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Barriers Affecting Cut Flower Transportation in India - Using AHP and FAHP Technique

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ABSTRACT
The air cargo transportation of cut flowers plays a fundamental part in the floriculture trade, facilitating swift and economical delivery of high-value flowers to markets worldwide. However, numerous barriers pose challenges to the successful transportation of cut flowers by air cargo. These barriers encompass regulatory compliance, quality control, temperature regulation, flight availability, and frequency, transportation costs, transit time, handling procedures, and safety and security measures. Overcoming these barriers necessitates meticulous attention to quality control, adherence to regulations, proper handling and storage protocols, and efficient logistics and transportation planning. By effectively addressing these barriers, transportation providers can enhance the quality and reliability of flower transportation via air cargo, leading to increased industry profitability and improved access to fresh flowers for consumers. These restrictions must be skillfully managed to develop the floriculture enterprise.

Keywords – Air Cargo , Barriers , Cut-Flowers , AHP and FAHP

INTRODUCTION

Flowers hold a profound significance in human communication, serving as powerful symbols of love, care, and compassion. However, to bring these heartfelt messages to life, flowers must navigate a complex network of climate-controlled supply chains, spanning vast distances from farms worldwide to local florists. Given their perishable nature and the imperative of swift transportation, air cargo plays a vital role in facilitating this intricate commerce. Air cargo is indispensable in ensuring that these delicate blooms reach their destinations promptly, enabling individuals to convey their emotions through the beauty and fragrance of fresh flowers.

Cut flower transportation by air cargo has emerged as a pivotal component of the global floral industry, enabling growers and suppliers to efficiently transport and deliver fresh blooms to markets around the world. The demand for high-quality, exotic flowers has fueled the need for a reliable and rapid transportation method, making air cargo an indispensable mode of transport. By harnessing the advantages of air transportation, such as speed, precision, and temperature control, the industry can ensure the preservation of delicate blooms, extending their vase life and enhancing their market value. This introduction explores the significance of cut flower transportation by air cargo, highlighting its advantages, challenges, and the critical role it plays in meeting the growing international demand for exquisite floral arrangements.

Due to the perishable nature of goods, particularly perishables, it is common to implement a cold-supply chain to ensure product integrity. This entails timely harvesting of the items at their optimal stage, transportation in small, temperature-controlled containers, and storing at appropriate locations for transportation to consumers. Except for expenditures in storage facilities, the perishable value chain mainly follows a forward integration concept. The supply chain's quality and related labor have improved as the floriculture industry moved towards greater value-added products. For instance, Kenya has shifted its focus to highly-priced boutonnieres, reflecting this evolution (Kuiper, G., & Gemählich, A. 2017). Large freight forwarders majorly contribute to the effective functioning of perishable cold chains, as highlighted by Babalola et al. (2011). Timely transportation is essential in preserving the freshness of perishable goods, as delays can result in product loss, and excessive storage time incurs additional costs due to reduced shelf life. In many cases, the local forwarders that own reefer trucks and facilities are directly linked to aviation. These small forwarders frequently have connections to bigger international businesses involved in the global supply chain. This integration allows for economies of scope and density, enabling cost efficiencies and ensuring quality control throughout the cold chain process.

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The revenue generated from flower bouquet exports across nations amounted to $8.4 billion in 2020. Projections indicate a prospective growth of approximately 6.3% in the global cut flowers market over the upcoming five years, with the market size anticipated to increase from $42.4 billion in 2019 to $57.4 billion in 2024.

The top 5 exporters of flower bouquet-related goods were the Netherlands, Colombia, Ecuador, Kenya, and Ethiopia, accounting for 84% of total overseas sales. With shipments totaling $4.8 billion, or 56.9% of the global total, European nations sold the most cut flowers abroad in 2020 in terms of monetary value.

The Indian floriculture industry has experienced steady growth in recent years, with air cargo transportation playing a pivotal role as a preferred mode of transport. The export of flowers from India using air cargo has experienced a consistent upward trend, with a primary focus on the United States, the United Kingdom, and the Middle East markets. Key airports in India, such as Bengaluru, Mumbai, Delhi, Chennai, Kolkata, and Hyderabad, are instrumental in facilitating flower exports through air cargo. Notable varieties of cut flowers exported from India via air cargo include roses, carnations, gerbera, and orchids. Utilizing air cargo for flower transportation offers several advantages, including quicker transit times, extended flower shelf life, and enhanced quality control. Nonetheless, the floriculture industry in India faces significant challenges concerning air cargo transportation, such as high transportation costs, inadequate packaging and handling facilities, and limited coordination among supply chain stakeholders. Addressing these challenges is crucial for the sustained development and competitiveness of the Indian floriculture industry.

Study Objective

The main purpose of the paper is to apply both the Analytical Hierarchical Process (AHP) and Fuzzy Analytical Hierarchical Process (FAHP) methods to rank the identified challenges in local cut-flower transportation by examining loads of vectors. The research seeks to achieve the below-mentioned goals:

1. Barrier's classification: Through rigorous analysis and examination, the study aims to identify the critical obstacles that impact the smooth functioning of the cut-flowers transportation supply chain.
2. Application of Multicriteria Methods: The study aims to apply multicriteria methods, specifically AHP and FAHP, to classify barriers. By utilizing these methodologies, the study will systematically evaluate and arrange the barriers. This will provide valuable insights into understanding the significance of each barrier and aid in decision-making processes related to mitigating their effects.

The study aims to provide valuable recommendations for addressing the identified barriers, ultimately enhancing the overall efficiency and performance of the industry.

Literature Review

The floriculture market operates on a worldwide scale, and competition among producers and exporters is intense. To access distant and lucrative markets, efficient logistics and effective postharvest technologies are essential. The floriculture industry relies on innovative technologies, offers a range of products, is sensitive to economic conditions, prioritizes visual quality, and operates in a competitive global market. Logistics and postharvest technologies play a crucial role in meeting market demands and reaching desirable markets (Ferrini, F. 2023). The study demonstrates the suitability of blockchain adoption in the fresh-cut flower supply chain, which faces perishability and time constraints The findings emphasize that implementing blockchain technology strategically and optimizing its deployment can result in reduced costs, differentiation of data-enabled products, enhanced profitability, and increased consumer surplus. The study concludes that a pervasive presence of blockchain is both expensive and unnecessary, as partial adoption can yield superior profit margins and consumer surplus (De Carvalho, P. R., Naoum-Sawaya, J., & Elhedhli, S. 2022).

The most significant obstacle is in the operating category, with heavy capital investment and issues related to planting infrastructure systems. In terms of significance, the organizational category ranks second and notably influences growers due to elevated labor costs, particularly when compared to the global average growth rate. The lack of knowledge and information about international markets and export handling is a major challenge, ranking third. Marketing techniques, including the impact of the cold-storage chain, flower variety, color, and after-sales services, rank fourth. Logistics, distribution channels, pricing, and credit facilities are also significant concerns. Product-related challenges include labeling, packaging, irrigation systems, and compliance with quality standards. Lastly, management-related obstacles include a lack

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of knowledge about markets, hesitancy in seeking new markets, and concerns about international transaction risks (Vanegas López, J. G., Merlos García, J. J., & Mayorga Abril, C. M. 2017).

There are substantial variations in the environmental footprint of cut flowers, with outdoor-grown flowers demonstrating lower environmental impacts in comparison to flowers cultivated in greenhouses. By adopting sustainable practices and technologies, the cut flower industry can reduce its environmental footprint and contribute to a more environmentally sustainable future (Lan, Y. C., Tam, V. W., Xing, W., Datt, R., & Chan, Z. 2022). The employment landscape has also transformed, with a greater prevalence of permanent positions in industry. However, despite earning wages above the government-mandated minimum, the majority of workers still struggle to achieve a reasonable lifestyle (Kabiru, J. G., Mbatia, P. N., & Mburugu, E. K. 2018).

The study aimed to identify the primary obstacles in international supply chain management within the Iranian flower industry. The research findings indicated that inadequate investment in the Iranian flower distribution sector is the foremost barrier. Furthermore, the existence of regulations that limit the involvement of international distributors in the country's flower industry was recognized as the second most significant hurdle. Drawing from the results of this study, it is advisable to allow foreign investors to participate in the sector. This step can significantly enhance the efficiency of the supply chain and promote the integration of modern supply chain technologies within the Iranian flower industry. (Riasi, A. 2015).

The study's focal point was the analysis of factors causing supply chain disruptions in the Kenyan floriculture industry, using Equator Flowers Limited as a case study. Among the significant factors identified were natural disasters, logistics process design, labor union actions, and production function mechanics, all contributing to disruptions in the supply chain. Natural disasters pose a considerable risk to the supply chain, emphasizing the need for comprehensive business continuity plans to mitigate their effects. Logistics process design was identified as another critical factor, highlighting the importance of developing redundancies in the logistical processes to enhance resilience. Finally, production function mechanics were identified as a factor impacting the supply chain (Kangogo, J., Guyo, W., Bowen, M., & Ragui, M. 2013).

The Ethiopian floriculture trade encountered substantial challenges when accessing the EU market, primarily due to the presence of rigorous standards and regulations already established. Required capabilities were lacking in the domestic market at the start of the industry, necessitating the acquisition of inputs from abroad. The government played a critical role in coordinating air transportation through Ethiopian Airlines, offering land and favorable credit terms to support the Ethiopian floriculture industry. Additionally, the organization undertook capacity-building efforts, encompassing training, quality control, and certification services. However, some areas like the cool chain and phytosanitary services experienced limited development. The study emphasizes the increasing impact of global buyers and standards in developed country markets, emphasizing the continuous need for enhancing capabilities, not only in production but also in marketing and logistics, to succeed in the globalized market. To address these challenges successfully, effective coordination among firms, industry collaboration, and strong public-private partnerships are essential (Gebreeyesus, M., & Sonobe, T. 2012). Ethiopia has achieved remarkable success in the cut flower export industry in Africa, establishing itself as a leading global producer and exporter of flowers. This accomplishment can be attributed to several advantages and opportunities that Ethiopia possesses. The study underscores the significance of foreign investments, government support, and the Horticulture Producers and Exporters Association in fostering the sector's growth. However, there are also challenges and threats that need to be addressed, including infrastructure limitations, shortages of agricultural inputs, a limited product range, and insufficient compliance with international standards. In the face of obstacles, the floricultural industry in Ethiopia is experiencing substantial growth, supported by government focus and inherent advantages, attracting both local and international investors. Ethiopia's success in this field sets an example for other African nations to pursue similar opportunities (Belwal, R., & Chala, M. 2008).

The limited availability of specific chemicals and air freight services negatively impacts the production and transportation of cut flowers. This scarcity can disrupt the supply chain and increase costs for businesses. Insufficient or inadequate regulations and policies specific to the cut flower industry create challenges for businesses. The absence of clear guidelines can lead to uncertainty and hinder the development of the sector. The industry's lack of specialized knowledge and skills can impede its growth. This includes expertise in areas such as flower cultivation, post-harvest handling, and logistics, which are crucial for maintaining the quality and competitiveness of the flowers. The scarcity of suitable infrastructure and building materials required for flower cultivation and processing facilities can hinder expansion and productivity in the industry. Inefficient government involvement and bureaucracy, particularly in exporting, can result in delays and

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administrative burdens. Excessive red tape and cumbersome procedures degrade the quality of the flowers and hinder the smooth operation of businesses (Semboja, et al., 2000).

The Favorable Factor for the Cut-Flower Industry Growth

According to the Airports Council International (2021) forecasts, it is predicted that emerging economies in the Asia-Pacific region, specifically China and India, will be ranked among the top three aviation markets by the year 2040. Following them closely will be Japan and Indonesia, as shown in Figure 1. These countries are projected to handle nearly 40% of the global passenger traffic. In terms of annual aircraft movements, China is expected to account for 23%, the United States for 16%, and India for 4% respectively. As per the forecast, the Indian aviation market is projected to experience continuous growth, with an average year-on-year growth rate exceeding 10%. By 2024, it is anticipated that the Indian market will surpass the United Kingdom and secure the third position. If the current growth rate is sustained, India is expected to become the third-largest aviation market by 2030 (Chakraborty, Ghosh, Sarker, & Chakraborty, 2020; Mahtani & Prakash, 2020).

To promote the growth of the floriculture industry, the Indian government has implemented several initiatives. These include the establishment of cold storage and packaging facilities at major airports, and ensuring proper preservation of flowers during transportation. Additionally, the government offers subsidies for air cargo transportation specifically for flowers, making it more affordable for farmers and businesses involved in the industry. These initiatives aim to support and enhance the development of the floriculture sector in India. The Indian floriculture sector possesses substantial potential for future expansion and advancement, driven by the rising global demand for premium and unique flowers. Additionally, fostering enhanced coordination among industry stakeholders, including growers, exporters, logistics providers, and government agencies, is vital to streamline operations and maximize the industry's competitiveness in global markets. By adopting these measures, the floriculture sector can better position itself for success in international trade. By embracing these measures, the Indian floriculture industry can unlock its full potential and establish a strong presence in the global market.

Apart from flowers, incorporating other visually appealing plants plays a crucial role in urban and rural environmental planning. This includes activities like reclaiming wasteland and mitigating pollution. The cut flower industry offers notable advantages by providing opportunities for young people and women to participate from rural and peri-urban areas with respectable employment opportunities, contributing to their socio-economic empowerment (de Keizer, M., et al., 2015).

The floriculture sector in India has witnessed significant advancements in recent years, particularly in the production of commercially farmed cut and loose flowers. This report provides an overview of the sector's growth, export potential, and the key states involved in cut flower production. Over a twenty-year period, the research investigates the industry's advancement and evaluates key factors such as export performance, export composition, transportation methods, and India's position in the global floriculture trade. India's annual flower production consists of approximately 19 lakh tons of loose flowers and 8.90 lakh tons of cut flowers, cultivated across 3.40 lakh hectares of land. This flourishing sector contributes substantially to both domestic and global commerce, generating significant revenue for the country. In terms of global trade, India holds the 18th position, accounting for 0.6% of the worldwide floriculture trade. Over the past decade, exports from the sector have shown a Compound Annual Growth Rate (CAGR) of 4%. India's floriculture sector has witnessed consistent growth in exports. Notably, during the period of 2010-11 to 2019-20, India became the leading exporter to the United States, with export values showing a progressive increase, from US $12.72 million in 2010-11 to US $19.49 million in 2019-20. The composition of India's floriculture exports includes a wide range of cut and loose flowers. The country offers a diverse selection of flowers, catering to different market demands. Specific varieties and popular choices are included in the export portfolio to maximize market penetration and revenue generation. Exports of floriculture products from India primarily rely on air transportation. Over the years, the share of exports via air has been increasing steadily. In 2010-11, exports by air accounted for 27% of the total, and by 2019-20, this figure had risen to 40.21%. The compound annual growth rate for air transportation during this period was 0.06%. India's share in the global floriculture trade, while significant, stands at 0.6%. The country has consistently enhanced its presence in international markets and expanded its share through improved production techniques, quality control, and market-oriented strategies. Continued growth and development in the floriculture sector are of utmost importance for India to expand its share in the global floriculture trade (Malviya, A., Vala, M., & Mankad, A. 2022).

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The study focuses on prioritizing the barriers affecting cut-flower transportation by air in India. The challenges were categorized and examined through the following approach:

- Gathering Data: Over 30 research articles, e-books, and secondary sources were collected to gather comprehensive data on the subject.
- Expert Interviews: Airport Cargo Managers from four metropolitan airports in India, Air Cargo Operational Heads from six airlines, and four ground handling organizations were interviewed to obtain relevant information about the barriers affecting cut-flower transportation in India.
- Academic Input: In addition to stakeholder perspectives, academics sought opinions to gain a holistic understanding of the topic.
- Expert Panel: The ranking of barriers and challenges was conducted with the participation of 38 professionals. These experts represented airports (13), ground handling staff (7), academics (6), and airlines (12). They had extensive experience of nearly 16 years in the aviation industry and held senior positions such as Senior Airline Cargo Managers and Operations heads in their respective organizations. Their wealth of experience provided a meticulous and comprehensive perspective, leading to valuable outcomes.

After extensive discussions with experts, the study identified a total of 09 barriers that impact the transportation of cut-flowers by air in India, presented in Table 1. The researchers used the Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (FAHP) methods to rank and quantify these barriers. The study's outcomes can offer valuable insights to air cargo operators and airline management, assisting them in making more informed decisions and streamlining their operations effectively.

Table 1. Barriers - Cut flower Transportation.

NOTATIONS	NAME OF BARRIER	DESCRIPTION	REFERENCES
B1	Lack of Infrastructure	Telephone services are lacking, Roads leading to the farm are not in good condition, and when electricity is scarce, producers must use generators, which raises output costs. low export facilities including greenhouses and Cold storage leads short shelf life of flowers	(Belwal & Chala, 2008). (Ganapathi, 2015). (Han et al., 2021). (Tizazu & Workie, 2018).
B2	High cost of airfreight transportation	The high cost of shipping goods to international markets is another significant constraint for the cut flower industry. The most effective way to move cut Flowers are an extremely delicate product by Air freight Because of high price of airfreight farmer use land transportations resulting in a drop in quality and vase the flower's life. According to a study's findings study conducted with exporters, transportation the component with the highest cost (35%) in the production prices for carnations	(Gauchan et al., 2009). (Deloach & Miklius, 1961). (Vega, 2008). (Perry, 2012).
B3	Lack of scientific knowledge	Education of farmer especially young generation is very crucial because it is very Sen stative business as well as Typically, Cutflower employees do not attribute their symptoms to chemical exposure. Safe handling procedures frequently have flaws, including improper labelling and handling of toxic materials, storage, application, and disposal of pesticides, as well as failures to warn workers about the risks of pesticide exposure, provide protective equipment, and dose and apply pesticides correctly.	(Dawabah et al., 2020). (Donohoe, 2008). (Senapati et al., 2016). van Doorn& & Tijskens, 1991). (Pichersky & Dudareva, 2007). (Zvi et al., 2008).
B4	Employment problems especially	In the cut flower industry, women make up most of the workforce. However, women in this industry often face health issues and discrimination. In Ecuador, the flower industry employs predominantly women, making it crucial to understand how this	(Riisgaard & Hammer, 2011). (Barrientos et al., 2003). (Riisgaard, 2009).

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	with the women	employment affects their reproductive health. While men may prefer permanent positions, women are often willing to work in cut flower jobs. However, persistent discrimination and health concerns could create an uncomfortable work environment and potentially hinder women's sustained participation in the industry.	(Hatibu et al., 2000). (Handal & Harlow, 2009).
B5	Knowledge barrier within supply-chain	Consumer taste can be influenced by various factors. For instance, in 2006, Dutch customers of roses switched to other flower products due to a notable increase in the price of red roses, which reached €2.65 per stem. As a result, suppliers experienced substantial losses. Supermarkets exert pressure on suppliers to match consumer demands, and this pressure is then transferred down the supply chain, making the working conditions for manufacturers in China and Kenya riskier. The business had begun to compromise between economy and ecology because of the growing demand for flowers.	(Milanzi, 2012). (Viviers & Calof, 2002). (Ibeh et al., 2012). (Kargbo et al., 2010). (de Keizer et al., 2015). (Button, 2020).
B6	Managerial Aspects	Key managerial issues in cut-flower transportation encompass perishability, time sensitivity, fragility, quality control, supply chain coordination, cost management, and regulatory compliance.	(Vanegas & Restrepo, 2016). (García & Avella, 2007). (Milanzi, 2012). (Fillis, 2002).
B7	Marketing Expertise	Price competition from international rivals often poses a barrier for companies in foreign markets, as they struggle to offer competitive prices, Price-related barriers include meeting client expectations, matching competitor prices, and difficulties with credit and payment abroad. Distribution barriers can arise at various stages of the supply chain, impacting suppliers, complex distribution channels, intermediaries, consignment methods, sales staff, bonded sales representatives, production chain contacts, diverse delivery options, and transportation and inventory management. These challenges may lead to high transportation and insurance costs, convenience constraints, and limited storage facilities availability in foreign markets.	(Leonidou, 1995). (Leonidou, 2004). (Vanegas López, J. G., Merlos García, J. J., & Mayorga Abril, C. M. 2017).
B8	Governmental Aspects	Governmental barriers in cut flower transportation encompass customs and import regulations, phytosanitary standards, export/import permits and licenses, transportation regulations, quarantine, and border control measures, trade agreements and restrictions, as well as export subsidies and incentives. Overcoming these barriers requires compliance with regulations, effective communication with government authorities, and active engagement with industry associations.	(Leonidou, 2004). (Ahmed et al., 2004; Leonidou, 2004). (Da Silva & Da Rocha, 2000). (Liargovas & Skandalis, 2008).

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B9	Safety and security issues in cut-flower transportation	Safety and security issues in cut-flower transportation involve concerns such as product damage and loss, theft and pilferage, contamination and pest control, transportation accidents, regulatory compliance, temperature control, and supply chain transparency. Mitigating these issues requires proper handling and packaging practices, secure transportation methods, robust quality control measures, regulatory compliance, temperature monitoring, and supply chain transparency mechanisms.	(Kaphle, B. D., Ghimire, M. S., Subedi, S., & Pandey, I. R. 2021). (Nguyen, C., Toriello, A., Dessouky, M., & Moore, J. E. 2013). (Nowakowska, M. 2015).

Research Methodology

A total of 38 experts were interviewed to collect their opinions regarding the importance of utilizing AHP (Analytic Hierarchy Process) and FAHP (Fuzzy Analytic Hierarchy Process) models, as proposed by Chen and Huang (2007), Saaty (1994), and Govindan and Murugesan (2011). The experts were selected using convenience sampling, which involves selecting a sample from a larger population based on availability. Of the 38 participants, 22 preferred AHP, while the remaining 16 favored FAHP.

The rationale behind selecting AHP and FAHP techniques was to conduct a comprehensive exploration of the cut-flower transportation issues by air. The inclusion of expert opinions from the air cargo industry, which represents individuals with direct experience of the actual challenges, was deemed crucial in ensuring the reliability and practicality of the study findings. The study used a chosen multi-criteria decision-making (MCDM) technique to incorporate expert opinions as qualitative data, thereby enriching the analysis comprehensively.

The participants were tasked with evaluating nine key barriers (B1-B9) that affect cut-flower transportation in India. To offer their assessments, the researchers utilized a weightage scale and the pairwise examination technique described in AHP and FAHP (Saaty, 1980). Once their responses were recorded as assigned weights, additional analysis was carried out using AHP and FAHP concepts. The primary objective of this analysis was to ascertain the criteria weights (Saaty, 1980; Saaty & Vargas, 1987) and their respective rankings (Kumar & Kansara, 2018) using the collected data.

Subsequently, the relationship between the criteria weights and their respective rankings was assessed by employing Spearman's correlation coefficient. The purpose of this statistical analysis was to validate the prioritization of rules B1-B9, as outlined in Table 1. This was achieved by separately evaluating the criteria weights and rankings to substantiate the findings.

To establish the legitimacy of the factors influencing barriers in the steel industry, this research applied both the AHP and FAHP methods. These methods were used concurrently to rank the variables that contribute to barriers in the cut-flower supply chain. The outcomes from both methods were combined to determine the final rankings. The strength of the association between the two variables was evaluated using Spearman's correlation coefficient. In this analysis, the criteria weights and their respective rankings were treated as distinct variables, enabling a comparison of the results produced by the two chosen multi-criteria decision-making (MCDM) techniques.

The Analysis

The assessment of variables using both AHP and Fuzzy AHP methods involved the utilization of Triangular Fuzzy Numbers (TFNs). The TFNs used for the evaluation are presented in Table 2.

Table 2 Importance level for AHP/FAHP

Preference rating	**TFNs**
Equal Importance	(1,1,1)
Extremely Low Importance	(1,2,3)
Very Low Importance	(2,3,4)
Low Importance	(3,4,5)
Average Importance	(4,5,6)
High Importance	(5,6,7)

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Moderately High Importance	(6,7,8)
Very High Importance	(7,8,9)
Extremely High Importance	(8,9,9)

Source: AHP and Fuzzy AHP analysis (Kumar & Kansara, 2018).

AHP Technique

The AHP method was employed for computing and classifying barriers. The weights of the key criteria were normalized to ensure comparability.

Table 3 depicts the standardized weights of the criteria.

Table 3. Normalized Weights of the key criteria (AHP)

Criteria	S1	S2	S3	S4	S5	S6	S7	S8	S9
B1	0.23	0.28	0.43	0.44	0.13	0.12	0.23	0.28	0.09
B2	0.11	0.14	0.14	0.15	0.13	0.12	0.13	0.06	0.06
B3	0.04	0.07	0.07	0.07	0.13	0.12	0.07	0.06	0.03
B4	0.04	0.07	0.07	0.07	0.26	0.12	0.07	0.06	0.03
B5	0.23	0.14	0.07	0.04	0.13	0.24	0.30	0.28	0.03
B6	0.23	0.14	0.07	0.07	0.06	0.12	0.13	0.13	0.03
B7	0.03	0.03	0.04	0.04	0.01	0.03	0.03	0.06	0.03
B8	0.02	0.07	0.04	0.04	0.01	0.03	0.02	0.03	0.03
B9	0.07	0.07	0.07	0.07	0.13	0.12	0.03	0.03	0.03

Source: AHP analysis

Step 1: The pairwise assessment of the values was based on the views of 38 participants.

Step 2: Table 3 displays the standardized format for each condition.

Table 4. Criteria Weights and corresponding Ranks

Criteria	Criteria Weight	Rank
B1	0.247	1
B2	0.116	3
B3	0.073	6
B4	0.088	5
B5	0.161	2
B6	0.109	4
B7	0.034	8
B8	0.032	9
B9	0.07	7

Source: AHP analysis

Step 3: Table 4 displays the calculated normalized weights and ranks for the main criteria. It also provides the estimated values for λ max (10.01), Consistency Index (CI) (0.12), and Consistency Ratio (CR) (0.088) for the key criteria. Since the CR value is below 0.10, it indicates the data's suitability.

APPLYING FAHP METHOD

To rank the challenges/barriers from B1 to B9, a systematic approach can be followed. The FAHP technique was applied through the following stages:

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- The criteria evaluation structure was defined by conducting pair-wise correlations of the criteria with 38 respondents.
- The algebraic average of the fuzzy weights for each condition was computed individually using the methods described by Chang (1996) and Buckley (1985), as shown in Table 5. The values for all criteria and equal weights were also presented. In the last row of Table 5, the order of the statistics is different to ensure that the fuzzy triangular numbers are in increasing order.
- The overall fuzzy weights for each criterion were determined using the specified formula provided by Ayhan (2013).
- The relative non-fuzzy weights of all models (Mi) and the standardized weights of each standard (Ni) were defined and compared with the rankings, as illustrated in Table 5.
  Mi was determined by assuming the normal fuzzy integers for each criterion, while Ni was obtained via the non-fuzzy Mi values.

Results & Discussion

The Fuzzy AHP method was used to rank barriers to efficiency on a scale from B1 to B9 . The process involved several steps:

Step-1: The standard matrix was computed to facilitate pair-wise calculations.

Step-2: The algebraic average of consequent fuzzy weights, as outlined in Table 5, was calculated using the technique established by Buckley (1985) and D. Chang (1996).

Step-3: Fuzzy weights were determined using an equation recommended by Ayhan (2013).

Step-4: The relative non-fuzzy weight (Mi), normalized weights (Ni), and their respective positions were computed (Table 5).

Established on the assessment conducted using the FAHP method and presented in Table 4, the final rankings are as follows: B1 > B5 > B2 > B6 > B4 > B3 > B9 > B8 > B7. Table 5 provides a comparison of the rankings obtained through both the AHP and FAHP methods.

Table 5. Geometric Means of the Fuzzy Weights w1, w2 and w3

Criteria	w1	w2	w3	M1	N1	Rank Based on N1
B1	2.34	2.84	3.27	0.27	0.26	1
B2	1.00	1.47	1.95	0.15	0.14	3
B3	0.71	0.89	1.07	0.09	0.08	6
B4	0.71	0.96	1.21	0.09	0.09	5
B5	1.36	1.59	1.84	0.16	0.15	2
B6	1.13	1.26	1.43	0.12	0.12	4
B7	0.34	0.44	0.58	0.04	0.04	9
B8	0.33	0.43	0.65	0.05	0.04	8
B9	0.76	0.82	0.93	0.08	0.08	7

Source: AHP and Fuzzy AHP analysis

Supply Chain Knowledge issues and the High Cost of Airfreight Transportation are fundamental and crucial obstacles that impede the growth of cut-flower exports in India. To achieve comprehensive development, it is essential for government policy decisions to adopt global best practices.

Ranked third is the Lack of Infrastructure (B3), underscoring the importance of prioritizing the development of basic infrastructure to achieve groundbreaking outcomes and generate additional revenues.

Temperature Control (B6) occupies the fourth position, emphasizing the need to promote technological innovations and establish a robust ecosystem. Businesses that can nurture unique, invaluable, value-added skills are often the ones that gain a competitive advantage (C. P. Barros, Wanke, Nwaogbe, & Azad, 2017).

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Table 6. Criteria Weight Ranks for AHP and FAHP

Criteria	AHP Method	FAHP Method
B1	1	1
B2	3	3
B3	6	6
B4	5	5
B5	2	2
B6	4	4
B7	8	9
B8	9	8
B9	7	7

Table7 The Potential Criteria in Sequence

RANKS	CRITERIA
1	B1
2	B5
3	B2
4	B6
5	B4
6	B3
7	B9
8,9	B8
9,8	B7

Source: AHP and Fuzzy AHP analysis

Conclusion

Based on the general AHP methodology, the model can help to identify the most critical barriers and prioritize them for improvement. By comparing the relative importance of various criteria such as cost, availability, and frequency of air cargo flights, quality and efficiency of air cargo services, and infrastructure and facilities for handling and storing cut-flower products at airports, stakeholders in the cut-flower industry can make informed decisions and allocate resources accordingly to improve the industry's performance in air cargo transportation. Furthermore, the AHP model can offer a framework for evaluating various alternative solutions and assessing their effects on the criteria and overall outcome.

In conclusion, the floriculture industry has tremendous potential for growth and development, both in India and around the world. However, the transportation of flowers by air cargo is subject to several barriers and challenges, including transportation and logistics, pest and disease control, and regulatory barriers.

To overcome these barriers, stakeholders in the floriculture industry can work together to invest in infrastructure development, establish efficient logistics networks, streamline regulatory processes, develop integrated pest management programs, and explore alternative transportation options such as sea or rail transport. These strategies can help to reduce transportation times and costs, improve the quality of the products, and increase the competitiveness of the industry in the global market.

In addition, the adoption of new technologies such as e-commerce platforms and digital marketing can help to increase market access and visibility for floriculture products. This can help to create new opportunities for growers and increase demand for their products. In terms of recommendations, policymakers and industry stakeholders can work together to develop comprehensive strategies to address the barriers affecting floriculture by air cargo. This may encompass investments in infrastructure development, regulatory reforms, and the adoption of new technologies aimed at enhancing the efficiency, quality, and competitiveness of the floriculture industry. By implementing appropriate strategies and making

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the necessary investments, the industry has the potential to sustain its growth and make significant contributions to the economic development of countries worldwide.

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