkbox in the column left of the function is checked off (true). Packaging Type Check Box is the location of the check box. Packaging Type Plastic Values'!Average of Plastic Packaging for Packaging Type references the packaging type plastic values tab and is the location of the average of plastic packaging for the packaging being referenced. This function outputs the average plastic packaging into the column to the right of the check box to assign each check box a value.

=if(Packaging Type Check Box=true,'Packaging Type Plastic Values'!Average of Plastic Packaging for Packaging Type Cell)

Other:

This function determines if a product is a fruit or vegetable or bread roll that is sold in "pieces" rather than in grams.

=IF(AND(OR(Category = "Fruits", Category = "Vegetables"),Unit= "piece"), "Produce Bag", AND(Category = "Bread Rolls" ,Unit= "piece"), "Bread Bag")

Plastic Packaging Average:

This function averages all the plastic packaging types checked off for the product. The function ignores columns that do not contain values when completing the average.

If a product is a vegetable or fruit that is sold in pieces, each piece is assigned a plastic value of a produce bag. If a product is a bread roll and is sold in pieces, each piece is assigned a plastic value of a bread bag.

=IF(AND(OR(Category = "Fruits", Category = "Vegetables"),UNIT= "piece"), 'Produce Plastic Packaging Amount,IF(AND(Cateogry = "Bread Rolls",Unit= "piece"), 'Bread Bag Plastic Amount, IF(NOT(ISTEXT(Row of Check Boxes)),AVERAGE(Row of Check Boxes))))

Order Simulation

The plastic reduction simulation allows a user to see the amount of plastic packaging waste that they reduce through ordering with Alpakas. The order simulation allows the user to input an Alpakas order and the simulation will output the amount of plastic the consumer reduced by ordering through Alpakas versus a conventional grocery store. This feature allows the user to search for the product and input how many units of the product they want to purchase. The amount of each product included in one unit when sold through Alpakas is referenced from the SKUs tab. This is multiplied by the quantity being purchased to determine the total number of grams or mL being purchased. Using the grams of plastic per gram or mL of product that was determined in the SKUs tab, the total number of grams or mL of the product is multiplied by the plastic waste per gram or mL of product. The outcome is the amount of plastic is reduced through purchasing that specific Alpakas product. After all the products are input, the sum of the plastic reduction is calculated to give an estimated value for the plastic reduction within that Alpakas order.

Because some of the Alpakas products are sold in liters rather than milliliters, the order simulation converts products sold in liters to milliliters so that the calculations still function. The spreadsheet determines if the unit of the alpakas product is in milliliters or in liters and does different calculations depending on the Alpakas product's initial unit. If it is in milliliters it multiplies the grams of plastic waste per mL of the product by the number of milliliters. If the product is sold in liters it multiplies the number of liters by 1000 and then multiples the grams of plastic waste per mL of the product by the converted L to mL amount. This function allows new products with either liter or milliliter units to be input into the SKUs tab.

Functions by Column:

SKU #:

=VLOOKUP(Alpakas Product Cell,{SKU!$1:$1704,SKU!AF:AF},column # SKU is located,0)

Amount:

=VLOOKUP(Alpakas Product Cell,{SKU!$1:$1704,SKU!AF:AF},column # amount in g/mL/L is located,0)*quantity of product

Unit:

=VLOOKUP(Alpakas Product Cell,{SKU!$1:$1704,SKU!AF:AF},column # product unit is located,0)

Average Plastic Packaging Waste:

Determines the amount of plastic waste reduced for each product Alpakas product by utilizing the grams of plastic per unit (g or mL) of product. For products in sold in liters, the function converts the liters to milliliters to complete the calculation for grams of plastic per milliliter.

=IF(AND(Unit="l"), VLOOKUP(Alpakas Product Cell,{SKU!$1:$5000,SKU!LetterColumn:LetterColumn},column # gram of plastic per unit of product is located,0)*Amount*1000, VLOOKUP(Alpakas Product Cell,{SKU!$1:$5000,SKU!LetterColumn:LetterColumn},column # gram of plastic per unit of product is located,0)*Amount)

Delivery Simulation

The CO2 emissions simulation allows a user to see the amount of CO2 emissions that they reduce through ordering with Alpakas. The following research was conducted to determine the average amount of CO2 emissions per kilometer when driving a passenger car and when driving a small delivery truck:

Vehicle[97]	CO2 Emissions (g/km)
Diesel Passenger Car	165.1
Gas Passenger Car	159.6
Diesel LCV	218.5
Gas LCV	184.8

To compare these delivery methods to Alpakas, the following research was conducted to determine the CO2 emissions from using E-Cargo Delivery Bikes:

Vehicle	CO2 Emissions (g/km)
E-Cargo Bike[98]	16
E-Cargo Bike[99]	22
Average	19

Functions by Column:

CO2 Emissions Reduced through Alpakas Delivery Service:

This function references the row in which the vehicle type is checked off. When checked the cell is "true". This function references the CO2 emissions difference per km column if the vehicle type in that row is true and then multiplies it by the number of km.

=IF(Check Box=true,CO2 Emissions Difference Cell,"")*Number of kilometers

[97]Tietge, U., Dornoff, J., Dias, S., Mock, P., Allekotte, M., Heidt, C., Knorr, W., Althaus, H.-J., Notter, B., Oberpriller, Q., Laderach, A., Hausberger, S., Matzer, C., Eisenman, C., & Kuhnimhof, T. (2020, December 10). *Erarbeitung einer Methode zur Ermittlung und Modellierung der Co2-Emissionen des Kfz-Verkehrs*. Umweltbundesamt. Retrieved April 22, 2022, from https://www.umweltbundesamt.de/en/publikationen/erarbeitung-einer-methode-zur-ermittlung

[98]Llorca, C., & Moeckel, R. (2021, June 17). *Assessment of the potential of cargo bikes and electrification for last-mile parcel delivery by means of simulation of urban freight flows - European Transport Research Review*. SpringerLink. Retrieved April 22, 2022, from https://link.springer.com/article/10.1186/s12544-021-00491-5#Abs1

[99]*Cycling facts and figures*. ECF. (n.d.). Retrieved April 22, 2022, from https://ecf.com/resources/cycling-facts-and-figures

Part G - Research Notes

CO2 Emissions Research

- 60.7% of CO2 emissions in the EU are from cars
- 11.9% of CO2 emissions in the EU are from light-duty truck
- Urban delivery trucks with a 4×2 axle configuration (4-UD) emitted on average 814.1 gCO2/km

Table 3. CO_2 emissions and fuel consumption in the baseline reporting period

Sub-group	CO_2 emissions (gCO_2/t-km)	CO_2 emissions (gCO_2/km)	Fuel consumption (Liters/100 km)[a]
4-UD	307.2	814.1	31.1
4-RD	197.2	627.0	23.9
4-LH	106.0	786.4	30.0
5-RD	84.0	861.7	33.2
5-LH	56.6	783.5	30.0
9-RD	111.0	696.9	26.6
9-LH	65.2	873.3	33.4
10-RD	83.3	854.1	32.7
10-LH	58.3	806.5	30.8

[a] Data available for diesel trucks only.

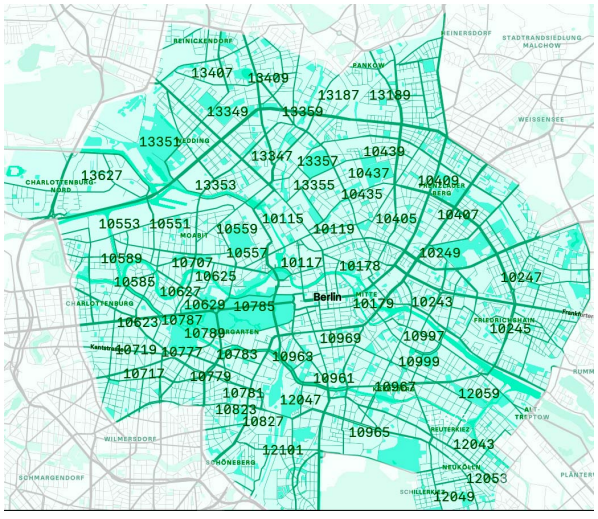
- "the mean cruising speeds of the two modes differ only slightly: 17.3 kph for car shipments and 15.9 kph for bike shipments"
- "If weight and volume were the only limiting factors, all bike shipments and 85% of the car shipments could be carried by E-CBs with a cargo box of 176 l"
- Cargo bikes' electricity consumption of 3 kWh/100 km (based on Saenz et al. [43])
- 16 g CO2/km for electric cargo bikes
- Average CO2 Emissions (g/km) of EURO class 6b for average diesel car: 165.1
- Average CO2 Emissions (g/km) of EURO class 6b for average gas car: 159.6
- Average CO2 Emissions (g/km) of EURO class 6b for average diesel LCV: 218.5
- Average CO2 Emissions (g/km) of EURO class 6b for average gas LCV: 184.8
- "The Federal Environment Agency therefore had the discrepancy between the official and real consumption values of European cars examined using 12 data sources with around 1.4 million vehicles. A new method for determining and modeling the real fuel consumption and the CO2 emissions from passenger cars and light commercial vehicles were developed…"
- Average g of CO2 Emissions per km for new vans sold in Europe in 2020: 158 g/km
- Average CO2 Emissions per km for all new passenger cars sold in 2020 in Germany: 113.6

Part H - Sponsor Description

Alpakas is a startup grocery, same-day delivery service based in Berlin, Germany. The company services a 5-mile radius around Otto-Weidt-Platz 9. They now fully service multiple districts including Mitte, Kreuzberg, Prenzlauer Berg, Wedding, Moabit, Europacity, with partial service to many others. The main goal of the company is to reach a more sustainable future by providing the public with a sustainable, zero-waste delivery service that is reliable, punctual, and plastic-free.

Founded in August of 2021, the Alpakas team started in Berlin. The concept of a service that provides zero-waste delivery groceries was inspired by the growing interest in eco-friendly shopping options in the Berlin area. In Germany, about 12 million tons of food is wasted per year. In recent years, society has been making efforts to lessen this waste. For Alpakas, this inspired them to start their service. By the end of October, Alpakas had roughly 150 products in their store. A month later they had 600 products and had 180 orders. Currently, they have over 700 products on their online Shopify store. In the future, the company has plans to grow its radius even greater as well as continue to expand the number of products offered. In December, they had a total of 280 orders; they are striving for 500 orders in January. Additionally, there are plans for an Android/Apple app to make ordering groceries even easier. Further down the line, Alpakas has hopes to expand its service to other cities as well.

The Alpakas team consists of 18 members and received 280 orders for the month of December. As a growing company, the goal for January is around 500 orders and to then in February launch their mobile app. In the following months, the organization plans to expand to other cities. There is a social and content manager, growth marketing manager, and a dual student media design position to help make sure the company continues to grow and expand its presence.



To help Berliners attain a sustainable lifestyle, Alpakas focuses on providing sustainable zero-waste packaging by reusing and recycling packaging products and emission-free delivery service using an ONO eCargobike. The choice to offer packaging with deposits that are reimbursed is known to be effective against many environmentally damaging habits. Returns limit plastic leakage into the ocean, generate less CO2 emissions, produce a higher quality recyclate, and even help the consumer to understand the impact they have on the environment. With support from the company, sustainable consumption is as efficient and reliable as regular grocery shopping but has less of a negative impact on the environment.

"With alpakas, we are launching a delivery service that is guided by the values, insights and achievements of the zero-waste movement. The huge success of unpackaged stores in Germany and Europe has shown that many people want a new way of consuming and shopping that produces less plastic waste. This is exactly where alpakas wants to start and go a new way, because the fact that we bring your purchases home already filled in reusable containers eliminates the cumbersome preparation before visiting the store. Together with us, you can make your everyday life more sustainable without much effort."

By providing a shopping experience that imitates the weekly market, the company provides a favorable grocery shopping experience. Alpakas customers order their groceries as needed; it is not a subscription service or a membership service. Their range of products includes locally sourced items such as baking ingredients, breads, spreads, cereals, eggs, dairy, coffee, tea, cocoa, noodles, rice, nuts, dried fruit, fruits, vegetables, juice, sauces, condiments, sweets, wine, beer, spirits, as well as general household products and health and beauty products.

Alpakas functions through an online ordering system. Delivery is offered six days per week directly to the customer's home. The delivery service follows a milkman principle; several deliveries are made in the same trip to multiple customers. For orders under 25 euros, delivery is 3,90 euros. All orders exceeding 25 euros are delivered for free. Products are purchased at a flat rate and a deposit fee is charged for the cost of the packaging. Packaging is returned at the next delivery, at which point the fee for the packaging is refunded to the customer. The collected, empty containers are cleaned following current industry standards, in compliance with strict hygiene measures, and refilled.

The current packaging options Alpakas offers are varied. All groceries are delivered in an Alpakas bag made of sturdy material and washed in between uses. Glass containers are resistant, sturdy, and can be reused many times; great for being stored for long-term use. For fruits and vegetables, cotton nets are used. Food is wrapped in a cellulose-based, 100% compostable paper that helps to reduce the rotting of fresh foods. Recycled cartons are used to protect against contamination of drugstore products. Recycled cardboard is also used to protect fragile foods like eggs. Alpakas hopes to expand its diversity of zero-waste packaging to offer more products to its customers.

The products provided by Alpakas all meet the sustainability standards of the company. These standards include the growth process of organic products being from controlled organic cultivation. For other products, it is required that the manufacturing companies produce their products in a sustainable manner. The company acquires products from manufacturers and farms by using recycled cardboard or reusable containers, like how the products are delivered to the public. The items are also restocked in copious amounts to minimize the waste in the restocking process. The process of delivery to consumers is also sustainable. By using Cargo bikes that are charged by green electricity the company cuts down on exhaust emissions to the environment. This method also reduces traffic as well as noise compared to using delivery trucks.

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