WPI Dining Services Delivery Plan

A Major Qualifying Project

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Abstract

The WPI Dining Services Delivery Plan project evaluated three major methods of delivery implementation for WPI Chartwells, identified the demand for a delivery service, and provided recommendations to achieve a successful, efficient, and more profitable service. It was in the best interest of both Dining Services and the team to help facilitate the life of the WPI community through the delivery service. The team conducted expert interviews, surveys, data transformation, decision making and risk analyses, and a Monte Carlo simulation to accomplish said outcomes. As a result, the team recommended sponsor WPI Chartwells to partner with Starship robot company to provide their service - helping Chartwells take the next step into both their business growth and modernization.

Authorship

During the three-term period that this project lasted, all of our members (Clarissa Casilla, Hannah Gelman, Alejandro Gerov, Abigail Perlee) contributed to the many steps that this project needed. All members put efforts in writing, editing, formatting, creating deliverables, and analyzing during the three terms that this project required.

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Executive Summary

This Major Qualifying Project (MQP) was completed in academic year 2021- 2022 in collaboration with Chartwells dining services at WPI. The original objective of this project was to enable Chartwells to operate a delivery service for food on the WPI campus. This service must be easy to use, be beneficial to students, and be cost effective for Chartwells. Dining services began offering online ordering during the COVID-19 pandemic, and the success of this program made them optimistic about offering a delivery option. Services like these are becoming more popular on campuses across the country and WPI did not want to get left behind.

The first objective of this project is to determine the demand for a delivery service on the WPI campus. If students would not use the service, then it would not be worth implementing. This objective was accomplished primarily through a survey of WPI students. This survey determined that there is demand for this type of service on the WPI campus. Additionally, the survey found that students would be willing to pay for this service and tip their delivery person. The positive results of this survey allowed the team to move on to the next objective of this project, determining the ideal implementation of a delivery service for the WPI campus.

Determining the ideal delivery method was the largest part of this project. This was accomplished through meetings with our sponsor, a literature review, and various modeling techniques including an influence diagram, SMARTER, FMEA, and Monte-Carlo simulation. The influence diagram helped us visualize how important decision factors interact in a clear way. The SMARTER analysis method helped us show which attributes are the most impactful for each delivery method and identify the best alternative. The FMEA method allowed us to determine the risk levels of all steps in each process of the different delivery options we evaluated, identifying failure modes, and providing control recommendations. The Monte-Carlo analysis simulated the different delivery scenarios we studied and calculated the expected net cost of each delivery option. This helped us study the impact of different variables through a sensitivity analysis. Additionally, the team conducted trial runs on campus to test the various methods. There are many different options for a delivery service including using student workers, using a third party, and using delivery robots. Each of these options was analyzed in order to create recommendations for Chartwells. Once a delivery mechanism is decided, Chartwells will need more information before being able to implement their chosen delivery system.

The final objective of this project was to determine the expected demand for this service. Our team used forecasting techniques and the results of our survey to predict the demand for this service. These forecasts will allow Chartwells to plan appropriately for the demands of delivery. The final result of this project is a set of recommendations for Chartwells detailing the ideal method for implementing a delivery service on the WPI campus. Each possible option will be evaluated for risks, costs, and overall satisfaction in order to make recommendations.

1.0 Introduction

1.1 Project Motivation

The motivation for this project is to help the WPI community have easier access to food from our dining services. This is also an opportunity for Chartwells to take the next step into their business growth and modernization. As WPI students, we believe our school should offer such highly demanded and necessary service to our community. With this project, we aspire to evaluate different business strategies and models of a delivery service for our campus.

1.2 Background

Worcester Polytechnic Institute has over 6000 undergraduate and graduate students, faculty, and staff (WPI, 2021). WPI is partnered with Chartwells Catering, which offers dining services to over three-hundred universities nationwide. It currently has three main dining locations:

- Morgan Dining Hall
- Campus Center Food Court
- Goats Head

The three locations have a variety of vendors within each one, and it is expected for Chartwells Catering to expand its locations in the future as needed by how the campus grows. WPI and Chartwells Catering are separate entities/businesses, so that means it is looking to make a profit on its own, without financial help from WPI (Joe Kraskouskas, personal communication, September 3, 2021; RoaringSky inc, 2021).

Chartwells Catering offers three main ways students can purchase a meal on campus which is described in Table 1.

Table 1. Chartwells Catering transaction classification

Meal Swipes	At the beginning of each semester, students can opt-in to one of the meal plans options available. These plans offer a different number of Meal Swipes and Bonus Points to be chosen depending on the person's needs. Customers can exchange these swipes for their meal equivalent foods in each of the locations.
Digital Cash	WPI has two different types of digital cash: ● A small amount of Bonus Points is included with the purchase of meal plans. They usually amount to less than $200 per semester. ● Goat Bucks is a debit-based currency where students can load a fixed amount of money to their student account. The transactions that happen through Goat Bucks get a 10% discount for transactions within the campus.
Regular Transactions	Debit Card and Credit Card options are also available at the dining locations.

Chartwells Catering's search to modernize itself in WPI's campus led to implementing a third-party app called GET, which has worked with Chartwells Catering in other universities, to allow for the online ordering of meals for pick-up. Allowing for online ordering, helped during 2020 where students couldn't experience the campus at full capacity due to the Covid pandemic. The next step Chartwells Catering would like to proceed with is to implement a delivery service for the dining location as several other universities have started to do (Joe Kraskouskas, personal communication, September 3, 2021).

1.3 Problem Statement

Chartwells dining services requested help from our student team to implement a food delivery service around the WPI campus. There is currently no delivery service run by WPI dining services. In the past two years, the school has been enforcing Covid regulations regarding the students' capacity in dining rooms due to social distancing. Furthermore, many students have had to quarantine or isolate due to exposure or close contact to Covid. Dining services have implemented new contact-free ways to order online through the app and fast food pick-up service in order to adapt and combat the restrictions experienced during the pandemic. Although these new additions have been successful, students have shown interest in a food delivery service where they can order food and receive it at their doorstep without having to leave their homes. With other schools executing deliveries as an easy way to provide food to their students, Chartwells saw this as an opportunity for the next step of growth for their business.

There are a few obstacles that the team identified and needs to work through in order to successfully design a delivery service for WPI. There is currently a shortage of workers at WPI working for dining services. To address this gap our team is going to investigate using student workers for the delivery service. An additional challenge for this project is that Chartwells is a for-profit company so the delivery service must be a profitable or at least cost-neutral solution for the company. The ultimate obstacle is to ensure the service is efficient and competitive compared to leading delivery companies and neighboring restaurants that offer delivery. In order to ensure this, students will have the option to pay for their food with goat bucks and meal swipes. Chartwells is seeking to get a head start due to the recent surge in delivery services, in order to have a well-established delivery service in a post-Covid era.

1.4 Project Goals and Objectives

This project has one main objective with several goals that will allow successful creation of a campus delivery service. The main objective of this project is to evaluate multiple delivery options to provide recommendations to Chartwells regarding the best option available for delivery service. Each goal will be completed during the course of the project to achieve our main objective. The first goal of this project is to identify the demand for a delivery service at WPI. This will be accomplished through a survey distributed on campus. The next goal is to determine the ideal way to implement a delivery service. We evaluated the different decisions that Chartwells must make during the process of implementing a delivery service. These decisions can be summarized by the following questions:

- Does Chartwells benefit more from outsourcing the delivery service or provide the service themselves?
- If outsourcing is the winner solution, then which outsourcing company is the most beneficial?
- If Chartwells should provide the delivery service itself, then which delivery mechanism would be best?

Our team will answer these questions by conducting research described in the Literature Review and in the Methodology such as simulations and risk analysis. Another goal of this project is to find the expected delivery volume by studying previous transactional data and surveying the student body. Once the expected volume is known we can gain insight into expected labor requirements and costs. These forecasts will allow Chartwells to plan appropriately for the demands of delivery. Finally, the team will determine the delivery fee for this service by surveying the students and analyzing the demand. It is essential to have a fair delivery fee. If the fee is too high students will not use the service, if it is too low then the service will not be financially viable. If all of these goals are successfully completed then our proposed delivery service will be cost-neutral, efficient, and have a positive impact on students.

2.0 Literature Review

In this section, we will conduct research about how the delivery service market has increased in the past two years leading to an increase in demand in the food industry. We discuss the market competition locally surrounding WPI Dining Services, as well as nationwide with popular third party delivery applications. We analyze labor, worker shortage challenges, and the supply chain requisites to ensure a dining service's success.

2.1 Delivery Service Market

In late 2019 the COVID-19 virus was spotted in the United States, this was the beginning of a global pandemic with long-lasting effects on all aspects of life. In the United States alone 680 thousand people have lost their lives to COVID-19 so far, with more cases appearing each day (Hollingsworth, 2021). Due to the highly contagious nature of this virus, many precautions were taken on both a local and federal level. These precautions include stay at home orders, mask mandates, and limited occupancy for restaurants and stores. These restrictions forced restaurants to change their operations to increase takeout and delivery options to accommodate the new normal. Many companies were able to capitalize on the shift in service needs, including UberEats, Grubhub, and DoorDash. For example, in 2020 GrubHub reported a 53% increase in revenue compared to 2019, with over 15 million new users joining the site in 2020 alone. Additionally, DoorDash saw 543 million completed orders in the first nine months of 2020, up from only 181 million during the same period of 2019 (Sumagaysay, 2020). These delivery apps were able to operate during a global pandemic that crippled many businesses. Unfortunately, one of the major ways they stayed profitable was through fees. These apps charge up to 30% to the restaurant plus a flat delivery fee for the customer. As many restaurants struggle to stay open during lockdowns, these fees can prove too much. According to the National Restaurant Association, the average restaurant only operates on a 6.1% profit margin (Biery, 2018). Meaning that for every dollar spent in a restaurant, that restaurant will only profit 6.1 cents. This small margin means that any fee can be detrimental to their bottom line. As COVID-19 restrictions get lifted across the country these apps have seen a slight decrease in sales but not back to the level they were at before the pandemic. Looking ahead, now that so many people are actively using these delivery apps, even after the pandemic ends many experts think they will continue to thrive. Quick, cheap, and convenient meal delivery has become standard for consumers across the country, and that expectation will continue long after the COVID-19 pandemic ends (Durbin, 2021).

2.2 Market Competition

To implement a delivery service at WPI, it is important to assess the competition with surrounding restaurants that have high demand from the same customers: WPI students. The restaurants located within a 1-mile radius are The Boynton, Tech Pizza, Thai Time, Sole Proprietor, Dragon Dynasty, Boomers, and Taqueria del Pueblo. In order to assess their delivery system, we visited all of the restaurants. We informally asked questions to learn more about their costs of delivery, delivery transportation, and peak days for delivery requests. Table 2 shows the list of the restaurants we visited with their respective requirements for delivery.

Table 2. List of restaurants within a 5-mile radius from WPI with their requirements for delivery

Restaurants	Delivery	Requirements/ Reason
Boomers	Yes	$1 delivery Fee (goes to driver); Anywhere near WPI
Thai Time	Yes	$25 min - Self Delivery; or GrubHub and DoorDash
Taqueria del Pueblo	No	Already too busy; Bad reviews during deliveries; Apps have very high fees
Tech Pizza	Yes	Only near WPI area
Sole Proprietor	No	Not enough staff; satisfied with current success without delivery (only dine-in and to-go orders)
Boynton	No	Not known
Dragon Dynasty	No	Not enough workers

After visiting the restaurants, only 3 out of 7 have a delivery system implemented. The first restaurant that offers delivery is Boomers. They started self delivering about 10 years ago, and not much has changed since then. Their requirements are simple, there’s a driver in charge of taking the food to the customers’ locations. If the customer is within the WPI area, the delivery fee is $1, anything further than that, the fee is $5. The money collected from the delivery fees, plus any tips, go directly to the driver. Customers can put in their orders via the Boomers app, through their website, or by phone. Since Boomers’ delivery is cheap and easy, most WPI students like to order delivery during the weekdays. Thai Time offers two delivery options: a minimum order requirement of $25 for their driver to deliver the food without a delivery fee, or using external apps like GrubHub and Doordash. Any order under $25 has to be requested on an external app. The Thai Time manager mentioned that it is not economically feasible to have their driver deliver small orders due to time, gas, and distance. Lastly, Tech Pizza is the third restaurant that offers delivery in the area. Since it's smaller, the owner does the delivery himself only in the WPI area. His deliveries have no extra fee, but they must be paid in cash. He does the delivery by walking to the nearby locations.

Other restaurants that don't offer delivery have restraints including fees and worker shortages. The newly opened Taqueria del Pueblo mentioned they already have too many customers with dine-in and pick-up options. With their other location, they tried implementing delivery, but the food wasn't arriving on time, and with lower quality. This was causing bad reviews on their page, and they didn't want to allow this to ruin their reputation. Lastly, the external apps they have tried using have a very high fee, and with the prices the restaurant offers, it was not feasible. Similarly, The Sole Proprietor, opened in 1979, has never offered delivery. After Covid, they were faced with a worker shortage, and they already have high demand with dine-in and to-go orders. Dragon Dynasty faces the same issue with the shortage of staff. They have considered implementing a delivery system, but without workers, they can't supply all of the demand. Finally, The Boynton has no plans of implementing delivery. They are satisfied with the demand and reviews they currently have. The restaurant did use an external app to deliver during Covid, but stopped using it due to the high fees of the app. It was interesting to learn the reasons for some restaurants not offering delivery, as they are similar to the constraints Chartwells has with the implementation of the delivery system. The constraints include worker shortages with very high demand, and a high-service fee for using available third party food delivery apps.

2.3 Digital Technology in Industry

There are many different delivery apps out there that thousands of people use every day. The most popular of these apps are Uber Eats, DoorDash, and Grubhub. All of these applications are very similar and just have small details that differentiate them all. Uber Eats is a food delivery service that is an offshoot of Uber, which is a ride service. You can use the Uber Eats mobile app or its website to order food from restaurants and have it delivered to your home for a small fee. Whether you are on the app or website there are many ways to search for food and restaurants (Helling, 2021). One doesn't need to get their food delivered right away either, they can place the order ahead of time and get it delivered at a specific point in time. UberEats charges a service fee with every order, and each restaurant can decide if they charge additional fees for deliveries. The UberEats fee for the customer is 10% of the order value and requires a minimum of $1. The customer needs to pay this fee in addition to the cost of their meal. In addition to charging the customer, uber eats charges restaurants a 30% commission on every single order (Helling, 2021). Delivery drivers who work for Uber can work whenever they want without a set schedule. They can just log onto the app when they want to work and log off when they are done.

DoorDash works in a very similar way to Uber Eats. Customers simply place their delivery orders online on the DoorDash website or on the app. There are many features of the app that help users choose the food they want to order. The company hires its own drivers who are called Dashers and the delivery fee for the app charges between $5 to $8 per order, which goes directly to the driver. The dashers have the ability to accept orders whenever they want to work. DoorDash charges a commission percentage of 20% from restaurants for each order. They also charge restaurants for their marketing and advertising on their DoorDash App. So, DoorDash makes money from each restaurant from their commission charges and also the restaurant's marketing on the DoorDash app. (Vivek, 2016).

Grubhub is another app that customers can use to get food delivered to their homes. Customers can look at all the different restaurants available on the GrubHub app or online website. The customer can choose to pay online or with cash. Once a restaurant receives an order they have to confirm it based on their availability. When an order is confirmed, a Grubhub driver can accept the delivery request and go to the restaurant to get the order. Grubhub has multiple fees attached to each order as do the other food delivery apps. There is a delivery fee that helps cover Grubhub's delivery-related costs. Next, there is a service fee that is usually 5-10% of the order. In addition, there is a small order fee which is an order under $10 and you'll need to pay a $2 fee at most restaurants. All of these fees are costs that the customer has to pay to the app and the money goes right to the driver. Grubhub also charges 27% as commission to participating restaurants. This is the only money that the restaurants need to pay to GrubHub. Lastly, most customers will choose to tip the driver and that money goes right to them (Rose, 2020).

EatStreet is another delivery service application. Although it's not very popular, it has a unique feature that sets it apart from the above-mentioned ones. EatStreet hires drivers as part-time employees, instead of hiring them as independent contractors. Drivers have to update their work availability for the week every Monday, entering the desired number of hours they wish to work through the app. Then, each driver has a manager in charge of making the schedules, this ensures constant communication and flexibility. If a driver wants to take more hours than originally planned, the manager will arrange that. The same applies if the driver can't make the hours they had scheduled. Furthermore, EatStreet offers great bonuses. They pay a wage of $10 per hour, drivers keep 100% of the tips, and they offer a $250 bonus for new drivers. Two of the benefits of being part-time employees, is that they don't have to pay contractor taxes, and they get dental and vision insurance. This service has expanded around 49 states in the US, with 200 employees, 800 drivers, and 15,000 restaurant partners (Khatia S, 2021).

Tapingo is another delivery service similar to GrubHub and UberEats, however, unlike those apps, it is staffed completely by students. The service works with both on and off-campus dining options and students can use their school meal dollars to pay for their meals. Tapingo CEO explains that out of all of its competitors, Tapingo offers the lowest delivery fees. Since Tapingo delivers to such a condensed area like a college campus, workers can deliver 3-4 orders an hour. Student workers can work on their own schedule and just turn on the app whenever they want to accept a delivery. The delivery app has a few unique features. The first is scheduled ordering so a student can place an order up to 36 hours in advance for pickup by the delivery driver at a certain time. The second feature is called quick picks which lets vendors identify items that have minimal prep times so student drivers can order them for immediate pickup (Tepper, 2015). Tapingo was actually acquired by Grubhub in 2018.

Another student-run delivery service that is currently being used by Washington University in Missouri is called DormDrop. DormDrop was founded by a group of WashU students who wanted to bring more convenience to the student body. To use DormDrop a student must sign up using their campus email address and delivery location, place their order by filling out the order form, and receive their delivery. Students order food using meal points through GrubHub. In order to become a delivery person, or "dropper," a student fills out an online interest form with their address and performed hours for each day of the week, and a DormDrop team member will reach out to them (DormDrop, n.d.). It can be seen that between all the food delivery apps on the market, students have many options when choosing how to get food delivered to their doors. Table 3 presents a summary of the delivery apps, their fees for the customers and for the food providers.

Table 3. Summary of Prices and Fees for current Delivery services on the market

Service	**Price of Service paid for by Restaurants**	**Delivery Fee paid by Customers**	**Service Fee paid by Customer**
UberEATS	15%-30% commission on depending on Subscription type	$10 - Free Depending on subscription with Restaurant	15% of Subtotal
DoorDash	15%-30% commission on depending on Subscription type	$2.99-$5.99 Depending on subscription with Restaurant	10% of Subtotal
Grubhub	5-20% marketing commission + 10% for delivery commission	Price set by restaurant, no restrictions	6.25% of Subtotal
Dorm Drop	0, Service provided by university campus	$0.99 delivery Fee	Included into Meal Plan

2.4 University Examples

WPI will not be the first school to implement a delivery service as a part of their dining halls. As delivery apps became more popular and COVID restrictions forced students to stay home, many universities implemented delivery options. These delivery programs vary greatly between schools from student-run efforts, full-time drivers, and even robots. These programs have also had varying levels of success, with some seeing quick returns and some never making it off the ground. In order to create a successful delivery service, we must understand the successes and shortcomings of existing delivery efforts on college campuses.

One example of a dining hall sponsored delivery service is at Ohio State. By partnering with GrubHub, Ohio state was able to deploy a fleet of self-driving delivery robots. This fleet of 50 robots hit campus at the start of the 2021 school year. They are the first of many to be deployed as part of an ongoing effort by GrubHub to deploy delivery robots on 250 college campuses across the country (Helling, 2021). The delivery robots are fully autonomous and utilize sidewalks to navigate the campus. These robots are made by a company called Yandex but are very similar to the Starship robots which will be discussed in depth later in this report. All 60,000 students at Ohio state will have access to the delivery platform during their operating hours between 9 am and 9 pm seven days a week. Students can place an order directly through the GrubHub app and receive meals from any on-campus dining hall. By partnering with dining services at Ohio State, GrubHub is able to accept student meal plans for the delivery service. Currently, this service is limited to all of the residence halls, and the campus library, although there are plans to expand the delivery radius in the future (Littman, 2021). By utilizing the existing GrubHub app and partnering with Yandex, Ohio State has created an effective delivery service for students.

2.5 Forecasting for Food Industry

In order to forecast, we need to understand the food industry and its labor. The past two years have been atypical for the food industry. With increasingly high demand and fewer employees, every restaurant is left with an employee shortage. We investigated the causes for this shortage in WPI, in the state of Massachusetts, and nationwide. When the pandemic started in March of 2020, most students were sent home to quarantine, but not every student was able to leave. With half of a semester remaining, the students, unable to go home, decided to stay on campus, many of which had a meal plan and solely depended on Dining Services to eat. This meant WPI Dining Services couldn't close. Most of the employees were sent home, and Dining Services was left with the few needed to help comply with the students' food demands. Similarly, restaurants around the nation faced an equal situation.

A year later, during the "post-pandemic," we see how every business has been economically impacted, and in desperate need for workers. The US has recovered 76% of the lost jobs during the Spring of 2020 (Davidson, 2021). Yet, after months of long-term unemployment, there are still workers holding back to go find jobs. Job levels fall under a 4.3% shortage based on the pre-pandemic statistics (Lotito et.al 2021). Furthermore, there isn't an urge to find jobs due to the newly added regulations to protect unemployed people. Figure 1 shows a list of reasons by percentages of unemployed workers not searching urgently for a new job.

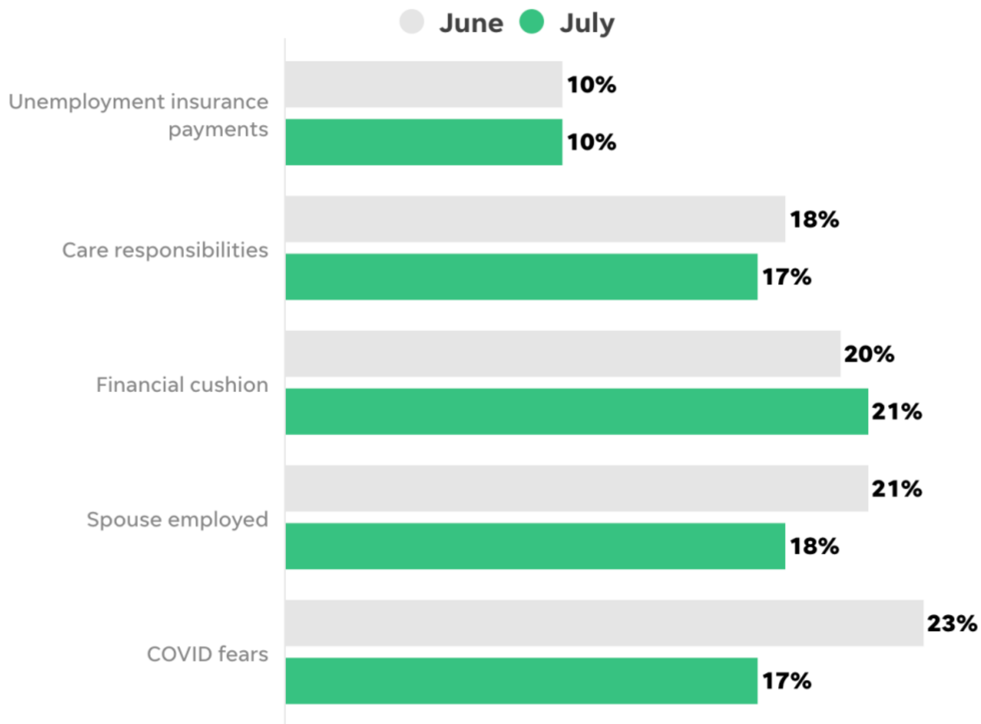

Figure 1. List of reasons by percentages of unemployed workers not searching urgently for a new job June-July 2021 (Davidson, 2021)

There are a number of reasons why some people prefer to remain unemployed longer. With vaccinations, the fear of Covid has decreased, and financial cushion is the highest percentage reason for remaining unemployed. Since the pandemic, more than 500 laws and regulations have been added. The regulations include paid time off to get the vaccine and to take care of a sick family member. Nearly 7.5 million people that wouldn't normally qualify, are benefitting from these regulations and earning money without working (Davidson, 2021). This is what is causing that financial cushion. Furthermore, with such high demand for workers, the law of supply and demand becomes a key factor. Knowing the increase in demand, workers have the ability to choose and request better pay and better benefits. Workers in the food industry are at an advantage, because nearly every restaurant is hiring.

WPI Dining Services is suffering from this shortage. They have to economically compete with other food services from all the universities near the area. As shown in figure 2, to overcome this shortage they will have to offer higher salaries, more benefits, and training (Campbell, 2021).

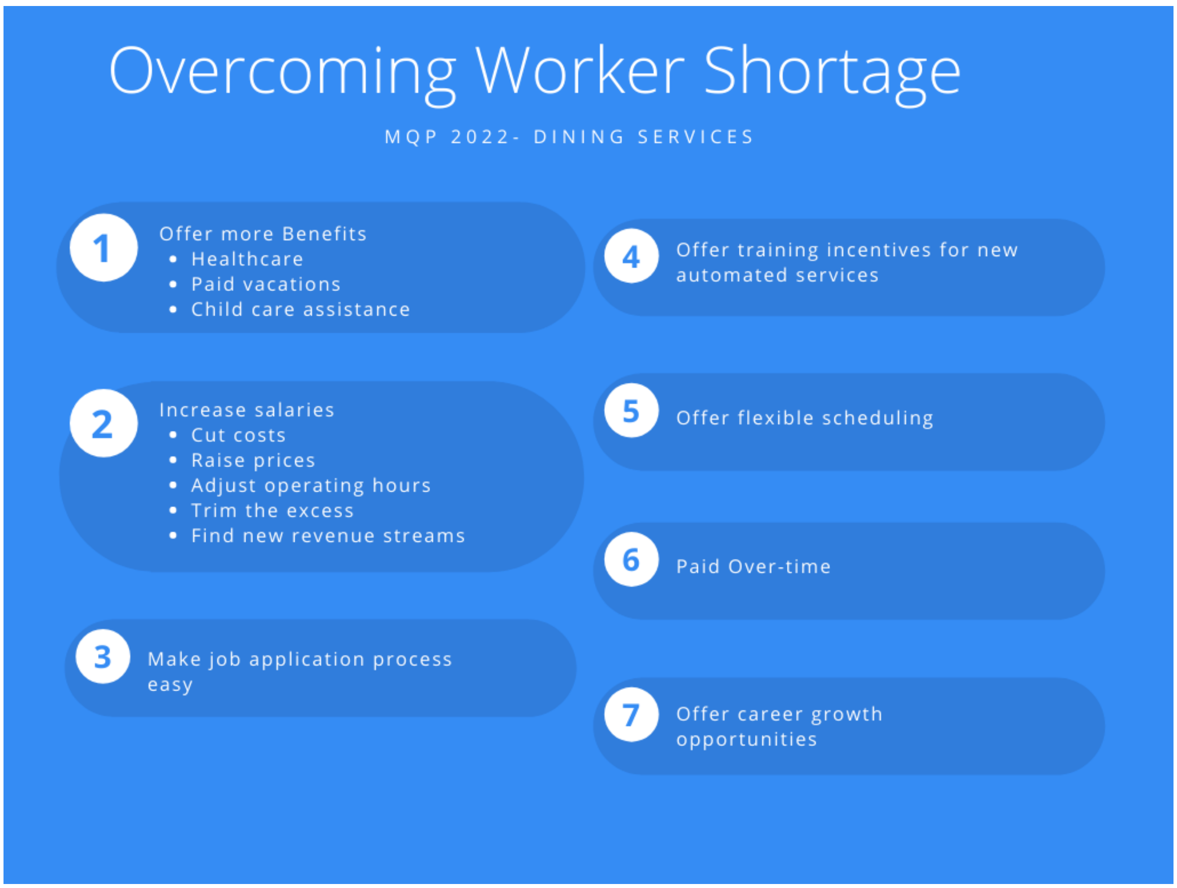

Figure 2. List of steps Dining Services will need to take in order to overcome the worker shortage

2.6 Describing Common Delivery Models

Meal delivery is not a new concept. Restaurants in America have been delivering food since the 1950s. Originally, this service was limited to pizza restaurants because of the ease of transporting pizza and the wide customer base of these restaurants. The introduction of delivery was so successful that restaurants at the time were doubling their sales with the new service (Viktor, 2021). Most restaurants follow the simple “restaurant to consumer” model for their deliveries. This is the classic model where to start the transaction a customer places an order, either over the phone or via a mobile app. Once the order is received the restaurant prepares the meal and a delivery driver brings it directly to the customer. These drivers are paid a nominal hourly rate and receive tips on completed orders. While it varies between restaurants, a small delivery fee is common to offset the labor cost associated with delivery. In most states, including Massachusetts, if a fee is labeled a “delivery fee” it must go directly to the driver, not to the restaurant. Depending on the location, drivers may use a car provided by the establishment they work for, their personal vehicle, or even complete deliveries on foot. The restaurant-to-consumer model has been successful for both small local restaurants and large chains including Domino’s and McDonald’s. This model has the notable advantage of keeping everything in-house, giving the restaurant full control of operations. This means there are no fees to be paid to a third party. This high level of control means restaurants can ensure a quality experience for customers. There are some disadvantages to the restaurant-to-consumer model as well. One large disadvantage is the liability associated with delivery drivers. If a driver is in an accident the restaurant would be held liable in the restaurant-to-consumer delivery model. Additionally, this model requires restaurants to pay delivery personnel so if the order volume is low they might not see a return (Brown, 2021). By keeping operation in-house the restaurant-to-consumer model maximizes control, but can also cause an added expense. This model works well for restaurants across the country but it is not the only option, as technology advances more delivery options.

As smartphones became more and more popular a new delivery model came with them, “platform to customer”. This is the model used by delivery apps such as GrubHub, UberEats, and DoorDash. These apps appeared in the early 2000s and have completely changed the delivery landscape. These services allow customers to order from a mobile app, those orders are then sent directly to the restaurant. A driver will then receive the request via the mobile app and pick up the delivery from the restaurant. This delivery model is widely adopted due to ease of setup and a large customer base. Drivers work directly for the delivery app instead of the restaurant itself. This means greater flexibility for drivers as they can clock in and out at their convenience and use their personal vehicles to perform deliveries (*Delivery Basics*, n.d.).

The platform to the customer model also allows drivers to deliver food from multiple restaurants, resulting in higher order volume. GrubHub, UberEats, and DoorDash all provide insurance for drivers, reducing liability for restaurants and drivers. With all of these advantages, it is easy to see why the platform to the customer model is so popular, but it also has some serious disadvantages. The most difficult aspect of these apps is the large fee charged to restaurants that use them (Viktor, 2021). These apps charge restaurants anywhere from 15 to 30 percent on all orders placed. On top of that, there is a delivery fee charged to the customer, typically between 1 and 10 dollars (Helling, 2021). With many restaurants operating on thin margins already, the high fees can mean deliveries cost restaurants more than they are earning. This puts restaurants in a tough spot, getting left out of possible orders by avoiding delivery apps, or losing profits to fees. When utilized effectively these apps can greatly increase profits by expanding the number of customers a restaurant can reach. Conversely, if a restaurant has small margins or a successful restaurant-to-customer delivery program, then these apps might do more harm than good to the bottom line.

As a way to deal with both the high cost of labor and the current shortage of workers, many companies have turned to robots as a method of delivery. Dominos, Amazon, and even a few college campuses have deployed delivery robots with varying success. One company, Starship, makes small robots that can autonomously deliver food or small packages. These 20-pound robots rely on a set of cameras and microphones to navigate their environment. By utilizing sidewalks instead of roadways, they can avoid traffic and other hazards. They move at the speed of an average pedestrian and are designed to be tamper resistant. Figure 3 shows a fleet of robots that Starship deployed at a different college.

Figure 3. A fleet of Starship robots deployed at a college campus.

These robots have become increasingly popular in recent years with many restaurants and college campuses utilizing their cheap delivery. In 2021 Starship made their one-millionth delivery via robot and this is just the beginning (Templeton, 2021). This is an exciting option for the WPI campus because these robots can attract new students to campus. In order to evaluate this option our team met with Starship to understand the costs associated with this option. Startup costs include mapping campus so the robots can navigate, software fees, and onsite support from Starship. Additionally, employees and students need to be trained on how to use unfamiliar robots. This meeting provided our team with the information needed to assess the viability of using Starship for our delivery system. All the information gained from meeting with Starship, along with our evaluation of this option is discussed in detail later in the methods and findings sections of this report.

2.7 Evaluating the Supply Chain in the Food Industry

One of the main challenges restaurants face daily is predicting how many customers are going to arrive. It is essential to know this because it determines how many ingredients will be needed, and it may even hint to the restaurant's management if better marketing is needed. However, there is no way to know for certain how the customer trend will behave, so this section will explore several methods to forecast customer behavior in the food industry which will help our project understand how to forecast the future food delivery system properly.

According to a study, eleven independent factors can explain customer behavior in the food industry at any time. These independent factors are shown in Table 4.

Table 4. Factors contributing to restaurant sales

Time	Month, week, day of week, hour
Weather	Temperature, rainfall/snow level, hour of sunshine
Holidays	Public or school holidays
Promotions	Promotion/regular price
Events	Events in the area/campus
Historical Data	Historical demand of data
Macroeconomic Indicators	Unemployment rate, population
Competitive Issues	Competitive promotions
Web	Social media comments/recognition
Location type	Type of venue
Demographics of location	Average age of customer

To successfully predict customer behavior, managers need to understand how these factors affect their business every day. Many managers rely on past experiences to make "judgmental" forecasting methods, but this leads to inefficient and possibly harmful results. The study mentioned above discussed several ways managers could standardize their methods to obtain helpful forecasting data.

3.0 Methodology

This section will detail the methods used to create recommendations for the delivery service. This project will rely on multiple methods including process modeling, and data collection. Each of these methods will work in tandem to achieve the project goals and objectives. If the methods detailed in this chapter are completed, our team will be able to make an informed and accurate assessment of delivery options at WPI.

3.1 Data Gathering and Analysis

The first phase in our methodology is data collection. This will consist of a survey of WPI students, a market study, and expert interviews. The data gathered will then be used as the basis of our analysis. It is important that accurate and representative data is collected so that the recommendations can be sound.

3.1.1 Survey of WPI Students

The first method the team took was to conduct a survey of students. This survey has been approved by the WPI institutional review board to ensure that no harm will come to participants. The information gained from this survey will be the basis of many of the recommendations made during this project. Successful survey design and distribution will be essential to the success of this project. The primary goal of this survey is to gain an understanding of how the current WPI student population would react to a delivery service. Participants can take the survey online through Google surveys. The survey starts with demographic information about the participants such as grade, meal plan status, and location of residence. These questions will help the team to aggregate answers based on different groups of students. Following the demographic information, students are asked if they would utilize a delivery service if one was offered. This question will allow Chartwells to be confident in whether or not a delivery service will be used by students here at WPI. Next, if the participant responded that they would use this service, they are asked specifics about how they would want it to operate. These questions include how long is an acceptable wait, how much a delivery fee could be, where they would order from, and how often they would use the service. These questions are to understand the expectations of the customer. Finally, participants are asked if they would be interested in working for the delivery service. This question is designed to gauge the amount of potential labor that is available. A full list of the survey questions is available in Appendix A. Our team carefully designed the survey, so each question provides valuable data for the creation of a delivery service.

When designing this survey, the number of responses was a top priority. This survey has to represent the student population of WPI so it is important that we get enough responses. With this in mind essential, questions such as “Would you use a delivery service” were put early in the survey so if a participant abandons the survey early, those answers will still be recorded. Additionally, many questions were left marked as optional. This is so that if a participant does not feel comfortable, or can not answer a question, they can skip it instead of exiting early. Finally, all of the questions are multiple-choice, or multiple-choice with optional comments. This design serves two purposes. The first is ease for participants to quickly complete the survey. People may feel intimidated by lots of short answer questions, but multiple-choice makes the process much simpler. Additionally, these answers will be much easier to analyze than written answers that would need to be categorized by hand. By being intentional with our survey design, our team will maximize responses and ensure that we receive usable data.

A survey is only as good as the number of participants that it reaches. This survey is attempting to represent the WPI undergraduate population. With 4,892 undergraduate students currently enrolled at WPI distribution will be essential. In order to determine a goal for the number of participants, our team used the following formulas. Table 5 shows the values our team used in order to calculate our minimum sample size.

Table 5. Values used to calculate the minimum sample size for our survey.

Variable	Description	Value
N	Population size, in this case WPI's undergraduate population	4,892
e	Margin of error. The allowable percent of variance between the sample and the population.	5%
z	Confidence level. Represented as a Z score, represents the reliability of measurements. For this study, a 95% confidence level is used.	1.96
p	Percentage value, based on responses to specific questions in a survey. First-time surveys such as this use a value of 0.5.	0.5

$$\frac{\frac{z^2 * p(1-p)}{e^2}}{1+(\frac{z^2 * p(1-p)}{e^2 N})} \rightarrow \frac{\frac{1.96^2 * 0.5(1-0.5)}{.05^2}}{1+(\frac{1.96^2 * 0.5(1-0.5)}{.05^2 4892})} \rightarrow \frac{2,936,423}{8,244} \rightarrow 356$$

Shown above are the calculations used to identify a statistically significant sample from the WPI population. This means that if the survey reaches 356 students then the team can confidently make assumptions about the rest of the population. In order to reach this many students, our team will utilize multiple distribution methods. The survey being digital makes these distribution methods very straightforward. First, the team will work directly with WPI dining services to post a link to the survey on their social media. The team is optimistic about this option because dining services regularly receive over one thousand views on posts made on social media. Additionally, posters featuring a scannable QR code will be posted on campus. In order to boost the effectiveness of these distribution methods, WPI dining has agreed to provide 10 gift cards, for $10 each, to the on-campus Starbucks to be raffled off to survey participants. If they wish to enter the raffle participants only need to enter their WPI email at the start of the survey. Once responses from this survey have been received our team will be able to move on to the other objectives of this project with confidence that our recommendations match the needs of WPI students.

3.1.2 Market Study

To understand the local demand within the WPI restaurants and customer behaviors, we collected data conforming to the transaction history from the past year across the different restaurants stored by fifteen-minute intervals. The C-BORD-system, which handles all the WPI ID card swipes, holds the transaction history database, and we export it out of the database as an excel file. With this data, we were able to understand how the customer cycles behave within the campus restaurants by identifying the peak times for each day of the week and the busiest days of the week throughout the term to see if there are any noticeable cycles between each academic term.

3.1.3 Interviewing experts

In this step, we will contact other Chartwells-partnered universities that have successfully implemented a delivery service. We will seek a contact within Chartwells corporate that can connect us to other universities' representatives. We will contact other universities ourselves to see how the process has been for universities outside of Chartwells. Our focus of these interviews with experts in the field is to understand the most common mistakes at the start of implementing such a service and advice on how to implement a successful delivery service.

3.2 Decision-Making Influence Diagram

We will construct an influence diagram. An influence diagram is a graphical representation of a decision at a certain time. This method will help us accomplish the goals of this project by understanding the factors needed to make decisions. There are different nodes to an influence diagram including decision nodes, chance nodes and consequence nodes. Calculations can also be included in an influence diagram. There are different logical relationships included in an influence diagram, a dotted line or a solid line. The dotted line indicates sequence and points only to decision nodes. The solid line indicates dependence and points only to chance nodes and consequence nodes. All the nodes are connected through logical relationships and show how nodes influence each other. This diagram will show how all parts of our delivery service influence each other. Early on in our research, this influence diagram will help us determine what aspects of a delivery service we need to consider. The influence diagram will help show how important decision factors interact in a clear and visual way. For example, we will be able to see which factors affect the demand and the delivery time for our service.

3.3 Risk and Decision-Making Analyses

3.3.1 SMARTER Analysis

There are a few different types of risk analysis that we will conduct in order to figure out the biggest risks of each delivery option we are analyzing. The first type of analysis we are doing is SMARTER analysis. This is based off of the SMART decision model: Simple Multi-Attribute Rating Technique. This technique helps identify decision makers, identify alternative courses of action and identify relevant attributes for each course of action. Then the performance of each alternative is measured for each attribute and a weight is determined for each attribute. The weighted average of values is then taken into consideration and a provisional decision is made. The SMARTER method includes Exploiting Ranks. With this method, weights for attributes are estimated from the decision maker's ranking of the swings. There are standardized weights determined by the SMARTER method depending on the number of attributes assigned by the decision maker. These weights follow the Rank Order Centroid (ROC) weights which were established by the fore thinkers of risk analysis, Edwards and Barron in 1994. For our analysis purposes we will be using profit, delivery time, system control, convenience, and growth cost as our attributes. The profit values will be collected from the Monte Carlo simulation, as described in the next section. The delivery time attribute values will be measured based on research data from the Literature Review and the GET App trial. Then, we will assign a value from 1 to 3 to each option – 1 being the shortest delivery time. The system control attribute was based on how much access and control Chartwells would have over the software and delivery service. Then, we will assign values to each option from 1-3 – 1 being Chartwells has full control and access. The convenience attribute refers to how much effort Chartwells would have to put in the day-to-day logistics of the service. The values will be assigned following a similar pattern; each option will be ranked from 1-3 – 1 being very convenient. Lastly, the growth cost attribute will be based on the cost associated with the increase in delivery capacity. We will assign values from 0-1 – 0 meaning no cost for expansion, and 1 meaning significant cost. This analysis will be explained in the findings section of our report. The main reason for using SMARTER is that there are multiple attributes to be considered when designing a delivery service. This analysis method helps show which attributes are the most important to the decision makers in order to help them narrow down and choose the best alternative. This analysis will help show us which delivery method is the best for WPI.

3.3.2 FMEA Analysis

The next risk analysis method that the group decided on was the FMEA method. FMEA stands for failure mode and effects analysis. This analysis helps identify areas of a process that most impact your organization. This will help us identify where our different delivery methods are most likely to fail. A failure mode is a way in which a process could fail to perform its intended function. First the group must list the different functions of our process. Then the potential failure mode and potential effects of failure are listed. Then the severity of each potential failure is listed on a scale of 1 to 10, 1 being not severe and 10 being very severe. As can be seen in figure 4, this scale is predefined by those who invented the FMEA process. The decision makers are the ones choosing the ranking based on this scale.

Severity Scale

Effect	Criteria: Severity of Effect	Ranking
Hazardous - Without Warning	May expose client to loss, harm or major disruption - failure will occur **without** warning	10
Hazardous - With Warning	May expose client to loss, harm or major disruption - failure will occur **with** warning	9
Very High	Major disruption of service involving client interaction, resulting in either associate re-work or inconvenience to client	8
High	Minor disruption of service involving client interaction and resulting in either associate re-work or inconvenience to clients	7
Moderate	Major disruption of service not involving client interaction and resulting in either associate re-work or inconvenience to clients	6
Low	Minor disruption of service not involving client interaction and resulting in either associate re-work or inconvenience to clients	5
Very Low	Minor disruption of service involving client interaction that does not result in either associate re-work or inconvenience to clients	4
Minor	Minor disruption of service not involving client interaction and does not result in either associate re-work or inconvenience to clients	3
Very Minor	No disruption of service noticed by the client in any capacity and does not result in either associate re-work or inconvenience to clients	2
None	No Effect	1

Figure 4. The severity scale used for the FMEA process

Then the potential causes or mechanisms of failure are listed for each function. The potential causes are given an occurrence scale of 1 to 10, 1 being not likely to occur and 10 being very likely to occur. This scale and the reasoning can be seen in figure 5.

Occurrence Scale

Probability of Failure	Time Period	Per Item Failure Rates	Ranking
Very High: Failure is almost inevitable	More than once per day	>= 1 in 2	10
	Once every 3-4 days	1 in 3	9
High: Generally associated with processes similar to previous processes that have often failed	Once every week	1 in 8	8
	Once every month	1in 20	7
Moderate: Generally associated with processes similar to previous processes which have experienced occasional failures, but not in major proportions	Once every 3 months	1 in 80	6
	Once every 6 months	1 in 400	5
	Once a year	1 in 800	4
Low: Isolated failures associated with similar processes	Once every 1 - 3 years	1 in 1,500	3
Very Low: Only isolated failures associated with almost identical processes	Once every 3 - 6 years	1 in 3,000	2
Remote: Failure is unlikely. No failures associated with almost identical processes	Once Every 7+ Years	1 in 6000	1

Figure 5. The occurrence scale used for the FMEA process

Then current design controls for each function are listed. These are activities which will make sure to take the failure causes under consideration. These controls are then each given a detection number on a scale of 1 to 10, 1 being easy to detect and 10 being not easy to detect. This detection scale can be seen in figure 6.

Detection Scale

Detection	Criteria: Likelihood the existence of a defect will be detected by process controls before next or subsequent process, -OR- before exposure to a client	Ranking
Almost Impossible	No known controls available to detect failure mode	10
Very Remote	Very remote likelihood current controls will detect failure mode	9
Remote	Remote likelihood current controls will detect failure mode	8
Very Low	Very low likelihood current controls will detect failure mode	7
Low	Low likelihood current controls will detect failure mode	6
Moderate	Moderate likelihood current controls will detect failure mode	5
Moderately High	Moderately high likelihood current controls will detect failure mode	4
High	High likelihood current controls will detect failure mode	3
Very High	Very high likelihood current controls will detect failure mode	2
Almost Certain	Current controls almost certain to detect the failure mode. Reliable detection controls are known with similar processes.	1

Figure 6. The detection scale used for the FMEA process

Then each function is given a Risk Priority Number (RPN). This is equal to severity ranking times occurrence ranking times detection ranking. A higher RPN number means that whatever step in your process you are evaluating, causes more risk to your process than a step with a lower RPN value. After all this, a recommended action is given for each significant characteristic of each function. With this analysis we will be able to use the Risk Priority Number to see what the biggest risks to our delivery systems are.

3.4 Monte Carlo Simulation and Sensitivity Analysis

In order to summarize and use the data extracted from the survey a transaction history dataset, we would be using Monte-Carlo simulations. We created multiple simulations, each of the different delivery options for Chartwells to consider. During this step, we only compared the delivery strategies with the numeric data available to us during this step, collected throughout the project. This means that qualitative data or extraordinary details pertaining to the different strategies would not reflect on the numeric comparison values we used to evaluate the different scenarios. Since, the main goal of the future delivery service is to have a non-negative net profit, the most important values that we will be studying are the expected daily and annual net profits for each of the different delivery scenarios.

3.5 List of Proposed Delivery Methods

We are evaluating different delivery methods to implement the food delivery service at the WPI campus. The traditional delivery method consists of hiring full-time employees to deliver the food. This method requires Chartwells to make sure the employees have active Massachusetts licenses, and provide vehicles to make the deliveries. It would work in a very simple manner. The dining restaurants will receive orders through the GET App, customers will provide their locations and complete the payment. Once the order is complete, the drivers will then deliver the food to the desired location. Customers will then decide on the tip as necessary. Some constraints for this method include the employee shortage, the hiring process time, and cost of gas and other maintenance requirements for a vehicle.

The second delivery method we decided to evaluate is a third-party delivery app method. Working with a third-party company to complete the deliveries is a very commonly used method. Known companies such as UberEats, GrubHub, and Doordash work similarly - they partner with restaurants and deliver their food. These companies do not hire full-time drivers, and instead, drivers work as independent contractors. They get to choose when, where, and for how long they will work. Although bigger cities don't have any issues with the availability of drivers, this could be a constraint for Chartwells at WPI. Another concern is the high fee (30%) the third-party companies charge per delivery.

The last delivery method we are evaluating are delivery robots. As previously mentioned in section 2.6, the delivery robots are a very effective appealing method as it is both innovative and easy to implement once a partnership with the robot company is done. Partnering with an external robot company will allow Chartwells to have less constraints regarding employee shortage, vehicle costs and maintenance, and other insurance concerns. The external company would be in charge of providing the robots, the application to order, the maintenance of the robots, and the costs and fees of bringing them to campus. Some constraints with this method include the recruitment of WPI staff to give proper maintenance to the robots, finding a large storage space on campus, and unexpected costs due to robot failure. In table 6 there are two options for Starship, 1a and 1b. At the beginning of the project there was only one option for Starship, and it was a 5-year contract worth around $500,000. However, as the project progressed and Chartwells met with Starship, a second contract was offered for a 5-year, $50,000 deal with the same service offering. This second contract is Starship 1b. Table 6 provides a listed summary of the proposed delivery methods and the constraints and requirements per each.

Table 6. Proposed delivery methods with requirements and constraints

Delivery Methods Ideas	Requirements	Constraints
Starship 1a: Delivery Robots	• Robots • Maintenance room	• Initial high cost of investing on the delivery robots (100,000 per year)
Starship 1b: Delivery Robots	• Robots • Maintenance room	• Initial investment cost (10,000 per year)
GETApp 1a: Hourly-wage Traditional Delivery	• Licensed drivers • Walking • Delivery cars/vans • Delivery fee	• Worker shortage • Cost of gas (if needed) • Hiring process
GETApp 1b: Tipped-wage Traditional Delivery	• Licensed drivers • Walking • Delivery cars/vans • Delivery fee	• Worker shortage • Cost of gas (if needed) • Hiring process
Third Party Delivery App	• Partnership with third party	• High commission fees • Dependent on availability of outside drivers

4.0 Findings

4.1 Survey Analysis

As mentioned in the methodology section of this report, one of the most important steps of this project was to conduct a survey to WPI students. The goal of this survey was to gain information that would be the basis of the recommendations made throughout this project. There were many different types of questions throughout the survey to help the team understand if this delivery service was in high demand at WPI, and if there would be a large enough student population to work for the delivery service. A final copy of this survey can be seen in Appendix A. When designing the survey, the number of responses was a top priority. Using formulas to identify a statistically significant sample from the WPI undergraduate population the team concluded that 356 survey responses had to be recorded to make significant assumptions about the whole WPI population. After multiple weeks of promoting the survey, the team surpassed this goal and received 435 completed surveys. The surveys provided the team with important data that helped set the team up for success when providing recommendations to WPI Dining Services.

There were many key takeaways from the survey data. First, for students who don't have a meal plan, they usually spend between $0-$20 a week using Goatbucks. The team assumed these students would not spend more than that on deliveries each week either. One of the most important takeaways from the survey can be seen in Figure 7 below. This figure shows that 80% of students said if WPI offered a delivery service, they would use it.

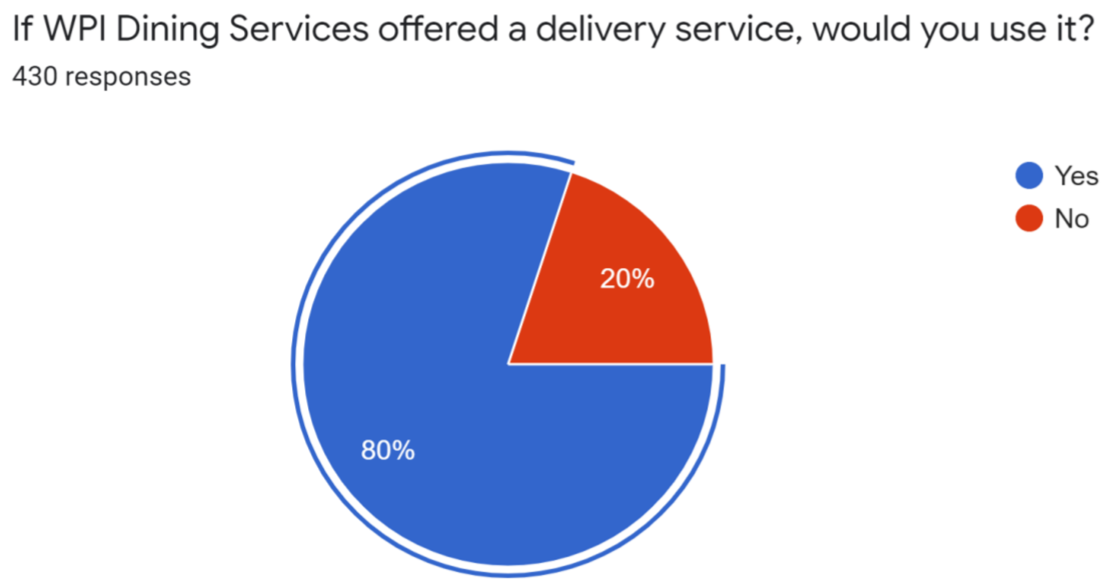

Figure 7. The demand for a delivery service at WPI

So, there is obviously a market for the delivery service and the team is on the right track by trying to implement one. One of the questions on the survey asked about paying a few for delivery, as most food delivery apps do. With this question, 30% of respondents said they would not pay a fee and 56% of respondents said they would pay $2-$3. The team concluded that a delivery fee above $3 might be a big limitation for students since the majority of respondents, 56%, would only pay no more than $3 for delivery. In the comments section of the survey, many respondents voiced that they get fed up with delivery apps because of their extremely expensive fees. Besides just asking about fees, we also made sure to ask about delivery times. Almost 70% of respondents said they'd wait 15-25 minutes for a delivery. After discussing this with Chartwells staff, the team realized that this time frame is unlikely, considering time to prepare food and other orders being made at the same time. The survey made it clear that orders would have to be fast to keep respondents using the delivery service. To add on, half of respondents said they'd want to pay with meal swipes, but there were also significant responses for goat bucks and credit/debit payments too. If feasible then the team recommends that all three of these options should be allowed. If Chartwells wants to experiment with one, then meal swipes would be the best option, if possible. Regarding tipping deliverers, almost 80% of kids said if their peers delivered their food then they would tip them. This is a good sign considering delivery drivers are usually expecting tips when they take a delivery. The survey also asked students which campus dining locations they could order delivery from. The majority of students said Campus Center Food Court, Starbucks and Goats Head. There was interest in Morgan Dining Hall too but if they can't all be offered at first then Campus Center Food Court would be the most popular one to start with. Figure 8 below shows the statistics for how often WPI students use food delivery services a week. Almost 50% of students use a delivery service 1-2 times a week, but almost 40% said they never use a delivery service to get food delivered to their homes. These delivery services include the apps mentioned earlier in the paper (Grubhub, Doordash and UberEats).

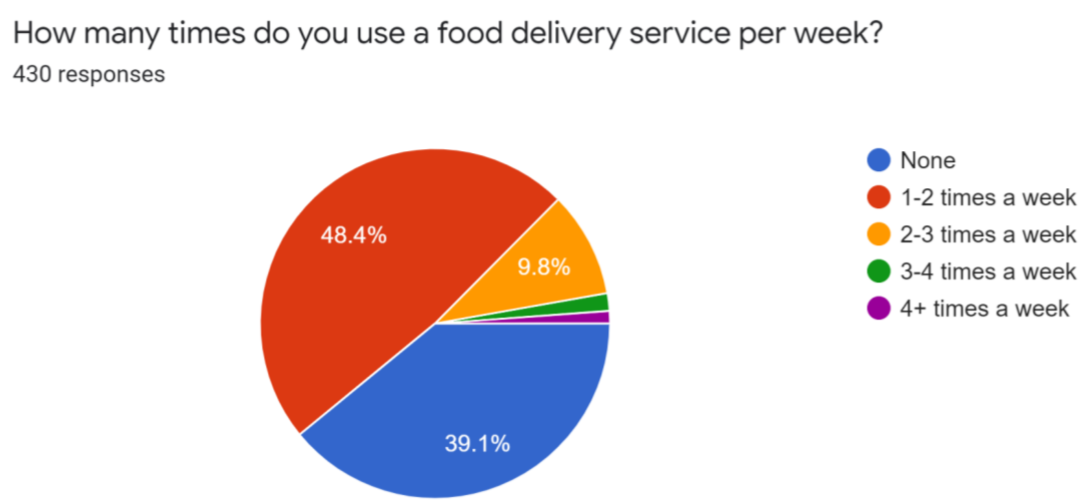

Figure 8. How often students use food delivery services per week

We think these numbers would change drastically if students could use their meal swipes instead of their own money. Also, only 13% of students said they never eat at a WPI dining location throughout the week while 40% of students said they eat at one more than 4 times a week. Regarding student workers for the delivery service, 40% of kids said they'd work delivering food around WPI. At first glance this may not seem like a lot but out of the 435 students surveyed that comes to 174 students. This number would go drastically if all undergraduate students were considered. Almost everyone who answered yes to wanting to work to deliver food said they would like to make $2-4 per delivery including tips and fees.

In general, some of the most important key takeaways from our survey results was that for this delivery service to be most successful, one of the payment methods must be meal swipes. Also, fees should not be higher than $3 or students will steer away from using the delivery service. Lastly, the main dining location that should be prioritized as the first one to offer delivery service should be the Campus Center Food Court. After that location, the next two offered should be Goats Head/Starbucks and then finally Morgan Dining Hall.

4.2 Findings from Experts

During the research phase of this project our team contacted three experts: our sponsor Joe Kraskouskas, Tomer the CEO of DormDrop, and a GET representative. Mr. Kraskouskas was a valuable source of information about our schools dining operations, Chartwells operations, and dining systems at different campuses. Information provided by Joe was the foundation of our team's understanding and directed our investigation. In addition to all of the qualitative information provided by Joe, he also supplied our team with the transactional data needed to complete the analysis.

In addition to Joe Kraskouskas, our team was able to interview Tomer Shkori, the CEO of DormDrop. This interview took place over Zoom and provided the team with valauble information. DormDrop operates very similarly to the mobile app option that our team investigated so this meeting was especially valuable. Tomer Explained to our team how DormDrop works. Students order through their schools existing online order platform, then fill up a form with their confirmation number DormDrop provided. Then a student worker known as a “dropper” will deliver the food right to their door. All of the Droppers are students, so their college allowed DormDrop employees to access student dorms only to make deliveries. This allows Droppers to enter the building but not the individual rooms, and this privilege only applies while workers are clocked in. This level of access allows Droppers to get much closer than an average delivery service which would be outside. In addition to logistical questions, Tomer answered our financial questions. He told us that Droppers are paid an hourly wage, and earn tips during their shifts. He also told us that most students tip their Dropper. This supports what was found in our survey of WPI students. Finally, Tomer told our team that DormDrop is not very profitable on delivery fees alone. They rely on a convenience store that sells small items that can be delivered by Droppers for the majority of their profit. This store allows them to mark up items and profit from their sale (Tomer Shkori, Personal communication, December 10th 2022). Although our team is not recommending that WPI implement the same strategy, it was informative to know that delivery fees alone may not be enough.

The final expert the team spoke with was as a representative from GET App. This meeting was to identify the capabilities of the existing GET App for WPI. A feature that would be needed to successfully deliver food would be to notify the drivers when an order came in, and which dining location it came from. During our early tests the team could not find this feature. Our GET representative informed our team that this option does not exist, an email notification is possible but will not stop when the employee clocks out. In addition to this feature our team wanted to enable tracking so the customer knows how far away their food is. This feature is valuable because it increases customers' patience and the speed at which they come out to get their food. Unfortunately, our GET representative informed our team that this feature is also not an option. By working with experts our team was able to expand our understanding of on campus delivery.

4.3 Investigating Delivery Robots

As discussed in the background, one option for delivery is robots. The main company in the robot delivery space is called Starship Technologies. Our team was optimistic about the viability of this option because it would add a new feature to the WPI campus. There are two factors that our team considered for Starship, cost, and viability. Chartwells is a for profit company so it is important that any system we create is generating revenue. In the case of delivery robots, the main concern is being able to make enough profit to offset the start up costs. In addition to cost, we needed to be sure the robots could successfully navigate our campus all year round. Our team reached out to Starship to set up an interview to get our questions answered. We were able to meet with Robert Buehler from Starship's sales team. First, we discussed the viability of using these robots on our campus. Robert assured us that they have already had success in snowy climates including at Bridgewater State University, another college in Massachusetts. With large wheels, lots of traction, and insulated storage, these robots are ready for any weather condition. Once we were confident that the weather would not be a factor we began looking at the traffic patterns on the roads around campus. Institute Road and Salisbury Street present no challenge because they are relatively low-traffic streets. In contrast, Highland Street and Park avenue were concerning for our team because of the heavy flow of traffic. Luckily, the robots will have no problem with either of these roads either. Robert told our team that some campuses have these robots crossing multiple-lane highways with no problem. Furthermore, this year Starship's robots made their two millionth street crossing, and they average 90,000 crossings each day. All of this assured our team that these robots are physically capable of operating on our campus.

With our technical worries covered our team moved on to the financial viability of this delivery option. In order for this to work WPI needs to provide a space to charge and store the robots. This space can be off campus but needs to be fairly large to house the entire fleet of robots. Starship would then hire student employees to maintain and charge the robots. A major advantage of this option is that Starship would be responsible for hiring and managing these student workers. This can save time and money for Chartwells who would otherwise need to hire these students themselves. Additionally, Starship takes on all liability and insurance associated with their robots. This can be a large saving for Chartwells as insurance can represent a substantial cost. Finally, we discussed the financial obligation that comes with these delivery robots. Robert estimated that for a campus our size we would need approximately 10 robots, but we could get more if needed. When our team met with Robert initially the cost of implementation would be $500,000. This is the only cost to Chartwells for this solution because it covers all aspects of robot delivery. This would include the robots, maintenance costs, management of the employees, liability coverage, and access to the Starship app. Unfortunately, once that investment is made there is no way to recoup that money. There is a fee for each delivery that consists of a $2.49 "delivery fee" and a "service fee" that is 10% of the order amount. Unfortunately, 100% of these fees go to Starship, meaning

Chartwells does not make any money on deliveries. This means that there is no return on investment for Chartwells, as Starship will earn all profits from delivery. Robert told the team that Starship and Chartwells were working on forming a business partnership that would reduce the cost of the robots. Once that agreement between Chartwells and Starship was finalized, the result was that it would only cost approximately $50,000 for a five year agreement with Starship. Our team discussed this option with our sponsor and the lower cost means that these robots could be viable. Additionally, Chartwells would not be the only group to benefit from bringing robots to campus. These robots could potentially draw new students to WPI, especially at such a technically focused campus. Currently, tuition at WPI is $56,000 per year. If only one student came to WPI because they saw these robots on a tour they would spend $224,000 over their four years of college. This would more than pay for the initial $50,000 investment required. At the end of our investigation our team decided that these robots are technically feasible, and they would not be cost-prohibitive for Chartwells.

4.4 Decision Making Diagram Findings

Our influence diagram was extremely helpful in explaining our decision problem framework. Our influence diagram can be seen in figure 9. All decision nodes are squares, all chance nodes are circles, and all consequence nodes are diamonds. As it can be seen in figure 9, our only consequence node is “introducing delivery service.” This is because all chance and decision nodes influence the delivery service. This influence diagram helped us identify the important factors in the decision-making process for implementing a delivery service and helped us in further analysis of the variables and calculation nodes described in the diagram.

Following along with this influence diagram, it can be seen that traffic conditions and weather affect delivery time which affects the delivery method. The number of delivery employees affect total cost of wages. Together with wage, transportation costs, and costs of delivery supplies all affect the cost of the delivery service. Having sufficient staff in the kitchen and the fixed capacity of kitchen production (based on GETApp capacity limitation, explained in section 4.5) limit the demand. In turn, demand affects delivery time and then affects profits. In addition, the ease of use, accessibility for different OS and payment systems all affect functionality which affect which software is being used. The profit also affects the delivery method. Together, delivery method, demand, and software used affect the introduction of the delivery service. The identified factors in our influence diagram are the most relevant for our decision-making process. The diagram worked as a visual representation of these factors to better assist our recommendations and Chartwells' decision.

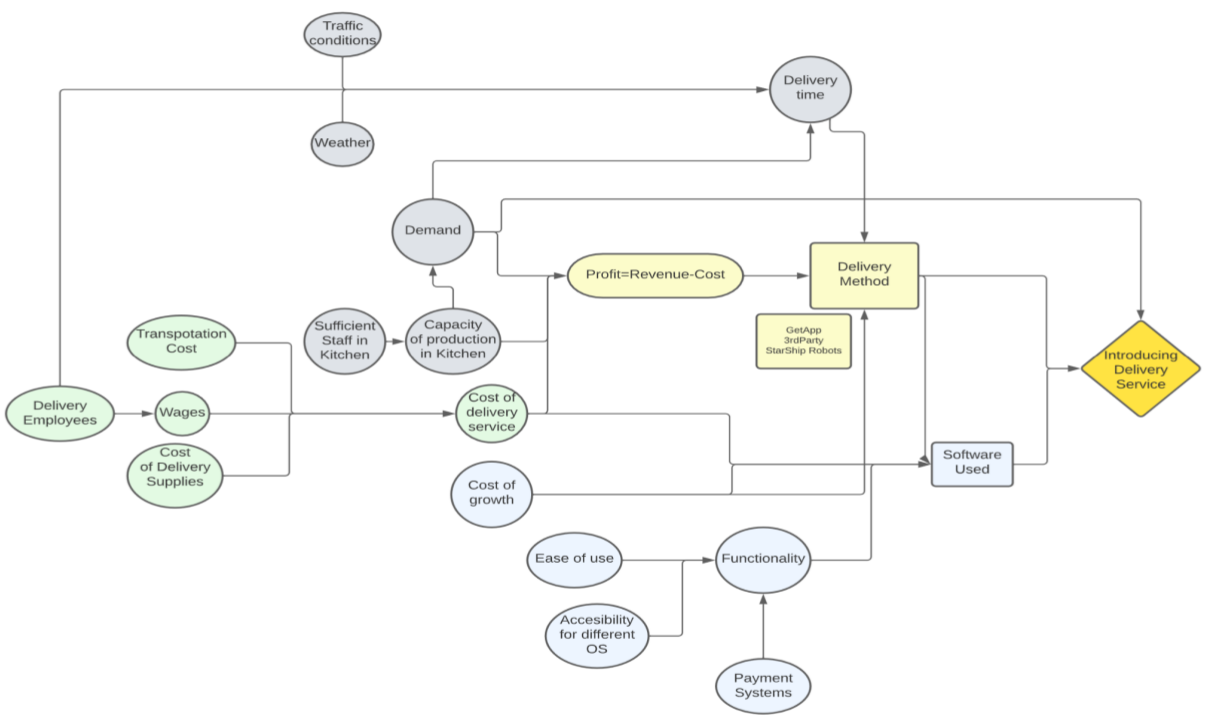

Figure 9. The influence diagram that affects delivery services

4.5 Restaurant Transactions Data Analysis

We requested all the transactions from A-Term. We calculated the peak hours and peak days for each restaurant: Goats Head, Morgan Hall, and Campus Center, seen in figure 10. Using data editing and transformation skills, we created a fixed method to manipulate the format of the given data to easily get the wanted results.

Goats Head

Average of Sum Day	Total
Sunday	37.4
Monday	119.5557022
Tuesday	110.690873
Wednesday	37.6875
Thursday	66.83333333
Friday	72.00952381
Saturday	89.37724615
Grand Total	78.24750045

Campus Center

Average Transactions per Day

Row Labels	Average of Sum of Total
Sunday	556.5416667
Monday	771.2906061
Tuesday	850.0333333
Wednesday	817.7666667
Thursday	811.5285714
Friday	625.6129032
Saturday	511.7878788
Grand Total	717.4659052

Morgan Hall

Row Labels	Average of Sum of Total
Sunday	910.7666667
Monday	1294.018879
Tuesday	1352.162037
Wednesday	1351.208549
Thursday	1381.067641
Friday	1195.100153
Saturday	745.8703704
Grand Total	1196.571319

Figure 10. The average total transactions per day of the week (peak days highlighted in yellow)

The Pivot Tables led us to understand that Campus Center and Morgan Hall have the most total transactions, where students like to purchase the most food, as seen in figure 11. Based on the number of transactions it's ineffective to only offer a delivery service for Goats Head, since it represents less than 5% of all transactions made during the week. Furthermore, we needed to analyze the capacity utilization of Goats Head for online orders, since it’s the only restaurant that currently offers online orders through the app. We requested the transactions for both A and B Terms.

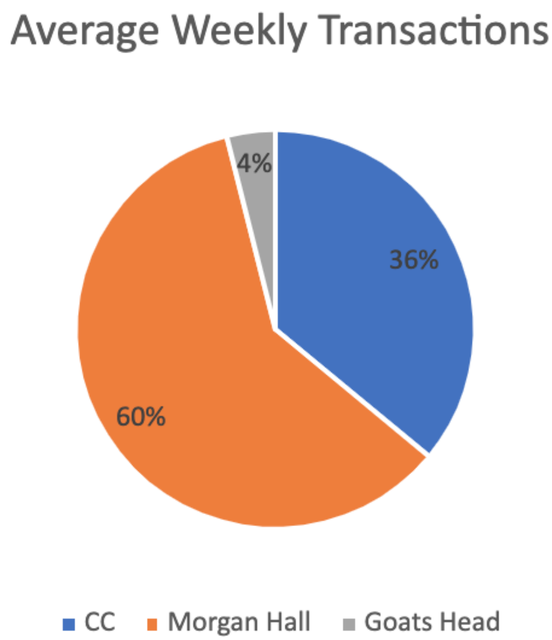

Figure 11. The total average weekly transactions per restaurant: Campus Center, Morgan Hall, and Goats Head

Goats Head has a maximum capacity of 25 orders per 15 minutes. Strangely, we found that at certain points the kitchen was able to work to up to 60 orders per 15-minute interval in some cases. After investigating these cases, we were able to understand that although the GetApp restricted 25 orders per 15-minute, there is no capacity restriction on the number of swipes one person can submit within the same order. That's why we were seeing over 60 orders at the end of the week (seen in figure 12 under total # of entries) when students wanted to spend all their meal swipes before the end of the week. Although the kitchen was able to manage with over capacity at times, they would like to stay with the 25-orders restriction to have the kitchen stay in order and to assure food will be prepared on time.

Row Labels	Average per day	# of entries	Total Transactions during the term	Average per WeekDay Underutilization
Sunday	570.9166667	12	6851	33.99%
Monday	555.2307692	13	7218	36.00%
Tuesday	551.3846154	13	7168	36.39%
Wednesday	596.9166667	12	7163	31.31%
Thursday	564.4545455	11	6209	35.21%
Friday	544	10	5440	38.66%
Saturday	497.6363636	11	5474	40.27%
Grand Total	**555.1585366**	**82**	**45523**	**35.87%**

Figure 12. The average underutilization of Goats Head online orders for each day of the week during A and B-Term

4.6 Risk Analysis Findings

4.6.1 SMARTER Findings

Our first risk analysis was the SMARTER method. A screenshot of our SMARTER analysis can be seen in figure 13. We chose five attributes for our analysis: profit, delivery time, system control, convenience, and growth cost. We then ranked all these attributes, 1 being the most important to our group. Each attribute was then given a weight which is standardized for every SMARTER analysis containing five attributes, as seen in figure 14. Then for each attribute there are five different options: Starship 1a, Starship 1b, GETApp 1a. GetApp 1b, and third-party (detailed descriptions in Table 6). Each given score within the attributes was multiplied by that attribute's standardized weight. For example, for Starship Delivery time, it was given a score of 2 indicating medium delivery time as can be seen in figure 13. This was then multiplied by 25.7, the weight of delivery time, to end up with a score of 51.4. After each attribute is multiplied by its weight, the values are normalized so the "total" column has equivalent comparable values. The option with highest total value is ranked as the best option based on the evaluated attributes. As a result, the Starship option 1b had the highest-ranking outcome proving to be the best option based on profit, delivery time, system control, convenience, and growth cost.

	Rank	Weight
Profit	1	45.7
Delivery Time	2	25.7
System Control	4	9
Convenience	5	4
Growth Cost	3	15.7

	Profit	Delivery Time	System Control	Convenience	Growth Cost
Starship 1a	-4570000	51.4	18	8	0
Starship 1b	-457000	51.4	18	8	0
GETApp 1a	-3675415	25.7	9	12	15.7
GETApp 1b	-2924499	25.7	9	12	15.7
Third-party	-2970215	77.1	27	4	0

	Profit	Delivery Time	System Control	Convenience	Growth Cost	Total	Rank
Starship 1a	0	50	50	50	100	250	4
Starship 1b	100	50	50	50	100	350	1
GETApp 1a	22	100	100	33.33333333	0	255	3
GETApp 1b	40	100	100	33.33333333	0	273	2
Third-party	39	0	0	100	100	239	5

Delivery Time	
Short	1
Medium	2
Long	3

System Control	
Full control	1
Medium control	2
No control	3

Convenience	
Very convenient	1
Convenient	2
Inconvenient	3

Growth Cost	
No Cost for Expansion	0
Significant Cost for Expansion	1

Figure 13. Our SMARTER risk analysis

	Number of attributes					
Rank	**2**	**3**	**4**	**5**	**6**	**7**
1	75.0	61.1	52.1	45.7	40.8	37.0
2	25.0	27.8	27.1	25.7	24.2	22.8
3		11.1	14.6	15.7	15.8	15.6
4			6.3	9.0	10.3	10.9
5				4.0	6.1	7.3
6					2.8	4.4
7						2.0

Figure 14. The standardized ranking numbers used for SMARTER attributes

4.6.2 FMEA Findings

Our next risk analysis was the FMEA method. This analysis was conducted for both Starship and the GET App. The FMEA is a risk analysis and decision-making method used to evaluate and identify risks and failure modes for each of four proposed delivery options. For Starship the steps of our processes include: order is placed, order is received and printed in the kitchen, food is ready and put in the robot, robot goes to location, drops off order, robot returns to campus and robot maintenance. After going through all the steps as explained in our methods section, each process step was assigned a value and then the RPN was calculated. For Starship, the processes with the least amount of risks included order is placed, drops off order and an accident with the robot. On the other hand, the biggest risk of the entire process was the robot going to the wrong location. Although it may seem like an accident with the robot and the robot going to the wrong location are both of similar risk weight, they have different occurrence values and detection mechanisms - making one much riskier than the other. A few other large risks included there being an invalid location when the order is placed, and the robot maintenance not happening resulting in the robot shutting down. As can be seen in figure 15, the RPN is color coded from green to yellow to red. Green, or a lower number, shows minimal risks while red, or a higher number, shows the most risk.

FMEA

Process Name: Starship
Responsible: Chartwells at WPI
Prepared By: Clarissa Casilla, Hannah Gelman, Alejandro Gerov, Abigail Perlee
FMEA Date (Orig.): 2/10/2022

Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (1 - 10)	Potential Causes	OCCURRENCE (1 - 10)	Current Controls	DETECTION (1 - 10)	RPN	Action Recommended	SEVERITY (1 - 10)	OCCURRENCE (1 - 10)	DETECTION (1 - 10)	RPN
What is the process step, change or feature under investigation?	In what ways could the step, change or feature go wrong?	What is the impact on the customer if this failure is not prevented or corrected?		What causes the step, change or feature to go wrong? (how could it occur?)		What controls exist that either prevent or detect the failure?			What are the recommended actions for reducing the occurrence of the cause or improving detection?				
Order is placed	Not received	Transaction canceled, food not received by customer, lost customer	4	Technical failure	7	Email Notifications, Admins can see order failures	1	28	-Contact customer to correct errors -Create app with user friendly interface -Set up app to accept meal plans and goat bucks	4	7	1	28
	Invalid location	Driver can't find recipient, food can not be delivered	5	Incorrect user input	6	Preset WPI locations, users must confirm each time they order	9	270		5	6	9	270
	Wrong contact information	Can not contact recipient, may not know food has arrived, kitchen can't correct order if needed	4	Incorrect user input	3	Must confirm phone number during account set up	1	12		4	3	1	12
	Transaction failure due to meal plan	Transaction canceled, food not received by customer, lost customer	9	Technical failure (monetary)	5	Trial runs, system set up to prevent this failure type	1	45		9	5	1	45

Figure 15. A screenshot of the FMEA Analysis for Starship

There were similar steps laid out for the GET App. The risks were evaluated with the main priority being the customer and orders being fulfilled - maintaining a long-term relationship with the customers. These steps included: Order is placed, order is received and printed in the kitchen, food is ready and put in cubbies, driver picks up order, driver goes to location, drops off order, and driver returns to campus. After each process was evaluated and given an RPN, the largest risks of the GET App were discovered. The smallest risks for this option included an order not being received, an accident while the driver delivers the food and an accident while the driver returns to campus. The greatest risk for the GET App was the order being stolen once the driver drops the order off to the customer. The second greatest risk was the driver going to the location and having the wrong address. The smallest risks with the Third-Party App are that the customer inputs the wrong contact info, and the order is never received. The greatest risks with the Third-Party App were order is stolen and wrong address input.

The FMEA method is extremely helpful in determining the risk levels of all steps in a process. With each risk being evaluated, we can provide solutions and recommendations to the worst-case scenarios of the identified failure modes. The calculated RPN allowed us to make decisions based on the severity of each option and determine areas of improvement. As seen in Figure 16, we created a box plot to better represent the overall risk values for each option. The GETApp has the highest risk average with two outliers. The Third-Party App has a slight lower (medium) risk average, and two outliers. Starship on the other hand, has the lowest risk average, with only one outlier – making it the best option in terms of risk.

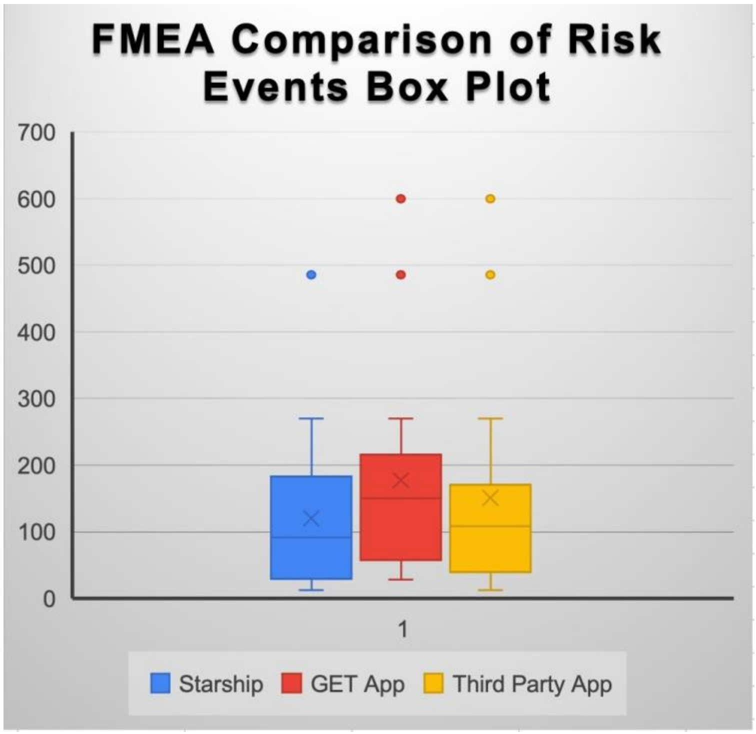

Figure 16. FMEA risk comparison Box Plot

4.7 Monte Carlo Simulation Findings

Chartwells has two main decisions to make:

1. Should they rely on a third party to deliver their food, or should they provide the service themselves?
2. If they hire the people themselves, what options do they have?

We built a Monte Carlo simulation model using Microsoft Excel to analyze three options to tackle these two questions with the main goal in mind of keeping the future delivery service with a non-negative profit. See Table 7.

Table 7. Summary of constructed MonteCarlo Models

Option 1a: Self-Hire hourly wage (GetApp)	This scenario analyzes the cost of labor in an hourly wage setting.
Option 1b: Self-Hire tipped wage (GetApp)	This scenario analyzes the cost of labor in a tipped wage setting to make the delivery service cost-neutral. The minimum tipped wage in Massachusetts consists of a minimum of $8.5 in addition to the tips left by customers. The aggregate of these two values must meet the minimum wage requirement, if it does not, the employer has to pay the difference to reach the minimum limit of $14.25 per hour. We expect this option to be viable as 80% of the surveyed students said they would tip, however for the purposes of this study we reduced this number to 50% to simulate a more conservative number.
Option 2: Big 3rd Party company	This option analyzes how partnering with a third party, such as DoorDash, which usually charges between 20% to 30% to vendors, would affect their overall sales.

4.7.1 Building the Models

First, we set up a collection of fixed parameters to standardize the setup variables for all the models. An average demand per hour and its respective standard deviation were calculated from the transaction history received from the Goats Head dining location during A-Term of 2021, which only accepted online pickup orders during this period. The restaurant values had a daily average of 555 orders with a standard deviation of 85 orders. We calculated the number of effective average hours of operations for the restaurant each day, 8.65 hours. We assume we will schedule the delivery service provided to match the effective hours of operation for the restaurant so that this number will be the center for the delivery service recommended.

To predict the expected number of delivery orders we would expect in a day, we calculated the delivery rate using data from the survey we did. We assumed that there was a significant meal per day per person, either for dine-in, self-cooked or delivery. The assumption is that potential customers only consider delivery service once per day in our model. Table 8 shows the *total expected delivery meals per week*. It is calculated by multiplying the *response count* by the *expected average meals per week.* The total of expected significant meals is seven times the response count. The *delivery rate* is the ratio between the *total expected delivery meals* and the *expected significant meals*, which turned out to be 15.7%. The delivery rate would translate that we can expect around 88.8 orders for delivery for the day with a standard deviation of 13.6 according to the previous data. This means that under this model adding a delivery service does not increase overall demand, but rather take away from current regular (pick-up) demand towards delivery. If demand is noticed to increase in the future, Chartwells can modify the Fixed Parameters in the simulation for decision-making to be accurate.

Table 8. Survey Responses regarding demand of delivery meals and delivery rate calculation

Respondant Category	Response Count	Expected Significant Meals	AVG of Delivery Meals Expected Per Week	Total Expected Delivery Meals per Week
Not interested in delivery	86	602	0	0
Interested in Delivery (SubTotals listed bellow)	344	2408		0
1-2 times a week	183	1281	1.5	274.5
2-3 times a week	41	287	2.5	102.5
3-4 times a week	6	42	3.5	21
4+ times a week	5	35	4	20
None	109	763	0.5	54.5
Grand Total	**430**	**3010**		**472.5**
	Expected Delivery Rate			15.70%

A $15 wage was set for employees in the model, and according to the 40% insurance cost for labor, the expected total cost of labor during an hour would be $21. We set up a "Service Rate" variable, the number of delivery orders a delivery person can handle within one hour, and defaulted the number to three deliveries per hour, after the conclusions from our GET App Trial. A $3 delivery fee was defined for all delivery based on the survey data. For the following models, we decided to compare them mainly based on the estimated cost of the service for each, however the overall revenue and cost of meal preparation is also portrayed, which considers the 6% profit margins that Chartwells makes on all its sales.

4.7.2 Model 1a: Self-Hire: Hourly Wage

This model is fairly straightforward. The model generated five-thousand randomized runs for the number of Daily Orders and Daily Average Order amount. These are used to complete the formula: "Profit = Revenue - Cost." The total revenue for each run was calculated to be Daily orders times the delivery fee plus the revenue of all sales. The total variable cost was calculated by dividing the Daily Orders by the Service Rate (3 orders per hour per delivery person) and multiplying by the total Labor Cost per hour ($21). The average profit for the runs with a delivery fee of $3 and a service rate of 3 orders per hour came out to be a daily loss of around $360 and an annual loss of about $80,0000. This simulation does not account for other costs that Chartwells may experience in the future such as transportation cost of a car or delivery supplies needed to satisfy the service, but they should be taken into account in the future if they appear.

4.7.3 Model 1b: Self-Hire: Tipped Wage

The minimum wage in Massachusetts is $14.25 for 2022. A minimum tipped wage in Massachusetts consists of a minimum of $8.5 in addition to the tips left by customers. The aggregate of these two values must meet the $15 minimum wage requirement, and if it does not, the employer has to pay the difference to reach the minimum limit of $14.25 per hour. For this model, the 40% extra cost to cover employees' insurance remains tied to the wage cost per hour. The assumed minimum wage per worker defaulted to $15 per hour, as defined earlier by the global constant.

Even though 80% of the surveyed students said they would tip, we selected 50% as the expected number of customers who would tip to have a more conservative estimate, and possibly more accurate model. The model randomized tips using a uniform distribution between 10% to 20% for those who did tip. The formulas for this model were:

- Revenue= Daily Orders × Delivery Fee + Sales of all orders
- Hourly Cost = Minimum tipped wage ($8.5) + ($7.5 - Hourly Tips) + Hourly Insurance Cost
- Total Cost per day = (Daily Orders / Service rate) × Hourly Cost + 94% of Sales of all orders

- Daily Profit = Daily Revenue - Daily Cost

This resulted in an annual loss of around $64000 when 50% of the customers are expected to tip, however if 80% of the customers tipping is achieved (as the surveyed suggested), the loss would be around $55000 instead.

4.7.4 Model 2: Third-Party (UberEats, Doordash)

This model simulates Chartwells hiring a third-party for such service, so there would be no way where this option, if implemented, could be cost-neutral due to the high service charge that is around 30% for all delivery order receipts to the restaurant. Usually, restaurants upcharge the customer when using this service to offset some of the cost of having this third-party service. It would not be unusual to see a regularly priced item of $10 cost around $12 when ordered through an online service such as DoorDash or UberEats. The option to UpCharge customers was integrated into the model; however, it was not used for the main evaluation of this specific model. Since there was no way this service could become cost-neutral, we analyzed the total annual cost of the service on Chartwells. While talking with Chartwells, it was concluded that their profit margins for regular dine-in orders were around 6%. The following formulas were used in the model.

For this model, two orders were randomized: The number of "Delivery Orders" and the number of dine-in orders called "Regular Orders."

Revenue = Regular Orders × Average Daily Receipt + Delivery Orders × UpCharged receipt (the default upcharge was at a 0%, so for the purposes of this analysis, the Average Daily Receipt and the UpCharged receipt were the same.)

Cost = 94% of all orders receipt (remainder 6% is the profit) + 30% of all delivery order receipts

Daily Profit = Revenue-Cost

Profit assuming no orders were for delivery was simulated to compare the two daily profits and calculate the total cost. The summary

Profit without Delivery= All Orders × Average Daily Receipt

We see a heavy decline in profits for Chartwells, where they would be earning around $370 per day without the delivery, but only around $76 while offering the third-party contracted service. Due to the service fee of third parties, there would be a profit loss of about 79% for the whole year for Chartwells on that specific location. Losing on average -$290 per day or upwards of fifty thousand dollars per year. The only way to reduce the number of losses would be to upcharge the customers for orders to try to reach a break-even point. For example, a 20% upcharge rate would mean losing around 42% of Chartwell's yearly profits instead of the 79% with no upcharge, becoming a 30 000 per year loss.

4.7.5 Monte Carlo Analysis

Table 9. Summary of one of the runs of the Monte Carlo model for all options

GetApp 1a	Daily Net Profit		Yearly Net Profit	
Average with Delivery implementation	$	6.84	$	1,532.84
Average with no delivery	$	366.81	$	82,166.39
Cost of Service	**$**	**(359.97)**	**$**	**(80,633.55)**

GetApp 1b	Daily Net Profit		Yearly Net Profit	
Average with Delivery implementation	$	79.59	$	17,828.75
Average with no delivery	$	365.31	$	81,829.93
Cost of Service	**$**	**(285.72)**	**$**	**(64,001.18)**

Third Party	Daily Net Profit		Yearly Net Profit	
Average with Delivery implementation	$	74.19	$	16,617.92
Average with no delivery	$	365.42	$	81,853.08
Cost of Service	**$**	**(291.23)**	**$**	**(65,235.16)**

Third Party - StarShip	Daily Net Profit		Yearly Net Profit	
Average with Delivery implementation		n/a	$	71,949.80
Average with no delivery	$	365.85	$	81,949.80
Cost of Service		n/a	**$**	**(10,000.00)**

Comparing these three options using the model we built, all the options had pros and cons. Between the two versions of option 1, 1b, tipped wage, ranked higher on average for greater returns more often. However, none of the alterations would make the delivery service cost neutral, but a large expense year over year.

The best option according to this model would be option 1b, where Chartwells hires students under a tipped wage, slightly ahead of a Third Party App. Still, there is also the scenario where Chartwells finds a more beneficial 3rd party contract where the cuts are not as high compared to the big companies.

4.7.5.1 Sensitivity Analysis and Graphs: What-If scenarios

In this section various scenarios are evaluated where one parameter is decreased/increased, and the effect on the Cost of Service (Yearly Net Profit of the Service when implemented) is displayed.

Option 2 as it considered all of the profits of Chartwells for the merchant location regardless of if there were delivery or not. Chartwells would lose 80% of their current earnings if they partnered with a delivery app, however if Chartwells increases the Up-Charge Rate in the delivery app, where they increase the menu price on items for delivery items, then they can mitigate some or even all cost, as seen in Figure 16. This option only considers the model for Third Party App since the Up-Charge rate only affects this model.

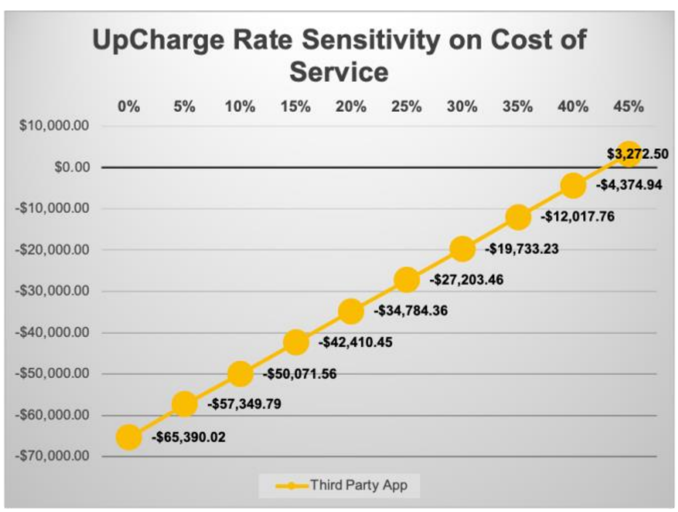

Figure 16. Up-Charge Rate Sensitivity on the Cost of Service (0% Original value)

The next scenario we evaluated was how the service rate, the pace at which delivery persons can deliver orders per hour, would affect the Cost of Service. As seen in Figure 17, If Chartwells were to choose either version of Option 1 (any o two alterations), they would require delivery persons to deliver at least five orders per hour to be near cost-neutrality.

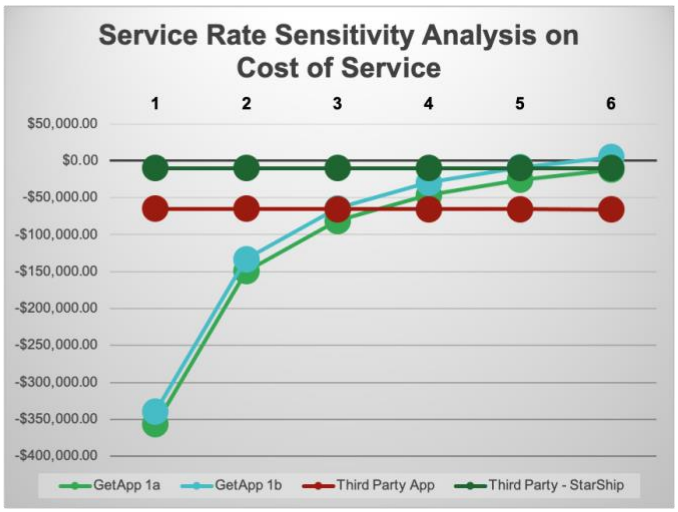

Figure 17. Service Rate Sensitivity on the Cost of Service (3 Original value)

As seen in the figure 17, the delivery service can reach cost neutrality when performing above 5 orders per hour per delivery person. If Chartwells finds a way to achieve this efficiency using the GET App, it could add additional transportation costs which are not accounted for within the model. Future decisions can become profitable with these details considered.

As seen in Table 9, none of the options are profitable. This means that if the delivery percentage parameter is increased, or demand for delivery orders increased, Chartwells would be losing even more money, as seen in Figure 18. So that means, Chartwells should seek to improve the efficiency of these services, otherwise in the long run, they would suffer heavy economic losses

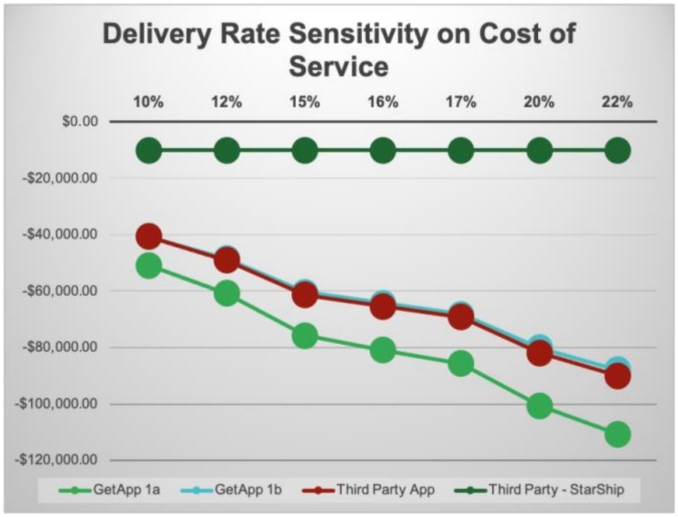

Figure 18. Delivery Rate Sensitivity on the Cost of Service (16% Original value)

The last What-If Scenario our team evaluated was how increasing the delivery fee affects the return, and eventually affects the cost of the delivery service. These results can be seen in Figure 19.

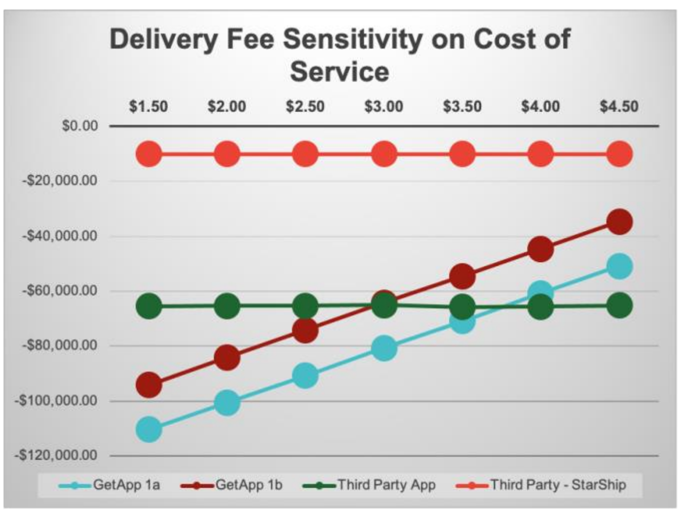

Figure 19. Delivery Fee Sensitivity on the Cost of Service ($3 Original value)

Even though there is a lineal increase for the GET App options, we cannot guarantee demand/sales will remain the same when the prices are increased, so even if this says that there would be a decrease in Service Cost, it could not accurately portray the situation if the demand changes.

To conclude our one-dimensional sensitivity analysis, the current best option remains the Starship robot company, as it is only a $10,000 yearly cost. If Chartwells makes improvement on efficiency of delivery to above 5 deliveries per hour per deliverer, they could see an increase in profits and even overall demand for their location when using the GET App.

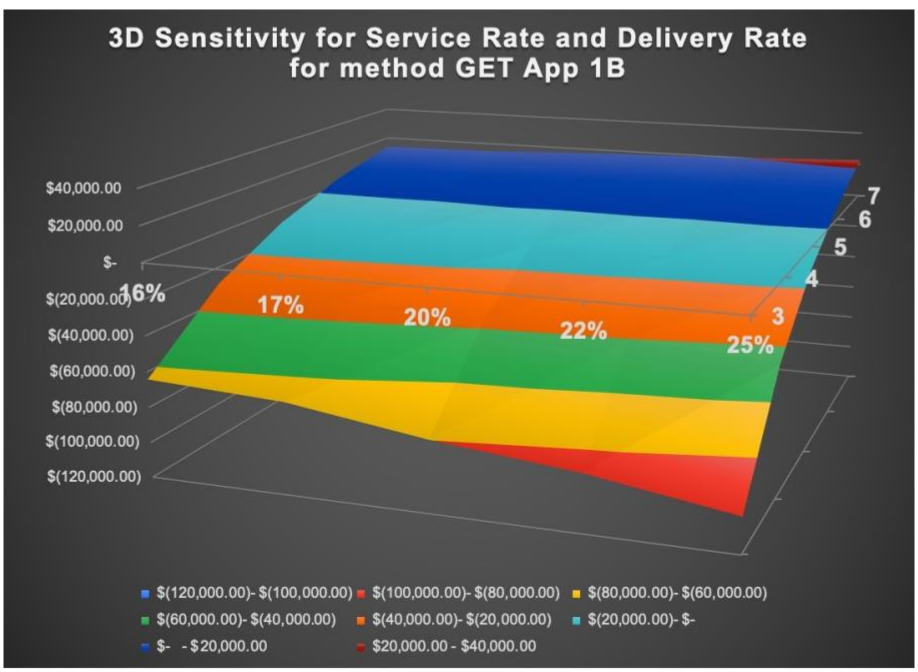

Figure 20. 3D Sensitivity chart for Service rate and Delivery rate

Since GETApp 1b seemed to have the biggest improvements by increasing certain values, we decided to analyze how would compound changes in attributes affect the result of this specific method of delivery. To evaluate this, we conducted a 3D sensitivity chart with an increase in the values in both service rate and delivery percentage together. As seen in Figure 20, we increased the values starting from parameter value 3 all the way to 7 from the service rate, and then increased the delivery percentage starting from 16% all the way to 25%. As a result, the profit becomes positive when the value of service rate is greater or equal to 6, meaning there is actual profit for the service. This graph shows that profit changes when delivery percentage and service rate are both increased. Similarly, another way we evaluated the compound changes, was by increasing the delivery percentage starting by 16% all the way to 25% and increasing the delivery fee starting from $3.00 to $5.00. As seen in figure 21, there is no profitable outcome below a $5.00 fee, however, the increase drastically lowers the cost of the service.

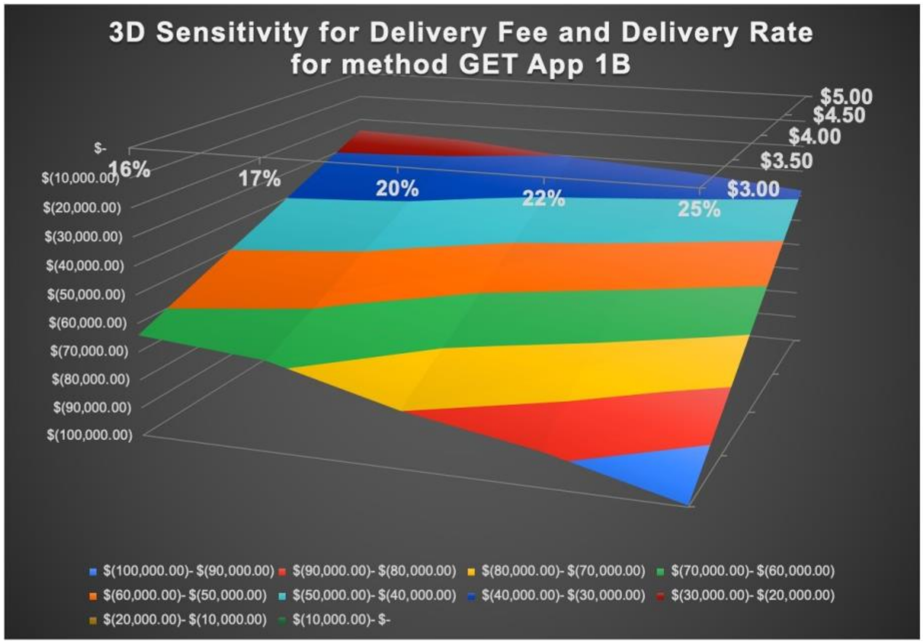

Figure 21. 3D Sensitivity chart for Delivery fee and Delivery rate

4.8 GET App Trial Findings

We conducted a delivery trial run to test the GET App interface and measure delivery times within campus. We worked along Chartwells to prepare the Goat's Head kitchen for incoming delivery orders and activate the delivery option in the app. The delivery option was open for two hours, and students placed orders between 2:00 and 4:00 PM. These were identified as peak hours based on the transactions analyzed data. On the users' side, they could place the order in the same way they would usually place a pick-up order but they could add a delivery address. For the trial we restricted locations to only be around campus residence halls. Furthermore, students were allowed to purchase their food using meal swipes, bonus points, and credit cards. Since all of the deliveries were within a small radius, we delivered the orders by foot with no fee.

With the trial we found areas within the app that should be improved if the GET App will ultimately be used for delivery. The GET App has poor interface for a delivery service - there is no way to notify the driver or delivery person that the order is ready to pick-up, as well as the person who placed the order has no way of knowing the driver is on their way or already in the location. The notifications were all done manually by calling the student. Another concern was that the person who placed the order had no access to their order number until the food was ready. This makes the whole tracking process very difficult, even from the kitchen side. We also encountered many issues with the orders being processed incorrectly and failing transactions. Orders that were placed with bonus points (instead of meal swipes) were giving a failed transaction, but the order was still received and prepared in the kitchen. This means, a lot of free orders were given that day. As a result, we ended up having few orders to deliver.

The last thing we evaluated with the trial was delivery time. Although all orders were delivered on time, it was decided that to deliver orders by foot was not efficient. Each order took an average of 20 minutes from the moment the order was ready in the kitchen to when the driver was back ready to pick-up the next order. With two people delivering food on campus, we were able to deliver a total of 8 orders in 2 hours. The small number of orders also led us to conclude that the peak hours of regular transactions would not be the same as delivery peak hours. While students are on campus they would rather purchase their food in person rather than order delivery.

4.9 Conclusion

Based on the findings discussed in this chapter our team made conclusions about each delivery option. These conclusions are summarized in Table 10 below.

Table 10. Finding summary for each delivery method (bolded best option based on analyses)

Delivery Options	Monte Carlo Net per Year	SMARTER score	FMEA Box Plot results
GetApp 1a	-$80 000	247.62	Highest risk
GetApp 1b	-$64 000	254.17	Highest risk
Starship	**-$10 000**	**350**	**Lowest risk**
Third Party App	-$65 000	216.67	Medium risk

Each result provides insight into the viability of that option. For the option of GET App 1a, where student workers are paid an hourly wage, the results show that this option is not viable. The Monte Carlo simulation predicts that Chartwells would lose $80,000 each year with this option.

That is the highest cost of a delivery option that we found. Additionally, with a SMARTER score of 247.62 making this option the second lowest performer in this category only ahead of a third-party app. Finally, this method has the highest risk result based on the box plot.

Looking down to the GET App 1b option we can see that this performed better than 1a in all categories. The Monte Carlo simulation predicts that Chartwells will lose $64,000 each year with this option. Other than Starship, this is the lowest loss for an option. Additionally, this option had a slightly higher SMARTER score than 1a with a 254.17. This is the second-best SMARTER score evaluated. Finally, the FMEA score is the same for both options as with 1a because the risks do not change. This means that 1b also has the highest risk based on the box plot. All of these results make option 1b better than option 1a and better than a third party. In the event that Chartwells does not want to partner with Starship, the best alternative option is GET App 1b.

Moving down to Starship, we can see that this option has a cost of $10,000 per year. Unlike the other options this cost is fixed, because of the contract with Chartwells and Starship. This is the lowest cost for all of the options evaluated. Additionally, Starship scored a 350 in the SMARTER analysis. This is the highest score of all the options, meaning it has the best SMARTER score. Finally, the FMEA analysis found that this option has the lowest risk based on the box plot. Starship performed best out of all the delivery options, in all analysis techniques used.

Finally, it is clear that implementing a third-party app is not viable. The Monte Carlo simulation predicts that this option would cost Chartwells $65,000 dollars each year. This is the second most expensive option, after only 1a. Additionally, these options scored significantly worse than the other three in the SMARTER analysis, with a score of only 216.67. This option has a medium risk level based on the FMEA analysis and box plot. This means that it is less risky than the GET App, but riskier than Starship.

5.0 Recommendations

One of our goals which we were tasked with was to identify a cost-neutral option for Chartwells while offering this service since their margins of profit from daily operations are only 6%. That goal turned out to be unrealistic since we didn't find a satisfactory solution for a cost-neutral service delivery method during our research. Chartwells would have to invest in this continuous service from other income sources. Using the insights about which factors affect different decisions in Chartwells described in the influence diagram (Figure 9) and all the analysis laid out in the Findings chapter, our team created the following recommendations for Chartwells at WPI for implementing a delivery service on campus.

- We recommend that WPI implements a delivery service on their campus. The survey conducted at WPI indicated that there is sufficient demand for this service. Additionally, a delivery service will provide value to the WPI campus.
- We recommend that WPI does not use a third party app such as Grubhub or Doordash for their delivery service. While these apps have advantages including quality interface, existing users, and ease of access for customers, they are cost prohibitive. The high fees to both Chartwells and the customers make this option unviable. Additionally, this service can not integrate with the existing meal plan system meaning that students can not pay with Goat Bucks or Meal Swipes. For these reasons our team does not recommend a third party app such as Grubhub or Doordash for delivery at WPI.

- We recommend that WPI does not do delivery through the GET App, unless major improvements are implemented. Through trials of the app, it was discovered that the interface is lacking enough quality for the future-delivery needs. Additionally, the GET App is lacking many features necessary for success including driver notifications, order tracking, and an interface for delivery drivers.
- We recommend that if WPI uses the GET App, for it to be improved on the customers' end. It would be beneficial for customers to see the order number in the transaction history as well as get the order number when the order is made rather than only after the order is ready and available for pick-up.
- We recommend that if WPI uses the GET App that they use a tipped wage for drivers. This was option GET App 1b in the simulations described above. This option was the least costly way to use the GET App, but it was still not profitable for Chartwells.
- If Chartwells uses option GET App 1b, it is important to identify the most important factors as listed in the sensitivity analysis and take actions upon them. For example, if Chartwells increases the efficiency while the service rate is equal to or higher than 6 orders per hour, it will be valuable to increase demand or the delivery percentage since it would now be profitable.
- We recommend that WPI works with Starship to implement delivery robots on campus. Before the deal between Chartwells and WPI this option was cost prohibitive, but the reduced price makes this a viable option.
- Finally, we recommend that WPI remains aware of the risks associated with a delivery service and remains proactive in preventing these risks. The largest risks associated with the GET App are orders being stolen. To reduce this risk WPI could create secure drop off

locations or drivers directly to customers. For the Starship option the biggest risk is the robot going to the wrong address. This can be prevented by having customers confirm their address during account set up. It is important that WPI remains aware of the risks associated with this service and continues to work to minimize those risks.

Based on our initial motivation for this project and because of our analyses, we recommend that Chartwells should use Starship to implement this service. Bringing the Starship robots will help Chartwells take the next step into both their business growth and modernization. As the service was proven to be highly demanded and necessary, our team believes that incorporating it to the WPI campus will add great value to the school by providing easier access to food from our dining services.

Appendix

Our team will provide Chartwells this report and the various analysis files created during our project to aid Chartwells in future decisions.

Appendix A - Survey Questions

Survey Questions

Are you over 18?

Yes: Survey continues

No: Survey ends

WPI email (for prizes) (unlinked from data gathered forward):

In which year are you right now?

- Freshmen
- Sophomore
- Junior
- Senior
- Grad

Where do you currently live?

- Off campus within walking distance of campus
- Off campus not within walking distance from campus
- Daniels Hall
- East Hall
- Faraday Hall
- Founders Hall
- Hampton Inn
- Institute Hall
- Messenger Hall
- Morgan Hall
- Sanford Riley Hall
- Stoddard Complex
- WPI Townhouses
- Other

Which meal plan do you currently use?

- Yes, I have a meal plan
- No meal plan, but I use Goat Bucks
- No meal plan, and I don't use Goat Bucks

IF no meal plan, but I have Goat Bucks→ How much do you spend per week on campus?

- $0 - $10
- $10 - $20
- $20-$40
- $40+

If WPI Dining offered a delivery service, would you use it?

- Yes
- No

What is the most you would pay for a delivery fee?

- I would not pay a fee
- $2-$3
- $3-$4
- $4-$5

How long would you expect to wait for a delivery from campus?

- 10-15 minutes
- 15-25 minutes
- 25-40 minutes

If you use this service how would you prefer to pay?

- Meal swipe
- Goat Bucks
- Credit/Debit card

If one of your peers delivered your food would you tip them?

- Yes
- No

What WPI food would you get delivered to you? Select all that apply.

- Morgan Dining Hall
- Campus Center Subs
- Starbucks

- Goats Heads

How many times do you use a food delivery service during the week?
- None
- 1-2 times a week
- 2-3 times week
- 3-4 times a week
- +4 times a week

Which meal delivery service do you typically use?
- Uber Eats
- GrubHub
- DoorDash
- PostMates
- Restaurant provided delivery
- Other

How many times a week do you eat from a WPI dining restaurant?
- None
- 1-2 times a week
- 2-3 times week
- 3-4 times a week
- +4 times a week

Would you like to work delivering food around WPI?
- Yes, if I could choose my own hours
- Yes, if I had assigned shifts
- No

If yes, what would be the minimum pay you are willing to work for?
- $1-2 per delivery
- $2-4 per delivery

Appendix B - FMEA Analysis

FMEA analysis created during our group as a deliverable

FMEA

Process Name: Starship
Responsible: Chartwells at WPI
Prepared By: Clarissa Casilla, Hannah Gelman, Alejandro Gerov, Abigail Perlee
FMEA Date (Orig.): 2/10/2022

Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (1 - 10)	Potential Causes	OCCURRENCE (1 - 10)	Current Controls	DETECTION (1 - 10)	RPN	Action Recommended	SEVERITY (1 - 10)	OCCURRENCE (1 - 10)	DETECTION (1 - 10)	RPN
What is the process step, change or feature under investigation?	In what ways could the step, change or feature go wrong?	What is the impact on the customer if this failure is not prevented or corrected?		What causes the step, change or feature to go wrong? (how could it occur?)		What controls exist that either prevent or detect the failure?			What are the recommended actions for reducing the occurrence of the cause or improving detection?				
Order is placed	*Not received*	*Transaction canceled, food not recited by customer*	*4*	*Technical failure*	*7*	*Email Notifications, Admins can see order failures*	*1*	*28*	*-Contact customer to correct errors -Create app with user friendly interface -Set up app to accept meal plans and goat bucks*	*4*	*7*	*1*	*28*
	Invalid location	*Driver can't find recipient, food can not be delivered*	*5*	*Incorrect user input*	*6*	*Preset WPI locations, users must confirm each time they order*	*9*	*270*		*5*	*6*	*9*	*270*
	Wrong contact information	*Can not contact recipient, may not know food has arrived, kitchen can't correct order if needed*	*4*	*Incorrect user input*	*3*	*Must confirm phone number during account set up*	*1*	*12*		*4*	*3*	*1*	*12*
	Transaction failure due to meal plan	Transaction canceled, food not received by customer, lost customer	9	*Technical failure (monetary)*	5	Trial runs, system set up to prevent this failure type	1	*45*		*9*	*5*	*1*	*45*
Order is received, and printed in kitchen	Kitchen out of capacity	Long wait time, or potential for cancelation	6	Too many orders, under staffed	6		4	*144*	-Update capacity limit based on avaliable staff -Screen for order management	*6*	*6*	*4*	*144*
	Dose not print or ticket is lost	Order won't be made, customer unhappy	10	Technical failure, Human mistake, or printer malfunction	5	Multiple printers, trained staff	3	*150*		*10*	*5*	*3*	*150*
Food is ready and put in robot	Incorrect Label	Wrong food delivered	10	Human error (kitchen)	5	Train staff, quality check when placed in robot	2	*100*	-Quality check when food is placed in cubie	*10*	*5*	*2*	*100*
	Missing item	Unhappy costumer, driver may go back	8	Human error (kitchen)	8	Items printed on ticket, quality check	3	*192*		*8*	*8*	*3*	*192*
Robot goes to location	Wrong Address	Can not find customer, won't be able to deliver	9	Technical failure or incorrect user input	6	None	9	*486*	-Consider weather -Track robot in app -raise awareness of robots in community -robot crossing sign	*9*	*6*	*9*	*486*
	Unexpected delay	Unhappy customer, long wait, cold food	6	weather, or pedestrians	7	Preset WPI locations, users must confirm each time they order	2	*84*		*6*	*7*	*2*	*84*
	Accident while delivering	Order won't arrive	10	Unsafe driving or conditions	3	Orange flag on robots, well programed	1	*30*		*10*	*3*	*1*	*30*
Drops off order	Customer dose not show up	Delay other deliveries, potential for cancelation	6	Incorrect user input, low battery, customer fails	3	Phone number is confirmed during set up	2	*36*	-Deliver directaly to customer -standard drop off window -Picture confirmation -Robots are tracked	*6*	*3*	*2*	*36*
	Order stolen	Unhappy customer	9	Bad luck, not delivered directly to customer	2	Robots lock and can be tracked if stolen	1	*18*		*9*	*2*	*1*	*18*
Robot returns to campus	Accident	Delay other deliveries	10	Unsafe driving or conditions	4	Orange flag on robots, well programed	1	*40*	-Consider weather -Track robot in app -raise awarenes of robots in community -robot crossing sign	*10*	*4*	*1*	*40*
	Delay	Delay other deliveries	6	Traffic, weather, other delays	9	Plan for delays, contact customer if happens	2	*108*		*6*	*9*	*2*	*108*
Robot Maintenance	Not done	Shut down of service	9	Poor training, understaffed	6	Employee training, supplied proper tools and workspace	4	216	-Good schedule for maintenance -Proper supervision	9	6	4	216
	Worker injury	Cost to Chartwells, Loss of employee	10	Poor training, unsafe environment	3	Employee training, supplied proper tools and workspace	1	30		10	3	1	30
	Improper maintenance	Damage robot, not charged (major delay), dangerous to community (security risk)	10	Poor training, lack of supervision, lack of process control, improper tools	3	Employee training, supplied proper tools and workspace	6	180		10	3	6	180

FMEA

Process Name: GET app

Responsible: Chartwells at WPI

Prepared By: Clarissa Casilla, Hannah Gelman, Alejandro Gerov, Abigail Perlee

FMEA Date (Orig.): 2/10/2022

Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (1 - 10)	Potential Causes	OCCURRENCE (1 - 10)	Current Controls	DETECTION (1 - 10)	RPN	Action Recommended	SEVERITY (1 - 10)	OCCURRENCE (1 - 10)	DETECTION (1 - 10)	RPN
What is the process step, change or feature under investigation?	In what ways could the step, change or feature go wrong?	What is the impact on the customer if this failure is not prevented or corrected?		What causes the step, change or feature to go wrong? (how could it occur?)		What controls exist that either prevent or detect the failure?			What are the recommended actions for reducing the occurrence of the cause or improving detection?				
Order is placed	*Not received*	*Transaction canceled, food not recited by customer*	*4*	*Technical failure*	*7*	*Email Notifications, Admins can see order failures*	*1*	*28*	*-Contact customer to correct errors -Improve GET interface -Set up GET to accept meal plans*	*4*	*7*	*1*	*28*
	Invalid location	*Driver can't find recipient, food can not be delivered*	*5*	*Incorrect user input*	*6*	*Preset WPI locations, users must confirm each time they order*	*9*	*270*		*5*	*6*	*9*	*270*
	Wrong contact information	*Can not contact recipient, may not know food has arrived, kitchen can't correct order if needed*	*4*	*Incorrect user input*	*6*	*None*	*10*	*240*		*4*	*6*	*10*	*240*
	Transaction failure due to meal plan	Transaction canceled, food not received by customer, lost customer	9	*Technical failure (monetary)*	5	Trial runs, system set up to prevent this failure type	1	*45*		*9*	*5*	*1*	*45*
Order is received, and printed in kitchen	Kitchen out of capacity	Long wait time, or potential for cancelation	6	Too many orders, under staffed	7	Capacity limit in GET	4	*168*	-Update capacity limit based on avaliable staff -Screen for order management	6	*7*	*4*	*168*
	Dose not print or ticket is lost	Order won't be made, customer unhappy	10	Technical failure, Human mistake, or printer malfunction	5	Multiple printers, trained staff	3	*150*		*10*	*5*	*3*	*150*
Food is ready and put in cubie	Incorrect Label	Wrong food delivered	10	Human error (kitchen)	7	Train staff, quality check when placed in cubie	2	*140*	-Quality check when food is placed in cubie	*10*	*7*	*2*	*140*
	Missing item	Unhappy costumer, driver may go back	8	Human error (kitchen)	8	Items printed on ticket, quality check	3	*192*		*8*	*8*	*3*	*192*
Driver Picks up order	Grab wrong order	Loss of two costumers	10	Human error (driver)	7	Double check numbers, Simple system	1	*70*	-Clear labels on bags -Have a back up plan	*10*	*7*	*1*	*70*
	Driver late to pick up order	Cold food, Wait time longer	6	Unexpected circumstances or human error (driver)	8	Plan for delays, contact customer if happens	3	*144*		*6*	*8*	*3*	*144*
Driver goes to location	Wrong Address	Can not find customer, won't be able to deliver	9	Technical failure or incorrect user input	6	None	9	*486*	-Train drivers to WPI standards -Consider weather	*9*	*6*	*9*	*486*
	Unexpected delay	Unhappy customer, long wait, cold food	6	Traffic, weather, or turkeys	9	Preset WPI locations, users must confirm each time they order	3	*162*		*6*	*9*	*3*	*162*
	Accident while delivering	Order won't arrive	10	Unsafe driving or conditions	4	Driver training	1	*40*		*10*	*4*	*1*	*40*
Drops off order	Can't contact recipient	Delay other deliveries, potential for cancelation	6	Incorrect user input, low battery, customer fails	7	None	2	*84*	-Deliver directaly to customer -standard drop off window -Picture confirmation	*6*	*7*	*2*	*84*
	Order stolen	Unhappy customer	10	Bad luck, not delivered directly to customer	6	Give order directly to customer, or place in secure location	10	*600*		*10*	*6*	*10*	*600*
Driver returns to campus	Accident	Delay other deliveries	10	Unsafe driving or conditions	4	Driver training	1	*40*	-Train drivers to WPI standards -Consider weather	*10*	*4*	*1*	*40*
	Delay	Delay other deliveries	6	Traffic, weather, other delays	9	Plan for delays, contact customer if happens	3	*162*		*6*	*9*	*3*	*162*

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