22F97-14

Facility Design and SAP ERP Configuration for a Food Distribution Warehouse

IE 4597: Senior Design – Final Report (Phase 1)

By:

Ryan BOUDREAUX (3)
Joshua BROOMFIELD (4)
Jared HYMEL (11)
Brennan LACOUR (15)

Submitted to

Course Instructor:
Dr. Bhaba Sarker

Project Advisor:
Dr. Gerald Knapp

VistaVu Director:
Mrs. Katherine Alford
VistaVu Solutions Inc | 605 5th Ave SW Suite 3310, Calgary, AB T2P 3H5, Canada
Tel: (225) 266-8916; email: katherine.alford@vistavusolutions.com

December 2, 2022

ABSTRACT

This project report covers the design of a food distribution warehouse to be located in Baton Rouge. We decided to center our warehouse for Zatarain's products since it fulfilled all the requirements of storing and distributing dry, frozen, and refrigerated goods specified by our sponsor. Matherne's, Winn Dixie, Albertsons, and Rouses were selected as likely as customers for the distribution center. The team then researched the OSHA and FDA requirements for warehousing and distribution to ensure we were providing a workplace free of hazards. Keeping these requirements in mind, the team calculated the space requirements for each area of the facility to meet customer demands. From there, the team analyzed the capital investments and recurring monthly costs to ensure that the business would be successful. We then determined that twenty-one or more grocery store customers would be needed to be profitable. After verifying that the space requirements would be sufficient to run our business model, the team moved on to analyzing the best layout for the facility. This included valuing the pros and cons for each model between the "I" layout, "U" layout, and the "L" layout. Ultimately, the team decided to select the "U" layout with the receiving and shipping on opposite ends of the front face of the building. Once this was completed, the team created a 3D model to accurately display each area in a presentable format. The data collected on specific products, costs, sale prices, margins, and economic order quantities will be a strong foundation for the implementation of the SAP instance next semester. The rationale behind each of these steps: spacing requirements, finances, and layout are detailed throughout the report.

EXECUTIVE SUMMARY

VistaVu Solutions began with the inspiration to service growing companies find operational efficiency and managerial effectiveness using technology. After much success with smaller companies, VistaVu

Solutions is looking to grow and expand their services to larger companies across many different industries. These industries currently include aerospace and defense, life sciences, industrial field services and machinery, and technologically advanced industries. With this rapid growth, VistaVu Solutions approached LSU with the mission to have students create an accurate business model for a food distributor, where the students would highlight the design of a virtual facility and accurately implement an Enterprise Resource Planning (ERP) solution for this facility. These two solutions should be aligned with the SAP By Design system, a cloud-based software ERP solution VistaVu Solutions offers to their customers. The product created by the team will be used to display to potential clients the value VistaVu Solutions could introduce to their company.

For the facility design, the team determined the facility needed 11 different areas – frozen storage, dry storage, refrigerated storage, main aisle, HVAC equipment, receiving, shipping, office, lobby, restrooms, and quality control. Accommodating for shelf life, products per box, boxes per pallet, and Economic Order Quantity (EOQ), the team created a nearly 15,000 square foot facility to successfully distribute Zatarain's branded products to our customers – Matherne's, Winn Dixie, Albertson's, and Rouses.

As for the SAP By Design, the team has not been introduced or given access, so within the next few months the goal will be to become comfortable with the system to ensure we have collected all the data necessary. From there, we will continue to make final corrections to the facilities layout and ensure all details are completed and documented for the SAP configuration.

CONTENTS

Description **Page**

ABSTRACT i

EXECUTIVE SUMMARY i

1. INTRODUCTION 1

2. BACKGROUND & MOTIVATION 2

3. PROBLEM DESCRIPTION 3

4. MANAGEMENT OBJECTIVES 4

5. SOLUTION METHODOLOGY 4

5.1 PRODUCTS 4

5.2 ECONOMIC ORDER QUANTITY 5

5.3 STOCK LEVELS 5

5.4 GENERATING LAYOUT ALTERNATIVES 5

5.5 SPACE REQUIREMENTS 6

5.6 OPERATIONAL COSTS 6

6. DATA COLLECTION 6

6.1 PRODUCTS 7

6.2 PRODUCT PRICES AND DEMAND 8

6.3 WAREHOUSE SIZE AND LOCATION 8

6.4 FACILITY ATTRIBUTES 8

6.5 CAPITAL COSTS 9

7. DATA ANALYSIS AND FINDINGS 10

7.1 PRODUCTS 10

7.2 EOQ 10

7.3 STOCK LEVELS 11

7.4 LAYOUT 12

7.5 SPACE REQUIREMENTS 13

7.6 FINANCES 13

7.7 OSHA & FOOD SAFETY 16

8. SOLUTION ALTERNATIVES 17

8.1 LAYOUT 17

8.2 CUSTOMERS 22

8.3 PALLET WRAPPING MACHINE 22

8.4 FORKLIFTS 23

9. RECOMMENDATIONS 23

10. IMPLEMENTATION & ASSESSMENT WORK PLAN 26

11. REFERENCES 27

APPENDICES 28

MEETING RECORDS 31

1. INTRODUCTION

VistaVu Solutions, founded in 1996, is a management consulting firm that helps small companies solve complex problems and find functional efficiency using technology. Over the years, through great success, VistaVu Solutions has provided solutions to globally recognized companies in Wholesale Distribution, Industrial Field Services, Manufacturing, Life Sciences, and Aerospace & Defense. VistaVu values and focuses on providing excellent service and forming everlasting partnerships with clients. One of the solutions VistaVu offers is SAP Business ByDesign; an Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) system. This cost-effective cloud-based system enables businesses to optimize and manage a multitude of business processes. SAP Business ByDesign has great flexibility and allows businesses to customize the software to their needs.

The services offered by VistaVu involve reviewing their client's business and its objectives. From there, they work towards implementing an instance of SAP customized and configured for the company's needs. This adds value to VistaVu's clients by digitizing and organizing business processes in a systematic manner. As a result, VistVu experiences an increase in administrative efficiency leading to higher customer satisfaction. Moreover, the advantages posed by ERP software such as SAP are essentially necessary for companies to compete in the competitive modern economic landscape.

Wholesale grocery distributors are an important industry that plays a keystone role in the food supply chain. As globalization has taken its hold on the world, the global food supply chain has developed into a mature and highly complex system characterized by rapid growth. Consequently, the need for grocery distributors is constantly increasing. However, distributors must often manage poor inventory management, lack of visibility and reporting, and unpleasant relationships with customers. This presses the need for well-planned facility layouts, intelligent enterprise planning software, and creative decision making in the industry.

A successful facility layout is vital to a business's productivity by ensuring a trouble-free flow of material and information. All characteristics researched this semester play a role in the well-designed facility. The team used previous knowledge from plant layout and supply chain logistics for the design stage of the warehouse. From there, prior exposure to SAP in information systems class will help with the master data setup in SAP Business ByDesign to create sales orders and issue inventory next semester. Once, this information is entered into our system, tasks such as the inbound and outbound of products will be simulated using SAP ByDesign. Productive project functionality will demonstrate SAP capabilities using warehousing techniques.

2. BACKGROUND & MOTIVATION

One of the services VistaVu provides to clients as part of their ERP consulting services is a variety of industry-specific SAP demonstrators that they can show to clients. These are great to give clients a solid visual idea of how SAP works and can be used to help solve the problems they face in managing their businesses. VistaVu currently lacks an SAP Business ByDesign demonstrator appropriate for grocery distribution. Therefore, they would like to understand more about how SAP can be applied in this area of industry. Given the importance of a good facility layout and ERP software to grocery distribution, the team focused on understanding how these two relate to each other in this context. We created a case study with the business case being the operation of a grocery distribution warehouse, and the study focusing on how this business translates to, and can be aided by, ERP software such as SAP. Facilitating this case study involves two major components: developing a virtual wholesale grocery distribution warehouse layout and implementing the attributes of that warehouse design into an instance of SAP Business ByDesign.

It is important for the virtual facility layout to realistically represent certain aspects of a real-world warehouse. More specifically, VistaVu requests that the warehouse be designed for use in a grocery distribution setting, and for the warehouse to have cold storage capabilities. Such a design involves unique components such as a large HVAC system, and special care made towards ensuring the integrity of the product regarding food safety regulations. By realistically and wholly capturing the design specifications of such a facility, it provides key information that can be used as metadata for the ERP software. Aiding VistaVu as they can provide a much more accurate depiction of what clients in this industry should expect if they are to consult VistaVu's services.

The instance of SAP Business ByDesign is the core business goal of VistaVu for this project. A central service of theirs is to provide consultation services to help clients with SAP. Clients expect precise solutions to problems they face in the ERP space. As a result, it is important for this implementation to be robust in its accurate portrayal of a grocery warehousing business. As such, the case study conducted for this project will be grounded on the well-established metadata derived from the specifications of the facility layout. By doing so, we can add value to VistaVu as this allows us to provide an SAP instance that has a lot of depth in its industry-specific representation.

Since VistaVu is growing, having an application already designed for grocery distributors allows VistaVu to appeal to a new group of clients. For instance, once this project is completed, VistaVu will be able to easily demonstrate a working product that shows the value that will be added if the company was willing to implement the SAP Business ByDesign. Additionally, this project can be treated as a pilot program to test for failures and polish a product for future customers. Summarily, the keystone motivator of this project is conducting a thoughtful case study of grocery warehousing and SAP that meets VistaVu's goals.

3. PROBLEM DESCRIPTION

VistaVu does not have a grocery distribution SAP mock-up to demonstrate to clients. The specific problem this project will be focused on is bridging that gap between having a food warehousing facility (in this case virtual) and tying it to systems such as SAP ByDesign. This problem has multiple constituent parts and can be broken down into those associated with designing the facility layout, and those associated with configuring the SAP implementation. During the first half of the project, the team focused on the facility layout, which was associated with several specific technical problems to solve. Generally, we needed to determine what products to distribute, the ordering regime & stock levels, space requirements, and expected costs & regulations associated with the facility.

- Determine the appropriate product mix, as well as associative demand, prices, and dimensions. Bearing in mind the importance of having sufficient product variety with a mix of dry and cold storage products.
- Determine the optimal ordering regime (economic ordering quantity) that minimizes costs and meets the specific constraints of the warehouse operation. Certain products have short shelf lives, and the warehouse receives deliveries by the pallet, so the ordering regime should be appropriate for these constraints.
- Determine the expected stock levels of each type of product in the warehouse, with particular attention given to the expected minimum and maximum stock levels of the facility. The maximum stock level is important for estimating the necessary capacity of the warehouse, and the minimum stock level is important for calculating the re-order point of the ordering regime.
- Determine ideal layout alternatives that best fit the needs of this warehousing operation. Industry standards include the “U”, “I”, and “L” designs. Selecting the best layout archetype for the context of this lower volume, cold-storage warehouse.
- Determine the estimated space requirements of the warehouse. Ensuring that there is enough square footage to create adequate capacity for the expected maximum stock levels. There also needs to be enough space for safe and efficient operation of the warehouse. Additionally, the size of the building footprint is also affected by the chosen layout type.
- Determine the financial viability of the proposed warehousing operation. This includes estimating the total annual revenues and total annual costs of the warehouse. Revenues are largely influenced by the prices and demand of the product mix. Costs include leasing of the building and its equipment, labor, HVAC electricity fees, overhead, and annual capital costs. It is important that the proposed warehouse design is profitable and economically viable.

By solving these technical problems, the team can be successful in designing a realistic and optimal warehouse layout. Additionally, many of the results and design specifications that arise from addressing these technical issues can then be used as metadata for the SAP implementation. This will be useful as the team will look to address the second stage of the project by creating the SAP instance.

4. MANAGEMENT OBJECTIVES

The goal of this study is to create a robust case study to demonstrate the capabilities of SAP in a food distribution warehousing setting. To achieve this goal, VistaVu seeks the following:

- To develop an optimal facility design for a food distribution warehouse that is a sufficiently realistic basis for the virtual case study of the project.
- To implement an instance of SAP Business ByDesign that is correctly configured to accurately reflect and serve the specific components of the virtual food distribution warehouse.

5. SOLUTION METHODOLOGY

Collection of data and evaluation of the following components of the food distribution warehouse were the foundation to solving the problem at hand. The team began by determining a product mix and calculating the number of products per box and pallet. Aiming to minimize inventory and holding costs, the team determined the ideal quantity of products to be purchased per order. The Economic Order Quantity totals were then used to determine the expected stock levels in the warehouse. Lastly, the team estimated the space requirements and calculated operational costs to determine the optimal facility layout.

5.1 PRODUCTS

After reviewing information from retailers such as Rouses Markets and Walmart Inc, the team decided to focus on Zatarain's brand of Louisiana-themed grocery items. From this research, a product mix of 20 products was selected that featured a variety of dry, frozen, and refrigerated products. The retail price, shelf life, and dimensions of these items were collected from these retailer's websites (Matherne's, 2022; Rouses Supermarkets, 2022; Walmart Inc, 2022; Winn-Dixie Stores Inc, 2022). Additionally, lead-times for each product were estimated according to their product type (McKinnon, 1998). The warehouse uses 48"x40" pallets and 24"x10"x8" cardboard boxes (Uline, 2022). To determine the number of products per box and per pallet the following methods were used:

- Number per Box:

  Using the dimensions of each product as (a, b, c), and the sides of the box as (x, y, z), then the number of products stacked in a box is $int\left(\frac{z}{c}\right)$. Next the number of products per box is calculated as: $\frac{\#\ of\ products}{box} = int\left(\frac{z}{c}\right) \cdot \max\left\{int\left(\frac{x}{a} \cdot \frac{y}{b}\right),\ int\left(\frac{y}{a} \cdot \frac{x}{b}\right)\right\}$

- Number per Pallet:

  Eight boxes can fit on a pallet, and the boxes are stacked five boxes high for a total pallet height of 46". This means that there are forty total boxes per pallet. Thus, the number of products per pallet is: $\frac{\#\ of\ products}{pallet} = \frac{\#\ of\ products}{box} \cdot \frac{40\ boxes}{pallet}$

Finally, to round out the products information the total annual revenue for each product and the entire warehouse is estimated by:

$\frac{Annual\ revenue}{product} = \frac{demand}{store} \cdot\ of\ stores \cdot wholesale\ price$, and $Total\ annual\ revenue\ = \sum_{i=1}^{21} \frac{Annual\ revenue}{product_i}$.

5.2 ECONOMIC ORDER QUANTITY

Using the information gathered and derived for each product the next step was to calculate the EOQ model for the warehouse. The model assumed that the demand (D) and unit cost (C) for each product were the estimated demand and manufacturing price derived for each product in the section above. Next, the carrying cost rate used was a standard return of I = 20%. Finally, the ordering cost was estimated based on the cost of shipping from the manufacturer in Gretna, LA to the warehouse in Baton Rouge. Using the formula $F = Ordering\ Cost = Distance \cdot \frac{Cost}{Mile}$.

Leading to the initial optimal ordering quantity of each product to be $Q = \sqrt{\frac{2FD}{IC}}$.

From here, several adjustments were made to the order quantity to account for the fact that orders are received in pallets, and that some products in the factory have a short shelf life.

- To adjust for the palletized orders, first the number of pallets to satisfy the current Q is $P = \frac{\#\ of\ pallets}{order} = \frac{Q}{\frac{\#\ of\ products}{pallet}}$.
- P is rounded up and rounded down to result in P+ and P- numbers of pallets to order. To decide which pallet to order, the following total cost formula was used $TC(Q) = DC + \frac{DF}{Q} + \frac{QIC}{2}$. As such, the number of pallets ordered for a product was $P' = P^{+} or\ P^{-} such\ that$ $\min\{TC(P)\}$.
- Finally, to account for shelf life the time between each order was calculated as $T = \frac{Q}{D}$. If T is greater than the shelf life of a product, then the order quantity for that product was readjusted as $Q_{shelf-life} = D \cdot T_{shelf-life}$. Additionally, the total cost for that product must be calculated using the equation above.

5.3 STOCK LEVELS

Minimum, maximum, and reorder point stock levels were determined through analysis below:

- The minimum stock level was set to cover exactly the lead time of each product $\min\{stock\} = \frac{product\ demand}{day} \cdot lead\ time$
- The maximum stock level was set to equal the min stock plus the order quantity $\max\{stock\} = \min\{stock\} + Q$
- The reorder point was calculated in terms of pallets by dividing the lead-time multiplied by the order quantity divided by the time between orders $R = \frac{LQ}{T}$.
- Finally, the maximum and minimum numbers of pallets expected in the warehouse overall and for each product classification was found by summing the maximum and minimum pallet levels for each product.

5.4 GENERATING LAYOUT ALTERNATIVES

To generate layout alternatives for the warehouse, we started by creating an activity relationship diagram for the proposed departments within the warehouse. Next, using the estimated space requirements and converting each department into unitized "blocks" multiple block layouts were developed. These followed the U, I, and L warehouse shapes respectively. Finally, the layout that best fit the management objectives was selected and a full draft of that warehouse was designed to ensure that it had sufficient

space for each department, and enough pallet capacity for the maximum expected pallets in the warehouse.

5.5 SPACE REQUIREMENTS

The maximum expected pallet numbers calculated above determine the needed capacity of the warehouse and the space needed for storage of each product classification, as well as the space needed for shipping and receiving. Space needs of other areas of the warehouse such as office area, Quality Control, and restrooms were estimated according to data collected from the 4th edition of the Facilities Planning Textbook (Tompkins, 2010). Altogether these space needs were brought together to create an estimate of the needed square footage broken down by department.

5.6 OPERATIONAL COSTS

On top of the cost of goods sold, which was calculated in the EOQ section of the project, several additional important operational costs were also considered for the warehouse.

- A key component of the warehouse is the cold storage section. A significant cost associated with this is the electricity needed to run the system which is calculated by

$$HVAC\ Operational\ Cost\ = \frac{HVAC\ Electricity\ Usage}{\frac{Year}{Sq\ Ft}} \cdot \frac{Electricity\ Cost}{KWh} \cdot Area\ of\ Cold\ Storage$$

- Overhead costs for the warehouse were calculated as $Overhead\ = \frac{Overhead\ rate}{sq\ ft} \cdot Warehouse\ Area$. An adjustment was made for the cold storage areas to slightly reduce the overhead rate to avoid double counting any HVAC-related electricity costs.
- Labor costs and staffing were estimated by the following two equations: $\#\ of\ staff\ = area/staff\ rate$, and $labor\ \cos t\ = labor\ rate \cdot\ of\ staff \cdot annual\ hours$
- Pallet wrapping and rack costs were estimated by looking at the total pallet needs for the warehouse and then determining the number of rack slots needed. This number was then multiplied by the per-unit price of the racks.
- Annual pallet wrapping costs were determined by finding the total annual pallets, determining the total pallet capacity for each roll of wrap, and then the cost of the amount of wrap needed to cover the amount of pallets.
- Annual capital cost was calculated by $EAC\ = \frac{Capital\ Cost \cdot Interest\ Rate}{1-(1+Interest\ Rate)^{-years}}$
- Leasing cost was calculated by researching the BR average PSF (annual leasing price per square foot) and then using this equation: $Annual\ Lease\ Cost\ = Area \cdot PSF$.
- Additional recurring costs such as forklift and safety costs were determined according to researched industry averages and posted rates.
- Associated costs for delivery to clients and truck delivery routes have been recognized. These characteristics will be evaluated in the remaining weeks of the semester.

6. DATA COLLECTION

Throughout this semester, the team has collected data on all aspects of the facility design. The team began by determining a list of Zatarain's products, a New Orleans based food and spice company, with variety in dry, refrigerated, and frozen goods. From there, product dimensions for each item were collected to be

used to calculate the number of products per box. Shelf life for the products were also obtained on McCormick & Company website, the owner of Zatarain's. The team then evaluated grocery stores in Baton Rouge to determine the customer list for the warehouse.

6.1 PRODUCTS

The warehouse will order and receive products from the Zatarain's manufacturing facility in Gretna Louisiana, approximately 70 miles from Baton Rouge. Through research and evaluation, the team composed a list of 21 loyal and trusted customers to distribute our products to. This includes all Rouses, Albertsons, Winn Dixie, and Matherne's Market in the Baton Rouge Metropolitan Area. The team then composed a chart of the supplier and customers along with a map of their locations, listed in Appendix A, Appendix B and mapped in Figure 1 (Google Maps, 2022).

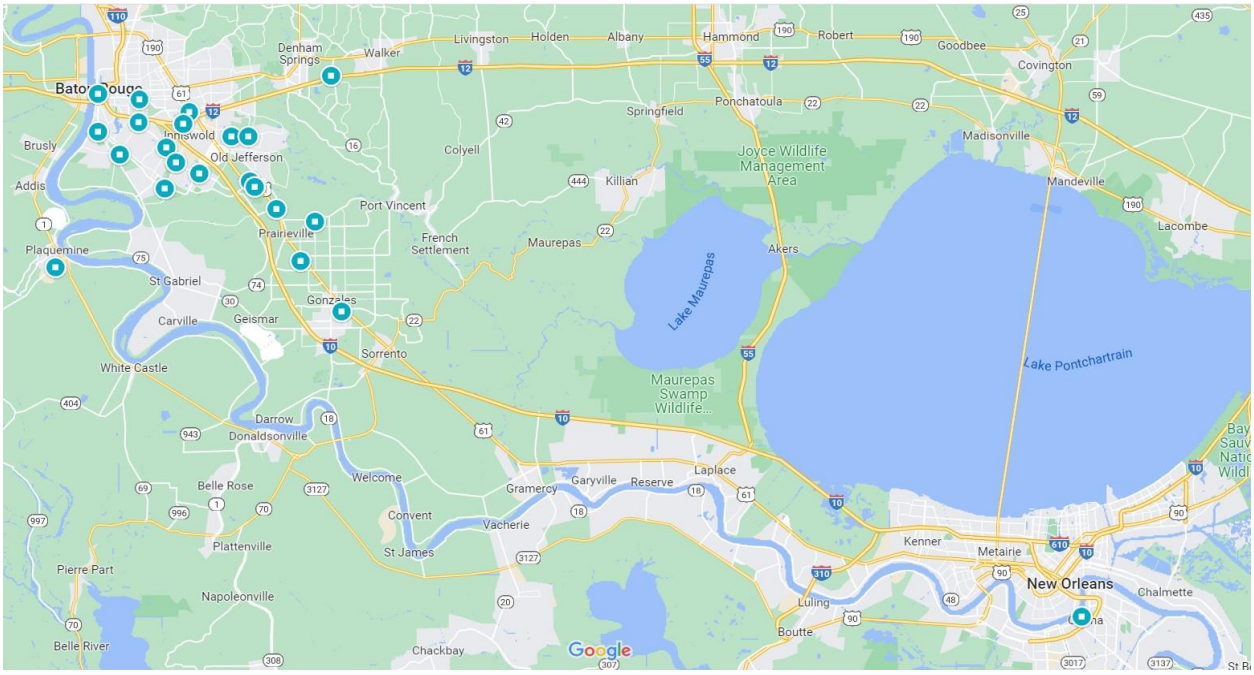


Figure 1: Supplier and Customers Map

6.2 PRODUCT PRICES AND DEMAND

After the customers were chosen, the team researched the retail prices of each product at Albertsons, Matherne's, Rouses, and Winn Dixie. Since the product prices differed based on the store, the average was calculated for the retail price. To determine the wholesale price for the warehouse to sell the products for, the team subtracted 2% from the retail price. The manufacturer price was then calculated by subtracting 7% from the wholesale price (Nichibei, 2018). A daily demand for each product per store was also determined by visiting our customer stores and recording the amount of goods on the shelf. The amount of goods differed based on frozen, refrigerated, and dry sections. Dry sections kept the most products on the shelf. Table 1 summarizes the collected data. Dry goods are highlighted in yellow, refrigerated in blue, and frozen in green.

Table 1: Product Prices and Dimensions

Products	Product Dimensions (L x W x H)	Shelf Life	Manufacturer Price	Wholesale Price	Retail Price	Daily Demand
Gumbo Base (4.5oz)	1.54 x 3.88 x 6.20 Inches	730	$2.00	$2.15	$2.19	20
Creole Mustard (12oz)	2.88 x 1.98 x 6.44 Inches	450	$3.16	$3.40	$3.47	30
Cajun Hot Sauce (10oz)	2.41 x 2.41 x 8.11 Inches	720	$3.45	$3.71	$3.79	50
Seasoned Fish Fry (12oz)	1.66 x 3.75 x 7.07 Inches	547	$1.81	$1.95	$1.99	10
Shrimp and Crab Boil (4oz)	1.94 x 1.94 x 4.26 Inches	730	$2.09	$2.24	$2.29	10
Creole Seasoning (8oz)	2.57 x 2.57 x 4.44 Inches	1080	$2.00	$2.15	$2.19	40
Jambalaya Mix (8oz)	1.54 x 3.88 x 6.20 Inches	720	$1.63	$1.75	$1.79	30
Red Beans & Rice Mix (8oz)	1.54 x 3.88 x 6.20 Inches	730	$2.54	$2.73	$2.79	20
Andouille Sausage (14oz)	1.25 x 10.10 x 3.75 Inches	14	$5.28	$5.67	$5.79	20
Cajun Style Smoked Sausage (14oz)	1.25 x 10.10 x 3.75 Inches	14	$5.28	$5.67	$5.79	25
Blackened Seasoned Chicken Sausage (14oz)	1.25 x 10.10 x 3.75 Inches	14	$5.28	$5.67	$5.79	15
Frozen Family Chicken Alfredo (24oz)	3.62 x 5.62 x 9.50 Inches	180	$9.30	$10.00	$10.20	15
Frozen Family Shrimp Scampi (20oz)	3.62 x 5.62 x 9.50 Inches	180	$9.30	$10.00	$10.20	10
Frozen Family Bourbon Chicken Pasta (24oz)	3.62 x 5.62 x 9.50 Inches	180	$9.30	$10.00	$10.20	15
Frozen Sausage & Chicken Gumbo (12oz)	1.79 x 6.76 x 5.75 Inches	180	$3.64	$3.91	$3.99	10
Frozen Shrimp Alfredo (12oz)	1.79 x 6.76 x 5.75 Inches	180	$3.64	$3.91	$3.99	5
Frozen Blackened Chicken with Yellow Rice (12oz)	1.79 x 6.76 x 5.75 Inches	180	$3.64	$3.91	$3.99	10
Frozen Chicken Carbonara (12oz)	1.79 x 6.76 x 5.75 Inches	180	$3.64	$3.91	$3.99	5
Frozen Red Beans & Rice with Sausage (12oz)	1.79 x 6.76 x 5.75 Inches	180	$3.64	$3.91	$3.99	10
Frozen Dirty Rice with Beef & Pork (12oz)	1.79 x 6.76 x 5.75 Inches	180	$3.64	$3.91	$3.99	5

6.3 WAREHOUSE SIZE AND LOCATION

In determining the location for the warehouse, the team evaluated three main factors: centrally located near customers, ease of access to interstates and highways, and ability to seen by the public. After careful consideration, Airline Highway was chosen as the location for the warehouse. Airline Highway is in a central location of our customers and is easily accessible to Interstate 10 (I-10) and Interstate 12 (I-12). Airline Highway is also in an industrial area that is built in for commercial purposes. The businesses in this industrial area are given more attention and are heavily recognized by the public. Therefore, the warehouse could see in an increase in business from people driving down Airline Highway.

6.4 FACILITY ATTRIBUTES

The following facility attributes were obtained from trusted sources online. These attributes are important to the data analysis and calculations for our warehouse costs and revenue. The team first discovered ordering costs for products are calculated based on $1.38 per mile (Epearce, 2012). About 70 miles from Gretna to Baton Rouge, this equates to approximately $100 for ordering costs. According to Louisiana Commercial Realty, the industrial real estate price per square foot is $6.51. General overhead costs along with refrigerated non-electricity overhead equates to $2 and $1.70 per square foot (ProLogis Inc, 2022; Shipley Energy, 2022). Likewise, the average electricity cost per kilowatt hour in Baton Rouge is 12 cents (Energysage, 2022). For refrigerated and frozen HVAC electricity, the usage rates were determined to be

50 and 55 kwh/ft^2 (Faramarzi, 2002). The team determined the average costs per employee based on findings from the US Bureau of Labor Statistics. For warehouses with 1-49 employees, the average employee cost is $30.23/hr, accounting for $22.43/hr in wages and $7.81/hr in benefits (US Bureau of Labor Statistics, 2022). Lastly, the estimated annual forklift cost is $9,000. (ProLogis Inc, 2022). These facility attributes are referenced in Table 2.

Table 2: Facility Attributes

Facility Attributes	
Ordering Cost	$100.88
Industrial Real Estate Lease Rate	$6.51/sq ft
Overhead	$2/sq ft
Refrigerated Non-Electricity Overhead	$1.7/sq ft
Baton Rouge Average Electricity	$0.12/kWh
Annual Refrigerated HVAC Electricity Usage Rate	50 kWh/ft^2
Annual Frozen HVAC Electricity Usage Rate	55 kWh/ft^2
Labor Rate	$30.32
Annual Forklift Cost	$9,000

6.5 Capital Costs

For the food distribution warehouse to be operable, it must endure one-time expenses known as capital costs. The HVAC unit for the refrigerated and frozen sections of the warehouse cost $100,000 (Allied, 2022). For startup costs for the equipment, the pallet wrapping machine costs $7,565 and the pallet racks costs $24,600 (Uline, 2022). The calculation for the pallet racks will be explained in the data analysis. The following safety equipment was obtained on Uline's website. Cold storage coveralls are needed for the workers in the frozen and refrigerated sections, priced at $195 apiece. Hard hats cost $10 each, frozen storage gloves for $39 each, and regular gloves for $3 each. Anti-fog glasses are also needed for workers in the frozen and refrigerated sections. These glasses were $3 each. All workers must wear safety vests while on the warehouse floor, costing $3.75 apiece. Lastly, prices for facemasks were collected for workers who are dealing with the food products. The startup cost for the safety program is $1,000 and OSHA training costs of $530 per employee for a total of $4,240. In total, upfront safety costs were $6,471 and annual safety costs were $2,400 (Roux, 2014; Safety Training, 2022). A breakdown of these totals is in Table 3.

Table 3: Safety Equipment

Safety Equipment	**Price**
Cold Storage Clothing	$780.00
Hard hat	$80.00
Frozen Storage Gloves	$156.00
Warehouse gloves	$24.00
Anti-Fog Glasses	$36.00
Safety Vests	$30.00
Facemasks	$125.00
Safety Program Startup	$1,000.00
Safety Trainings	$4,240.00
Total	$6,471.00

7. DATA ANALYSIS AND FINDINGS

After collecting the necessary data, the team then looked towards analyzing that data in order to understand the economic and design specifications of the warehouse. We utilized the methodology detailed above to analyze data pertaining to products, EOQ, stock levels, layout & space requirements, and finances.

7.1 PRODUCTS

Based on the product attributes that were collected several data points about each product were calculated, including the number of products per box and per pallet, as well as the total annual revenue per product. Table 4 documents this information.

Table 4: Product Calculations

Products	# per Box	# per Pallet	Total Annual Revenue
Gumbo Base (4.5oz)	30	1200	$329,012.46
Creole Mustard (12oz)	40	1600	$781,967.97
Cajun Hot Sauce (10oz)	70	2800	$1,423,467.15
Seasoned Fish Fry (12oz)	36	1440	$149,482.83
Shrimp and Crab Boil (4oz)	60	2400	$172,017.93
Creole Seasoning (8oz)	21	840	$658,024.92
Jambalaya Mix (8oz)	30	1200	$403,378.29
Red Beans & Rice Mix (8oz)	30	1200	$419,152.86
Andouille Sausage (14oz)	12	480	$869,854.86
Cajun Style Smoked Sausage (14oz)	12	480	$1,087,318.58
Blackened Seasoned Chicken Sausage (14oz)	12	480	$652,391.15
Frozen Family Chicken Alfredo (24oz)	6	240	$1,149,290.10
Frozen Family Shrimp Scampi (20oz)	6	240	$766,193.40
Frozen Family Bourbon Chicken Pasta (24oz)	6	240	$1,149,290.10
Frozen Sausage & Chicken Gumbo (12oz)	12	480	$299,716.83
Frozen Shrimp Alfredo (12oz)	12	480	$149,858.42
Frozen Blackened Chicken with Yellow Rice (12oz)	12	480	$299,716.83
Frozen Chicken Carbonara (12oz)	12	480	$149,858.42
Frozen Red Beans & Rice with Sausage (12oz)	12	480	$299,716.83
Frozen Dirty Rice with Beef & Pork (12oz)	12	480	$149,858.42

7.2 EOQ

Using the EOQ method and adjusting for both the palletization and shelf-life for the products, the EOQ in terms of products and pallets, the time interval between orders, and the estimated total annual cost for each product was calculated. This model assumed a carrying cost rate of 20% and used the ordering cost discussed in data collection above (Tuovila, 2022). Table 5 shows a breakdown of how the EOQ was calculated.

Table 5: Economic Order Quantity

Products	# of products per order	# of Pallets per Order	Time Between Orders (days)	Total Annual Cost
Gumbo Base (4.5oz)	8400	7	20	$309,499.26
Creole Mustard (12oz)	8000	5	12	$732,659.93
Cajun Hot Sauce (10oz)	11200	4	10	$1,331,145.15
Seasoned Fish Fry (12oz)	7200	5	34	$141,398.84
Shrimp and Crab Boil (4oz)	7200	3	34	$162,553.34
Creole Seasoning (8oz)	12600	15	15	$616,932.84
Jambalaya Mix (8oz)	12000	10	19	$379,032.61
Red Beans & Rice Mix (8oz)	8400	7	20	$393,789.18
Andouille Sausage (14oz)	5280	11	12	$814,680.24
Cajun Style Smoked Sausage (14oz)	6240	13	11	$1,017,597.06
Blackened Seasoned Chicken Sausage (14oz)	4800	10	14	$611,673.12
Frozen Family Chicken Alfredo (24oz)	3600	15	11	$1,075,408.31
Frozen Family Shrimp Scampi (20oz)	2880	12	13	$717,922.07
Frozen Family Bourbon Chicken Pasta (24oz)	3600	15	11	$1,075,408.31
Frozen Sausage & Chicken Gumbo (12oz)	4800	10	22	$282,093.09
Frozen Shrimp Alfredo (12oz)	3360	7	32	$141,740.85
Frozen Blackened Chicken with Yellow Rice (12oz)	4800	10	22	$282,093.09
Frozen Chicken Carbonara (12oz)	3360	7	32	$141,740.85
Frozen Red Beans & Rice with Sausage (12oz)	4800	10	22	$282,093.09
Frozen Dirty Rice with Beef & Pork (12oz)	3360	7	32	$141,740.85

7.3 Stock Levels

With the order quantity now determined, the next step was finding the minimum and maximum stock levels in the warehouse. Minimum and maximum stock along with minimum and maximum number of pallets is documented in Table 6.

Table 6: Product Stock Levels

Products	Min Stock (reorder point)	Min # of Pallets	Max Stock	Max # of Pallets
Gumbo Base (4.5oz)	3600	3	12000	10
Creole Mustard (12oz)	4800	3	12800	8
Cajun Hot Sauce (10oz)	8400	3	19600	7
Seasoned Fish Fry (12oz)	2880	2	10080	7
Shrimp and Crab Boil (4oz)	2400	1	9600	4
Creole Seasoning (8oz)	5880	7	18480	22
Jambalaya Mix (8oz)	4800	4	16800	14
Red Beans & Rice Mix (8oz)	3600	3	12000	10
Andouille Sausage (14oz)	960	2	6240	13
Cajun Style Smoked Sausage (14oz)	1440	3	7680	16
Blackened Seasoned Chicken Sausage (14oz)	960	2	5760	12
Frozen Family Chicken Alfredo (24oz)	1440	6	5040	21
Frozen Family Shrimp Scampi (20oz)	960	4	3840	16
Frozen Family Bourbon Chicken Pasta (24oz)	1440	6	5040	21
Frozen Sausage & Chicken Gumbo (12oz)	960	2	5760	12
Frozen Shrimp Alfredo (12oz)	480	1	3840	8
Frozen Blackened Chicken with Yellow Rice (12oz)	960	2	5760	12
Frozen Chicken Carbonara (12oz)	480	1	3840	8
Frozen Red Beans & Rice with Sausage (12oz)	960	2	5760	12
Frozen Dirty Rice with Beef & Pork (12oz)	480	1	3840	8

Based on the minimum and maximum pallet amounts for each product, the total expected minimum and maximum pallet levels in the warehouse both overall and by product classification was determined Table 7 highlights this information.

Table 7: Minimum and Maximum Pallets

Min Total Pallets	58	Max Total Pallets	241
Min Frozen Pallets	25	Max Frozen Pallets	118
Min Refrigerated Pallets	7	Max Refrigerated Pallets	41
Min Dry Pallets	26	Max Dry Pallets	82

7.4 LAYOUT

In considering the layout of the warehouse, the team started by brainstorming what was necessary to run a successful warehouse. The team came up with 12 essential areas that our warehouse will have: a receiving and shipping area, pallet storage areas, loading docks, office, lobby, restrooms, quality control areas, and an HVAC area. From there, the general layout of the warehouse was discussed, and an activity diagram was created to see which areas of the warehouse needed to be paired together to have optimal flow through the warehouse. In Figure 2, you can see letters and numbers stemming from each pairing of the different areas of the warehouse. In general, anything labeled an A, E, or I would mean these areas should be neighboring each other for better flow and anything labeled an O, U, or X have no neighboring significance and can be placed anywhere. Similarly, the number below the letter shows the importance of the pairing with the 1 being the highest and 5 being the lowest. For instance, in the activity diagram, one can see that the pairing for HVAC and the frozen storage is labeled A/1 meaning these two areas should be next to each other, while receiving and shipping is labeled U/3 meaning they do not need to be placed near each other as it will not help the flow of materials through the warehouse.

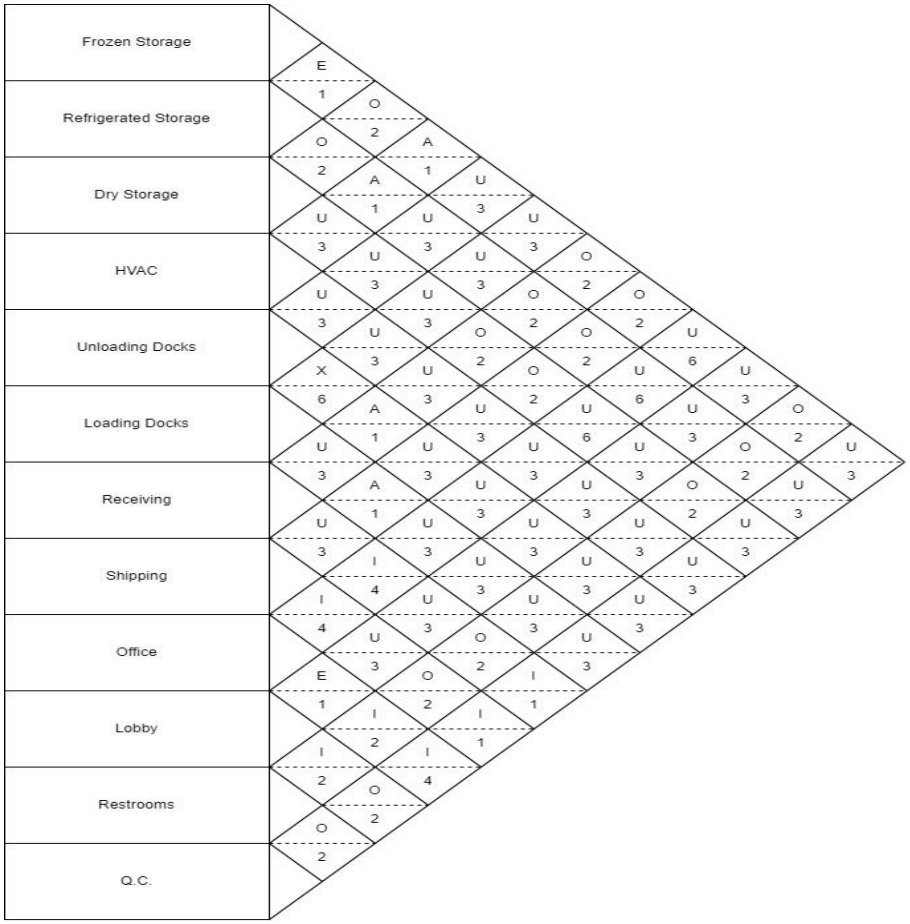


Figure 2: Activity Relationship Diagram

7.5 SPACE REQUIREMENTS

Using the expected pallet numbers and list of needed departments, the general space requirements of the warehouse were then derived. For the warehouse 9x2x3 slot pallet racks were selected. The frozen section would require three sets of pallet racks for a total of 162 pallet slots. The refrigerated section would require one set of pallet racks for a total of 54 pallet slots, and the dry section would require two sets of pallet racks for a total of 108 pallet slots. This led to estimated space requirements of ~4000 ft^2 for frozen storage, ~3000 ft^2 for dry storage, and ~1,800 ft^2 for refrigerated storage. Additionally, 200 ft^2 was reserved for the HVAC equipment. For office space a total of 600 ft^2 was estimated to provide enough space for two office workers and one Q.C. office with 200 ft^2 per office worker. The restrooms required 200ft^2 total with 100 ft^2 for each gendered restroom. These estimated space requirements are summarized in Table 8.

Table 8: Estimated Area Requirements

Department	Estimated Area (ft^2)
Frozen Storage	4200
Refrigerated Storage	1800
Dry Storage	3000
Main Aisle	2200
HVAC Equipment	200
Receiving	600
Shipping	800
Office	400
Lobby	600
Restrooms	200
Q.C.	200
Total	14200

After furthering the design process the final space requirements for the facility are broken down overall and by department in the alternatives section of this report. Notably, the final facility was determined to be 14,778ft^2.

7.6 FINANCES

Total annual revenue and total annual cost of goods sold have already been determined in the product and EOQ calculations portion of this analysis. Thus, to gain a complete picture of the warehouse's finances, additional costs such as operating costs and annual capital costs also need to be calculated.

- HVAC operating costs:

  Using an average rate of 40-60 KWh per square foot in annual electricity usage for cold storage (Faramarzi et al, 2002), and an average price of $0.12/KWh in the Baton Rouge area, the total HVAC operating costs was calculated to be $40,032.00 (Energysage, 2022). Additionally, a

capital cost of $100,000 is required for the HVAC system (Allied, 2022). These totals are referenced in Table 9.

Table 9: Estimated HVAC Operating Cost

Annual Refrigerated HVAC Electricity Usage Rate	50 KWh
Annual Frozen HVAC Electricity Usage Rate	55 KWh
Frozen Area	4320 ft^2
BR Average Electricity Cost	$0.12/KWh
Annual Frozen Electricity Usage	273,600 KWh
Annual Refrigerated Electricity Usage	96,000 KWh
Total Annual Electricity Usage	333,600 KWh
Total Annual Electricity Cost	$40,032.00

- Warehouse operating costs:

  At an estimated size of 14,868 ft^2 and with 6,240 ft^2 of that cold storage, and 8,628 ft^2 as non-cold storage sections of the warehouse; the total annual operating cost was calculated to be $30,264.00. This includes the adjustment to avoid double-counting HVAC electricity costs in the cold storage sections of the warehouse (ProLogis Inc, 2022). Also included is an annual safety cost of $2,400.

- Labor costs:

  For a warehousing operation, an employee is needed for every 1,500-3,000 ft^2 of warehouse (Griffin, 2021). In this case, with a warehouse of roughly ~15,000 ft^2 this means five to ten employees are needed. We selected eight employees since the lower shelf-lives of food mean that products will be moving in and out of the warehouse with relatively high volume. For warehousing operations with 1-49 employees, an employee costs $30.32/hr including benefits (US Bureau of Labor Statistics, 2022). Assuming employees are working a 40/hr per week schedule at 50 weeks per year, that brings the total annual labor cost to $485,120.00.

- Pallet wrapping & rack costs:

In order to build six sets of 9x2x3 slot pallet racks, a capital cost of $24,600 is incurred and was calculated by summing the cost of the 12 starter and 24 add-on pallet rack modules needed to provide the 324 total pallet slots in the warehouse (Uline, 2022). This is summarized in Table 10.

Table 10: Pallet Rack Cost

Pallet Model #	Size	Starter Price	Add on Price	Total Price
H-6806	144" x 48 " x 96"	$780	$635	$24,600
		Number Needed	Number Needed	
		12	24	
			Total Cost for Pallet Racks	**$24,600**

Additionally, there is a $7,565 capital cost incurred for the pallet wrapping machine, and an annual pallet wrapping cost of $1,848. The annual pallet wrapping cost was found by first determining the annual pallet wrap needs, and then getting the cost of that amount of pallet wrap (US Packaging and Wrapping L.L.C, 2022). Table 11 provides a breakdown of the pallet wrapping rolls cost.

Table 11: Pallet Wrapping Cost

Wrap Model #	Size
S-114988	20"x 6,000'
Feet of Film Needed Per Pallet	155.467
Stretch Feet Per Roll	21000
Number of Pallets per roll	135
Total Number of Pallets Per Year	2814
Order Quantity	21
Price Per Roll	88
Cost of Rolls Per Year	$1,848.00

- Capital costs:

  The building will be leased, so there are no upfront capital costs associated with the construction or purchase of the building. As such, factoring in the upfront costs for the pallet racks, wrapping machine, HVAC, and safety there is a total upfront capital cost of $138,636.00 associated with this project. The estimated annual capital cost assuming an interest rate of 10% and a 20-year time period is $16,284.00 per year. Table 12 summarizes the warehouse capital costs.

Table 12: Capital Costs

Capital Costs	**Price**
Pallet Racks Cost	$24,600
Pallet Wrapping Machine Cost	$7,565
HVAC Upfront	$100,000.00
Safety	$6,471
Total	**$138,636**
Annual Capital Cost	$16,284

- Leasing costs:

  In the Baton Rouge metro area, the average annual leasing price per square foot (PSF) is $6.51 (Louisiana Commercial Realty, 2021). With the layout being 14,868 ft^2 that brings the total annual leasing cost for the warehouse to $96,790.68.

Altogether, summing the annual revenue of each product resulted in a total annual revenue of $11,359,568.33 for the warehouse. Similarly, the total annual cost of goods sold based on the EOQ model is $10,651,202.07 yielding a gross margin of $708,366.25. Furthermore, subtracting the operating expenses discussed above results in an annual operating margin of $29,027.44.

7.7 OSHA & FOOD SAFETY

Even though the warehousing and storage industry are an essential part to the supply chain, warehouses are often known for being a hazardous place to work. As part of the United States Department of Labor, the Occupational Safety and Health Administration (OSHA) ensures safe operating conditions for workers by enforcing standards through training, assistance, and outreach. Operating facilities for general merchandise, refrigerated, and frozen goods in the warehousing and storage industry must adhere to and enforce the General Industry OSHA 1910 standards and subparts (Occupational Safety and Health Administration, 2022). The warehouse recognizes, adheres to, and enforces the following workplace safety standards, ultimately creating a safer workplace:

- 1910 Subpart D – Walking-Working Surfaces
- 1910 Subpart E – Exit Routes and Emergency Planning
- 1910 Subpart G – Occupational Health and Environmental Control
- 1910 Subpart I – Personal Protective Equipment
- 1910 Subpart K – Medical and First Aid
- 1910 Subpart L – Fire Protection
- 1910 Subpart N – Materials Handling and Storage
- 1910 Subpart O – Machinery and Machine Guiding

In addition to adhering to the OSHA workplace safety standards, the warehouse also recognizes the following National Consensus Standards. The National Consensus Standards are not federal regulations but provide guidance for worker protection. These standards include:

- ANSI/ITSDF B56 standards for powered and non-powered industrial trucks
- ANSI MH16.1 Specification for the Design, Testing, and Utilization of Industrial Steel Storage Racks
- ANSI/ASSP A1264.1 Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems

As part of the safety standard 1910 Subpart N, OSHA requires new competent forklift operators to complete forklift training as numerous hazards are associated with operating powered industrial trucks. Certifications must also be updated every three years to ensure safety standards are continuing to be enforced. Likewise, it is a violation of Federal Law for anyone under the age of 18 and non-certified workers to operate a powered industrial truck (Occupational Health and Safety Administration, 2022). Costs for training and certification have been accounted for in the capital costs for the warehouse and calculated in Table 3.

OSHA also requires a fire extinguisher for every 3,000 square feet of a building and travel distance to the nearest fire extinguisher should not exceed 100 feet (Occupational Health and Safety Administration, 1996). With a warehouse of 15,000 square feet, five fire extinguishers have be strategically place for easy access for the workers. Additionally, OSHA does not require a specific number of first aid kits but does require at least one kit to be present in a building. Two first aid kits have been included for the office workers and the workers on the facility floor. Appendix C displays the facility layout with the locations of the fire extinguishers in the red circles and the first aid kits in the blue squares.

The United States Food and Drug Administration (FDA) ensures safe treatment and condition of food products through regulations, protecting customers from contaminated foods. While the food distribution warehouse recognizes and enforces the FDA regulations, the major regulations acknowledged by the facility are summarized. In order for the facility to be able to handle food, the warehouse must register with the FDA before operating. With the creation of the Food Safety Modernization Act in 2011 to prevent food contamination, the FDA requires facilities to be inspected once in the first five years of opening, and every three years after the first inspection (FW Logistics, 2022). Food contact surfaces, food equipment and warehouse equipment must be cleaned often enough to prevent contamination. Lastly, the FDA requires stored food to be maintained based on frozen, dry, and refrigerated products (Food and Drug Administration, 2021).

The FDA regulations for each department include:

- Dry Goods – Store products between 50°- 70° F with maximum shelf life at 50° F
- Refrigerated Goods – Products should be stored at or below 40° F
- Frozen Goods – Freezer temperatures should be 0° F

Proper Personal Protective Equipment for workers operating in refrigerated and frozen good sections of the warehouse have been calculated and included in Table 3. Although considering and enforcing the regulations set forth by OSHA and the FDA increases the startup costs for the warehouse, the workplace will be safe for workers to operate, and the products will avoid contamination. Likewise, expenses in the future will be reduced by avoiding fines and citations issued by the FDA and OSHA.

8. SOLUTION ALTERNATIVES

Once the team had analyzed the data, we had the information we needed to begin brainstorming potential design alternatives for the facility. We began by first drafting block layouts of the facility based on our estimated unitized block space requirements. After selecting the best block layout, a more detailed layout was drafted. During this process, the team also considered alternatives for equipment in the warehouse such as the forklifts and pallet-wrapping machines.

8.1 LAYOUT

After careful consideration, the team created three draft block layouts to best satisfy the activity diagram above. After creating each layout, the team evaluated it according to the management objectives. Specifically, by looking at the spatial optimality and realistic use in this warehousing context. These layouts were based off industry standard "L", "I", and "U" shaped layouts. The first iteration was an L shaped (

Figure 3) warehouse with the shipping in the upper left corner and receiving in the bottom right corner.

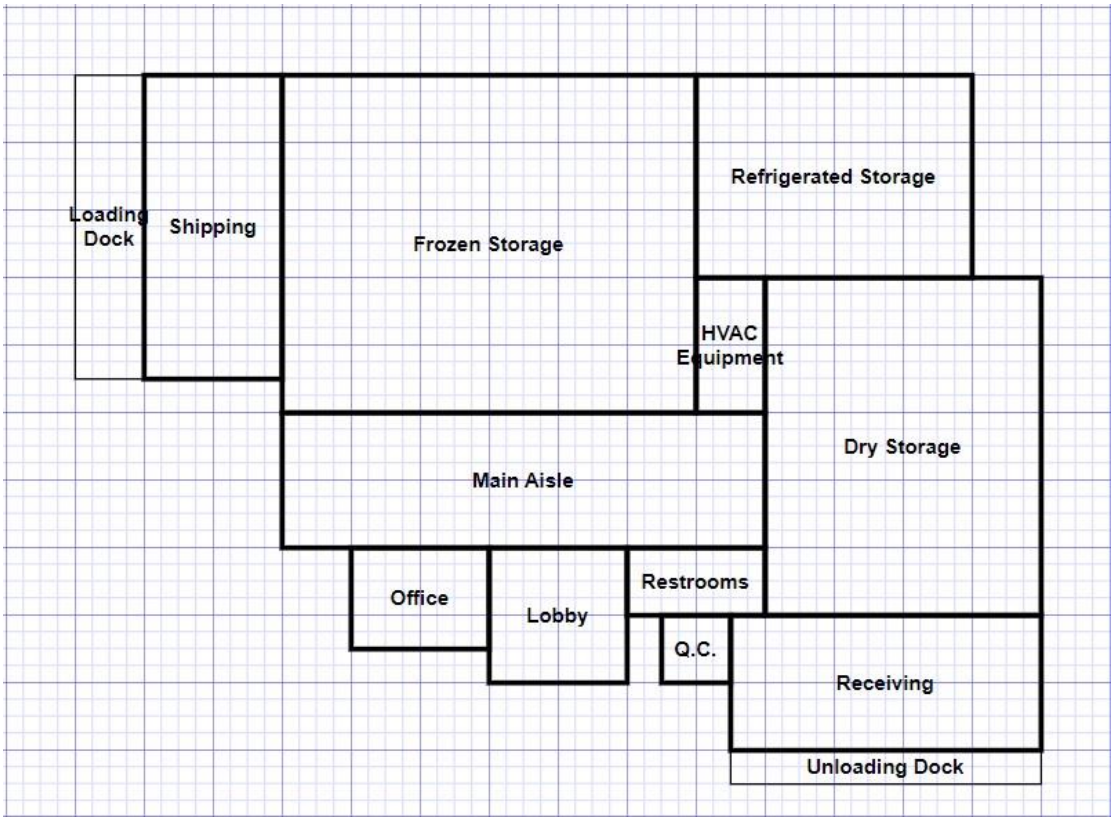
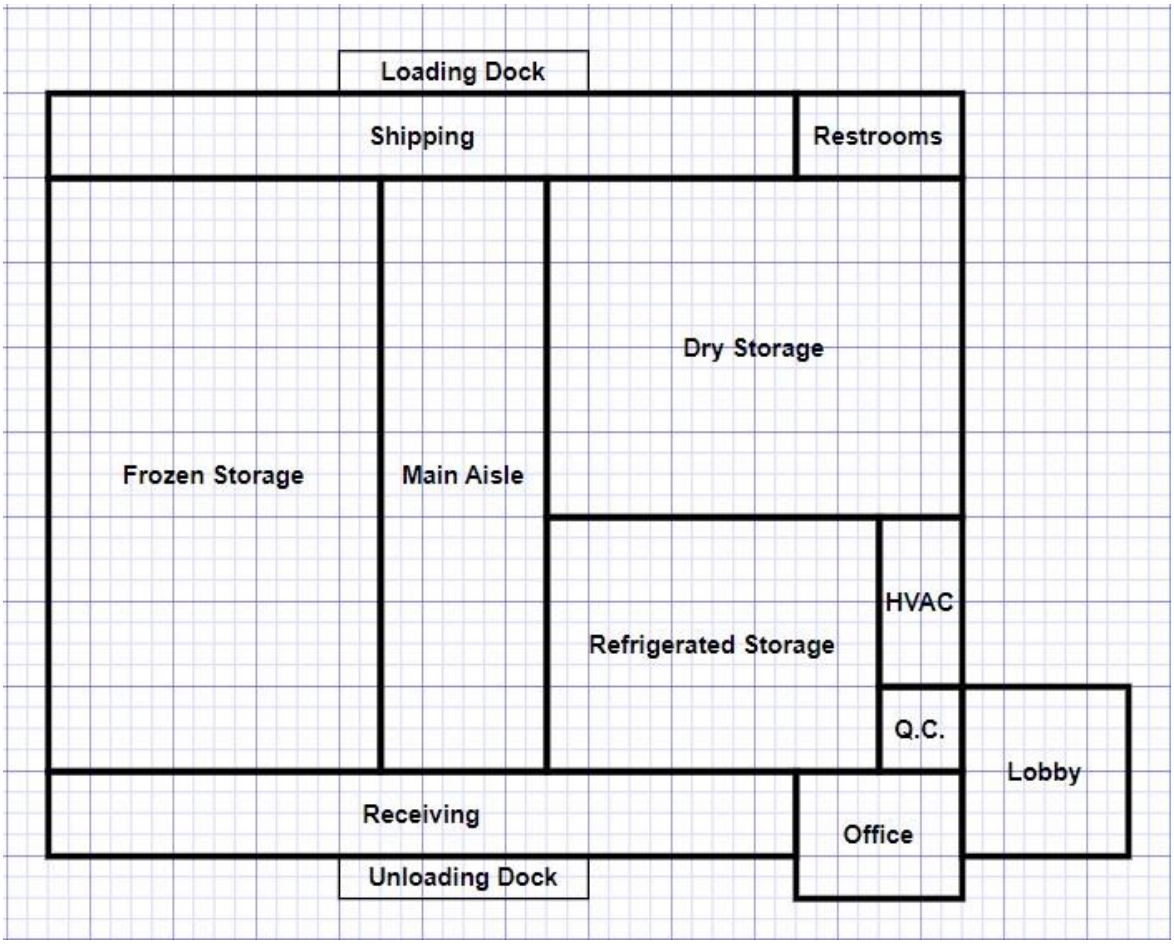


Figure 3: L-Shaped Block Layout

This layout was evaluated to be a poor fit for the purposes of this warehouse. Despite maintaining the necessary activity relationship between departments, the shape and material flow of this layout is awkward. Thus, the layout does not optimally fit the footprint of a standard rectangular shaped building, and the novel, high-volume placement of the loading docks on opposite corners is not realistically needed for a warehouse of this type.



The second iteration the team came up with was the I-shaped layout in Figure 4, which allowed for the shipping to be done at the top and the receiving at the bottom.

Figure 4: I-Shaped Block Layout

This layout satisfies the activity diagram by keeping the essential areas next to each other and having good flow throughout the warehouse. Additionally, unlike the "L" shaped layout, this iteration much better fits an optimal rectangular building footprint. However, for the purposes of this warehouse, it is not a realistically necessary alternative. There are added costs and complexities associated with having separate driveways and loading docks on opposite sides of the building. With the relatively low volume of this facility, this is not necessary and would make an "I" shaped warehouse prohibitively expensive in the context of our modest food distribution operation.

The third iteration the team came up with was the U-shaped layout in Figure 5. This layout allows for the receiving and shipping to be done on the same side as each other, just in opposite corners.

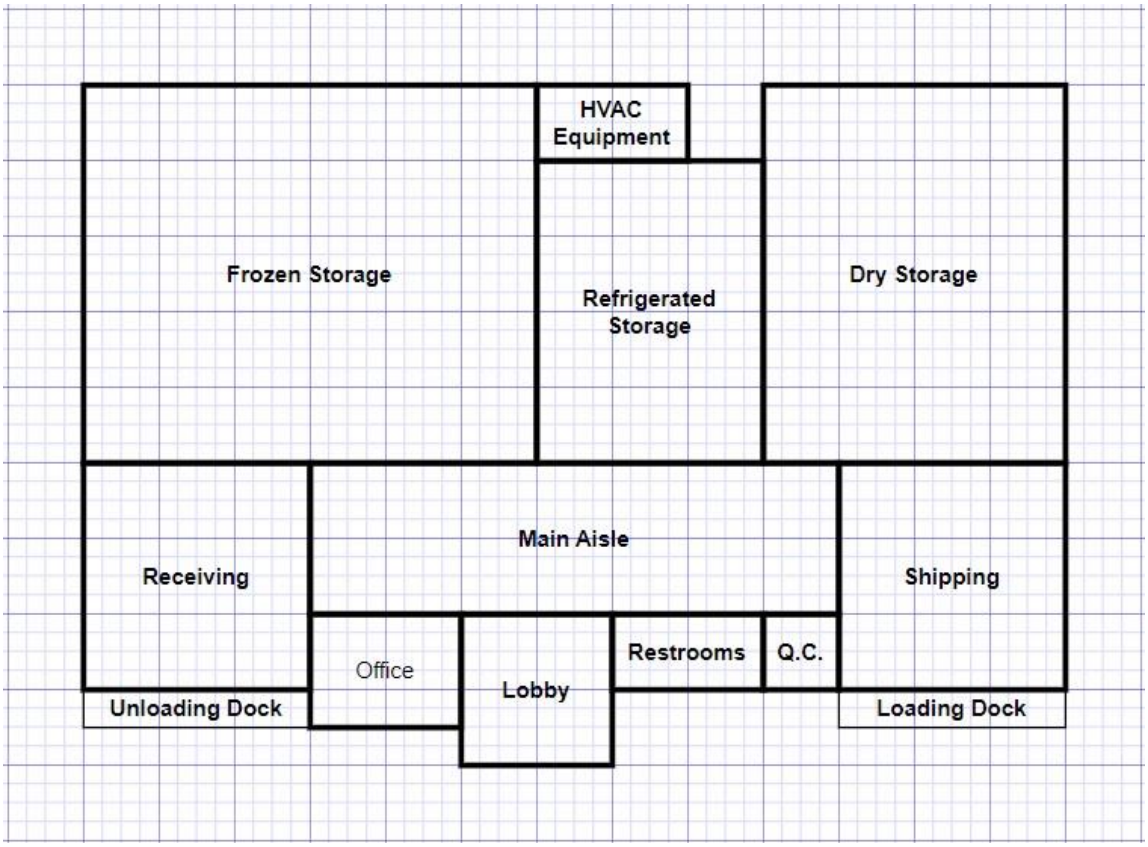


Figure 5: U-Shaped Block Layout

This layout satisfies the activity diagram by keeping all the essential areas next to each other. This layout also has natural flow through as products come in the bottom left-hand corner and can be stored meanwhile products can get exported through the bottom right-hand corner all at the same without any interruption. It is assumed that receiving and shipping will occur at different times of the day to reduce traffic in the main aisle. Also, the layout fits in a standard rectangular shaped building meaning it would not have any dead space and be optimally using all the space available. Additionally, due to the simple nature of this design, it was a more realistic alternative for the context of our project. Ultimately, iteration three, the U-shaped layout is the chosen alternative for the warehouse.

Knowing the necessary dimensions of components such as the pallet racks, aisle widths, and office space, a detailed draft layout for the warehouse was generated. This layout was designed in the U-Shape design and locates the HVAC adjacent to the frozen and refrigerated storage and overall maintains an efficient flow throughout the facility. Additionally, the facility has adequate capacity to handle the maximum expected pallet numbers for each product type. The draft layout for the warehouse, including labels for the different departments, as well as detailed dimensions is shown in Figure 6.

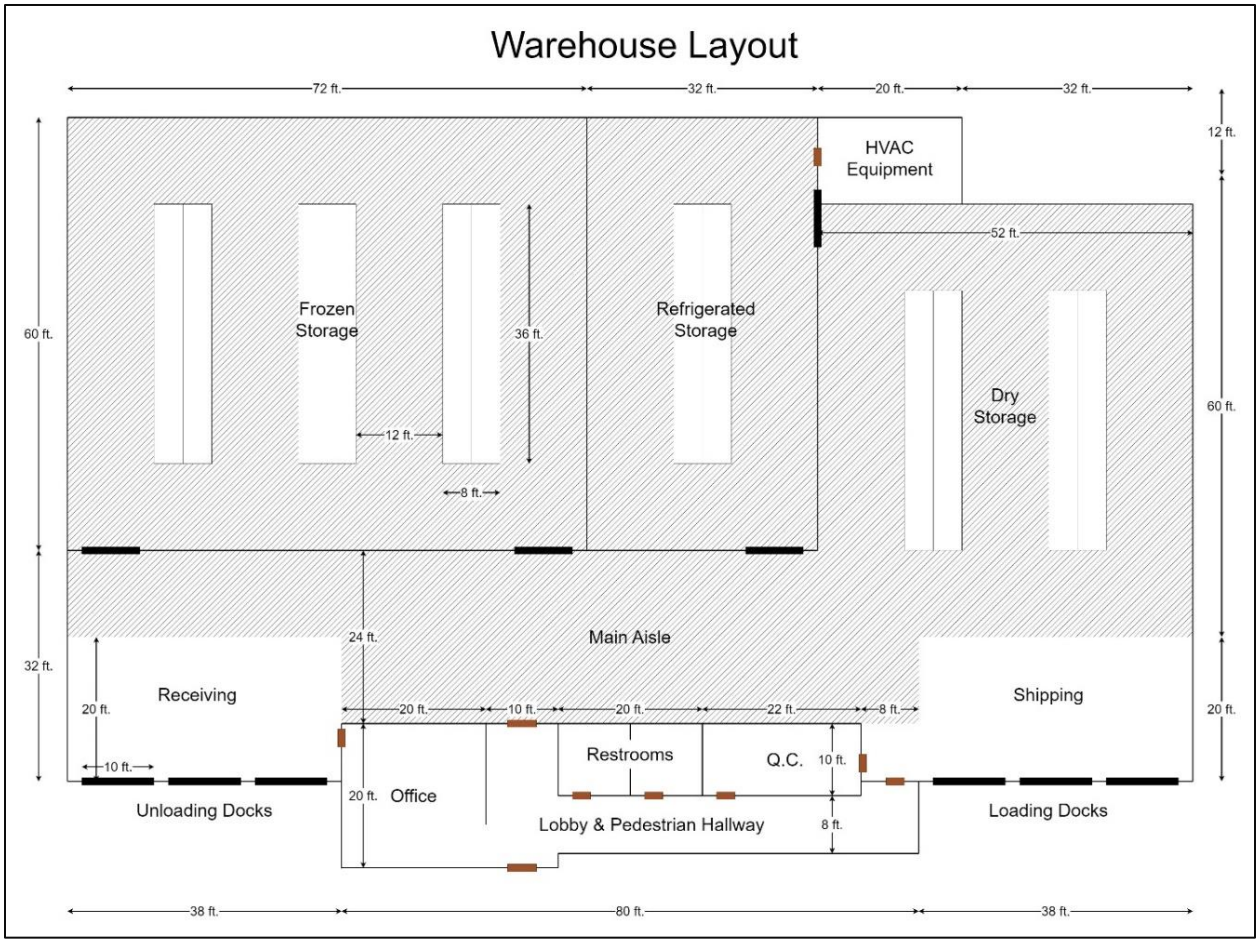


Figure 6: Detailed Warehouse Draft Layout

Based on this layout, the areas for each department, as well as the entire facility are detailed in Table 13. The financial analysis for the warehouse with an area of 14,868 ft^2 is discussed in the data analysis and findings section of this report. The big takeaway is that this warehouse layout is profitable with an annual operating margin of $29,027.44.

Table 13: Final Estimated Space Requirements

Department	**Area** (ft^2)
Frozen Storage	4320
Refrigerated Storage	1920
Dry Storage	3120
Main Aisle	2232
HVAC Equipment	240
Receiving	760
Shipping	824
Office	400
Lobby	632
Restrooms	200
Q.C.	220
Total	14868

8.2 CUSTOMERS

When determining the optimal number of stores, the team knew it was necessary to have a location within reasonable distance of the Zatarain's supplier in Gretna, La. This opened us up to all the groceries store in the local Baton Rouge area near LSU. When looking at the options, the team decided not to go with Walmart since they have their own unique distributing centers. This left us with the other main grocery stores like Mathernes, Winn Dixie, Albertson's, and Rouses. The team also considered many local and smaller stores in the initial research; however, the warehouse was profitable without them and would skew preliminary calculation in designing the layout of the facility.

8.3 PALLET WRAPPING MACHINE

One of the major capital costs was the pallet wrapping machine. We knew this would be an essential item and did not want to choose a risky or cheaply made machine as everything shipped from our distributor would go through this machine. After comparing many of the machines on the internet, the one the team chose was the U-Line stretch wrap machine. The cheaper option, Figure 7, was $4,200, yet was not a fully automatic process to wrap the boxes. The U-Line wrapping machine, Figure 8, was $7,565, but offered a completely automized process, which the team decided was worth the money. Additionally, the load capacity is 4,000 pounds, the shipping weight is 1,175 pounds, and the max skid size is 52 x 52 x 80". These specifications satisfy all the potential load sizes we may experience when shipping our Zatarain's products. Therefore, the U-line machine was the best option since we are already ordering tooling from U-Line, which makes our relationship and customer service better as we are showing loyalty and spending more money.

Figure 7: Material Handling Solutions Stretch Wrap Machine

Figure 8: U-Line Stretch Wrap Machine

8.4 FORKLIFTS

Another capital cost the team had to consider were the forklifts. The forklifts we ultimately decided on had an exceptional bulk purchasing deal. The first forklift purchased would be expensive ($9,500), however, the next ones after would be severely discounted ($8,600). These forklifts were 7,400 pounds, with a lifting weight of 4,400 pounds and could flow through the warehouse with ease. Also, the company's customer service had significantly better reviews than their competitors with respect to maintenance, down time, and replacements if necessary. In this instance, we are paying a slightly higher price for our forklifts but expecting the best service in return to avoid downtime. As previously stated, OSHA requires all forklift operators must be certified and update their certification every three years. The forklift operators in the warehouse will be certified before operating the power industrial truck. Figure 9 is a picture of the forklift used for the warehouse.

Figure 9: LPG Forklift

9. RECOMMENDATIONS

Altogether, the team recommends that the 14,686 sq ft U-shaped layout warehouse be utilized as the basis for the SAP By Design case-study. Figure 10 depicts the model of the facility in Sketchup, a premier 3D design software. Figure 11 shows the layout of the U-shaped warehouse with the furnished equipment such as pallet racks, pallets, forklift, office equipment, HVAC, and the pallet wrapping machine.

Figure 10: 3D Model

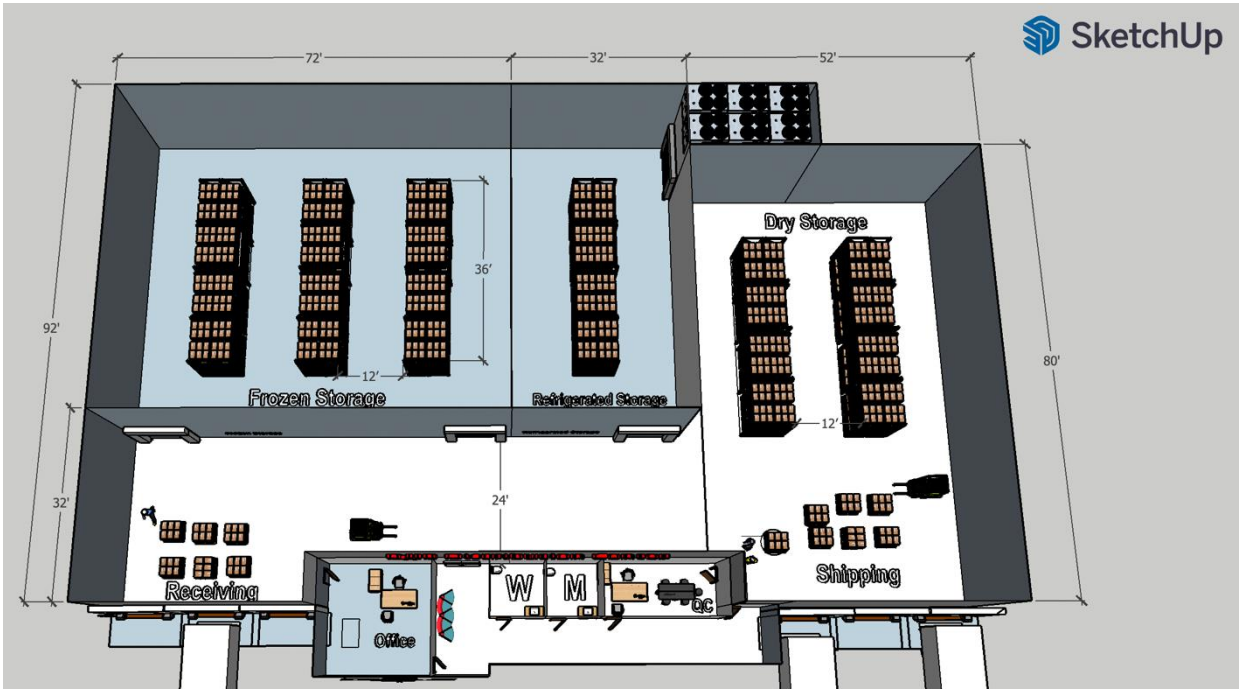


Figure 11: Facility layout

This recommendation is based on the management objectives and goals laid out for this project.

- This warehouse layout fulfills the first management objective of the project and is a design that is both optimal and sufficiently realistic to serve as a basis for the SAP case-study to be conducted next semester.
- The layout fully satisfies the first management objective of this project. The warehouse layout is appropriately sized for expected inventory levels and meets necessary workplace and food safety requirements. As a large portion of warehouse space is determined by the amount of inventory needed to continue in business. Thus, this layout is altogether a sufficiently realistic design to be used as a basis for the SAP ByDesign case study. Secondarily, the warehouse is sized in accordance with the EOQ inventory model which establishes the most financially optimal inventory and ordering regime for the facility (Tompkins, 2010). Thus, the layout is altogether an optimal warehouse facility from the perspective of maximizing the profit of the warehouse.
- Specific calculations of costs and revenues are discussed in the Data Analysis & Findings section of this report. Based on this analysis, the overall finances of the warehouse are summarized in Table 15. The warehouse finances are portrayed annually. With an annual revenue of $11.36 million, we expect the warehouse to have an annual gross margin of $708,000 and an annual operating margin of $29,000. This is an important finding because it demonstrates that this warehouse layout is profitable and therefore economically feasible. In the context of our project, an optimal and sufficiently realistic warehouse needs to be economically viable, so this further reinforces the assertion that this layout meets the first management objective of the project.

Table 15: Project Finances

Project Finances	
Total Annual Revenue	$11,359,568.33
Total Annual Cost of Goods Sold	$10,651,202.07
Annual Gross Margin	**$708,366.25**
Annual Lease Cost	$96,790.68
Annual Operating Cost	$30,264.00
Annual Forklift Cost	$9,000.00
Annual Labor Cost	$485,120.00
Annual Pallet Wrap Cost	$1,848.00
Annual HVAC Operating Cost	$40,032.00
Annual Capital Cost	$16,284.13
Annual Operating Margin	**$29,027.44**

- In selecting this overall layout, the team considered three overall layout alternatives: those being the “U”, the “I”, and the “L”. Ultimately, the team decided that the U-shaped layout was best suited for the project needs since it allowed for convenient placement of the HVAC system, efficient material flow, and a simple, fiscally responsible building design. Additionally, the pallet wrapping equipment was selected for its basic design and brand commonality with our pallet racks and cardboard boxes. The forklifts chosen were in the middle of the pack, yet capable and we decided to lease our forklifts.

10. IMPLEMENTATION & ASSESSMENT WORK PLAN

Next semester the team will first gain access and become familiar with SAP ByDesign. This will involve attending training and meetings in order to learn how to use the software. From there, the team will enter the master data from the findings this semester into SAP ByDesign. This master data will include, customer and supplier data, warehouse data, economic order quantities, minimum and maximum stock levels, and inventory information. Once the master data has been configured in SAP ByDesign, ERP tasks such as purchase orders, bill of materials, sales orders, etc will be simulated in the configuration. At the end of next semester, VistaVu Solutions will be able to present a configured operational software to food distribution companies. Figure 12 depicts the project schedule for next semester and shows the average amount of time the team believes it will spend on a task.

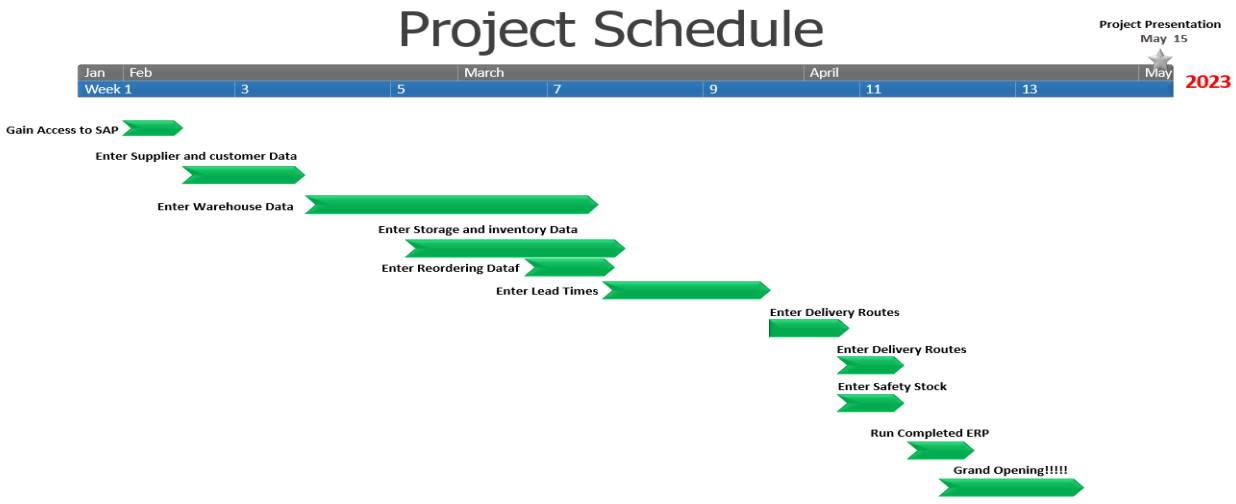


Figure 12: Project Schedule

11. REFERENCES

Allied. Allied Builders, 2022, www.alliedbuildings.com/how-much-does-it-cost-to-build-a-cold-storage-warehouse/#:~:text=HVAC%20units%20are%20installed%20inside,upfront%20costs%20greater%20than%20%2450%2C000.

Energysage. "Cost of Electricity in East Baton Rouge County, LA." Energysage.com, 23 Oct. 2022, www.energysage.com/local-data/electricity-cost/la/east-baton-rouge-county/#:~:text=The%20average%20residential%20electricity%20rate,rate%20of%2018%20%C2%A2%2FkWh.

Epearce. "Calculating the Real Cost of Trucking per Mile." Quick Transport Solutions Inc., 12 Sept. 2012, quicktransportsolutions.com/blog/calculating-the-real-cost-of-trucking-per-mile/#:~:text=Over%20the%20average%20mileage%20of%20a%20commercial%20truck%2C,cost%20of%20the%20truck%2C%20trailer%20and%20the%20driver.

Faramarzi, Ramin, et al. Showcasing Energy Efficiency Solutions in a Cold Storage Facility. American Council for an Energy-Efficient Economy, 2002. The American Council for an Energy-Efficient Economy, www.aceee.org/files/proceedings/2002/data/papers/SS02_Panel3_Paper09.pdf.

Food and Drug Administration. "Are You Storing Food Safely?" FDA.gov, US Department of Agriculture, 9 Feb. 2021, www.fda.gov/consumers/consumer-updates/are-you-storing-food-safely.

FW Logistics. "FDA Regulations for Food Distribution Warehouses." FW Logistics, Nov. 2022, fwlogistics.com/fda-regulations-for-food-distribution-warehouses/.

Google Maps. 2022, www.google.com/maps.

Griffin, Amber. "The Challenges of Warehouse Worker Retention and How to Combat Them in Dallas, TX." The Wonolo Blog, 14 June 2021, www.wonolo.com/blog/blog-the-challenges-of-warehouse-worker-retention-and-how-to-combat-them-in-dallas-tx#:~:text=In%20a%20non%2Dfulfillment%20operations,700%20to%201%2C000%20square%20feet.

Louisiana Commercial Realty. "Prices All Sectors - Baton Rouge." Louisiana Commercial Realty, 2021, www.louisianacommercialrealty.com/prices-all-categories-baton-rouge/#:~:text=Industrial%2D%20%2445%20per%20square%20foot,10%20percent%20from%20%2485%20PSF.

Matherne's. 2022, www.mathernes.com/.

McKinnon, Alan. Quick-response in the Frozen Food Supply Chain:The Manufacturers' Perspective. June 1998. Research Gate, www.researchgate.net/publication/237417857_Quick-response_in_the_Frozen_Food_Supply_Chain_The_Manufacturers%27_Perspective#pf11.

Nichibei Global. "What Margins Are Standard for a Distributor, Agent, or Dealer?" Nichibei Global, Nichibei Global LLC., 2018, nichibeiglobal.com/what-margins-are-standard-for-a-distributor-agent-or-dealer/#:~:text=In%20a%20situation%20where%20the%20distributor%20has%20minimal,what%20services%20are%20added%20to%20the%20final%20delivery.

Occupational Health and Safety Administration. "1926.150 - Fire Protection." OSHA, US Department of Labor, 20 June 1996, www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.150#:~:text=A%20fire%20extinguisher%2C%20rated%20not,shall%20not%20exceed%20100%20feet.

"Powered Industrial Trucks - Forklifts." OSHA`, US Department of Labor, 2022, www.osha.gov/powered-industrial-trucks.

ProLogis Inc. "What Are the Best Ways to Reduce Warehouse Costs?" ProLogis, ProLogis Inc., 2022, www.prologis.com/what-we-do/resources/best-ways-to-reduce-warehouse-costs#:~:text=Operational%20expenses%2C%20which%20can%20include,%24750%20and%20%241%2C000%20per%20month.

Rouses Supermarkets. Rouses Markets, 2022, www.rouses.com/.

Roux, Lance. Weblog post. SafetyPro Resources, 30 Jan. 2014, www.safetyproresources.com/blog/what-does-it-cost-to-hire-a-good-isnetworld-consultant#:~:text=Prices%20vary%20widely%20depending%20on,for%20one%20that%20includes%20everything.

Safety Training. 2022, midamsafety.com/training/training-prices/.

Shipley Energy. "Guide to Warehouse Electricity Costs." Shipley Energy, 2022, www.shipleyenergy.com/resources/guide-to-reducing-warehouse-electricity-costs/.

Tompkins, James A. Facilities Planning. 4th ed., Hoboken, Wiley, 2010.

Tuovila, Alicia. "Inventory Carrying Cost Formula, Examples, Tips to Lower It." Investopedia, 28 Sept. 2022, www.investopedia.com/terms/c/carryingcostofinventory.asp.

Uline. 2022, www.uline.com/.

US Bureau of Labor Statistics. Table 6. Private Industry Workers by Establishment Size and Industry Group. June 2022. US Bureau of Labor Statistics, www.bls.gov/news.release/ecec.t06.htm.

US Packaging and Wrapping L.L.C. 2022, uspackagingandwrapping.com/blog/how-many-pallets-will-a-roll-of-stretch-wrap-cover.html#:~:text=With%20the%20amount%20of%20footage%20after%20stretch%20is,roll%20of%20stretch%20wrap%20Example%20using%2044%E2%80%9Dx48%E2%80%9Dx60%E2%80%9D%20Pallets.

Walmart. 2022, www.walmart.com/.

"Warehousing." OSHA, US Department of Labor, 2022, www.osha.gov/warehousing/standards-enforcement.

Winn-Dixie. 2022, www.winndixie.com/.

APPENDICES

Appendix A: Supplier List

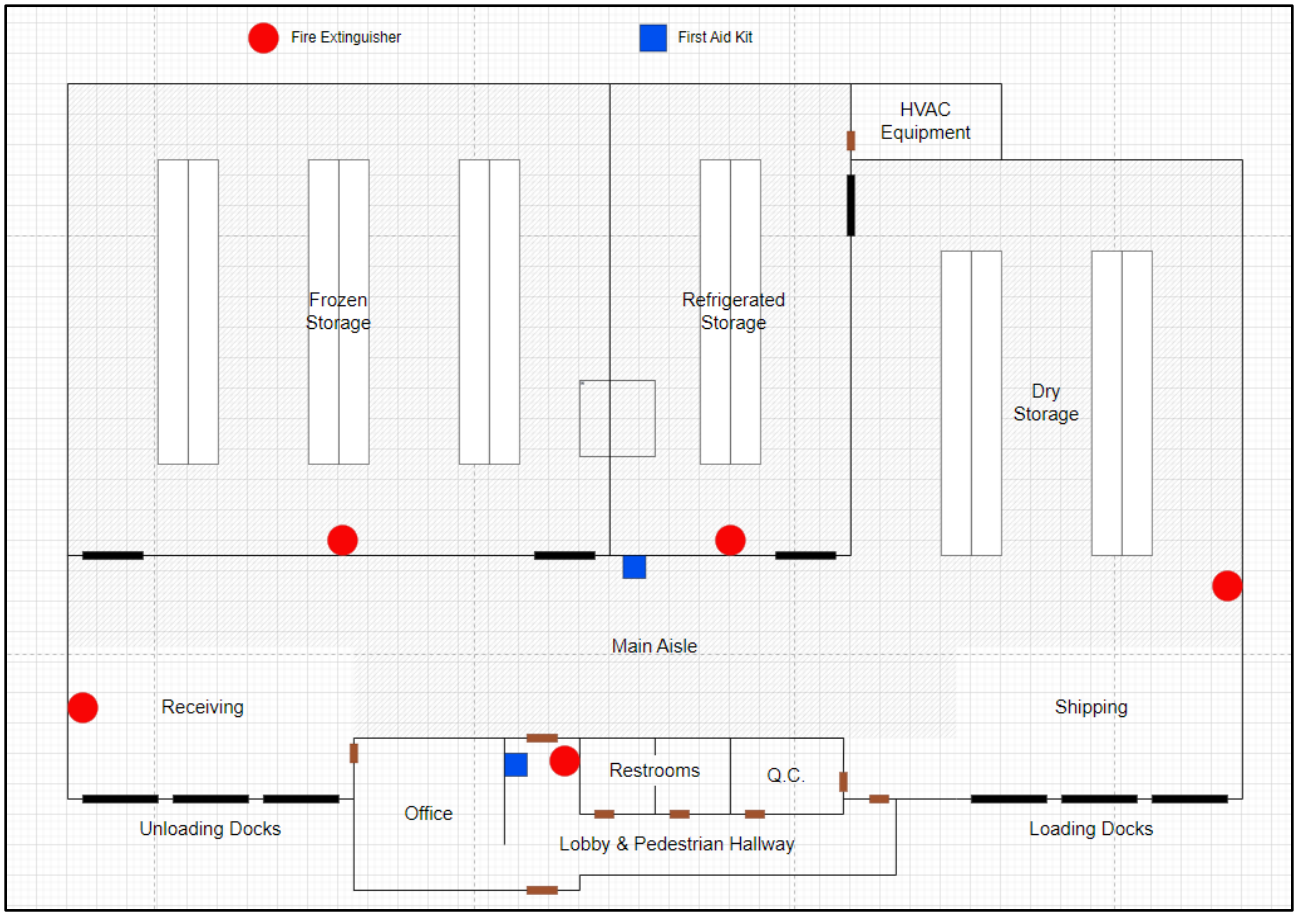
No.	Supplier	Address	Phone Number
1	Zatarain's Manufacturing	82 1st St, Gretna, LA 70053	(504) 367-2950

Appendix B: Customer List

No.	Customer	Address	Phone Number
1	Rouses Market Airline 1	209 S Airline Hwy, Gonzales, LA 70737	(225) 644-6686
2	Rouses Market Airline 2	14635 Airline Hwy, Gonzales, LA 70737	(225) 673-4255
3	Rouses Market Highway 42	40017 Highway 42, Prairieville, LA 70769	(225) 622-4041
4	Rouses Market Village Market	14630 Village Market St, Baton Rouge, LA 70817	(225) 448-0050
5	Rouses Market Bluebonnet	7580 Bluebonnet Blvd, Baton Rouge, LA 70810	(225) 251-1010
6	Rouses Market Arlington	600 Arlington Creek Centre Blvd, Baton Rouge, LA 70820	(225) 448-0271
7	Rouses Market Drusilla	3446 Drusilla Ln, Baton Rouge, LA 70809	(225) 766-4800
8	Rouses Market Denham	10130 Crossing Way Ste 300, Denham Springs, LA 70726	(225) 435-7070
9	Rouses Market Plaquemine	58440 Belleview Rd, Plaquemine, LA 70764	(225) 685-0422
10	Winn Dixie Siegen	8601 Siegen Ln, Baton Rouge, LA 70810	(225) 766-8400
11	Winn Dixie Coursey	13002 Coursey Blvd, Baton Rouge, LA 70816	(225) 756-7102
12	Winn Dixie Airline	17682 Airline Hwy, Prairieville, LA 70769	(225) 677-9701
13	Albertsons Airline 1	15128 Airline Hwy, Baton Rouge, LA 70817	(225) 751-2808
14	Albertsons Bluebonnet	9960 Bluebonnet Blvd, Baton Rouge, LA 70810	(225) 768-7775
15	Albertsons O'Neal	15232 George O'Neal Rd, Baton Rouge, LA 70817	(225) 753-0700
16	Albertsons Perkins	7515 Perkins Rd, Baton Rouge, LA 70808	(225) 769-6100
No.	**Customer**	**Address**	**Phone Number**
17	Albertsons Airline 2	9650 Airline Hwy, Baton Rouge, LA 70815	(225) 926-9304

18	Albertsons College	2950 College Dr, Baton Rouge, LA 70808	(225) 924-6084
19	Albertsons Government	4857 Government St, Baton Rouge, LA 70806	(225) 216-7226
20	Matherne's Market LSU	85 Gateway Center Ln, Baton Rouge, LA 70802	(225) 367-6074
21	Matherne's Market Downtown	440 3rd St Ste 100, Baton Rouge, LA 70802	(225) 343-0600

Appendix C: Fire Extinguisher and First Aid Kit Locations



MEETING RECORDS

LOUISIANA STATE UNIVERSITY

Department of Mechanical & Industrial Engineering

IE-4597 Senior Design Project I

Fall 2022

VISITING RECORDS

Group#_____14_____

Day	Date	Time	Duration	Students names	Faculty/Sponsor's Name	Advisor's Signature*
1	8/29	10 AM	1 hour	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
2	9/1	5:30 PM	1 hour	RB, JB, JH, BL	C. and K. Alford	*Katherine Alford*
3	9/8	6 PM	1 hour	RB, JB, JH, BL	C. and K. Alford	*Katherine Alford*
4	9/12	10 AM	1 hour	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
5	9/19	10 AM	1 hour	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
6	9/28	10AM	30 min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
7	10/3	10 AM	30 min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
8	10/10	10 AM	30 min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
9	10/12	7 PM	1 hour	RB, JB, JH, BL	C. and K. Alford	*Katherine Alford*
10	10/19	10 AM	30 min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
11	10/26	10 AM	30 min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
12	11/2	10AM	30 Min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*
13	11/22	10AM	30 Min	RB, JB, JH, BL	G. Knapp	*Gerald Knapp*