Research Document
– Greenzone –

Made by: Tim Hoevenaars, Mike Verlinde, Diego Mercado Alzamora , Victor Kloeppel
Semester: AI Advanced
Version: 2.0
Date: 06-01-2025

Summary

As a Fontys student group, we have developed an AI model for Greenzone based on Sarimax. This model is designed to provide insight into seasonal sales trends and to make accurate forecasts of the future demand for flowers. The project responds to an important problem with which Greenzone is currently struggling: the lack of a structured and data -driven approach for stock management. The current methods at Greenzone are largely based on experience and intuition of employees. Although this approach has proven to be valuable in the past, it also entails risks, such as too high stocks that lead to waste, or, on the contrary, shortages that result in dissatisfied customers and missed turnover.

The Sarimax model we developed offers a promising solution. It can analyze historical sales data and bring the influence of external factors, such as seasons, holidays and events, in the predictions. With this, the model lays a strong foundation for improving stock management at Greenzone. The first results of the model are positive and indicate that it is able to recognize patterns and offer valuable insights.

However, during the development process it became clear that the current data volume and the quality of the available data are not sufficient to make completely reliable and detailed predictions. The model needs more extensive and granular data, for example about regional differences, customer preferences and other external influences. Without this data, the prediction power of the model is limited, which is an important challenge for the implementation of a data -driven stock management system.

Nevertheless, this project offers a solid starting point for Greenzone to make the switch to a more innovative and future -oriented approach. It shows that a data-analytical approach is not only possible, but also necessary to increase operational efficiency and to improve customer satisfaction. By investing in the future in collecting more data and further developing the model, Greenzone can distinguish itself in the competitive flower market and lay a sustainable foundation for further growth.

With this project, as a student group, we not only made a working AI model, but also made a valuable contribution to the strategy and digital transformation of Greenzone.

Table of Contents

Introduction

Greenzone, a medium-sized flower company, is an important player in the dynamic and competitive flower market. The company supplies a wide range of flowers and plants to customers throughout Germany, and has built up a loyal customer base. However, the rapidly changing market conditions and the seasonal nature of the demand for flowers entail considerable challenges. Greenzone is currently facing the urgent need to develop a more efficient stock management system that better fits in with these fluctuations in demand.

Current processes at Greenzone are largely dependent on the many years of experience and intuition of their employees to make purchasing decisions. Although this method can be valuable in specific situations, it also entails risks. Trust in personal experience and judgment can lead to inaccurate estimates of the required stocks. This often results in problems such as stock shortages, which can lead to dissatisfied customers, or surpluses that increase operational costs and entail waste. In a sector where timing and quality are crucial, a lack of a structured stock management approach can seriously undermine the competitive position of Greenzone.

That is why this research report focuses on thoroughly analyzing the existing stock management processes at Greenzone and exploring modern technological solutions that can optimize the company's purchasing strategies. A data -driven approach is essential to gain insight into seasonal sales trends and to predict future needs more accurately. The goal is to develop a digital dashboard that provides insight into historical sales data and trends, so that the purchasing department can respond proactively to changes in demand. This dashboard will not only visualize current sales trends, but also offer prognoses about which flowers are popular in different periods.

An important aspect of the research is to identify the most important factors that influence the demand for flowers. This includes seasonal patterns, events and holidays, as well as regional preferences. By analyzing these factors, Greenzone can better anticipate the needs of their customers and adjust their stock management strategies accordingly. This research will also investigate how a calendar function can be integrated in the dashboard, making it easy for employees, regardless of their experience, to quickly understand which flowers they should order and when the demand for specific species will be the highest.

The report presents the methods that are used to develop this data -driven system, including the data collection strategies, the analysis methods and the implementation steps. By following this approach, Greenzone not only expects to increase operational efficiency, but also improve customer satisfaction by offering better and faster service. Ultimately, this project strives to position Greenzone as an innovative and responsive company within the flower industry, with a solid basis for future growth and development.

About Greenzone

Greenzone is a medium -sized flower company that is active in Germany and cooperates with around 1000 florists. The company offers efficient logistics service and supplies flowers with the next day delivery. However, current stock management is largely based on the experience of employees and intuitive decisions. This entails challenges, such as predicting the right amounts of flowers for different seasons, which can lead to shortages or surpluses. Greenzone now wants to switch to a data-driven system to improve their purchasing process and to achieve more consistency in stock management.

Business Information

Greenzone is an ambitious and growing company specialising in the flower industry. The flower industry is a sector that revolves around the production, distribution and sale of fresh flowers, plants and floral arrangements to individuals and companies. Within this sector, Greenzone plays an important role as a logistics link between florists and flower growers. The company operates from Germany and has positioned itself as a reliable partner for florists who want to deliver high-quality flowers with a fast and efficient service.

Shareholders and company structure:
Greenzone is owned by three shareholders: Niels, his father, and Fleurop Germany, a business large platform supporting a network of florists across Europe. Fleurop is a renowned name in the flower industry, with a strong presence in both Germany and the Netherlands, as seen on their websites fleurop.de and fleurop.nl. This partnership with Fleurop strengthens Greenzone's position in the market and provides access to a wide range of clients and opportunities.

Services and customers:
With a customer base of around 1,000 florists in Germany, the Netherlands and Austria, Greenzone is well established in the European flower market. These florists rely on Greenzone to deliver fresh flowers and arrangements, taking advantage of the next-day delivery service offered by the company. This means florists can receive their orders quickly and offer them directly to their own customers, without delays. This quick turnaround time is essential in the flower industry, where freshness is crucial. After all, flowers do not stay fresh for more than 3 days.

Process:
Greenzone's unique selling point is the strong logistics infrastructure they have built up. Orders are processed efficiently, using a streamlined system in collaboration with Fleurop. The process begins when a florist places an order through the Fleurop platform. Fleurop then forwards this order to Greenzone, where the logistics team begins putting the order together. This starts with carefully selecting the right flowers from the refrigerated storage facility, also known as the ‘cold room’. The flowers are then expertly packed to ensure they arrive at the florist in perfect condition. What sets Greenzone apart is their approach to stock management. Instead of using complex systems or forecasting software, the company relies on their years of experience in the

industry to anticipate customers' needs. Greenzone's employees have a deep understanding of seasonal trends and their florists' preferences, allowing them to accurately estimate what flowers and quantities will be needed to meet demand. This human expertise does represent a bottleneck for Greenzone. When a new staff member is hired, and therefore lacks experience, it takes a long time to get this expertise.

Competition and innovation:
The flower industry is competitive, and Greenzone faces a number of larger competitors that are unlikely to take the same personalised approach. Many of these larger players may not use advanced technologies such as artificial intelligence (AI), although they often have more resources and economies of scale. What is striking is that, despite their competitors, Greenzone is willing to explore new technologies and methods. Although they have not yet tested existing solutions, they are open to innovation and possible improvements in their processes.

Future prospects:
The flower industry continues to evolve, and Greenzone is well positioned to benefit from the ongoing changes in the market. Through their strategic partnership with Fleurop, their strong customer base of 1,000 florists, and their dedicated team of employees, the company has solid foundations to grow further. Moreover, with a focus on innovation and their willingness to explore new technologies, Greenzone can adapt to market demands and exceed their customers' expectations.

The Current Problem

The current problem at Greenzone lies in their approach to inventory management. While the company stands out by relying on their employees‘ years of experience to predict their customers’ needs, this method also creates challenges. Greenzone does not currently use modern technologies, such as sophisticated inventory management systems or forecasting software. Instead, purchasing decisions are made based on intuition and practical experience. While this approach can be effective in the short term, it carries risks in the long term, especially when it comes to anticipating trends in flower sales.

Biggest Current Challenge:
One of Greenzone's biggest challenges is maintaining a clear and consistent overview of flower sales trends throughout the year. This information is essential, because only with a good understanding of which flowers are popular at which time of year can the company effectively plan how much to buy, what types of flowers to order, and when exactly. Without a structured overview of these trends, Greenzone relies on the intuition of experienced staff, which increases the likelihood of mistakes.

This problem is compounded by the fact that new employees at Greenzone often lack the experience to predict these trends in the same way as their more experienced colleagues. It takes time, often years, to develop the necessary expertise to carry out effective inventory

management. In the meantime, decisions can be made that lead to stock shortages, surpluses or waste. In addition, the lack of a structured approach creates a lack of consistency, making operations vulnerable in times of staff turnover or expansion.

The Solution:
A dashboard with trends and a calendar. To address these challenges, Greenzone could benefit from a more data-driven approach. Introducing a digital dashboard in which predicted flower sales trends are clearly presented through AI would go a long way. This dashboard should not only give an overview of which flowers are selling the most at which time of year, but also provide detailed information on how much to buy in specific periods.

An essential part of this system would be a calendar function, visualising seasonal trends and showing exactly when specific flowers are popular. This way, purchasing department staff, regardless of their experience, can easily see what types of flowers they need to order and when demand for certain flowers will be highest. This data should be accessible in a clear and user-friendly way so that everyone in the company can easily work with it.

Benefits for purchasing and marketing:
Such a system would benefit not only the purchasing department, but also the marketing department. By understanding the trends of flowers sold, the marketing department can make more effective choices on how to market certain flowers. For example, if trends show that there is a spike in demand for tulips in spring, the marketing department can capitalise on this by running targeted campaigns that boost tulip sales. This would also improve the planning of promotions, campaigns and other marketing activities, as they would be much more attuned to actual market demand.

Long Term Advantages:
In the long run, such a system would not only help increase Greenzone's operational efficiency, but also reduce its reliance on human intuition and experience. New employees could be inducted faster as they would have immediate access to the data needed to make informed decisions. In addition, the company would be less vulnerable to inventory management errors and could strengthen its competitive position by responding more accurately to market trends and customer needs.

Assignment and Activities

The primary goal of the project at Greenzone is to investigate and identify an optimized approach for stock management. Currently, Greenzone leans strongly on the many years of experience of their employees to predict customers' demand. Although this method can be valuable in the short term, it also entails challenges, especially when it comes to anticipating flowers of flowers.

Greatest current challenge:

One of the biggest challenges with which Greenzone has to do is maintain a clear and consistent overview of the sales trends of flowers during the year. This insight is essential, because only with a good understanding of which flowers are popular at what time, the company can effectively plan how much they should buy, which types of flowers should be ordered, and when exactly this should be done. Without a structured overview of these trends, Greenzone relies on the intuition of experienced employees, which increases the chance of errors.

This problem is exacerbated by the fact that new employees at Greenzone often do not have the experience of predicting these trends in the same way as their more experienced colleagues. It often takes years to build up the expertise that is needed for effective stock management. In the meantime, decisions can be made that lead to shortages, surpluses or waste. Moreover, the lack of a structured approach causes inconsistency, making business operations vulnerable during staff fluctuations or extensions.

The solution:

A dashboard with trends and a calendar. To tackle these challenges, Greenzone could benefit from a more data-controlled approach. The introduction of a digital dashboard in which predicted sales trends of flowers are clearly presented via AI would solve many problems. This dashboard should not only provide an overview of which flowers are the most sold at what time of the year, but also provide detailed information about how to purchase in specific periods.

An essential part of this system would be a calendar function that visualizes seasonal trends and shows exactly when specific flowers are popular. In this way employees of the purchasing department, regardless of their experience, can easily see which types of flowers they should order and when the demand for certain flowers will be the highest. This data must be accessible in a clear and user -friendly way, so that everyone within the company can easily work with it.

Expected results:

The implementation of this system will have considerable benefits for Greenzone. By using data analysis and predictions, purchasing decisions can be made with more accuracy, which leads to less waste and better stock control. Moreover, the company will be less dependent on individual knowledge, which promotes operational consistency, even during personnel fluctuations.

The Research

The research within this project focuses on the development and implementation of a data-driven stock management system for Greenzone, which can tackle the current challenges in the field of seasonal sales trends and purchasing decisions. This system will be based on a combination of historical sales data, seasonal patterns and predictive analysis, using a digital dashboard. To achieve an optimal system, a thorough analysis of both current processes at Greenzone and the possible technological solutions that are available.

This part of the project describes the research process, including the research methods, the data collection strategy and the way in which the results are analyzed. The research will first of all focus on identifying trends in the Greenzone sales dates and the development of a suitable prediction model. In addition, it is investigated how a dashboard with a calendar function can support and improve stock management at Greenzone.

Main Research Question

"How can Greenzone optimise their inventory management and marketing by implementing an AI-driven system that reveals sales trends and seasonal patterns, in order to buy more efficiently and market in a more targeted way?"

The main research question explores how Greenzone can optimize their inventory management and marketing strategies by implementing an AI-driven system that provides insight into sales trends and seasonal patterns. This system would allow them to make more informed purchasing and marketing decisions, ultimately leading to more efficient operations and higher customer satisfaction.

Currently, Greenzone manages their inventory primarily based on experience. However, with the help of AI, they will be able to estimate much more accurately which flowers are popular at what time. This allows them to tailor their inventory management to actual demand patterns rather than feel, reducing waste and lowering storage costs. In addition to inventory management, an AI system also provides opportunities for targeted marketing. By identifying seasonal patterns and customer preferences, Greenzone can tailor their marketing campaigns to what customers are looking for at specific times. This allows them to respond to peaks around holidays and special occasions, which increases the effectiveness of their marketing and contributes to customer satisfaction.

Furthermore, AI helps plan purchasing decisions so that they are better timed at expected peak times, without under- or overstocking. This lowers costs and ensures that customers always have access to popular products. Thus, through an AI-driven system, Greenzone can respond to demand fluctuations, purchase more efficiently, and market in a more targeted way, ultimately making them competitively stronger in the marketplace.

How are the current inventory management methods implemented at Greenzone?

Greenzone manages their flower inventory in a traditional way, mainly based on their workers' experience. Instead of using modern computer systems to predict how many flowers they need, the staff members make these decisions based on what they have learned over the years. They know which flowers sell well during different seasons and what their customers usually want. This is not a cost-efficient way since learning new customers could take years. The company stores their flowers in a special cold room to keep them fresh. When they receive orders through their clients or Fleurop (their partner company), workers go to this cold room, pick the right flowers, and pack them carefully for delivery. The whole process works well because the experienced staff know what they're doing.

Quality control:
Quality control at Greenzone is currently managed through their employees' experience and knowledge, just like their stock management. The staff members use their expertise to check the quality of flowers when they arrive and while they're stored in the company. However, this system isn't perfect and can lead to problems. Sometimes they might have too many flowers that don't meet their high standards, or they might run out of top-quality flowers when customers need them. Since Greenzone wants to keep their customers happy and maintain their good reputation in Germany, they need to make their quality control better. That's why they're planning to create a new digital system (dashboard) that will help them track not just how many flowers they have, but also the quality of these flowers throughout different seasons. This will help them make sure they always have enough high-quality flowers to meet their customers' needs.

Flowers that do not sell:
When Greenzone has flowers that haven't been sold to florists, they don't let them go to waste. Instead, they sell these flowers at local flower markets. This is a smart way to reduce losses and still make some money from flowers that might otherwise be thrown away. The flowers are still fresh enough to be sold at these markets, just not quite perfect enough for their regular florist customers who need top quality. By selling at local markets, they not only recover some of their costs but also help make fresh flowers available to local people at lower prices. This system helps Greenzone manage their inventory better and be more environmentally friendly by reducing waste. It's a win-win situation: the company loses less money, and local people can buy nice flowers at good prices.

Conclusion:
However, this way of working has some problems. The biggest issue is that it takes a long time to train new workers because they need to learn everything from scratch. They can't just look at a computer system to know how many flowers to order - they need to gain this knowledge through experience. While this system has worked well for Greenzone so far, it might make it harder for them to grow bigger in the future, as they depend too much on their experienced workers' knowledge.

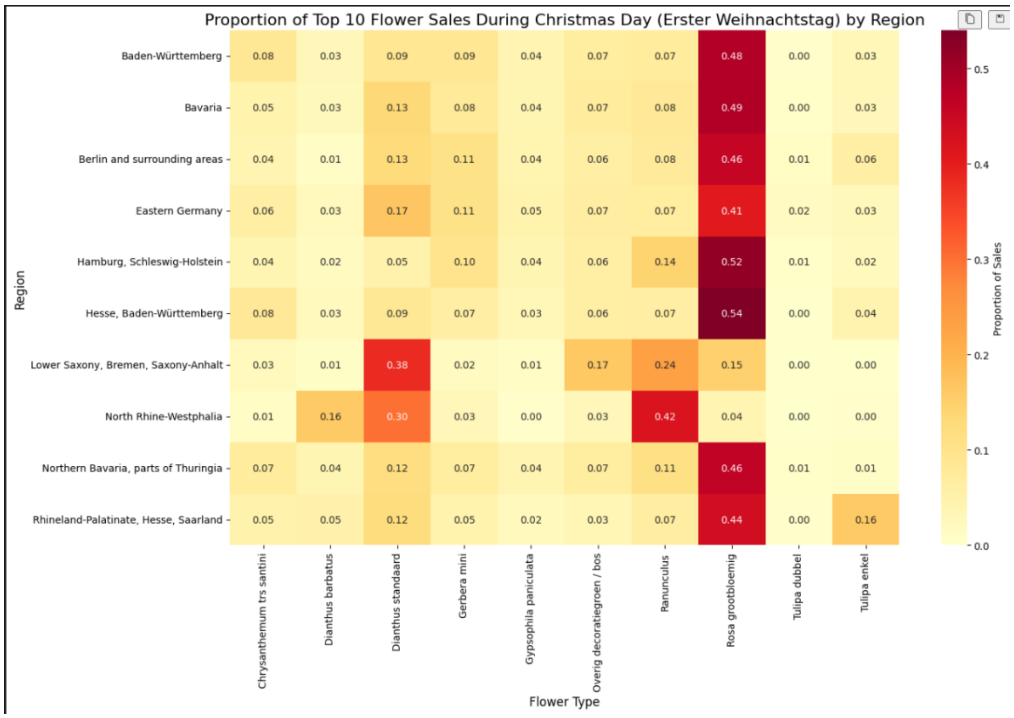
What sales trends and seasonal patterns affect the flower market in which Greenzone operates in Germany?

The Flower Markets operated by Greenzone in Germany mainly focus on the eastern regions but are not restricted to them, as their delivery service covers all postal codes across the country.

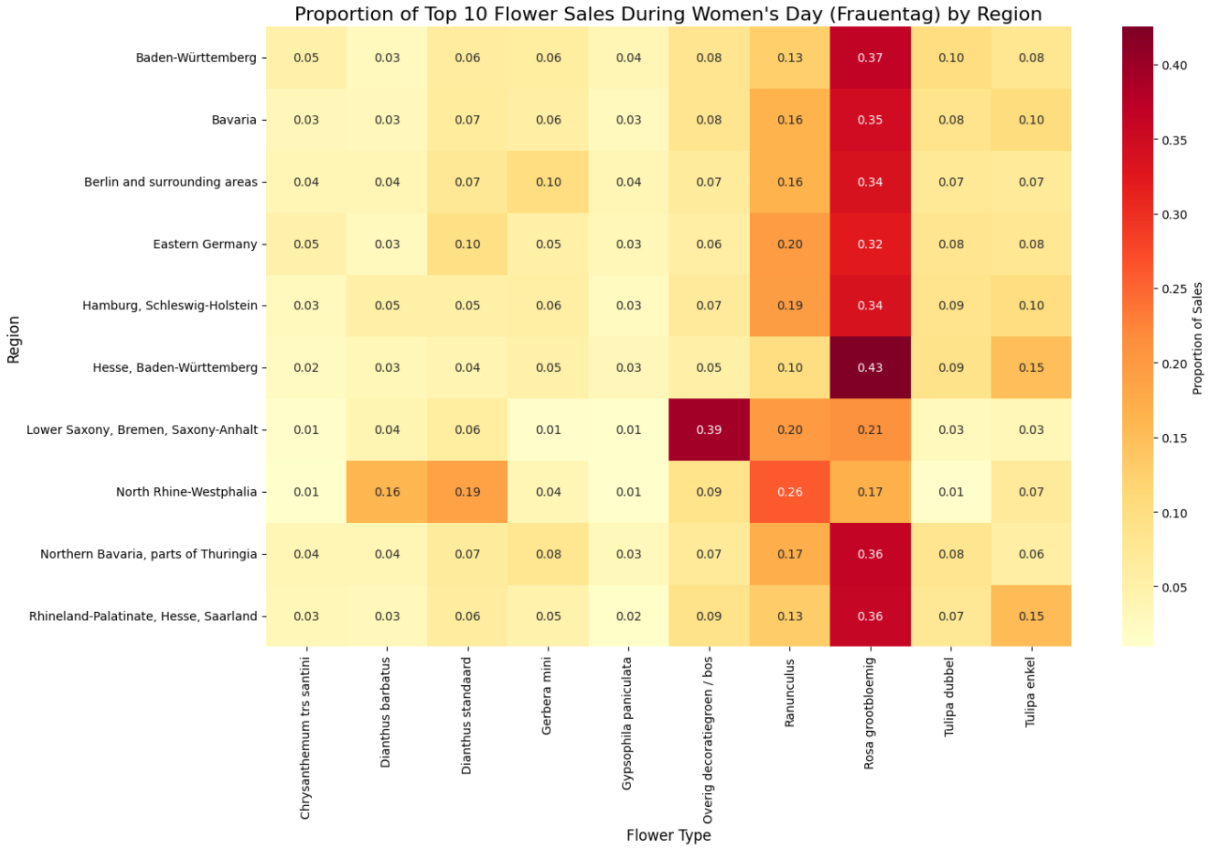
Germany can be divided into regions based on postal code areas:

- **Region 0**: Eastern Germany
- **Region 1**: Berlin and surrounding areas
- **Region 2**: Hamburg and Schleswig-Holstein
- **Region 3**: Lower Saxony, Bremen, and Saxony-Anhalt
- **Region 4**: North Rhine-Westphalia
- **Region 5**: Rhineland-Palatinate, Hesse, and Saarland
- **Region 6**: Hesse and Baden-Württemberg
- **Region 7**: Baden-Württemberg
- **Region 8**: Bavaria
- **Region 9**: Northern Bavaria and parts of Thuringia

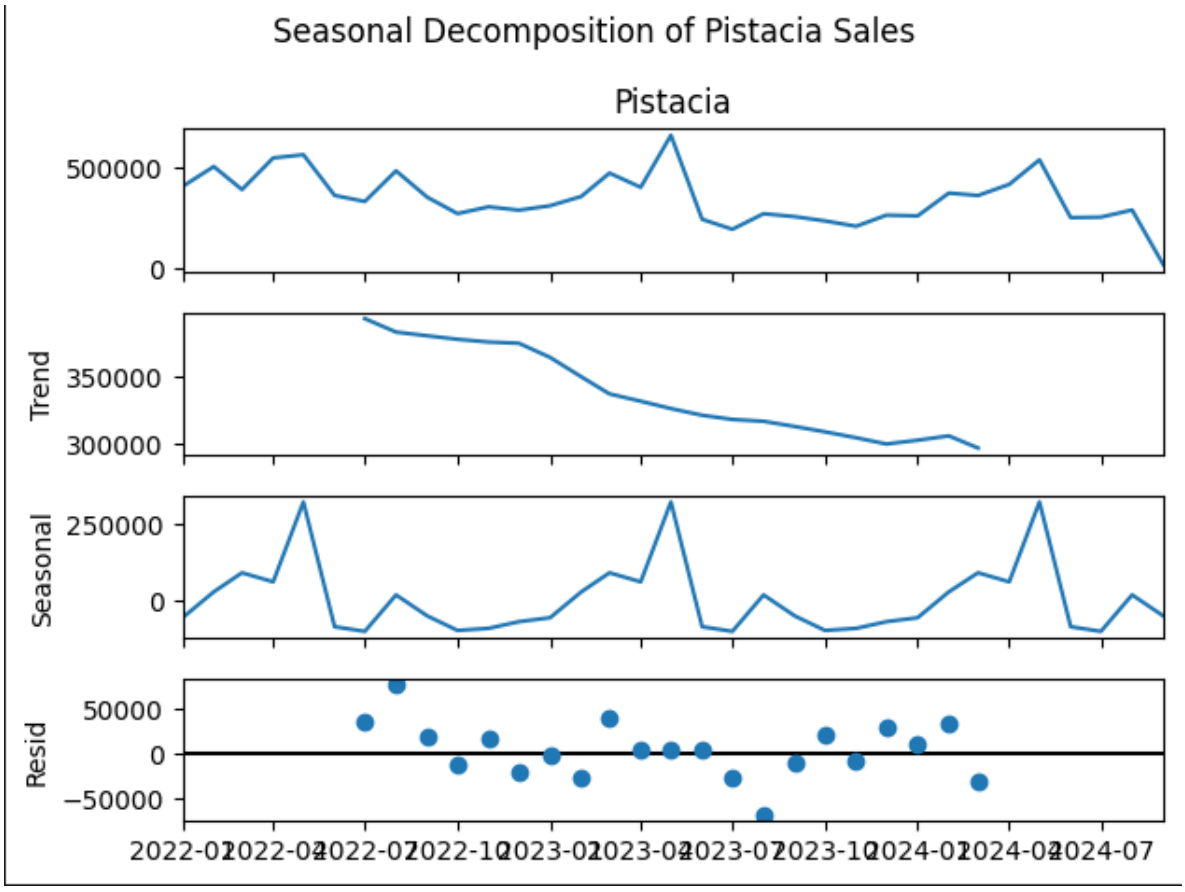
Understanding holidays, seasonal patterns, and sales trends in the flower market is complex because these factors vary by region. Different regions celebrate holidays in unique ways, often using specific types of flowers, and the cultural tradition and significance of flowers may differ from one region to another. Additionally, certain regions, like North Rhine-Westphalia, play a larger role in the market as they host around 30% of all flower wholesalers in Germany, influencing supply and trends in those areas.



This graph illustrates flower sales on Christmas Day across various regions. It highlights that most regions tend to celebrate with **Rose Grootbloemig** as the preferred flower. However, **North Rhine-Westphalia** shows a distinct trend, favouring **Ranunculus** over roses, with very few roses being purchased during this time. In contrast, regions like **Lower Saxony** display a preference for **Dianthus**, making it their most commonly bought flower for Christmas. This regional variation underscores how local traditions and preferences shape flower sales during the holiday season.

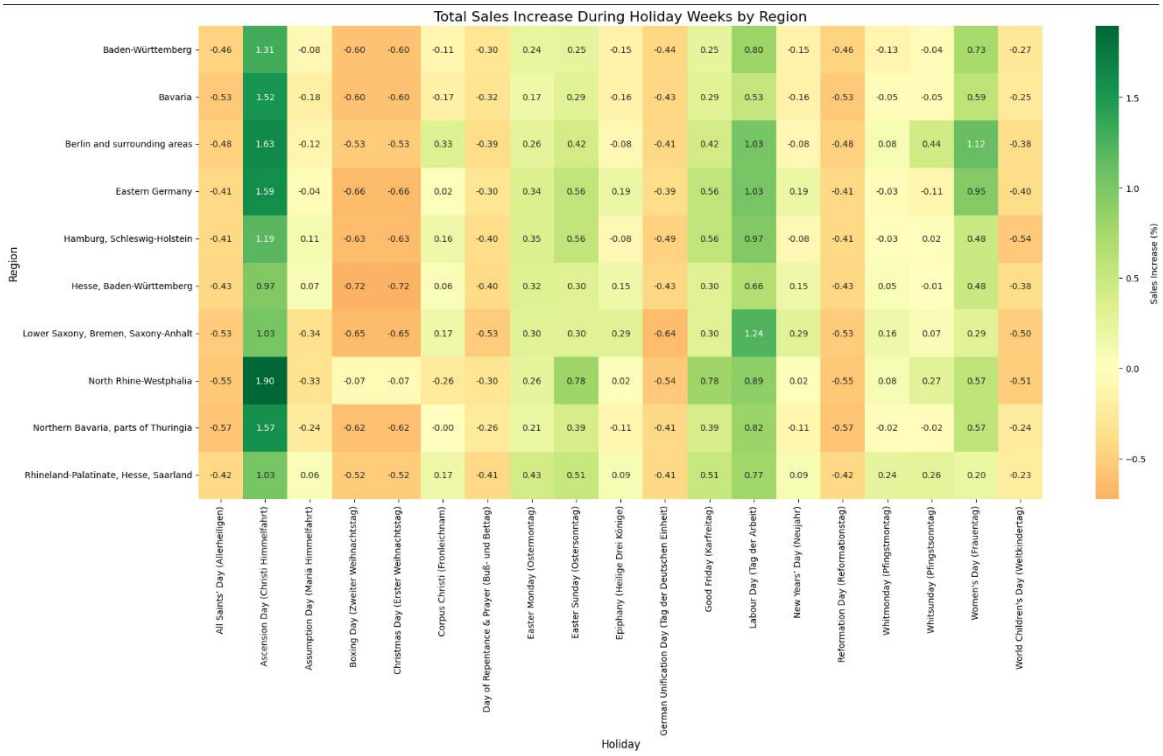


Celebrations like Women's day tend to shift the market toward other plants, in this case Ranunculus can be seen to gain a significant amount of popularity during this weeks. Which means that tradition and culture do affect the market in significant ways.



Seasonal trends play a significant role in the flower market, as flowers are inherently tied to the seasons throughout the year. A 52-week seasonality pattern becomes evident when analyzing trends, as seen in the seasonality graph of Pistacia (spanning from January 1st, 2022, on the left, to September 2024, on the right). This pattern highlights how flowers tend to thrive and bloom more vibrantly during specific seasons, while in others, their growth may be limited.

The 52-week seasonality is a clear example of how supply and demand dynamics are influenced by nature. When flowers do not grow well or lack their usual beauty, customers are less likely to purchase them. This results in decreased sales for wholesalers, which in turn discourages farmers from planting these flowers. The same seasonality trend is apparent across most types of flowers, reflecting the cyclical nature of their growth and market demand.



This heatmap illustrates the impact of various holidays on flower sales across different regions. Values range from 0 (no change) to negative (a decrease in sales) or positive (an increase in sales). Some holidays, such as Ascension Day, are traditionally celebrated with flowers in Germany. For example, Germans mark the Ascension of Christ with vibrant, colourful flowers, leading to a noticeable spike in sales nationwide.

However, some unexpected trends emerge, such as a significant decrease in flower sales during Christmas and Boxing Day. These two holidays demonstrate a distinct sales pattern characterized by a sharp decline. Long holidays often lead to reduced flower sales because many flower shops close for celebrations, customers may travel elsewhere, and the market becomes less predictable and harder to track. In the case of these consecutive holidays, sales can drop by over 70% in some instances. This highlights the complexity of holiday-related sales trends in the flower industry.

The German flower market, where Greenzone operates, is shaped by strong seasonal patterns and holiday-driven sales trends. A clear 52-week seasonality affects the supply and demand, as flowers bloom better during certain periods, leading to higher sales, while off-seasons see a dip due to lower quality and reduced planting by farmers. Holidays play a crucial role, with events like Ascension Day boosting sales nationwide as vibrant flowers are a traditional part of the celebration. However, extended holidays such as Christmas and Boxing Day result in a significant decline in sales—up to 70% in some regions—due to shop closures, reduced consumer activity, and unpredictable market conditions. Regional preferences further diversify the market, with North Rhine-Westphalia favouring Ranunculus over roses for Christmas, Lower Saxony leaning toward Dianthus, and most other regions preferring Rose Grootbloemig. These factors underscore the importance of aligning operations with regional demands, seasonal patterns, and holiday-specific trends to effectively navigate the market.

What technological solutions for inventory management are available in the market?

Inventory management is a system that helps businesses determine which items and quantities to stock, as well as the best timing for reordering. It tracks inventory through its entire journey, from purchase to sale, and helps businesses respond to demand trends, ensuring there's always enough stock to meet customer needs while preventing shortages.

Inventory remains an asset on the balance sheet until it is sold, at which point it becomes revenue. However, until it's sold, inventory ties up cash and can reduce cash flow if overstocked.

A key measure of effective inventory management is inventory turnover, which shows how frequently stock is sold within a certain period. High turnover reflects efficient sales, while low turnover can lead to deadstock, or unsold inventory, which can increase costs and reduce profitability.

Effective inventory management is critical in the flower industry because of the perishable nature of flowers and the seasonal changes in demand. Today, several technological solutions can help streamline inventory processes, reduce waste, and improve responsiveness to demand. This section explores some modern technologies that are especially helpful for managing inventory in the flower industry.

Inventory Management Software (IMS)

IMS platforms are software solutions that provide real-time tracking of inventory, order management, and demand forecasting. In the flower industry, IMS can replace manual or experience-based systems with a structured, data-driven approach, improving accuracy and reducing shortages or excess stock. IMS helps businesses manage purchasing decisions, monitor stock levels, and optimize storage, so that stock levels align better with real demand.

Radio-Frequency Identification (RFID)

RFID technology uses tags and sensors to automate the tracking of items in inventory. RFID can be helpful in flower inventory management by providing real-time data on stock levels and item locations. This reduces the need for manual checks, speeds up order fulfilment, and ensures proper storage and rotation. RFID is especially useful for reducing errors in inventory counts and making sure the right flowers are selected for orders quickly.

Internet of Things (IoT)

The IoT connects physical devices to the internet, allowing them to collect and exchange data. For flower inventory management, IoT sensors can monitor storage conditions like temperature, humidity, and light. These factors are crucial to keep flowers fresh and high quality. IoT systems can alert staff if conditions go outside optimal ranges, helping to prevent spoilage and reducing waste, which is especially important in the flower industry.

Demand Forecasting using AI or ML

AI and ML are powerful tools for analyzing past sales data and predicting future demand patterns. In flower inventory management, AI-driven forecasting can consider seasonal trends, holidays, and special events to help businesses anticipate demand more accurately. This improves stock planning, helping avoid shortages or excess stock. Machine learning algorithms can also adapt to changes in demand over time, becoming more accurate as they process more data.

Cloud-Based Solutions

Cloud-based inventory systems offer scalability and easy access, allowing real-time access to inventory data from multiple locations. For flower inventory management, cloud-based systems let employees across different locations view and manage stock levels consistently, which is valuable for businesses with multiple storage facilities or regions. Cloud systems also lower upfront IT costs, provide data backups, and ensure all team members can access the latest data, improving coordination across locations.

How Greenzone Could Use Technology to Gain a Competitive Advantage

Greenzone could use these technological solutions to transform its inventory management, helping it become more efficient and competitive in the floral market. By using advanced Inventory Management Software (IMS), Greenzone would gain real-time visibility into stock levels, allowing for precise, timely purchasing decisions and reducing waste from overstocking. Adding Radio-Frequency Identification (RFID) would increase accuracy by automatically tracking flower quantities and locations, ensuring quick and accurate order fulfilment, which is crucial for fresh flowers. Using Internet of Things (IoT) sensors to monitor storage conditions like temperature and humidity would keep flowers fresher, reduce spoilage, and improve customer satisfaction. Artificial Intelligence (AI) and Machine Learning (ML) could provide Greenzone with forecasts based on seasonal trends, allowing it to plan for high-demand periods like holidays and adjust its stock accordingly. A cloud-based inventory system would also offer scalability and remote access, supporting Greenzone's growth and making it easier to coordinate inventory across multiple locations. Together, these technologies would help Greenzone respond more effectively to customer demand, adapt faster to market trends, and improve service quality, which would strengthen its position in the floral industry.

How can a dashboard with sales trends and a calendar function help optimise inventory management?

A dashboard with sales trends and an integrated calendar function provides a powerful way to optimize inventory management at Greenzone. By visually displaying historical data, the company can gain insight into the demand for specific flowers and plants during different periods. For example, the system can reveal which flowers sell the most around Valentine's Day or Mother's Day, or which plants are popular in the summer. These types of insights allow Greenzone to proactively adjust inventory to expected peaks and troughs, reducing waste and better serving customers.

Data-Based Decisions

Another important aspect of the dashboard is the calendar feature, which is directly linked to sales trends and external factors such as holidays, events and seasonality. This feature allows Greenzone to plan purchasing decisions based on accurate forecasts. For example, suppose the dashboard indicates that demand for red roses begins to rise three weeks before Valentine's Day. In that case, Greenzone can order additional stock in a timely manner, preventing shortages and ensuring customers receive on-time deliveries. At the same time, the calendar feature helps minimize surpluses after peak periods, reducing both costs and waste. In addition, the dashboard provides a data-driven basis for decision-making, reducing the company's reliance on intuition and experience. While the knowledge of experienced employees remains valuable, a dashboard can provide objective insights that support the decision-making process. This is especially important in a dynamic and competitive market such as flowers, where unexpected changes in demand can occur quickly. By combining sales data with predictive analytics, Greenzone can respond more efficiently to these changes while making long-term strategic decisions.

Easy to Use

An added benefit is that the dashboard is easy to understand and use, even for employees without technical knowledge. With intuitive visualizations, such as graphs and interactive tables, users can quickly identify trends and action items. This increases efficiency and ensures that decisions are made faster and on a more informed basis. In addition, departments such as purchasing and sales can use the dashboard to better collaborate and align their processes.

Long Term Advantages

In the long run, such a system can help Greenzone not only improve operational efficiency, but also increase customer satisfaction. By always having the right products in stock at the right time, the company can deliver faster and be more responsive to customer needs. This not only strengthens the relationship with existing customers, but also makes it possible to attract new customers in a competitive market. Moreover, the dashboard provides the ability to analyze trends over multiple years, which is a valuable tool for strategic planning and growth.

How can understanding sales trends help Greenzone develop targeted marketing strategies?

Every marketing campaign has a specific goal that drives its strategy and implementation. These goals serve as the foundation for measuring success and determining resource allocation. For example:

- A company may aim to increase sales for any given product, whether it's launching a new item or boosting the performance of existing offerings in their portfolio.
- A government may aim to educate about a certain topic, such as public health initiatives, environmental conservation, or civic responsibilities.
- A charity may aim to increase awareness about an unjust phenomenon, mobilizing public support and gathering resources to address societal challenges.

Marketing is resource intensive, requiring significant investments in time, money, and human capital, because of which conversion is an important marker of its success. The strategic allocation of these resources can make the difference between a campaign's success and failure. Here, conversion is defined as the effectiveness with which desired goal is reached, measured through various metrics such as sales numbers, engagement rates, or participation levels. There are many factors that determine the conversion, such as those concerning the product and message, including price point, product quality, messaging clarity, and channel selection. One of the factors that may be improved with the available data is to better understand the market, based on which targeted marketing strategies can be composed, ensuring optimal resource utilization and maximum impact.

The patterns extractable from the dataset may reveal the demands of the market, specified per type of flower, date, and region, allowing for sophisticated market analysis and prediction models. This comprehensive understanding enables marketers to identify trends, seasonality, and regional preferences with unprecedented accuracy. This allows the campaign to be directed to those who are more likely to exhibit requested behaviour, as the campaign more closely resembles the demands of the market and addresses specific consumer needs. In turn, this increases conversion, because of which the campaign is more effective or resource efficient, leading to better returns on marketing investments and improved overall performance metrics.

So how exactly can understanding sales trends help the development of targeted marketing strategies? The answer lies in the power of data-driven decision making and predictive analytics. By mapping out the correlation between flower types, dates, holidays, regions, and possibly even the weather, the demand may be predicted with increasing accuracy. This analysis can uncover hidden patterns and relationships that might not be apparent through casual observation. That forecast of demand is then used to target those who are most likely to make the purchase, optimizing marketing spend and improving campaign effectiveness. For example, a flower of which the demand is known to increase in the upcoming timeframe may be marketed more intensely, with promotional efforts timed to coincide with peak demand periods. The region in which this campaign is active may also be based on where the flower does and does not typically sell, ensuring resources are allocated to areas with the highest potential return.

What are the risks and challenges in implementing a data-driven system for inventory management and marketing?

Implementing a data-driven system for inventory management and marketing can offer significant benefits to companies in the floral industry, such as more accurate stock replenishments, avoidance of over- and understocking, and the ability to better align marketing activities with customer needs. However, such a transition also presents numerous challenges and risks that must be thoroughly considered and managed to reap the full benefits of the system. This section discusses the key risks and challenges associated with implementing a data-driven system, focusing on maintaining data quality, integration complexity, employee adoption, security concerns and the need for human oversight.

Quality and Availability of Data

An effective forecasting system is closely related to the quality, completeness, and reliability of input data. Especially in a data-intensive industry like floriculture, where seasonal patterns, weather conditions, and special days all play a role, inaccurate or incomplete data can lead to disrupted inventory levels and customer satisfaction.

Importance of Consistent and Reliable Data Entry:
The predictive models of a data-driven system are only as good as the data on which they are based. Inconsistent or outdated data can lead to inaccurate predictions, which can lead to inventory shortages (understocking) or surpluses (overstocking). At Greenzone, for example, the lack of an up-to-date weather monitoring system could lead to incorrect demand estimates on days with unexpected weather conditions, such as a sudden cold snap or heat wave. Thus, the company must invest in ensuring data quality by automating data entry and regularly checking the data for completeness and accuracy.

Challenges with Integrating External Data:
For a complete picture of market conditions and customer behaviour, the system must include not only internal sales data but also external data, such as weather data and holiday dates. However, this external data can come from different sources and in various formats, which complicates its integration. An example is combining multiple weather models that predict weather differences by region at different times. The complexity increases further when these external data need to be updated live, requiring robust API connectivity and data processing time.

Challenges with Data Volume and Storage Management:
As more data is collected, the volume of stored data also grows significantly. Companies must ensure that their storage capacity and processing power are adequate to handle large amounts of data quickly and efficiently. This comes at a cost, both in terms of hardware upgrades and managing a cloud-based storage system. In addition, storing data such as temperature readings and consumer behaviour can conversely have negative effects on the speed at which analyses can be performed, which can lead to delays in decision making.

Complexity of Seasonal Patterns and Sales Trends

In the flower industry, sales trends vary significantly throughout the year. Flower demand is highly dependent on season, climate and special occasions, which adds an additional dimension of complexity to predictive models.

Influence of Seasonal Demand Variability:
Many demand spikes are predictable - such as increased sales around Valentine's Day and Mother's Day - but there are also numerous less predictable fluctuations in demand that arise from other factors, such as temporary weather conditions, for example. A data-driven system must be flexible enough not only to recognize regular seasonal patterns, but also to respond quickly to unforeseen changes, such as an unusually warm winter or rainy spring, that can dramatically affect demand.

Weather Influences and Flexibility of Models:
The influence of weather on flower sales is often complex and non-linear. For example, sunny weather can lead to higher sales, but extreme temperatures can have just the opposite effect. Therefore, prediction models must not only take historical sales data, but also use machine learning algorithms that recognize patterns and can even identify unforeseen scenarios. However, these models are often more complex and require constant adjustments, which increases operational costs and maintenance requirements.

Risk of Oversimplification of Data:
Another challenge is the risk of oversimplifying assumptions in the models. Stock models in the flower industry must take into account a variety of variables, from types of flowers and their specific seasons to regional customer preferences. A model that does not take these fine-grained variations into account can provide incorrect predictions and make inventory management more difficult.

Technical Integration and System Management

Implementing a new system also brings technical challenges, especially if the system must integrate with existing software and processes within the company.

Compatibility with Existing Software:
Companies such as Greenzone often already use specific software for inventory management and order processing, such as Florasoft. The new data-driven technology must be compatible with it to work together effectively. Incompatibility between systems can lead to data loss, operational inefficiencies, and even duplicate data entry, which can result in costly errors. It is essential to examine whether the new technology can be seamlessly integrated with existing systems prior to implementation.

System Maintenance, Updates and Long-Term Support:
New technologies require regular maintenance and updates to continue to function effectively. This is especially true for predictive systems that depend on changeable variables, such as weather forecasts and customer behaviour. Regular updates are necessary to ensure that models remain accurate and forecasts reliable. This means the company may need an internal IT department to resolve problems quickly, or a contract with an external service provider for support and maintenance.

Employee Adoption and Training

Implementing a new, data-driven system often means a significant change in work processes for employees. This can lead to resistance, especially when employees feel uncertain about their technical skills.

Need for Training and Knowledge Building:
Introducing a predictive system requires targeted training so that employees learn to interpret the data generated and apply it in their daily work. In the flower industry, this may specifically mean that employees need to learn how to translate predicted demand into customized purchasing decisions. Lack of training can lead to misinterpretations and loss of efficiency, reducing system reliability and employee engagement.

Change in Work Culture and Work Processes:
Using data-driven decisions often requires a change in business practices. Employees accustomed to making decisions based on intuition may have to switch to an analytical, data-driven approach. This may initially create resistance, but may also require a culture change in which data-driven decision-making is encouraged and supported by the organization.

Risks of Excessive Automation

Automation offers great benefits, but it also carries risks, especially if the system does not account for unforeseen events or anomalies.

Vulnerability to Unforeseen Events:
A fully automated system may be vulnerable to unexpected changes in demand, such as a sudden increase in flower sales due to an unexpected event. Without adequate monitoring, the system may make errors in inventory forecasting and inventory management. It is important that there is ample room for human intervention in such situations, such as allowing employees to manually adjust inventory levels when circumstances call for it.

Risks of Blind Reliance on Predictive Models:
Predictive models can provide valuable insights, but it is important to view these insights as tools and not absolute truths. Predictions always depend on the accuracy of the data and the specificity of the models used. Human intuition and market knowledge can be valuable complements and should not be excluded from the decision-making process.

Privacy and Data Security

Protecting customer data and business information is a crucial part of implementing a data-driven system, especially in an era when the amount of data processed and stored is increasing exponentially. For companies in the flower industry, such as Greenzone, insecure processing of sensitive information can lead not only to a loss of customer trust but also to legal complications. The General Data Protection Regulation (GDPR), as well as other relevant privacy laws, imposes strict rules on how companies collect, store and use personal data. Failure to comply with these regulations can have serious consequences, such as large fines and reputational damage. This section discusses key aspects of privacy and security that are important when implementing a data-driven system.

Sensitive Information and AVG Compliance:
Data-driven systems typically collect and analyse a wide range of information, ranging from customer data and purchasing history to debtor location data. Under the AVG, special requirements apply to the collection and processing of personal data, especially if the data is not directly necessary for business operations. Thus, the flower company must carefully consider which data are essential for inventory forecasting and which data can be disregarded. When processing data such as customer locations and preferences, even inadvertent over-collecting of data can lead to privacy risks.

Security Measures and Data Governance:
In addition to preventive measures such as encryption and access management, it is important to establish a robust system of data governance. Data governance includes a set of procedures and responsibilities that ensure data is managed consistently and securely. Greenzone can benefit from a clear data governance policy to ensure that all data activities are aligned with business goals and regulatory requirements.

What impact would a data-driven system have on efficiency and customer satisfaction at Greenzone?

Operational efficiency

An implementation of predictive analyses to assist in Greenzone's inventory management could significantly reduce inefficiencies. By analyzing historical sales patterns, seasonal trends, and external factors, the system is able to predict needed stock levels for upcoming periods. This may lead to reductions in product wastage, more efficient use of storage space, and ultimately lower carrying costs.

On top of that, a more accurate estimate of the required stock reduces the number of times a flower is out of stock, and with that associated waiting times caused by the need to restock.

All this ultimately leads to a reduction in waiting times, improved cash flow, and more predictable stock management.

Customer satisfaction

Improved stock management also improve criteria that determine customer satisfaction. With sales predictions, product availability improves, and thus stockout incidents decrease.

Product quality also improves, as optimized stock management results in a more efficient and faster rotation of stocks. This means the time between harvest and delivery decreases. A decrease in selling near-expiry benefits both Greenzone's direct customers, and their customers.

Results of the Research

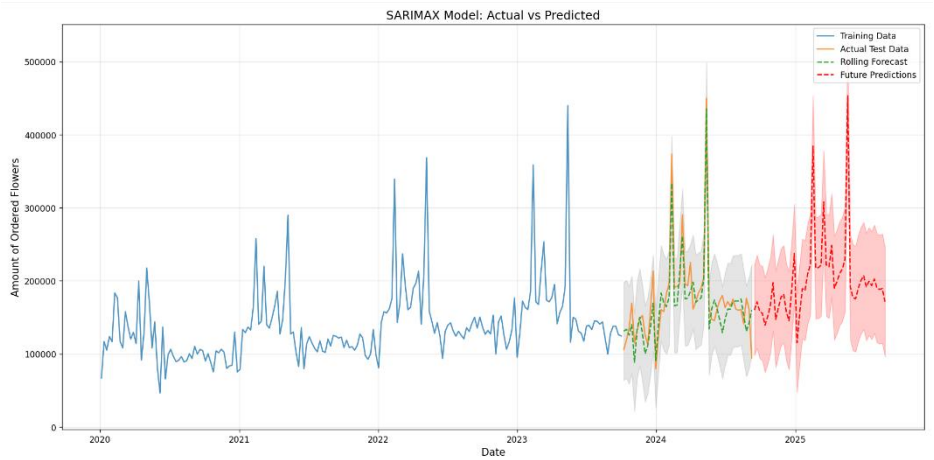
Our project has resulted in the successful development of an AI model that can predict Greenzone's future sales with a fair degree of accuracy. This model offers promising opportunities to optimize the company's inventory management and improve operational efficiency. By using this technology, Greenzone can not only significantly reduce overstocking and understocking, but also plan more strategic and targeted marketing campaigns. This dual impact - more efficient inventory management and more effective marketing - allows the company to better respond to market needs and increase customer satisfaction.

The model has been able to analyze historical sales data and from it identify trends and patterns relevant to future forecasting. This enables Greenzone to respond to peak periods and key seasonal demand cycles in a timely manner. This allows the company to deliver the right products to its customers at the right time, providing a significant competitive advantage. In addition, this contributes to a more efficient allocation of resources, saving costs and reducing waste of unsold products.

Nevertheless, we identified a key challenge during this project: the limited availability of historical data. Although the AI model performed well within the limits of the available data, this data was not sufficient to produce fully reliable and robust predictions. This lack of comprehensive and long-term data sets limited our ability to exploit the full potential of the model. Therefore, collecting more data over a longer period of time is essential to further improve the model. By creating a larger and more diverse data realm, we can understand seasonal patterns and market dynamics even better and integrate them into forecasts.

Therefore, the next step in this project is to build a solid base of historical data to further train the model. This will improve forecast accuracy and enable Greenzone to operate even more strategically. In addition, research into integrating the AI model into existing systems, such as the Qlik dashboard used by Greenzone, will be necessary. A seamless integration will ensure that employees have easy access to the predictions and insights provided by the model, allowing them to apply them directly in their day-to-day decision-making.

In short, this project has laid a strong foundation for a data-driven approach at Greenzone. Although steps are still needed to further refine and implement the model, the potential of this technology shows how AI can contribute to more efficient inventory management, improved marketing strategies and improved customer satisfaction. With further investment in data and technology, Greenzone can position itself as an innovative and forward-looking player in the competitive flower market.



Conclusion & Discussion

During our project, we developed an AI model capable of predicting future sales at Greenzone. The goal of this model is to provide insight into sales trends to improve inventory management and marketing strategies. While the model has already shown promising results, it has also identified limitations that require further improvement. In this section, we discuss key findings, limitations and recommendations for the future.

Conclusion & Discussion

The AI model developed provides a solid basis for forecasting future sales at Greenzone. It contributes to more efficient inventory management by reducing the likelihood of overstocking and understocking. In addition, the model allows the company to plan targeted marketing campaigns based on expected sales trends, promoting both cost savings and customer satisfaction.

Still, there were challenges, most notably the limited availability of historical data. This limited the accuracy and reliability of predictions. To further improve the model, collecting more data over longer periods of time is essential. Research is also needed to integrate the model into Greenzone's Qlik dashboard so that employees can easily access actionable insights.

All in all, this project has shown how AI can play an important role in optimizing business processes. By investing in additional data and technology, Greenzone can further develop as an innovative and forward-looking player in the flower market.

Future Advice

In order to optimally deploy the SARIMAX model we developed and fully utilize the benefits of a data-driven approach, we advise Greenzone to take a number of strategic steps. The success of the model depends not only on the quality of current forecasts, but also on further development and integration into business processes. Below, we outline comprehensive future advice aimed at improving the model and implementing it effectively into operational systems.

Training with Multi-Year Data

A key recommendation is to train the model with more extensive data sets that include multiple years of sales and external data. Currently, the available data volume is limited, leaving the model unable to recognize in-depth and robust seasonal patterns. By collecting historical data of at least three to five years, the model can:

- Identify seasonal trends more accurately, such as peaks around holidays or specific flower preferences by season.
- Discover long-term patterns that affect demand, such as changes in customer behaviour or market trends.
- Better analyze regional differences, which can help Greenzone target local customer preferences.

Researching Integration in Qlik

Greenzone currently uses Qlik as its dashboarding software. For a successful implementation of the SARIMAX model, it is crucial to research ways to integrate the model into this platform. The integration process requires a combination of technical and functional steps:

- Technical Implementation: Analyze how the SARIMAX model can be linked to Qlik, for example by exporting predicted values as datasets that can be automatically loaded into the dashboard. This can be done via API links or by generating data output from the model in a format such as CSV or SQL.
- Visualization Design: Ensure that the output of the model is presented comprehensibly in Qlik. Consider charts and tables that show seasonal trends, sales forecasts for specific periods, and recommendations for purchasing. Adding interactive elements, such as filters and drill-down functionality, can help employees quickly find relevant insights.
- User acceptance: Explore how best to support employees in using the new features in Qlik. This can be done by organizing training sessions and developing clear manuals. The goal is to make the system accessible to everyone, regardless of their technical background.

Data and Process Management

To ensure the long-term effectiveness of the model, a structured approach to data and process management is needed:

- Data Quality Assurance: It is essential to continuously monitor and improve data quality. This includes identifying errors, missing values and inconsistencies. An automatic data validation and cleansing tool can help with this.
- Periodic Model Updates: The model must be regularly retrained with the latest data to remain accurate. Setting up an automated process for model training and validation can make this process more efficient.
- Feedback loop: Collect feedback from employees who use the model and dashboard. This input can identify areas for improvement and further optimize the system.

Long-term strategy

In the long-term, Greenzone can take further steps to strengthen their data-driven approach:

- Exploration of Advanced Models: In addition to SARIMAX, more advanced techniques such as machine learning or deep learning can be explored, for example to create customer segmentations or model complex interactions between variables.
- Extension to Other Processes: Consider applying predictive models for marketing campaigns or logistics planning.
- Partnerships and Collaborations: Consider collaborations with data analytics firms or universities to access expertise and additional datasets.

Bibliography

IBM. (n.d.). *AI for inventory management*. IBM. Retrieved November 7, 2024, from https://www.ibm.com/think/topics/ai-for-inventory-management

Cashflow Inventory. (n.d.). *Technologies in inventory management*. Cashflow Inventory Blog. Retrieved November 7, 2024, from https://cashflowinventory.com/blog/technologies-in-inventory-management/

Shopify. (n.d.). *What is an inventory management system?* Shopify. Retrieved November 7, 2024, from https://www.shopify.com/enterprise/blog/inventory-management-system

NetSuite. (n.d.). *Inventory management*. NetSuite. Retrieved November 7, 2024, from https://www.netsuite.com/portal/resource/articles/inventory-management/inventory-management.shtml