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Industry 4.0 in the Retail Sector: Sustainability of Food Retail with a Focus on Food Insecurity in Dayton, OH

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Industry 4.0 in the Retail Sector: Sustainability of Food Retail with a Focus on Food Insecurity in Dayton, OH



Honors Thesis

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Department: Engineering Management, Systems and Technology

Advisor: Sean A. Falkowski, M.S.

December 2020

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Abstract

In recent years, large scale agricultural and food processing industries have experienced a great worldwide digital transformation. The advent of Industry 4.0, which has become popular in Europe, has helped many industries optimize their operations. Relatively new is the idea that food processing industries and other stakeholders in the food distribution supply chain cannot only optimize their processes but also, track and provide timely customer service. This has technical and managerial challenges that might limit the potential benefits of industry 4.0 in the efficient distribution of fresh food produce. For example, food retailers have to meet the increasing customer desire for fresh and high-quality food produce on demand. This has led to overstocking and understocking of some food items, as well as waste in transportation and labor, which adds to the total cost of food. Dayton, Ohio and other cities designated as food deserts have limited access to affordable and healthy high-quality fresh food. Preliminary data from this study suggest that lower-income communities in Dayton do not have immediate access to affordable, healthy and high-quality food. However, the other communities in the Dayton area usually see an oversupply of fresh, affordable and high-quality food in retail shops. Therefore, this study aims to utilize Industry 4.0 concepts to propose a more equitable and efficient way to minimize food insecurity in food deserts and create a more sustainable environment.

Acknowledgements

I dedicate my thesis to my family, advisor, professors and all who have taken part in helping me get to where I am today. A special feeling of gratitude to my best friend Daniel for praying for, encouraging and believing in me. I would not have been able to accomplish all that I have without your support.



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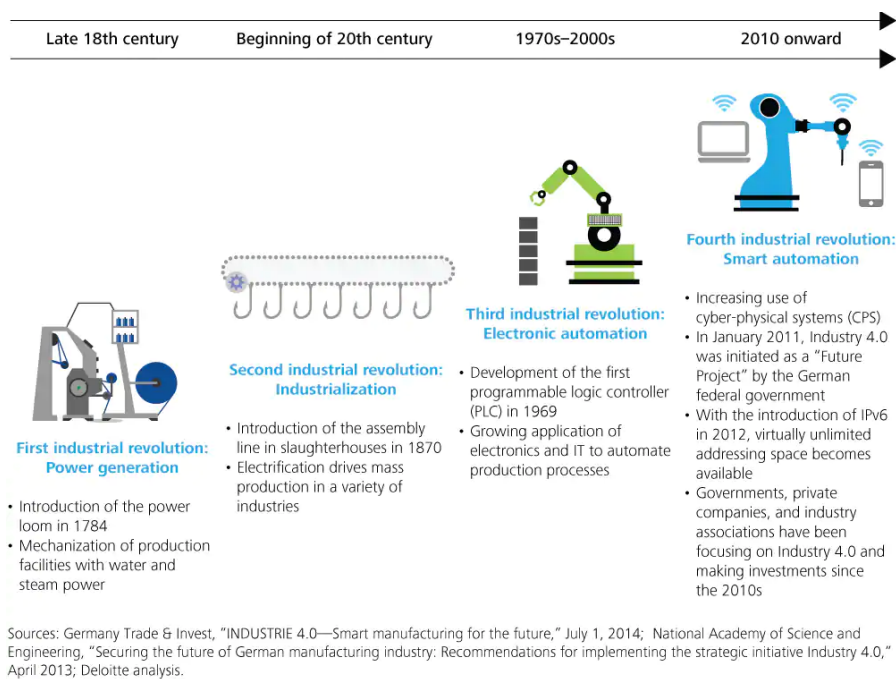
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Introduction

Industry 4.0 is described as the “marriage of digital and physical systems” [8].

Industry 4.0 was first introduced in 2011 and was defined as:

“A paradigm shift . . . made possible by technological advances which constitute a reversal of conventional production process logic. Simply put, this means that industrial production machinery no longer simply ‘processes’ the product, but that the product communicates with the machinery to tell it exactly what to do” [7].



Graphic: Deloitte University Press | DUPress.com

Figure 1. The Different Waves of the Industrial Revolution [7].

Industry 4.0 ties into retail, more specifically, food retail, because the satisfaction of the customer is an important factor that Industry 4.0 focuses on [6]. Customers are wanting items faster than ever before, and everything should be attainable to them. When a customer goes to a grocery store, there should not be any items out of stock that they

have to wait to get back in stock. Schmaus et al. described Industry 4.0 in relation to food retail as:

“The Industry 4.0 digital revolution is mobilizing a new type of R&C (Retail and Consumer goods) consumer, who wants a seamless, fast, efficient shopping experience and who is looking for products that are more personalized than ever before. For retailers, these preferences can be addressed through multichannel offerings, a combination of an online and physical outlet shopping experience with channels that consumers can switch between with ease, depending on their schedule or preferences on any given day. In a multichannel environment, enhanced product tracking and transparency lead to improved consumer services” [6].

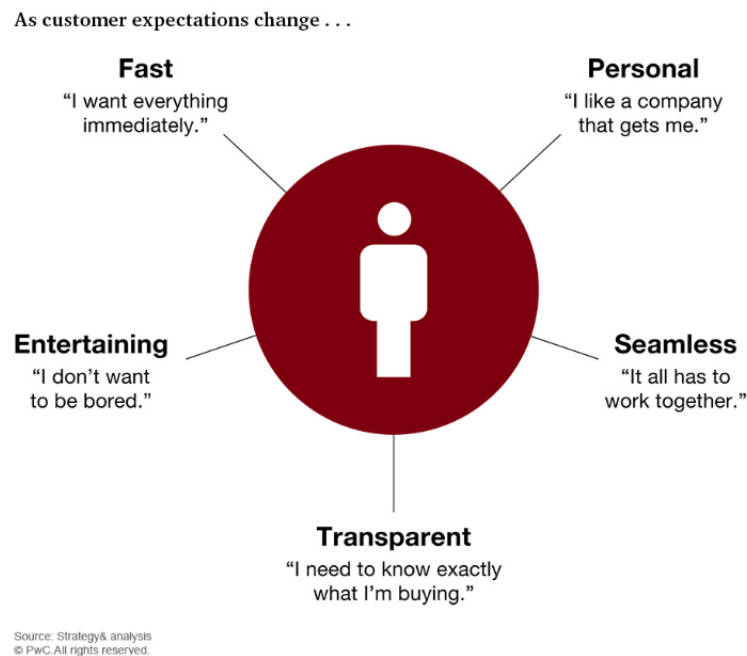


Figure 2. Customer Satisfaction [6].

Online grocery shopping is a direction in which food retail is headed. Currently, most grocery stores have an online pickup service, such as Meijer Curbside, or Kroger

ClickList [2,4]. This is where one can order their groceries online and pay for them, and then pick the groceries up at whatever time the customer chooses. Online food retail is still in its beginning stages, but it is already significantly popular for consumers. In the year of 2020, online grocery shopping has increased more than ever before due to the COVID-19 pandemic. With people not leaving their homes due to contracting the sickness, having an auto-immune disease, etc., online food retail is a necessity to survival for some consumers [16].

Aside from Industry 4.0 and how that relates to food retail online, one of my main focuses is how sustainable food retail industries are, and how to create a more sustainable environment in each company without decreasing profit significantly. Along with making the grocery store chains sustainable, I am researching how these companies educate their shoppers on sustainability. For example, I am looking to see if resources are available at the grocery store (advertisements, signs, brochures, charts, etc.) to encourage people to live a more sustainable lifestyle by standing with their local grocery to help create a healthier and more organic environment.

Lastly, the main focus of my research is on food insecurity. This is the newest point of research I have become passionate about. I began this research in May of 2018 and wanted to focus on grocery store sustainability as a whole, not really the focus of Dayton or of feeding those without. I am from Dayton, OH, but never understood that most experiences in my life rooted from bigger issues until I began attending the University of Dayton. I learned about food deserts and apartheid and realized the city of Dayton is in fact a food apartheid, and this was an issue that needed to be addressed and resolved.

After learning all of this new information, on Memorial Day in May of 2019 we had the awful tragedy of tornadoes strike Dayton. This is when I learned how much of our system was truly broken, driving past neighborhoods daily, including now in December of 2020, that still were not repaired, and this also had a toll on grocery stores.

In 2019 after the tragedy, at least three grocery stores closed without plans to reopen. Before all of this happened, Dayton was already defined as a food apartheid, so what are we doing to fix this issue? It feels like we are taking steps backwards when we should be moving forward. This switched the focus of my thesis to be more centered around food insecurity in Dayton, as opposed to simply grocery store sustainability. I realized if I left out grocery stores not serving everyone in the community, the triple bottom line (people, profit, planet) was not being accomplished and this research wouldn't be geared to being fully sustainable.

When defining locations as food deserts and apartheid, it is important to know the definitions to ensure we are defining them correctly, so that we know how to solve the problem at hand. A food desert is defined as a community/neighborhood having zero access to food at all [11], whereas a food apartheid is more encompassing because there is access to food, but it is not healthy or sustainable food. For example, someone who has to do their grocery shopping at a dollar store, or a gas station would have access to food, but not a large variety or quantity of goods. These foods would also be more expensive and less nutritious than shopping at a Kroger or Meijer. Karen Washington, a food justice activist in her community, goes on to explain the deeper rooted issue of food apartheid and how they are more systemic than a food desert because grocery stores pick specific areas to build based on the socioeconomic status of an area [10]. This is why we see more

issues of obesity and malnutrition in lower income areas, not because the people are always choosing to eat those things, but that is all they have access to or can afford. A case study from Kansas City stated, “We have more grocery store square feet in this country than we did 60 years ago, but we have fewer stores. The stores have gone where population density is greatest, in suburban or wealthy areas” [12].

While working on the literature review, I learned so much more about the food retail industry, as well as how advanced our society has become with all of our industries working in real time. Industry 4.0 is so present with our ever-advancing digital world, and it is only going to increase from this point. Companies need to stay up to date with the latest trends in retail, such as online grocery shopping, due to the immediate need when COVID-19 first occurred. This will probably not be the only time we need to go completely remote, so the next time hopefully more preparation will be put in place. I have also seen an increase in the desire to live sustainably from when I first began my research to now, which is also something food retail will need to keep in mind when stocking their stores in the future. I believe it will be interesting to continue to research how our society advances within food retail, given all of the changes that have happened in such a short time frame.

Methods

Participants

During my research, I did field work where I visited twelve different grocery stores within the Dayton, OH area. These grocery stores were in three different areas of incomes: lower class, lower-to-middle class, and middle-to-higher class (Ref. Table 1). I visited four grocery stores in each different-incomed area, and the common grocery store in every city was Kroger.

Grocery Stores Visited in Dayton, OH		
Lower	Lower-to-Middle	Middle-to-Higher
Kroger	Kroger	Kroger
Kroger	Walmart	Trader Joe's
Grocerylane	Aldi's	Whole Foods
Drexel Foodtown	Meijer	Dorothy Lane Market

Table 1. Grocery Stores Visited.

Following the grocery store visits, I had an informal interview with a Manager at the most common grocery store in the Dayton area, Kroger, which was located in a lower-class area. I also had an informal interview with a user of the online and pick-up option (Meijer Curbside) at the grocery store, Meijer, and this user was from a middle-to-higher class area. Lastly, I volunteered at a co-op for 10 hours a week to try to get more of an insight on the city of Dayton and how to combat food insecurity.

Procedure

While in each grocery store, I had a specific plan of what I would look for upon entering. My main focus was the products, and more specifically, the produce. I looked at the variety of goods, quantity, quality, and pricing. Further than that, I wanted to look if each grocery store contained special areas for dietary restrictions such as: an organic section, a “dairy free” section, etc. If the grocery store contained such areas, I further analyzed that specific area to see also its variety, quantity, quality, price as well as the overall size of the specialized section. After looking at the products, I would observe the advertisements and information given around the grocery store. I was curious if there were signs that said anything about local farmers and nutrition. I was also curious if these grocery stores contained any educational resources on sustainability, even if that means a small sign that says, “Go Green!” to encourage sustainability and make the shopper wonder what exactly that means.

After the observations of all twelve grocery stores, I decided to have an informal interview with a manager from a Kroger in a lower income area. My goals were to obtain some samples on their recorded highest areas of waste and figure out what Kroger’s plans were to reduce that amount of waste, on a corporate level as well as a local level. I was also curious about what Kroger’s goals were overall with sustainability and where they plan to go as a company in the next five to ten years.

I also wanted to look more into the cyber-side of things, from the perspective of Industry 4.0, and learn about online grocery shopping and where it is currently at. This led me to having another informal interview, but this time with a user of Meijer Curbside.

I wanted to learn more about the exact process of online grocery shopping, as well as figure out what customers like and what they do not like about the process.

Finally, I found where I truly wanted to focus my research and that's when I chose to volunteer at the Gem City Market, a co-op founded by Co-op Dayton. This led me to find three potential solutions to help solve the issue of food insecurity.

Results

Due to Kroger being the common grocery store in all three different areas, I chose to mainly use that information to compare the differences.

After entering the grocery store, I noticed different things at each location. At the lower-income Kroger, I saw large yellow signs in almost every area that read, “Low Price!” as well as the largest signs in the entire grocery store (Ref. Figure 3). In the lower-to-middle and middle-to-higher income areas, I saw many signs about Kroger going local and organic. The signs were greener and had more of a clean look to them that made the grocery store look “high end” (Ref. Figure 4).

When looking at the produce, the middle-to-higher income areas have a much larger variety of goods (Ref. Figure 4) when compared to the lower income areas. The section itself in the higher income area is much larger. In some grocery stores, the produce section was at least double in size. The produce at the higher income grocery stores was very fresh and was fully stocked with many options to choose from (Ref. Figure 5). Looking at tomatoes and avocados for example, there were multiple brands and types of each item, whereas at the lower income grocery stores, there was only one type and kind of produce items, and the stock was much lower and not much to choose from (Ref. Figure 6). Due to there not being a large produce section in the lower income areas, I continued to observe the other sections of the grocery and noticed there were many non-produce items that were high in fats, calories, carbs, or anything else that is filling. This food was also significantly less expensive.

When analyzing organic and dietary restriction sections, almost every grocery store had an organic section. The higher income stores also had a “non-dairy” refrigerated area, which contained a wide variety of goods that seemed to replace most dairy items. At the lower income stores, the organic section was usually a fourth of the size, sometimes smaller, and did not have a large variety.



Figure 3. Largest advertisement in Lower-Income Kroger.

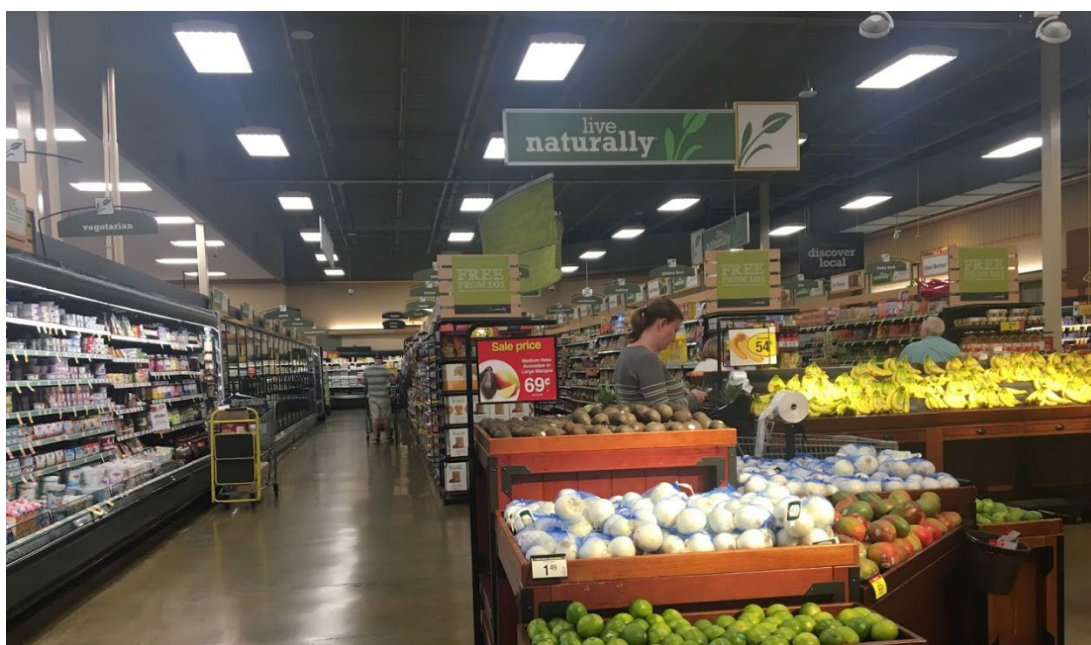


Figure 4. Part of the produce section at Middle-to-Higher Income Kroger.

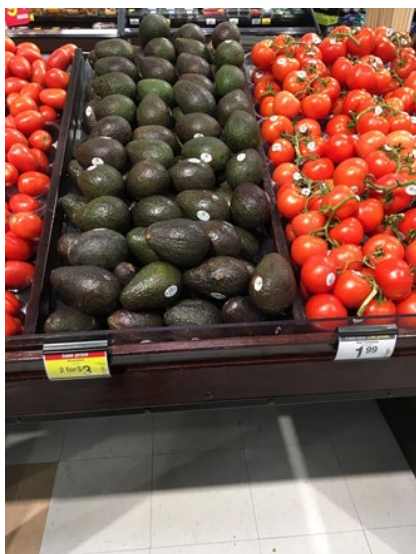


Figure 5. Produce from a Middle-to-Higher Income Kroger.



Figure 6. Produce from a Lower-Income Kroger.

After visiting the grocery stores, I chose to speak to a manager from one of the Kroger stores to obtain a more personal and local point of view of the sustainability methods and goals to eliminate waste. After the informal interview, I researched further into Kroger's sustainability goals online and everything seemed to line up from a corporate perspective as well. I achieved only half of my initial goal due to the fact that the manager was not willing to share specific information on the highest areas of waste, so we mainly discussed how waste is aiming to be reduced at Kroger.

This manager discussed their "Shrink Care" with me, which is what Kroger calls their "sustainability commitment" and "was developed to take steps in further reducing waste" [3]. Kroger has been making an effort to go local, but local is defined differently for each company, due to mainly the large size of some companies, like Kroger. Kroger corporately is committed to zero food waste by 2025 and is very confident in this goal [3]. The manager stated that Kroger is committed to eliminating plastic shopping bags eventually, but stated the time that would happen has not been confirmed. As far as what Kroger is currently doing, they have created a bag recycle barrel, which is where customers can bring their own recycling in, so it is not being wasted. Kroger also takes food that is still edible to food banks, and puts produce on sale if it near expiration. This Kroger, I am not sure about every Kroger, has created a "clearance rack" for produce where they will bundle different produce items together and the bundle will only cost around \$1 to also help produce near expiration to be sold.

Next, I had an informal interview with a user of Meijer Curbside. We discussed the pros and cons of the online pickup option (Ref. Table 2).

Pros and Cons of Meijer Curbside	
Pros	Cons
<ul style="list-style-type: none"> • Convenience • Can make changes to order up to 3 hours before pickup • \$10 fee but saving money in long run <ul style="list-style-type: none"> ○ Aren't buying things you don't need • Loves staff <ul style="list-style-type: none"> ○ Pick out desirable produce • Can add notes to list <ul style="list-style-type: none"> ○ i.e. "make sure avocados aren't too ripe" • Still get all sales as inside grocery • Website is simple and easy to use 	<ul style="list-style-type: none"> • Some items aren't in stock <ul style="list-style-type: none"> ○ They don't tell you right away <ul style="list-style-type: none"> ▪ 1 hour before or at pickup time ○ Can tell them to substitute items <ul style="list-style-type: none"> ▪ Can be very different • The system could glitch since it's online <ul style="list-style-type: none"> ○ Hasn't happened yet • Less exercise • Don't get personal time that you would at the grocery • Not every store has this option

Table 2. Perspective on the Pros and Cons of Meijer Curbside.

The main thing the user liked about Meijer curbside was its convenience. They loved that they could sit at home and order their groceries while watching their children and picking out whatever time they wanted to pick the groceries up. The user stated that they receive all the same sales as inside the grocery, and the website is extremely user-friendly, even for someone who is not very experienced with computer use. The user is someone who is very picky about their produce, but they stated that the staff at Meijer picks out exactly what is desired, and you can even specify the ripeness of your produce in the notes

section. Changes can be made to the order up to three hours before pickup, and there is only a \$10 fee. The user said they are actually saving money in the long run because when they normally physically go to the grocery, there are many things they will see in the aisles and grab them because in the moment it sounds good [2].

There were a few things the user disliked about the website as well. When you are ordering, the website does not always say if things are out of stock. Sometimes, you can order an item and Meijer will not notify you the item is out of stock up until an hour before or even at pickup time. There is an option to substitute if an item is out of stock, but the user said they never do this due to the fact that the item that is substituted could be nothing like what you originally wanted. The user also stated that many people enjoy going to the grocery and use it as exercise and also to get out of the house, and this user specifically will still go to the grocery store physically when they want to take their time and just browse the aisles. Another downside to using something online is the system could glitch. This has not happened to the user yet, but they said it is a potential cause to not use this shopping option. Lastly, the user also brought up that not every location currently has this option, so mainly in lower-income areas, it is not accessible to everyone [2].

Lastly, I participated in a volunteer-internship with the Gem City Market (GCM), and am currently still volunteering there. Since GCM is run by Co-op Dayton, this introduced me to the idea of a co-op. Defined by the International Co-operative Alliance, “A cooperative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise.” [13] This means that people gather together

and become members (or shareholders) of a company built by the community. This concept is great way to engage the community and bind them together, and also helps the economy. Instead of shopping at Kroger, Wal-Mart or Meijer and giving money to an external source, when you shop at a local grocer, such as GCM, you are putting money back into your own community. Members of the GCM also have a vote a community meetings, and organizes events such as the Healthy Eating Children's Cook-off, where children can participate and be educated on how to cook more nutritious food that they may not normally be exposed to every day. The GCM will also be hiring workers at a livable wage, they have been collecting receipts to see what people normally purchase at the grocery so that they can ensure their shelves will also be stocked with those items, and if the market is successful, shares will be given to members. The concept of GCM was created in 2015 and will be built by the end of 2020 where people will finally be able to shop at their own community market. [14]

After developing a research plan, choosing my participants and gaining results, I have gained a deeper understanding for how the retail world works on a physical level. I learned that even though it can be the same company, the advertisements can change depending on the socio-economic area. Industries do change the format and style of the store depending on the crowd, which is smart, but sometimes I think that can lead to a negative impact. I feel like my research was successful, because my goal was to show that those in lower income areas do not have the same food accessibility as those in higher income areas. If I were to look at different topics (education, housing, etc.) I am sure I would find similar systemic issues. The only thing I feel wasn't successful was how many different areas of food retail I wanted to look at in such a small time frame. I

felt like I sized down my research immensely from 2018, but looking back I should've focused on an even smaller sector of food retail. I am happy this is the topic I chose, because I gained a completely new perspective, I had no previous experience with grocery stores, aside from shopping at them. Now when I go to any new place, I find myself constantly looking at the area I am in, and if there is a grocery store nearby, and going inside and seeing if this is a place I would be happy with shopping at based on all the factors I looked into. This research has changed the way I look at the world, which I did not expect.

Data Analysis and Conclusion

The observations made in each area of income were almost parallel to one another. For example, the Kroger in the lower income area had similar results to the other three grocery stores in the lower income area, and the same pattern repeated throughout. Even though the grocery store changed, the advertising techniques and variety and quantity of products remained the same. The only variable that changed anything was the income of the area I was observing. The fact that the produce was less in quality, quantity and variety at the low-income grocery stores makes it difficult for people to want to purchase the produce. The consumers already do not want to purchase produce because it is less filling and more expensive than other foods, and now the consumers really will not purchase the produce because it is poor quality on top of all of that.

The consumers of all incomes should be encouraged to eat healthy and live sustainably. This should not be an idea solely for “the higher class”. As well as having organic and non-dairy sections. There are all kinds of people who have food allergies or people who just choose to eat a no-dairy or no-meat diet, and someone of a low income should not have to travel to a completely different grocery in a different area to purchase foods that meet their wants and needs.

After taking into account all research done thus far, I have created my own personal ideas that I believe grocers can implement into their stores that are small ideas, but will make a big difference in the long run.

I believe taking food to foodbanks, which most grocers already do, is extremely important. But more than foodbanks, more fresh food can be taken to many different

areas other than foodbanks. For example, perishable items such as produce can be composted if it is no longer edible, or if it is edible, it can be taken to places where people living with homelessness stay at.

I also believe shoppers should be educated on sustainability. Shoppers are going to make majority of the difference in the food retail industry, because the consumers are who keep the grocery stores in business. The grocery stores can only do so much, but once the consumers take the groceries home, what they do with them is completely out of the stores' control. Most people do not even know what is recyclable and what isn't, as well as how to even go about composting. If grocery stores even had simple advertisements that said, "Go Green!", and then in a smaller font, "Ask us for more information or go to our website". I believe the shoppers would highly consider going more in depth and learning about living more sustainably.

While looking at potential solutions to eliminate the food apartheid in Dayton, I have three ideas that I think have the potential to be very successful. The first being co-ops, that I stated earlier. Co-ops boost the community's economy, engage the community and educate shoppers on sustainability and the concept of having a share and a vote within their community [15].

Another idea is a mobile market. There is a successful mobile market in Kansas City, MO and it is essentially a food truck of produce. Their mobile market accepts all forms of payment, including EBT, and they have paid employees as well as volunteers [12].

My last solution is having grocery store chains, or even co-ops like GCM, partner with Community Supported Agriculture (CSA) groups. CSAs "allows city residents to

have direct access to high quality, fresh produce grown locally by regional farmers” [9]. One farm which participates in CSA is Mission of Mary Cooperative (MMC) which was founded by lay Marianists from the Dayton area [5]. MMC is a nonprofit and strives to help the food desert issue in the Dayton area by providing those of lower incomes with fresh produce at a more affordable price, while also being sustainable [5].

Another organization which grocery stores can partner with is Homefull, which is similar to MMC, but Homefull also has other services such as housing those living in homelessness [1]. I believe that if grocery stores partner with organizations such as these, it will help resolve the food desert issue, as well as improve the economy, similar to GCM, because those with lower incomes who do not normally purchase produce would start to. It would also be beneficial to the nonprofits, because the larger chain grocery stores could donate their compostable items to these organizations, which would be more sustainable as well as give groups, like MMC and Homefull, compost to use.

After analyzing my data and looking at conclusions, I wish I would have known at the beginning I wanted to focus on food insecurity. I began my research in 2018, and changed my focus mid-2019, giving me only about a year to tie together what I wanted my thesis to be about. I would have also been able to look into how lower income areas were affected by the pandemic and having to shop online, since many grocery stores in lower income areas did not originally offer online grocery shopping. There is so much more that needs to be analyzed within food retail, and I am excited to see where it will go in the future.

Recommendations for Future Research

Due to COVID-19, I was unable to get as far as I desired to in my research. I hope to continue this research in the future, and these are the topics I wish to look deeper into. In the future, I have many different directions I could potentially elaborate on with my research. My ultimate goal is to help fix the issue of food insecurity in Dayton, but I would still like to finish my field work of looking at grocers in different incomes and relate back to Industry 4.0.

I need to see if the Gem City Market is repeatable before determining it to be a 100% successful solution. Although GCM was created in five years, not every area of lower income will be as quickly to respond as the Dayton community was. This project was built pretty quickly due to the amount of people who volunteered their time, effort, and finances, and that might not be the case in every neighborhood.

Another goal is to introduce the idea of a mobile market to GCM and see if they think it would be successful. One downfall of a mobile grocer is the pricing. Like most small businesses, the pricing is not as cheap as Kroger or Wal-Mart because a truck can only hold so much food, making the quantity less and the price more in order for the company to make a profit.

I also would like to see if it is possible for CSA groups to be on a larger scale than they already are. When I volunteered at MMC, they had five farms and were still growing, but I am not sure if MMC would be able to meet the needs of a place like Kroger, but I think it is definitely possible for them to partner with a co-op like GCM.

When looking back to grocery store chains, after speaking with the manager at Kroger, I learned that the method that is already set in place to deliver food to local food banks is not at its full potential and could be reorganized. I would like to research further into what that distribution looks like, and how it could be altered to be more organized and be more beneficial to Kroger, along with other grocery store chains, as well as the food banks. I want to see if these large-scale grocery stores can have that local impact like GCM does. Obviously local has a different definition with a larger store, but there are still ways to support more local efforts.

Furthermore, I would like to look deeper into online grocery shopping and its future. I believe online shopping in general is increasing daily, especially once COVID occurred. I would like to incorporate online grocery stores in my overall method of sustainability, but I have to make sure the method is proven to be more sustainable than physically going to the grocery store. In its current state, I think online grocery shopping is just more convenient as opposed to sustainable since the only difference is, people aren't getting out of their cars. I believe things like Shipt are more sustainable, because it is one person driving to the grocery store and delivering groceries to various places. I think there is a lot of potential to make online grocery shopping more sustainable.

Another potential area of study could be looking further into online grocery shopping at chains that do not have a physical store, more specifically, more along the catalog route to places such as Schwan's. I am interested to see if their methods of delivery and transportation are more sustainable than what physical stores are already doing, and if we could implement their methods into this sustainability method and use it as a model for grocery stores.

I also think it would be interesting to look at the shoppers and their contribution to waste and sustainability revolving around grocery stores. While I cannot change people, I can encourage grocers to educate their shoppers and create more of an awareness of sustainability. I know many people are still using plastic bags, and are not aware that places like Kroger will recycle your bags for you if you bring them back to the store. I think shoppers need more education on how to recycle, compost, and simply live more sustainably. I know for myself; I was too scared to ask what was recyclable and what wasn't, thinking everyone knew but me. Educating consumers is essential to creating a more sustainable environment in all aspects of life, including while grocery shopping.

When looking back over my research, I have learned that everything is tied together. I think that is why it was so difficult for me to only focus on one area of study. I wanted to look at those affected, the customers, how they were affected, by grocery stores, and why they were affected, which was due to food insecurity and socio-economic status. This is a real issue that needs communities to come together to help resolve it, which is why I am so passionate about the topic. These issues won't be solved by one thesis, or one person trying to make a change. I am thankful that I am a Dayton-local, so that I can remain in this community and try to help as much as I can.

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