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# Inventory Management System of Seasonal Raw Materials of Feeds at San Jose Batangas through Integer Linear Programming and VBA

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## Abstract

The branch of business management that deals with inventory planning and control is known as inventory management. It comprises keeping track of supply levels and forecasting demand, as well as scheduling when and how to plan. Keeping excess inventory results in a loss of money takes up physical space, and raises the risk of damage, spoilage, and loss. On the other hand, too little inventory frequently causes operations to be disrupted and raises the possibility of low customer satisfaction, both of which can be detrimental to a company's reputation. The United Victorious Feed Mill Corporation's present inventory management practices were assessed in terms of inventory level, warehouse allocation, ordering frequency, shelf life, and production requirement. To help the company achieve their optimal level of inventory, a mathematical model was created using Integer Linear Programming. Due to the season, the goal function was to reduce the cost of purchasing US Soya and Yellow Corn. Warehouse space, annual production requirements, and shelf life were all considered. To ensure that the user only uses one application to record all relevant information, like production output and delivery, the researcher built a Visual Basic system. Additionally, the technology allows management to change the model's parameters.

## Keywords
Inventory Management, Integer Linear Programming, Inventory Management System, Feed Mill

## 1. Introduction
Inventory management is the area of company management that deals with the planning and control of inventories. Inventory Management is defined as a framework used in firms to control their inventory interest. It entails recording and monitoring stock levels, estimating future demand, and deciding when and how to arrange. Keeping excess inventory takes up physical space, increases the likelihood of damage, spoilage, and loss, and results in a financial loss. Too little inventory, on the other hand, frequently disrupts operations and increases the likelihood of poor customer satisfaction, which can harm an entity's reputation.

Managing inventory in feed mills is a critical process because some raw materials are seasonal, and mistakes in inventory can lead to future shortages that affect production. Most feed mills do their inventory manually, which usually results in data variances, with no tally of actual count versus existing record. Feed production will be halted during manual inventory to prioritize actual counting. Furthermore, some feed mills will be unable to complete their inventory because it will take several days without production.

United Victorious Feed Mill Corporation is a feed manufacturer based in San Jose, Batangas. San Jose, known as the Egg Basket of the Philippines, has many poultry farms that will require a large amount of feed. The company not only supplies feed to San Jose Batangas, but also to other nearby cities. Their warehouse is 1000 square feet in size. meter, where they kept all their ingredients, a total of 41 different types of raw materials. Yellow corn, along with US soya, consumed nearly 90% of their warehouse. These raw materials were stockpiled based on batch, quality, and material type. Yellow corn is a seasonal raw material that is used as one of the main ingredients in feed. It can be purchased at a reasonable price during its peak season, which runs from July to September; however, during the off-season, its price usually rises by around 12%, which has a significant impact on the company's profit.

In terms of frequency, they have no standard way of making orders, some were done every 3 weeks, and some were done every 3 months. They usually conduct their manual inventory every end of month, meaning, that is the only time they can identify which raw materials must be ordered immediately to prevent shortages. Whenever the company encountered shortages at the middle of the month, they still need to wait for month-end inventory to solve the discrepancies.

Ordering seasonal raw materials in bulk may be cost effective due to discounts and having stock during off-season times, but there are still some factors to consider. The warehouse size and capacity, shelf life of each raw material, ordering and holding costs, and production capacity should all be considered by the company. Currently, the company lacked a standardized and optimal inventory management system.

### 1.1 Objectives

The main objective of the study is to provide UVFC an inventory management system using integer programming. Specifically, the study aims to determine the current situation of inventory management in feed mills, then to formulate the objective function using Integer Linear Programming to maximize the capacity of the warehouse and be able to make a system using Excel by integrating the ILP.

## 2. Literature Review

Inventory management is critical to a company's financial performance because it is the most valuable physical asset on the balance sheet. As a result, IM should be well managed and replenishment rules for each item, such as the strategies mentioned, implemented. The appropriate stock should be available in the appropriate location and quantity, and at the lowest possible cost. Stock-outs typically occur when there is a high demand in the market and there is insufficient stock for fast-moving items, resulting in lost sales and customer loyalty. Excessive stock in the company results in higher storage costs, handling costs, and interest on short-term borrowings. When selling, a loss may be experienced if materials are sold at a lower price than usual. The primary goal of IM is to reduce total inventory costs while maximizing operational profits. Many cases have been reported in which IM and inventory planning decisions were successful thanks to the development and implementation of inventory planning models (Machined et al. 2019). A defined process is important to start off inventory management. Currently, tools and applications are used to do this, but some are complex. Practicing good inventory management does not require simple human intervention, but the company or business must invest in a good software tool to ensure the profitability and efficiency of its processes. Some types of inventories include raw materials, unfinished products, finished products, in-transit goods, cycle inventory, anticipation inventory, decoupling inventory, maintenance, repair, and operating (MRO) supplies, and buffer inventory. One thing that makes inventory management helpful is the fact that it has categories. It has a system that separates finished products from raw materials. Some of the well-known inventory management software applications include TradeGecko, Odoo, Fishbowl, Stitch, and Contalog (Caramela 2021).

Proper management of inventory has various benefits. Knowing that it is vital to the health of the company as it gives a report about the stocks, some of its benefits include the following: (1) The ability to decrease costs of the company as the managers know the number linked with the stocks, which are unsold, and what specific orders must be fulfilled; (2) It improves cash flow as inventory management shows which of the products are sold fast and which are not; and (3) It develops loyal customers and increases their satisfaction levels. These benefits are highlighted because these represent the core of inventory management, which is to secure the risk of the company from stockouts or inaccurate inventory records (Jenkins 2020).

Inventory management is often used for its accuracy. However, it is not always the case. As a matter of fact, it was found that not all companies have an accurate and up-to-date system in their inventory. They continue to practice it as it gives them a better tracking system of their resources. The challenges that various industries experience in relation to inventory management include the (1) difficulty of consolidating a single view of inventory through retail channels, (2) there is often a high volume of transactions in consumer packaged goods (CPG), making it extra difficult, (3) B2B companies have existing contracts with their clients, and when their products are not delivered on time, they gain penalties, and (4) the lack of omnichannel experience in telecommunications companies. Encountering problems and challenges in inventory management may stop the business from earning more, knowing that their system reflects the services they provide. A good inventory system equates to more satisfied customers and accurate inventory (Kenyon 2021).

A recent study from Ethiopia analyzed the impact of implementing inventory management in micro and small enterprises (MSEs). It specifically looked at how the said practice could impact the competitiveness and the overall performance of the organization. Using the data collected from over 180 MSEs in Ethiopia, it was found that the more its managers employ inventory management at higher levels, the more advantageous it is to the company. The inventory management practices included various forecasting and analysis tools such as the ABC Analysis, Economic Order Quantity (EOQ), Vendor Managed Inventory (VMI), Demand Forecasting, Computerized Inventory Management, and JIT. These practices were implemented and resulted in competitive advantages in terms of price, quality, and delivery; and organization performance in terms of profitability, market share, the efficiency of costs, and output level (Atnafu & Balda 2018).

A similar study delved into the study of inventory management from raw materials to finished goods. Companies do not just fulfill the management of their inventories for the company itself, but also for the satisfaction of the customers. These companies cannot fall behind the demands of their customers by fulfilling them and avoiding the risks of overstocking and stockouts. From raw materials, followed by the production process, up until these raw materials turn to finished goods, security and safety of stocks should be guided by proper inventory management. This case study concludes that the application of inventory management equates to having precise records where finished goods are prepared for shipment. Overall, it increases the satisfaction of the customers, the revenue and profits of the company, and the positive environment for the employees (Sheakh 2018).

There is a strong relationship between inventory management and financial decisions in companies. A study conducted in Harare, consisting of small and medium enterprises (SMEs), found that 54 percent of the SMEs that participated in the study said that inventory management has strongly and positively impacted financial performance. Meanwhile, only 2 percent perceived it as strongly negative. Overall, 93 percent of these corporations agreed that the practice has a positive impact on the maintenance of positive financial performance in their respective organizations. This result agrees with the benefit of inventory management that was mentioned above, particularly on improving cash flow within the company. This would lead to more profitable operations in the future (Muchaendepi et al. 2019).

In the Philippines, inventory management is taken seriously. It is considered a top priority that drives the business into successful cost control in operations. Setting inventory objectives should be timely, based on software programs, based on needs or economic order, indicating the running of the inventory, and the information about the vendors linked in the business. Looking for an inventory management system that is reliable, efficient, and accurate does not just cut the costs of the inventory, but it also poses speeding up of inventory processes (Martinez 2020). This means that there must be a system that works well with inventory management.

Inventories are materials that have been stored, are being processed, or are being processed. They are prevalent in all sectors of the economy. Almost any company's balance sheet, for example, will reveal that a significant portion of its assets are inventories of raw materials, components and subassemblies in the manufacturing process, and finished goods. Most managers dislike inventories because they are like money in a drawer, assets tethered to investments that aren't producing any return and, in fact, incurring a borrowing cost. They also incur costs for storage and are susceptible to spoilage and obsolescence. Over the last two decades, industry has developed a slew of programs aimed at lowering inventory levels and increasing shop-floor efficiency. Conwip, kanban, just-in-time manufacturing, lean manufacturing, and flexible manufacturing are some of the most popular. Nonetheless, despite the negative aspects of inventories, they serve useful purposes. Raw material inventories provide a consistent source of input for production. Majority of the assets of the company are being stocked as an inventory of a company. Some of the inventories are in terms of raw materials for the manufacturing companies and some are finished goods for the wholesalers or distributors. In a manufacturing company, goods are being pulled from the stock areas and moved to production area where they are processed into finished goods.

There are some raw materials that can be stocked for longer period; however, there are perishable goods that are being stocked within in the limit based on the usage of the said goods.
It is said that while ensuring that the materials are available as and when needed, prudent and wise inventory management is essential for reducing depreciation, theft, and waste in inventory. They provided additional evidence for this, emphasizing that in order to maximize earnings and ensure the survival of a corporation, which are the fundamental objectives for every firm, systematic and that being the case, specific performance indicators have been proved to depend on the level of inventory management practices (Ardiansyah, et al. 2020).

**Inventory Management through Integer Programming Using Microsoft Excel**

Many businesses choose advanced software that is currently available in the market for crucial business processes, including but not limited to accounting, record-keeping, and inventory management. However, though much software is available, other businesses would prefer using Microsoft Excel as an alternative way to track the inventory of the firm. Excel inventory management makes use of excel spreadsheets in organizing, sourcing, selling, and storing inventory. It is believed that the use of excel inventory management fits well for start-ups and small to medium businesses, making it still relevant today. There are different ways available in this process, including the following: (1) creating a spreadsheet for important information, (2) adding categories and columns for necessary products, and (3) adding the actual products in each column or category. Though these processes are not costly and have easier steps compared to when inventory is managed through advanced software, it has various drawbacks. These include the fact that it is time-consuming, there is a lack of automation as well as real-time reporting, and has a greater chance of human-related misinput. Despite these drawbacks, Microsoft Excel is seen as beneficial in inventory management for businesses (Henry 2021).

Inventory management is referred to as a process where the inventory levels are guaranteed to be sufficient for customer demands and are adequate for the replenishment of stocks. It is monitored and controlled on a regular basis. There are different methods and tools that businesses can use in adding greater business value, which draws the cruciality of inventory management in meeting the general business processes (i.e., increasing business performance, reducing the response time in meeting the demands of customers, and meeting higher customer satisfaction). The concept of inventory management should not be excessive and limited, whereas, if it is too excessive, it tends to reduce the working capital and might affect the liquidity of the business; while when it is too limited, it might lead to stocks outage and missed sales opportunities, resulting to a lesser profit. Some businesses still use traditional inventory management and slow-paced options, such as Microsoft Excel, though perceived as insufficient in meeting the increasing demands in inventory management in a competitive environment (Priniotakis & Argyropoulos 2019).

Microsoft Excel has an add-in called Excel Solver, where computations can be automated very quickly. It was mentioned above that inventory management is applied to any industry, knowing that controlling and monitoring supplies is crucial to business success. A study conducted in India showed the importance of inventory management in controlling and monitoring essential military supplies in the Indian Army. Its objectives include the following: (1) creating a statistical demand forecast while showing sufficient control of inventory, (2) optimizing the transportation model to reduce potential costs in operations, and (3) optimizing warehouse space and minimizing opportunity costs with the help of VED analysis. All these objectives are provided with solutions through Microsoft Excel. Overall, the aforementioned software contributed to rejecting the null hypothesis of the paper, where the created inventory management was able to achieve the following: (1) reduced the total inventory costs, (2) reduced the transportation costs, and (3) reduced the potential inventory management costs. This only shows how Microsoft Excel has a huge potential in managing large-scale inventory, just like in an army (Kaur et al. 2019).

It was said that businesses are losing millions to inventory management costs. There are instances where supply chain networks are not managed well, probably because advanced software is too costly and is not always utilized. A relevant study used Microsoft Excel and saw its potential to aid advanced software. Two platforms were used in the study: (1) Microsoft Excel for managing and assembling datasets as an input and (2) R Studio to finally run codes and test their results. As for Microsoft Excel, it was categorized and was put into columns. Various tables were utilized, including “lookups” and “pivot”. Linear trend and quadratic trend were used for this. Overall, it was found that the use of Microsoft Excel, when mixed with advanced software, helps. Data inputting became more efficient in the supply chain management whereas from 72 percent average accuracy, it increased to 75-80 percent, noting that the use of both Microsoft Excel and R Studio actually improves supply chain networks (Praveen et al. 2019).

Many methods were already mentioned above. There are ABC, VED, and ANA analyses that proved the efficiency of the use of Microsoft Excel in inventory management and supply chain networks. In a similar study, an inventory management information system was designed and built for a telecommunication company in Indonesia. The researchers agreed that manual inputting of data could result to slow progress, but also believed that the use of Microsoft Excel is important on top of an existing inventory management system. The system was called “Sprint”, which allowed the collection of data through a web-based inventory management network. The use of Microsoft Excel enters when users opted to input relevant data in this software, then imported and exported to the system. Overall, the system utilized Microsoft Excel and is seen to have a huge potential in an increasing demand for inventory management. It concludes that the designed and built web-based inventory system collected incoming and outcoming

supplies on a real-time basis, and with stricter control and monitoring processes, it can officially be integrated into businesses.
Fonseca (2019) highlighted that in the modern world, businesses are deemed to improve only if they are ready to maximize their processes and improve them. It could either help the business reduce its costs or improve the service they provide to its customers. This study was conducted for a cement business by employing inventory management with its focus on transporting bagged cement from warehouses and determining the costs and optimization of forklift operations. It used an integer programming model and called the process a ship loading management tool. The researchers agreed that Microsoft Excel is already sufficient as the basic solver of these kinds of problems. Though the concern in Microsoft Excel is the fact that it is simple with the use of an integer linear programming model, it was said that its simplicity and organizing aspect is beneficial to inventory management. Additional tools can be used to overcome the limitations of Excel, whereas Front-Line Solver and Gurobi Optimization as some in-app extensions of Excel are used. As a result, optimizing the existing inventory management system was successfully implemented. On top of this, the ship loading business was able to properly utilize at least 50 percent of its available resources.

According to Dhaiban (2021), the use of programming models is already observed even before. Though certain improvements are still needed to properly utilize the use of Microsoft Excel as an inventory management system. In addition, optimal control models are used to investigate this scenario in recent studies, but the inclusion of integer conditions appears to be missing out. Focusing on inventory and its processes such as meeting the supply and demands of customers, and solving optimal control problems, among others, a study was conducted to obtain these goals. This study introduced new approaches in inventory management while highlighting integer values of production and inventory: (1) New Approach and (2) Quadrating Programming. In conclusion, the study was successful in testifying that it is applicable to using an integer optimal control model in inventory management and supply chain processes that were often missed out in the past.

The application of the said model, as discussed above through the study of Dhaiban (2021) is like another study where the use of integer programming in inventory management was applied to large-scale vaccine supply chains. It is known that these products are prone to expiration and are sensitive in terms of storage and transportation, which are only some of the important aspects of vaccine inventory. Since the pandemic began, revenues for the global vaccine were said to have reached $59.2 billion already. With this amount, it is just a simple notion that proper inventory management is employed. The researchers agreed that mixed integer programming is beneficial to controlling and monitoring vaccine logistics. With the help of the said programming process, the researchers collected 25 studies tackling vaccine allocation strategies for diseases like Influenza, Dengue, HPV, measles, and many more. All these studies used integer programming problems, which if summarized, have one thing in common: the studies claim that the said programming problem benefited the reduction of costs by at least 20% each. It resulted in a reduction of impacts of the diseases, improvement in the allocation of vaccines, prevention of outbreaks, etc. (Lopes et al. 2022).

**Synthesis**
To solve the perishable products inventory routing problem, a mixed integer linear programming (MILP) model is built with the time window cost and opportunity constraints in mind. A MILP model with deterministic demand is presented, and the initial feasible solution is obtained, with the goal of designing a perishable product distribution system (Ji et al. 2020). Dhaiban (2017) developed an inventory system optimal control model, and it discussed a linear deterioration function, single item, time functions of demand and holding cost, and two inventory review policies - continuous and periodic. With the periodic review policy, a model was developed to achieve administration goals on inventory levels and production rate with time-dependent demand. Linear programming is another mathematical model used for production-inventory systems. Most researchers want to reduce total costs or maximize total profits. Many parameters were considered in the plan, including storage space, multi-period, machine work, multi-product, and production capacity.

With the available studies, different integer linear programming was designed focusing on different constraints. The first model focused only on the delivery of perishable goods while the second model was focused on the cost, space and production capacity. United Victorious Feed Mill Corporation current proper is knowing when to order by how much considering the warehouse capacity, production requirements, seasonality and the cost of ingredients based on season. Combining these two studies will be beneficial to the company problem being encountered.

## 3. Methods

Applied research employs high-quality research standards as well as cutting-edge methods and tools to develop practical solutions to real-world social problems confronting organizations and individuals. Basic research findings and theories are frequently applied by applied researchers. In other words, whereas basic research generates universal knowledge, applied research typically applies this knowledge to solve specific client problems.

The research was carried out at United Victorious Feed Mill in San Jose, Batangas, with a focus on both the operators and the owner. This is consistent with the use of the purposive sampling technique. Purposive sampling, also known as subjective sampling, is a non-probability sampling technique in which the researcher chooses variables for the sample population at their discretion. In this case, the entire sampling process is dependent on the researcher's judgment and understanding of the context. When done correctly, purposeful sampling assists the researcher in filtering out irrelevant responses that do not fit into the study's framework. The initial step done by the researcher to conduct this study was to request for accommodation from the company through submission of letter to allow the researcher to observe the process inside the company.

After the approval, the researcher interviewed the president about the problem being encountered by the company and mentioned that they are struggling with ordering raw materials that are seasonal. With the problems being stated, the researcher was able to identify the problem statement and objectives of the study. To solve the research problem, the researcher interviewed again the manager to obtain the necessary information about their production and ordering system of raw materials. The shelf life and price of each raw material was also asked, and the actual warehouse was also visited. After data gathering activities, mathematical model was formulated to determine the optimal order for each ingredient.

## 4. Data Collection

Personal interviews were used to gather information about the warehouse's available raw materials, the average number of orders per month, the lead time of the raw materials, and the actual size of the warehouse. Direct observation of the procedures used by inventory personnel for receiving, storing, checking inventory, and delivering raw materials to production was also conducted.

## 5. Results and Discussion

### 5.1 Numerical Results (11 font)

The company used to maintain stocks of 4,023 sacks for US Soya and 7,965 sacks of Yellow Corn which is good for 3 weeks production. With this safety stocks, almost 39% of the entire warehouse was utilized. In times that the company is experiencing unexpected shortage, they need to make an urgent purchase request and wait for the earliest delivery. The amount of floor space used by each sack of raw material was also measured to determine the warehouse's maximum capacity. Based on real stock levels, all raw materials were packaged in 50-kg bags with a 0.64m2 surface area, and the company stacked its bags up to a maximum of 20 bags high. Despite having a sizable warehouse, they only stack up to 20 sacks at a time to protect the safety of each raw material. However, there are several restrictions that the business must consider when using their warehouse. Only components from the same lot should be kept in the same container. Some ingredients, particularly those given when they are out of season, are not of good quality. With these constraints, the company cannot utilize their warehouse capacity properly.

The ordering frequency was also determined based on the current inventory level and warehouse capacity allotted for each main ingredient. UVFC used to order their main ingredients every three weeks, according to the table. This order was based on their three-week production safety stock. Regardless of the season, the company orders once a month in the same quantity. Even though raw material prices are low during peak season, the company does not order more than the usual amount. The company is hesitant to purchase more because they are concerned about the product's shelf life.

The shelf life of the raw materials must also be considered when calculating the required stock level. To guarantee that the warehouse is being restocked with high-quality goods, it is crucial to determine the shelf life of each item. According to the interview, US soy and yellow corn can be kept in the warehouse for six months if the ingredients are received in good shape. Knowing this, the company's maximum order must be filled within six months of production.

The company's monthly requirement must also be calculated in order to guarantee that the inventories will be used within their shelf-life. The problem of the raw material demand per month can therefore be solved since 14.9 kg of US soya and 29.5 kg of yellow corn are needed for every sack of feed mill, and 18,000 sacks of feed mill are needed each month. With this, 10,620 sacks of Yellow Corn and 5,364 sacks of US Soya are needed overall. Knowing these numbers, the total number of raw materials needed will determine how many months the inventory will be stored.

**Objective Function:**

Min z = 1550X1 +1650X2 + 1025X3 + 1125X4

**Constraints:**

(1) $0.032X1 + 0.032X3 < 966$
(2) $0.032X2 + 0.032X4 < 966$
(3) $9X1 + 7X2 > 64,368$
(4) $9X3 + 7X4 > 127,440$
(5) $1/5364X1 < 6$
(6) $1/5364X2 < 6$
(7) $1/5364X3 < 6$
(8) $1/5364X4 < 6$

where z is the total cost for purchasing both US Soya and Yellow Corn
X1 is the quantity of US Soya to be purchased per order during peak season.
X2 is the quantity of US Soya to be purchased per order during out of season.
X3 is the quantity of Yellow Corn to be purchased per order during peak season
X4 is the quantity of Yellow Corn to be purchased per order during out of season

The mathematical model was formulated based on the condition and practice of UFCV. As shown on the objective function, the aim is to minimize the cost to be used for raw materials to be purchased. The coefficients 1550, and 1650 are the costs of each sack of US Soya that will be ordered during peak season and out of season respectively. The Yellow corn can be purchased for Php 1,025 during peak season and will increase to Php 1,125 during out of season. The peak season usually falls from July to September, but the price started to increase 3 months after the season.
The first and second constraints represents the warehouse allocation of raw material. The actual area of one sack of ingredient is equivalent to 0.64m2, since the company allows 20 sacks per stack, the total area for one sack is 0.032 m2. This is applicable for both ingredients and for both seasons. The right-hand side of the equation is the total available size for the incoming raw materials. The original size of the warehouse if 1000 m2, however since the company has safety stocks, the space allocated for the safety stock must be considered. That is why the researcher came up with the limitation of 966 m2.

The third and fourth requirements represent the overall annual requirement considering the volume of orders being processed. Regardless of the season, the corporation places order every three weeks. The frequency of the company's orders during the peak and off-peak seasons is shown by the coefficients 9 and 7, respectively. Given that the company's monthly aim is to produce 18,000 sacks of feeds, the right-hand side shows the total amount of US soya and yellow corn needed for the entire year.

The last four constraints are referring to the shelf life of the raw materials. Since the monthly requirement of US Soya and Yellow corn is known, the number of months the raw materials will be stocked can also be computed. The stocking of raw materials must not be greater than 6 months as it will not be good to use for production. An inventory management policy is defined by considering the optimal quantity for an order and the time for ordering in order to avoid costs associated with understock or overstock (Acosta 2018).

## 5.2 Graphical Results

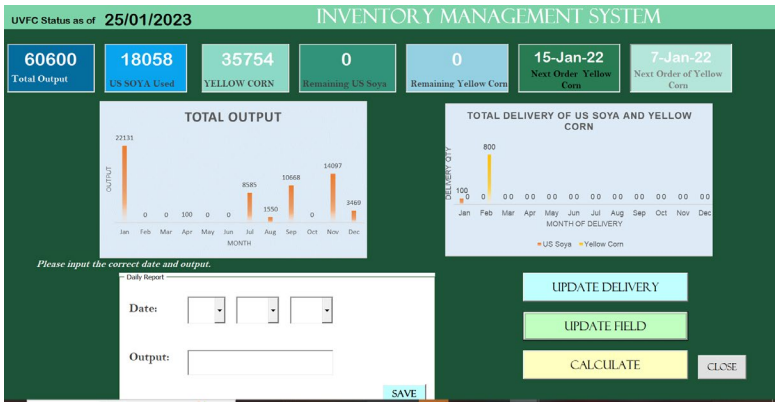


Figure 1. Inventory Management System

Figure 1 shows the system for Inventory Management of UVFC. After analyzing the current condition of UVFC and formulating the mathematical model, the ILP model was also embedded to Microsoft Excel Macro. And for the company to prevent from opening several files and doing repetitive actions, the system that was provided used Visual Basic under Excel also. The system has five (5) features that will help the company to monitor the usage and remaining stocks of their main ingredients namely US Soya and Yellow Corn. The user will be able to update the daily output and delivery quantity. The system will also help the owner to check the status of their production and inventory at one glance. In case that there will be changes on the set-up of the company, the owner can also make some editing on the parameters. Lastly, the system can dictate the number of sacks the company should order by just on click. Microsoft excel was chosen since the company is more familiar with this and it is not that difficult to operate and to use. Small and medium-sized businesses, in particular, have come to rely on computers and computerization for business transactions, particularly inventory management systems (Buhia 2018).

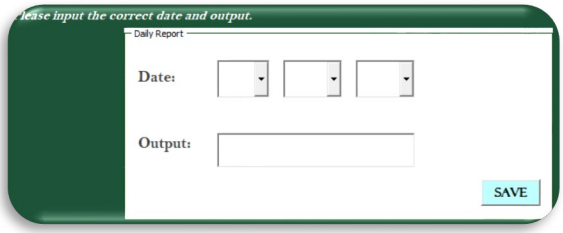


Figure 2. Interface for Output Updating

Figure 2 shows the interface for Output Updating. The user will be able to update the output per day without opening any files. Details like date and output must be inputted correctly. Dropdown list for the month, date and year was provided to ensure that input is correct. After completing the date, the number of sacks being produced will be inputted on the allotted space.

Table 1. Master Data for Output Update

| Month | Day | Year | Date | Output per day |
|---|---|---|---|---|
| Jan | 5 | 2022 | 5-Jan-22 | 151 |
| Jan | 6 | 2022 | 6-Jan-22 | 1565 |
| Jan | 7 | 2022 | 7-Jan-22 | 1515 |
| Jan | 8 | 2022 | 8-Jan-22 | 300 |

Table 1 shows the master data where the updated output will be saved. Once the details are complete, the user will simply click the Save button then the data will directly be saved to the master data. One the data saved to the master data; the textbox will be cleared automatically. All the inputted information will be reflected on the table. At the corporate and inter-organizational levels, adequate master data quality management is critical (Schäffer & Leyh, 2017).


Figure 3. Inventory Progress

Figure 3 shows other feature of the system which is the progress report. This enables the user to view the overall output produced, the US soy and yellow corn utilized based on production, the remaining US soy and yellow corn considering the starting inventory, delivery and production consumption, and the date of when to place the next purchase. With this, the management may easily check the condition of their inventory and production without having to perform numerous calculations or open numerous files.

## 5.3 Proposed Improvements

Based on the findings, the researcher proposes that the company use the Inventory Management System to provide real-time updates and monitoring. With the said system, the company will be able to know when to order raw materials and how to order in order to reduce purchasing costs while also maximizing space.


Figure 4. Interface for Integer Linear Programming Input

Figure 4 depicts the interface for integer linear programming. The user just needs to enter the anticipated demand and the price of each sack of raw material if it becomes necessary to calculate the number of sacks per order due to an abrupt change. The user will click the Save button to update the master data after the data is complete. The user will then select the Calculate button to run the integer linear programming macro that was previously recorded. The quantity of sacks that must be ordered will show up after the computation. There is a specific outcome for off-season (January to June) and peak season (July and December).

## 5.4 Validation

The researcher explained the system to the business owner. Owners like the method because it allows them to keep track of their employees' progress and reduces the need for repetitive tasks. However, because the company is currently preparing for the relocation of company buildings, actual testing of the system is not possible. The researcher concluded that this system will be useful because it will be simple to change the parameters as a result of their recent acquisition of a larger warehouse and new building.

## 6. Conclusion

The level of inventory, warehouse allocation, ordering frequency, shelf life, and production requirements were used to assess the company's present inventory management position. The researcher discovered that the company used to keep a safety stock sufficient for three weeks of production. The warehouse allocation was also determined by measuring the actual size of raw material packaging. The company also used to order every three weeks, which equated to 17 orders per raw material regardless of season. Each raw material is considered good for production even if it is stocked for 6 months, especially if it is of high quality. Finally, the number of raw materials to be stocked was determined by the monthly requirement, which is 18,000 bags of feed mill.

A mathematical model was developed using Integer Linear Programming to assist the company in achieving their optimal level of inventory. The goal function was to reduce the cost of purchasing US Soya and Yellow Corn due to the season. Warehouse space, yearly production requirements, and shelf life were all considered. This model also restricts all decision variables to integers, ensuring that all orders are exact numbers of sacks. The decisions that will be made will be equivalent to the quantity of raw materials per order.

To reduce the number of repetitive computations in solving linear programming, a Microsoft macro was used. A Visual Basic system was also offered by the researcher to make sure that the user only needs to utilize one program to record all relevant data, such as production output and deliveries. The system also allows the management to modify the model whenever the parameters change.

The researcher explained the system to the business owner. Owners like the method because it allows them to keep track of their employees' progress and reduces the need for repetitive tasks. However, because the company is currently preparing for the relocation of company buildings, actual testing of the system is not possible. The researcher concluded that this system will be useful because it will be simple to change the parameters because of their recent acquisition of a larger warehouse and new building.
The proposed system will be used to monitor the raw materials of the feed mill; however, the system will not be used to determine the quality status. As a result, stocking and using raw materials will have no effect on the model's output. For further research, the system can be modified by incorporating all raw materials, allowing the company to monitor all ingredients and reduce manual inventory.

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