Jurnal E-Komtek
Vol.8 No. 2(2024) pp. 566-582
https://jurnal.politeknik-kebumen.ac.id/index.php/E-KOMTEK
p-ISSN : 2580-3719 e-ISSN : 2622-3066

Clustering Analysis Approach to Enhance Inventory Management and Product Recommendations in the Ornamental Plant Industry

Muhammad Iqbal Faturohman[1], Thalia Naziha[2]

[1]Engineering Industry, Universitas Telkom, Indonesia, 53147
[2]Agricultural Industry Technology, Universitas Gadjah Mada, Indonesia, 55281

iqbalfaturohman@telkomuniversity.ac.id

https://doi.org/10.37339/e-komtek.v8i2.2142

Published by Politeknik Piksi Ganesha Indonesia

Artikel Info
Submitted:
28-11-2024
Revised:
24-12-2024
Accepted:
25-12-2024
Online first :
28-12-2024

Abstract

The ornamental plant industry has grown significantly as consumers seek to enhance living spaces with diverse plant species. This study aims to optimize inventory management and marketing strategies by applying K-Means clustering to categorize plants based on price, pot size, light requirements, care levels, and popularity. The method used is K-Means clustering, which groups plants into three clusters based on key characteristics. By analyzing these attributes, K-Means clustering identifies patterns and similarities among different plant species, allowing businesses to understand consumer preferences and inventory management better. The results identified three main clusters: Cluster 1 (moderate care, light, popularity) plants like Aglaonema require balanced stock and targeted promotion for medium-light environments. Cluster 2 (low care, light, popularity) plants such as Aglaonema Chiangmai need high stock levels and budget-friendly marketing. Cluster 3 (high care, light, popularity) plants like Alocasia demand elevated stock, premium quality, and care-focused promotion.

Keywords: *Clustering Analysis, K-Means Algorithm, Ornamental Plant*

Abstrak

Industri tanaman hias telah berkembang pesat seiring dengan meningkatnya minat konsumen untuk memperindah ruang hidup mereka dengan berbagai spesies tanaman. Penelitian ini bertujuan untuk mengoptimalkan manajemen inventaris dan strategi pemasaran dengan menerapkan K-Means clustering untuk mengkategorikan tanaman berdasarkan atribut seperti harga, ukuran pot, kebutuhan cahaya, tingkat perawatan, dan popularitas. Metode yang digunakan adalah K-Means clustering, yang mengelompokkan tanaman ke dalam tiga klaster berdasarkan karakteristik utama. Pendekatan ini memberikan wawasan berharga mengenai preferensi konsumen dan membantu dalam pengelolaan inventaris serta pemasaran yang efektif.Hasil penelitian mengidentifikasi tiga klaster utama: Klaster 1 (tanaman perawatan sedang, cahaya sedang, popularitas sedang) seperti Aglaonema, yang memerlukan stok yang seimbang dan promosi yang tepat untuk lingkungan cahaya sedang. Klaster 2 (tanaman perawatan rendah, cahaya rendah, popularitas rendah) seperti Aglaonema Chiangmai, yang membutuhkan tingkat stok tinggi dan pemasaran yang ramah anggaran. Klaster 3 (tanaman perawatan tinggi, cahaya terang, popularitas tinggi) seperti Alocasia, yang membutuhkan stok tinggi, kualitas premium, dan promosi yang fokus pada perawatan.

***Kata-kata kunci**: Analisis Klaster, Algoritma K-Means, Tanaman Hias*

1. Introduction

The ornamental plant industry has seen substantial growth as consumers increasingly seek to enhance their living spaces with diverse and attractive plant species [1], [2]. This surge in demand has introduced significant challenges for businesses operating within this sector, particularly in managing inventory effectively and developing targeted marketing strategies. To address these challenges, clustering analysis has emerged as a powerful tool for uncovering patterns and characteristics of ornamental plant products. This analytical technique segments plants based on various attributes such as sales price, product availability, pot size, light requirements, care levels, and plant popularity, thereby facilitating more efficient inventory management, optimized pricing strategies, and tailored marketing initiatives [3] of ornamental plant products. This analytical technique enables the segmentation of products based on attributes [3] such as sales price, product availability, pot size, light requirements, care levels, and plant popularity, facilitating improved inventory management, pricing strategies, and marketing initiatives.

Sales price is a critical determinant in consumer purchasing decisions [4]. Variations in price points can result in disparate demand patterns for plants [4], [5], [6]. For instance, premium-priced plants might attract a niche market segment seeking exclusivity, while more affordable options may appeal to a broader audience. Clustering analysis allows businesses to categorize plants into different price ranges, which helps manage inventory levels appropriately. Companies can devise targeted pricing strategies that align with consumer willingness to pay by understanding the demand associated with various price segments. This segmentation also aids in setting promotional prices and discounts that resonate with specific customer segments, optimizing revenue and minimizing stock imbalances.

Product availability significantly influences customer experience and inventory control [7]. Data on product availability can be leveraged to categorize plants with analogous availability levels, thus enhancing stock planning and mitigating risks associated with inventory shortages or surpluses [8], [9]. For instance, identifying patterns such as heightened demand for specific plant species during particular seasons or within distinct geographic regions can significantly inform inventory management strategies. Businesses can strategically adjust inventory levels by analyzing these demand patterns to align with fluctuating consumer preferences. This data-driven approach ensures that high-demand plants are adequately stocked to meet consumer

needs while mitigating the risk of overstocking plants with lower demand. Such targeted inventory adjustments enhance operational efficiency, allowing for a more balanced and responsive inventory system. Consequently, this method improves inventory turnover rates. It optimizes resource allocation, leading to more effective management of stock levels and enhancing customer service by ensuring the availability of sought-after products while minimizing excess inventory **[7]**.

Pot size significantly impacts plants' care requirements and inventory management's logistical aspects. Larger pots necessitate more space and different care considerations compared to smaller pots **[10]**. Clustering analysis can segment plants according to pot size, which aids in developing more effective storage solutions and logistical strategies. For instance, larger pot plants may require more substantial shelving or display units, while smaller pots might be better suited for compact shelving. This segmentation helps streamline storage operations and ensures that plants are stored and displayed to meet their specific needs, thereby enhancing the overall efficiency of inventory management.

Light requirements represent another crucial attribute affecting consumer purchasing behavior. Plants vary in light needs, ranging from direct sunlight to low-light conditions **[11]**. Categorizing plants based on their light requirements permits organizations to deliver precise and contextually relevant information to consumers, facilitating the recommendation of plant species congruent with the specific lighting conditions of their residential environments. This analytical approach refines the accuracy of plant recommendations by correlating species' light preferences with the prevalent light conditions found in various home settings. Such segmentation optimizes plant health and growth potential by ensuring that selected species are well-suited to the ambient light available in the consumer's environment. By employing comprehensive data on the light requirements of diverse plant species, businesses can effectively guide consumers towards choices that align with their lighting conditions, thereby enhancing customer satisfaction and mitigating the risk of plant failure attributed to insufficient or inappropriate lighting **[11], [12]**. This approach enhances customer satisfaction by aligning plants with the specific lighting conditions of their residential environments and mitigates the risk of plant mortality associated with inadequate lighting conditions. Furthermore, organizations can leverage this information to develop optimized in-store displays and educational materials emphasizing plants' specific light requirements. Such targeted resources facilitate informed consumer decision-making and promote the successful integration of plants into varying home

lighting scenarios, thereby contributing to improved plant health and longevity.

Care levels also influence purchasing decisions, particularly for consumers with limited time or expertise in plant care [11]. Clustering analysis enables the systematic categorization of plants based on their care requirements, thus facilitating the selection of plant species that correspond with consumers' available time and expertise. By segmenting plants into distinct categories, such as low-maintenance and high-maintenance, this approach supports the creation of specialized care guides and instructional resources tailored to the specific needs of each plant category. This stratification enhances the precision of care recommendations provided to consumers, improving overall customer satisfaction. Additionally, aligning plant choices with users' capabilities and constraints effectively reduces the risk of plant neglect and subsequent loss due to inadequate care. The resulting targeted care information helps ensure that consumers are equipped with the necessary knowledge to maintain plant health, promoting plant longevity and minimizing the incidence of plant mortality.

Plant popularity is a significant metric for gauging consumer demand and interest within the market. Plants that exhibit high popularity generally demonstrate elevated sales volumes and are preferentially selected by consumers. Utilizing clustering analysis to categorize plants according to their popularity enables firms to delineate distinct market segments and understand varying levels of consumer preference. This segmentation facilitates the refinement of marketing strategies by aligning promotional activities with the observed popularity trends. Through this method, businesses can implement targeted marketing campaigns, optimize resource allocation, and tailor their product offerings to better meet the preferences of different consumer segments. This approach enhances the effectiveness of marketing strategies and maximizes engagement and sales potential by addressing the specific interests and demand patterns associated with popular plant species **[13]**. Highly popular plants typically demonstrate increased sales rates and heightened consumer preference. Businesses can strategically refine their marketing approaches to align with consumer demand by applying clustering analysis to categorize plants according to their popularity. Plants with elevated popularity can strategically benefit from targeted promotional activities, such as specialized marketing campaigns, prominent in-store displays, or time-limited discounts, to further amplify consumer attraction. Conversely, plants with lower popularity may necessitate additional marketing interventions or pricing adjustments to augment their market appeal. This targeted marketing methodology allows for aligning promotional strategies with observed consumer preferences, optimizing marketing efforts'

effectiveness and enhancing overall sales performance.

Applying clustering analysis to ornamental plant product data provides profound insights that enhance inventory management, marketing strategies, and overall customer experience. Businesses can achieve a more nuanced understanding of market dynamics and consumer preferences by systematically categorizing plants based on price, availability, pot size, light requirements, care levels, and popularity. This methodological approach facilitates informed decision-making by enabling companies to align their inventory practices with demand patterns, establish pricing strategies that reflect market segments, and offer personalized recommendations that cater to specific consumer needs. Additionally, clustering analysis supports identifying and addressing challenges and opportunities within the ornamental plant sector, thereby optimizing operational efficiency and strategic planning. Through this detailed segmentation, businesses are better positioned to manage stock levels effectively, adjust prices dynamically, and tailor marketing efforts, ultimately enhancing customer satisfaction and maximizing competitive advantage in the market.

2. Method

This study employs a quantitative approach with clustering analysis approach using K-Means method to analyze data on ornamental plant products. This choice is informed by K-Means' capability to partition the dataset into distinct, non-overlapping clusters, which is essential for delineating meaningful groupings within the data **[14], [15]**. The K-Means algorithm will be employed to categorize the data by identifying and grouping similarities across multiple attributes, such as sales price, product availability, pot size, light requirements, care levels, and popularity. This algorithm operates through an iterative optimization process, wherein it continuously adjusts cluster centroids to minimize the variance within each cluster and maximize the variance between clusters. This iterative refinement ensures that each resultant cluster exhibits high internal homogeneity and coherence concerning the specified attributes. By leveraging this method, the K-Means algorithm will systematically delineate clusters that accurately reflect distinct groupings of product characteristics, thereby facilitating a more precise and nuanced analysis of the ornamental plant data **[14]**. The research design includes the following steps which can be seen in **Figure 1.**

Figure 1. The Research Design

2.1. Data Collection

Data for this study will be sourced from multiple internal channels, including the inventory management system, sales records, customer feedback surveys, and other pertinent data sources. The objective is to compile a comprehensive dataset encompassing several critical attributes of ornamental plant products. Specifically, the dataset will encompass information on the sales price of each product, its availability status, the pot's dimensions in which it is housed, the light requirements essential for its optimal growth, the level of care required, and its popularity. This multifaceted dataset will enable a nuanced understanding of the products, facilitating robust clustering analysis. The data can be found in **Table 1.**

Table 1. Ornamental Plant Data

ID	Name	Price (000)	Availability	Pot size (cm)	Light requirements	Care levels	Popula-rity
1	Sirih Gading	150	50	20	Medium	Easy	7
2	Scindapsus Pictus Exocita	200	30	25	High	Medium	8
3	Scindapsus Moonlight	180	40	22	Medium	Easy	6
4	Monstera Borsigiana	250	20	30	High	Medium	9
5	Black Lipstick	120	60	18	Low	Easy	5
6	Alocasia Silver	160	35	23	Medium	Medium	7
7	Aglonema Chiangmy Balon	140	45	21	Low	Easy	6
8	Alocasia Sanderiana	170	25	24	High	Medium	8
9	Aglonema Legacy	190	30	22	Medium	Medium	7
10	Alocasia Reginae	130	50	20	Low	Easy	6
11	Anthurium Crysatalli-num	220	15	25	High	Difficult	8
12	Aglonema Red Brju	140	40	21	Low	Easy	6
13	Alocasia Black Velvet	200	20	26	Medium	Medium	7
14	Keladi Black Magic	250	10	30	High	Difficult	9
15	Begonia	110	55	18	Medium	Easy	5
16	Begonia Keong	130	45	19	Medium	Easy	6
17	Sygonium Neon	160	40	22	Medium	Medium	7
18	Aglonema Red Majesty	150	50	21	Low	Easy	7
19	Aglonema Suksom	180	30	23	Medium	Medium	6
20	Scindapsus	200	25	24	Medium	Easy	7
21	Calathea Silverplate	170	35	22	Medium	Medium	6
22	Aglonema Golden Hope	140	50	21	Low	Easy	6

ID	Name	Price (000)	Availability	Pot size (cm)	Light requirements	Care levels	Popula-rity
23	Aglonema Big Papa	160	40	22	Medium	Medium	7
24	Aglonema Red Anjamani	180	30	23	Medium	Medium	7

2.2. Data Preparation

The collected data will thoroughly be cleaned to identify and rectify any missing or inconsistent entries. This step ensures that the data is accurate and reliable for analysis. The data will be transformed into a format suitable for clustering analysis. This involves normalizing the data to adjust for discrepancies caused by differing scales among the attributes. Preprocessing is essential to ensure that each attribute contributes fairly to the clustering process, thus avoiding potential biases.

2.3. Clustering Analysis

The K-Means clustering algorithm will be employed to effectively segment ornamental plant products. K-Means was chosen due to its ability to partition data into distinct clusters based on similarity, making it highly effective for identifying patterns and structuring data into meaningful groups. K-Means clustering is also widely used due to its simplicity and efficiency in handling large datasets **[16]**. This study utilizes the Orange software for clustering, which provides an intuitive and interactive data analysis platform **[17]**. Orange's user-friendly interface and robust analytical capabilities facilitate efficient execution of clustering processes, allowing researchers to categorize ornamental plant products based on a range of attributes in a comprehensible and manageable manner **[17]**.

The use of K-Means is particularly urgent and appropriate for this study due to its efficiency in handling large datasets and its capacity to identify well-separated clusters, which are essential for effective market segmentation. The algorithm's ability to minimize within-cluster variance while maximizing between-cluster variance makes it a powerful tool for uncovering underlying patterns in the data that may not be immediately apparent. The resulting clusters will undergo rigorous evaluation to assess their significance and interpretability after the clustering process. This evaluation is critical to ensure that the clusters are distinct and substantively meaningful. The goal is to provide actionable insights that can inform strategic decision-making in inventory management [18], pricing [15], and marketing [19]. This assessment will validate that the K-Means clustering has effectively captured the underlying

patterns in the data, thereby supporting the development of well-defined and strategic product segments [20]. The urgency of employing K-Means lies in its ability to deliver precise and actionable insights, which are crucial for optimizing business strategies and enhancing the efficiency of decision-making processes in the ornamental plant market [20].

3. Results and Discussion

3.1 Result

In this research, determining the optimal number of clusters utilizing silhouette score is pivotal for ensuring that the clustering outcomes derived from the K-Means algorithm accurately capture the underlying data structure **[21]**. A higher silhouette score indicates superior cluster quality, reflecting both strong internal cohesion within each cluster and clear separation between distinct clusters. Internally cohesive clusters exhibit high similarity among data points, suggesting that the elements within each cluster are closely related and homogeneous. Conversely, distinct separation between clusters implies that the boundaries between different clusters are well-defined, minimizing overlap and enhancing the differentiation of clusters. Such a silhouette score suggests that the chosen number of clusters effectively represents the underlying structure of the data, capturing its intrinsic patterns and relationships. In essence, a higher silhouette score validates the adequacy of the clustering solution, demonstrating that the clusters accurately reflect the data's natural groupings and facilitate meaningful and actionable insights. Utilizing orange software for clustering analysis, the optimal cluster count was identified as 3, corresponding to the highest silhouette score attained, as illustrated in Figure 1.

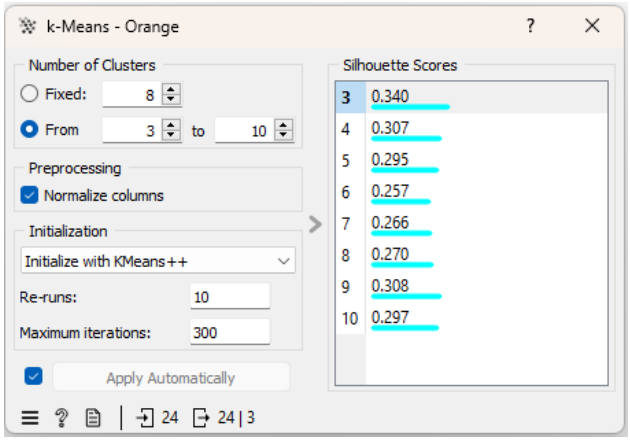

Figure 2. Shilloute score

Based on the silhouette score analysis, 3 clusters were delineated using the K-Means algorithm, each exhibiting distinct characteristics. Clusters are established by analyzing the proximity between data points across various variables, where the similarity of their attribute values determines proximity. The spatial relationships between the resulting clusters are depicted in Figure below, which illustrates these relationships through a scatter plot representation.

Figure 3. Scatter plot for stock availability

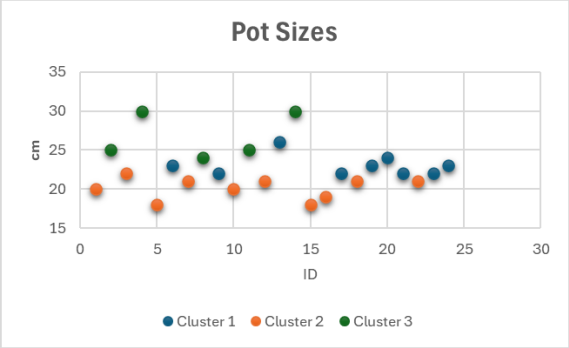

Figure 4. Scatter plot for pot sizes

Figure 5. Scatter plot for light levels

Figure 6. Scatter plot for care levels

Figure 7. Scatter plot for popularity

The specific attributes of these clusters are illustrated in **Table 2**.

Table 2. Cluster formed

Cluster	ID
C1	6, 9, 13, 17, 19, 20, 21, 23, 24
C2	1, 3, 5, 7, 10, 12, 15, 16, 18, 22
C3	2, 4, 8, 11, 14

3.2. Discussion

Based on the results, three primary clusters have been identified, categorizing ornamental plant products based on the analyzed attributes. Each cluster represents a group of products with similar characteristics, determined by applying the K-Means clustering algorithm using orange software. Below is a summary of each cluster.

Cluster 1

The analysis identifies Cluster 1 as encompassing plants that require pots with diameters ranging from 22 to 26 cm, necessitate moderate light conditions for optimal growth, and present

a medium level of care complexity. The plants in this cluster are rated with a popularity score between 6 and 7 out of 10, indicating a moderate appeal among horticulturists and plant enthusiasts. Notably, four of the twelve plants in Cluster 1 belong to the genus *Aglaonema*. According to **[22]**, *Aglaonema* thrives under shaded environments that provide moderate light intensities, typically between 1000 and 2500 foot-candles (fc) **[23]**. This implies the necessity for a shading net with 70% to 90% coverage to protect the plants from excessive direct sunlight, which can lead to leaf burn. *Aglaonema* exhibits adaptive characteristics such as leaf positioning and forming angles less than 45°, which help mitigate light exposure **[22]**. Given its moderate light requirements, care for *Aglaonema* involves specific practices: watering should be done every 2 to 3 days using a sprayer to distribute water evenly, and the plant prefers daytime temperatures between 27 and 30°C and nighttime temperatures from 21 to 24°C **[22]**.

In addition to *Aglaonema*, Cluster 1 includes two species from the genus *Alocasia*, which are native to Indonesia. *Alocasia* typically requires a light intensity of about 400 fc and benefits from a 60% shading net. The ideal temperature range for these plants is between 20 and 25°C, with a humidity level of 75%. Although this genus is relatively popular in the ornamental plant market, additional specific popularity metrics are not provided.

Other plants in Cluster 1 are *Calathea*, *Scindapsus*, and *Syngonium*. *Calathea* originates from the tropical Americas and is sensitive to intense sunlight, which can cause leaf curling. It prefers light intensities between 1500 and 2000 fc and requires a 75% shading net for optimal growth. *Scindapsus* thrives in bright, indirect light and must be maintained within a temperature range of 18 to 29°C, with at least 50% humidity to prevent leaf scorching. *Syngonium* prospers under indirect light and needs 40-50% humidity and temperatures ranging from 15 to 30°C to avoid leaf burn (Anonim, 2021). Collectively, the plants in Cluster 1, including *Aglaonema*, *Alocasia*, *Calathea*, and *Syngonium*, share common needs in terms of light intensity and temperature for optimal growth, aligning with the cluster's criteria for moderate light requirements, medium care difficulty, and appropriate pot sizes.

Cluster 2

This cluster includes ornamental plants with substantial stock levels, such as Aglonema Chiangmy Balon, Aglonema Golden Hope, Aglonema Red Brju, Aglonema Red Majesty, Alocasia Reginae, Begonia, Begonia Keong, Black Lipstick, Scindapsus Moonlight, and Sirih Gading. These plants are noted for their low popularity, which often corresponds with high stock availability and lower prices **[24]**. This lower popularity is typically linked to high stock levels

[24] due to market demand and supply dynamics, allowing for reduced price points and greater accessibility for budget-conscious consumers. Reduced consumer preference for these plants can be attributed to several factors. This cluster is characterized by plants that need minimal maintenance, can thrive in low light, are not highly sought after, and are suitable for small pots.

These plants are ideal for low-light indoor environments, such as shaded rooms or spaces with limited natural light. Their low-maintenance nature means they do not require frequent care or special conditions, making them suitable for individuals who prefer easy-to-care-for plants. Specifically, Aglonema Chiangmy Balon, Aglonema Golden Hope, Aglonema Red Brju, and Aglonema Red Majesty fit well within this cluster due to their low care needs [25], [26] and tolerance for low light [25], though their popularity varies. Apart from several types of aglonema, cluster 2 also consists of begonia genus. These plants generally don't need to pruning and watering too often, so they are quite easy to care for. This group also consists of genus Epipremnum, namely Sirih Gading which grows well both in low light conditions of indirect light and tolerant of lower light conditions but will grow more slowly. Therefore, this cluster contains plants that are easy to care for (Anonim, 2021).

Cluster 3

This cluster comprises ornamental plants with high maintenance demands, bright light requirements, significant popularity, and the need for larger pot sizes. Alocasia sanderiana and Anthurium crystallinum exemplify these traits with their needs for high humidity [27], stable temperatures [28]Bright, indirect light requires sizable pots to support their root systems. Keladi Black Magic also fits the cluster due to its intensive care needs, preference for bright, indirect light, and large pot requirement. Monstera borsigiana and Scindapsus pictus Exotica are also included, though they have lower maintenance demands. Despite their easier care, both meet the criteria for high light [29], large pot sizes [29], and significant popularity. Collectively, these plants align with the cluster's parameters, demonstrating variations in care intensity while fulfilling the overarching requirements.

This cluster encompasses ornamental plants distinguished by their high maintenance needs, preference for bright light, substantial popularity, and requirement for larger pot sizes. Alocasia sanderiana and Anthurium crystallinum are prime examples, both demanding high humidity [27], stable temperature conditions [28], and bright, indirect light, and large pots to support their expansive root systems. Keladi Black Magic aligns with the cluster's characteristics due to its intensive care requirements, including high humidity and precise watering practices,

while thriving under bright, indirect light and needing a large pot. Monstera borsigiana and Scindapsus pictus Exotica, although requiring less intensive care, still fit within the cluster by meeting the criteria for high light levels and large pot sizes. Monstera borsigiana is adaptable to varying light conditions and Scindapsus pictus Exotica is valued for its aesthetic foliage and ease of care. Collectively, these plants reflect a spectrum of care intensity but share common traits of high maintenance demands, substantial light requirements, large pot sizes, and notable popularity. This cluster illustrates the diversity within high-maintenance ornamental plants, demonstrating uniformity and variability in their care and cultivation needs.

3.3. Implications in Inventory Management and Product Recommendations

1. Cluster 1 (Moderate Care, Moderate Light, Medium Popularity)

In managing inventory, plants categorized under Cluster 1, including Aglaonema and Calathea, necessitate pots with diameters ranging from 22 to 26 cm and thrive under moderate light conditions. Due to their intermediate level of popularity, it is essential to maintain a balanced stock to reconcile availability with demand. Given their moderate care requirements, stock levels should be carefully managed to prevent overstocking and stockouts **[30]**. Regular inventory assessments will facilitate the optimization of stock levels per seasonal demand and sales trends. Regarding product recommendations, it is essential to prioritize promoting plant species such as Aglaonema and Calathea for environments characterized by moderate lighting conditions. These species are particularly well-suited to indoor settings requiring moderate care levels, making them ideal for consumers seeking plants that thrive in such conditions. Emphasis should be placed on highlighting the adaptability of Aglaonema and Calathea to medium-light environments and their resilience in low-maintenance settings. This targeted promotion will not only align with the specific lighting needs of potential buyers but also underscore the practical benefits and ease of care associated with these plants. By effectively communicating these attributes, businesses can enhance consumer satisfaction and support informed decision-making, thereby optimizing the alignment of plant selections with their customers' environmental conditions and care preferences. Providing educational resources on their care requirements and optimal conditions will assist customers in understanding their needs, thereby reducing return rates. Marketing materials should accentuate the adaptability of these plants to various pot sizes and indoor environments **[31]**.

2. Cluster 2 (Low Care, Low Light, Low Popularity)

In inventory management, the cluster encompassing plant species such as Aglaonema Chiangmai Balon and Scindapsus Moonlight is distinguished by its inclusion of varieties with low maintenance requirements and compatibility with low-light environments. The strategic maintenance of elevated stock levels for these species is advantageous due to their relatively lower popularity and cost-effectiveness, which aligns with the preferences of budget-conscious consumers. Effective inventory management practices should prioritize ensuring that stock levels are sufficient to meet consumer demand while concurrently avoiding the pitfalls of excessive inventory accumulation. This balanced approach not only optimizes resource allocation and minimizes holding costs but also enhances the overall efficiency of inventory management by aligning stock levels with the economic and practical considerations of the target consumer segment. Regular promotions or discounts can facilitate inventory turnover and enhance sales performance [32]. Regarding product recommendations, these plants should be marketed as ideal for beginners or individuals seeking low-maintenance solutions. Highlight their adaptability to low-light conditions and minimal care requirements. Position them as both affordable and practical choices for compact spaces. Additionally, provide detailed guidance on their care and optimal placement to help customers optimize their experience with these plants.

3. Cluster 3 (High Care, Bright Light, High Popularity)

In managing inventory for Cluster 3, which includes plants such as Alocasia sanderiana and Monstera borsigiana, attention must be given to their requirement for larger pots and bright light. These plants, recognized for their high maintenance requirements and substantial popularity, necessitate a strategic approach emphasizing the maintenance of elevated stock levels and the assurance of superior product quality. Given their significant consumer demand, it is crucial to implement inventory strategies that prioritize adequate stock replenishment to avoid stockouts and fulfill market demand consistently. Concurrently, ensuring high standards of product quality is essential to meet consumer expectations and sustain the plants' popularity. This involves rigorous quality control measures to maintain plant health, appearance, and overall condition. By integrating these practices, businesses can effectively manage the inventory of high-maintenance, highly popular plants, thereby optimizing customer satisfaction and reinforcing market presence. This comprehensive strategy not only addresses the challenges associated with high-demand products but also

supports long-term operational efficiency and brand reputation. Regular inventory assessments are crucial to align stock with high demand and adjust levels as needed to meet consumer expectations [33]. In terms of product recommendations, these plants should be marketed as premium options suitable for dedicated horticulturalists capable of managing their high maintenance needs. Emphasize their aesthetic value and their suitability for well-lit indoor environments. Provide detailed care guidelines and highlight the necessity of larger pots. Consider the development of bundle offers or premium packages that include care accessories, thereby enhancing customer satisfaction [34] and supporting optimal plant growth [35].

4. Conclusion

In this study, K-Means clustering was utilized to categorize ornamental plants into three distinct clusters based on their care requirements and popularity, significantly enhancing inventory management and marketing strategies. Cluster 1 includes plants such as Aglaonema and Calathea, which thrive in moderate light and medium-sized pots. These plants require balanced inventory levels due to their moderate popularity and care needs, necessitating regular stock reviews to align supply with demand. Cluster 2 features low-maintenance plants like Aglaonema Chiangmai Balon and Scindapsus Moonlight, ideal for low-light environments and small pots. Despite their lower popularity, these plants should be stocked in higher quantities, with promotions and targeted marketing strategies used to boost their appeal and sales. Finally, Cluster 3 comprises high-maintenance plants such as Alocasia sanderiana and Monstera borsigiana, which need bright light and large pots. These popular plants demand high stock levels and premium marketing efforts to meet their significant popularity and specific care requirements. The K-Means clustering algorithm proved effective in grouping plants based on shared characteristics, leading to more precise decision-making and improved operational efficiency in the ornamental plant market. By identifying distinct clusters, the algorithm enables tailored inventory management and marketing strategies, ultimately enhancing customer satisfaction and business profitability.

References

[1] C. Chwoyka, D. Linhard, T. Durstberger, and J. G. Zaller, "Ornamental plants as vectors of pesticide exposure and potential threat to biodiversity and human health," *Environ. Sci. Pollut. Res.*, vol. 31, no. 36, pp. 49079–49099, 2024, doi: 10.1007/s11356-024-34363-x.

[2] A. Patel *et al.*, "Ornamental plant breeding is tools for new generation," *Int. J. Adv. Biochem. Res.*, vol. 8, no. 3, pp. 368–372, 2024, doi: 10.33545/26174693.2024.v8.i3e.742.

[3] M. F. Nur and A. Siregar, "Exploring the Use of Cluster Analysis in Market Segmentation for Targeted Advertising," *IAIC Trans. Sustain. Digit. Innov.*, vol. 5, no. 2, pp. 158–168, 2024, doi: 10.34306/itsdi.v5i2.665.

[4] A. R. Syamsuri, K. Sinaga, Y. Afrina, R. F. Ananda, and A. R. A. Harahap, "Effect of Variation of Products and Prices on Consumer Purchase Decisions," *J. Bisnis Mhs.*, vol. 2, no. 2, pp. 174–182, 2022, doi: 10.60036/jbm.v2i2.38.

[5] I. Hustić and I. Gregurec, "The influence of price on customer's purchase decision," *Cent. Eur. Conf. Inf. Intell. Syst.*, pp. 1–6, 2015, [Online]. Available: http://www.ceciis.foi.hr/app/public/conferences/1/ceciis2015/papers/754.pdf

[6] E. Azis and Hapzi Ali, "Literature Review Purchasing Decisions: Price Analysis, Online Consumer Reviews and Consumer Trust," *Int. J. Adv. Multidiscip.*, vol. 2, no. 3, pp. 772–781, 2023, doi: 10.38035/ijam.v2i3.372.

[7] E. Calvo, R. Cui, and L. Wagner, "Disclosing Product Availability in Online Retail," *Manuf. Serv. Oper. Manag.*, vol. 25, Oct. 2020, doi: 10.1287/msom.2020.0882.

[8] K. Liu, L. Yao, and M. Zhang, "The Influence of Availability Bias in Marketing Strategy on People's Shopping," *Highlights Business, Econ. Manag.*, vol. 10, pp. 99–105, May 2023, doi: 10.54097/hbem.v10i.7941.

[9] H. Lyu, "Research on Applications of Availability Heuristics," *Adv. Econ. Manag. Polit. Sci.*, vol. 21, pp. 165–169, Sep. 2023, doi: 10.54254/2754-1169/21/20230249.

[10] M. T. Islam, F. Arshad, I. Hossain, R. A. Kanta, I. Shaum, and D. Uddin, "POT SIZE ON COLE CROPS PRODUCTIVITY IN ROOFTOP GARDENING," *Int. J. Bus. Soc. Sci. Res.*, vol. 11, pp. 37–41, Feb. 2024, doi: 10.55706/ijbssr11208.

[11] P. C. Tung and H. M. Tu, "Key Factors and Personal Influences on Consumer Consideration in Online Potted Plant Purchases," *HortScience*, vol. 59, no. 7, pp. 1027–1032, 2024, doi: 10.21273/HORTSCI17788-24.

[12] M. J. Knuth, B. K. Behe, A. Rihn, and C. R. Hall, "Effects of Benefits Messaging on Consumer Purchasing of Plants," *HortScience*, vol. 58, no. 5, pp. 481–487, 2023, doi: 10.21273/HORTSCI16993-22.

[13] M. Kim, S. Yun, and T. Chang, "An Analysis of Preference for Potted Houseplant Products Using a Conjoint Analysis Method for the Development of Pet Plant Products," *J. People, Plants, Environ.*, vol. 26, no. 4, pp. 283–294, 2023, doi: 10.11628/ksppe.2023.26.4.283.

[14] M. N. Burhanuddin Balit and F. S. Utomo, "K-Means Algorithm To Determine Marketing Strategy At Codeverse Computer Accessories Store," *JURTEKSI (Jurnal Teknol. dan Sist. Informasi)*, vol. 10, no. 2, pp. 395–402, 2024, doi: 10.33330/jurteksi.v10i2.3064.

[15] Y. Pratama, E. Sulistianingsih, N. N. Debataraja, and N. Imro'ah, "K-Means Clustering dan Mean Variance Efficient Portfolio dalam Portofolio Saham," *Jambura J. Probab. Stat.*, vol. 5, no. 1, pp. 24–30, 2024, doi: 10.37905/jjps.v5i1.20298.

[16] A. Naufal, M. Fadhil, and . W., "Clustering and Financial Performance Analysis of Indonesian Coal Mining Industry Stock Prices," *J. Teknol. Dan Sist. Inf. Bisnis*, vol. 6, no. 1, pp. 20–28, 2024, doi: 10.47233/jteksis.v6i1.1081.

[17] F. S. Cahyaningrum, I. A. S. K. Dewi, N. Riwibowo, and T. F. Tama, "Evaluation of Distance Measurement Using Complete Linkage Method," *bit-Tech*, vol. 6, no. 2, pp. 167–175, 2023, doi: 10.32877/bt.v6i2.1045.

[18] Chandra Mohini C.P and V. Raghavendran, "Applying K Means Clustering Techniques on Retail Shop," *Int. J. Adv. Res. Sci. Commun. Technol.*, pp. 616–623, 2024, doi: 10.48175/ijarsct-19084.

[19] Baiq Nikum Yulisasih, H. Herman, and S. Sunardi, "K-Means Clustering Method For Customer Segmentation Based On Potential Purchases," *J. ELTIKOM*, vol. 8, no. 1, pp. 83–90, 2024, doi: 10.31961/eltikom.v8i1.1137.

[20] A. U. Narestami and D. Suhartono, "Implementation of K-Means Algorithm to Determine Marketing Strategy," vol. 8, no. April, pp. 1200–1208, 2024, doi: 10.30865/mib.v8i2.7335.

[21] H. Mulyani, R. Setiawan, and H. Fathi, "Optimization of K Value in Clustering Using Silhouette Score (Case Study: Mall Customers Data)," *J. Inf. Technol. Its Util.*, vol. 6, pp. 45–50, Dec. 2023, doi: 10.56873/jitu.6.2.5243.

[22] L. I. Haryanto, Sukrianto, F. A. Maulana, and M. Ulum, "Keragaan dan Pendapatan Usahatani Tanaman Hias Aglaonema di masa New Normal," *Semin. Nas. Penelit. LPPM UMJ*, pp. 1–11, 2022, [Online]. Available: http://jurnal.umj.ac.id/index.php/semnaslit

[23] F. Jasmine, R. M. Hartati, and E. Firmansyah, "Pengaruh Intensitas Penyinaran dan Komposisi Media Tanam terhadap Pertumbuhan Aglaonema Varietas Dud Unyamanee," *AGROISTA J. Agroteknologi*, vol. 7, no. 1, pp. 18–25, 2023, doi: 10.55180/agi.v7i1.430.

[24] H. Mujiati, "Jurnal Bianglala Informatika Vol 3 No 2 September 2015 – http://lppm3.bsi.ac.id/jurnal," vol. 3, no. 2, pp. 10–18, 2015.

[25] K. Balfour, D. Greco, R. Gridzak, G. Piggott, B. Schamp, and L. Aarssen, *Smaller species experience mild adversity under shading in an old-field plant community*. 2021. doi: 10.22541/au.163254488.83050416/v1.

[26] S. V Holalu, S. K. Reddy, and S. A. Finlayson, "Low Red Light:Far Red Light Inhibits Branching by Promoting Auxin Signaling," *J. Plant Growth Regul.*, vol. 40, no. 5, pp. 2028–2036, 2021, doi: 10.1007/s00344-020-10253-7.

[27] D. M. Saragi, F. Hamami, and T. Mulyana, "Implementasi Logika Fuzzy Untuk Pendukung Keputusan Sistem Penyiraman Otomatis Tanaman Anthurium," *J. Sist. Komput. dan Inform.*, vol. 4, no. 1, p. 146, 2022, doi: 10.30865/json.v4i1.4895.

[28] W. Elibox and P. Umaharan, "Genetic basis for productivity in anthurium andraeanum hort," *HortScience*, vol. 49, no. 7, pp. 859–863, 2014, doi: 10.21273/hortsci.49.7.859.

[29] C.-Y. Chang, W.-C. Tang, and C.-C. Chu, "First Report of Dickeya dadantii Causing Bacterial Soft Rot of Scindapsus pictus in Taiwan," *Plant Dis.*, vol. 107, Mar. 2023, doi: 10.1094/PDIS-12-22-2885-PDN.

[30] M. D. A. Syahputra, H. Santoso, and F. H. Sibarani, "Implementasi Sistem Pengelolaan Persediaan dengan Algoritma FIFO Pada Gudang Sparepart Sepeda Motor," *J. Teknol. Dan Sist. Inf. Bisnis*, vol. 6, no. 1, pp. 167–176, 2024, doi: 10.47233/jteksis.v6i1.1126.

[31] J. Brennan, "Do potted-plants improve the indoor environment?," p. 160, 2011, [Online]. Available: file:///C:/Users/Shaimaa/Downloads/02Whole.pdf

[32] N. P. D. Pramesti, T. Limansyah, and D. Lesmono, "a Mathematical Model With Inventory- and Selling Price-Dependent Demands Considering All-Units Discount and Carbon Emission," *BAREKENG J. Ilmu Mat. dan Terap.*, vol. 18, no. 1, pp. 0129–0140, 2024, doi: 10.30598/barekengvol18iss1pp0129-0140.

[33] R. Muzawi, T. Tashid, and M. Nasution, "Sistem Monitoring Ketersediaan Bahan Baku Cor Beton Menggunakan Metode Market Basket Analysis," *J. Teknol. Dan Sist. Inf. Bisnis*, vol. 1, no. 2, pp. 1–7, 2019, doi: 10.47233/jteksis.v1i2.39.

[34] M. Levens, "Enhancing the Value of Lifestyle Bundles," *Econ. Cult.*, vol. 16, no. 1, pp. 1–7, 2019, doi: 10.2478/jec-2019-0001.

[35] J. G. Straeter and P. Fantz, "(12) Patent Application Publication (10) Pub. No.: US 2004/0060235 A1," vol. 1, no. 19, 2004.