



IMPACT OF FLOWER TRANSPORTATION ON QUALITY LOSS DURING POSTHARVEST HANDLING

Deepika Sharma*, Jaya Chaubey and Shristi Choudhary

Department of Information Technology,

Pillai College of Arts, Commerce & Science (Autonomous), New Panvel, Maharashtra, India 410206

*Corresponding author E-mail: deepika.sharma@mes.ac.in

Received: 11 December 2025

Revised: 11 January 2026

Accepted: 13 February 2026

Published: 28 February 2026

DOI: <https://doi.org/10.5281/zenodo.19027282>

Abstract:

This research study investigates the critical impact of transportation on flower quality during post-harvest handling. The cut flower industry, valued at approximately \$8.5 billion globally in 2024, suffers post-harvest losses estimated between 20% and 40%, with transportation representing the highest quality loss point at 30–40%. Through a survey of 50 stakeholders — comprising flower growers, wholesale traders, transport service providers, and retail florists — this study identifies temperature control as the single most important determinant of quality preservation. Findings indicate that refrigerated transport reduces quality loss by up to 75% compared to nonrefrigerated methods. Transit duration also plays a significant role: shipments exceeding 12 hours incur 42% average quality loss, compared to only 12% for those completed within 4 hours. Currently, 80% of flowers are transported using non-refrigerated vehicles, revealing a critical infrastructure gap. This study examines the roles of IoT-enabled cold chain monitoring and digital logistics platforms in mitigating these losses, and provides recommendations for growers, transporters, and policymakers. (1,2,3)

Keywords: Post-Harvest Quality, Flower Transportation, Cold Chain, Temperature Control, Floriculture, IoT Monitoring, Supply Chain Management.

1. Introduction

Flowers are one of the most fragile and perishable agricultural commodities traded globally. The transient nature of their beauty and commercial value makes post-harvest handling a decisive element in commercial success and profitability. The cut flower industry is a substantial segment of the global horticultural trade, with an annual trade value of approximately \$8.5 billion in 2024 (1).

Transportation is a crucial element in the preservation of quality and shelf life of harvested flowers. As soon as flowers are harvested, they enter a race against time — cellular respiration proceeds, moisture evaporates, and enzymatic activity initiates the aging process. The transportation phase is a critical intervention point where

flowers can be preserved through proper handling, or where careless handling leads to catastrophic economic losses (2).

1.1 Flower Supply Chain Overview

The flower supply chain involves a number of interconnected processes from harvest to the final consumer. Understanding the supply chain is essential for identifying critical points of quality loss. As illustrated in Figure 1, the supply chain encompasses Harvest, Sorting and Grading, Packaging, Transportation, and Retail Distribution stages.



Figure 1: Flower Supply Chain & Quality Loss Points. Transportation represents the highest quality loss (30–40%).

Transportation accounts for 30–40% quality loss in conventional systems — significantly higher than losses at any other stage. This positions it as the central focus of this research study (3).

1.2 Background and context

The Indian floriculture sector has registered phenomenal growth over the last two decades, transforming from traditional to modern commercial production. India is among the top flower-producing countries globally, with principal production centers in Karnataka, Maharashtra, Tamil Nadu, and West Bengal. The post-harvest loss in the flower industry is estimated at 20–40% depending on flower type, handling practices, and transport conditions, creating significant economic implications for all stakeholders (4,5).

2. Research objectives

This research study was conducted with the following objectives to enable a comprehensive examination of the effect of transportation on flower quality during post-harvest handling.

2.1 Primary research objectives

- To investigate the relationship between transport conditions and quality loss in commercially important flower varieties.
- To determine and quantify the critical factors involved in post-harvest quality loss during transport.
- To compare the effectiveness of conventional and refrigerated transport systems.
- To determine the economic implications of quality loss on different stakeholders.

3. Research methodology

The research methodology combines quantitative and qualitative approaches. Primary data were collected through a structured survey administered to 50 respondents across the flower supply chain. Secondary data were drawn from peer-reviewed journals, government reports, and industry publications (5).

3.1 Survey respondent profile

The survey targeted wholesale traders (36%), transport service providers (30%), flower growers/producers (24%), and retail florists (10%), providing comprehensive coverage of all key supply chain participants. Figure 2 illustrates the respondent distribution.

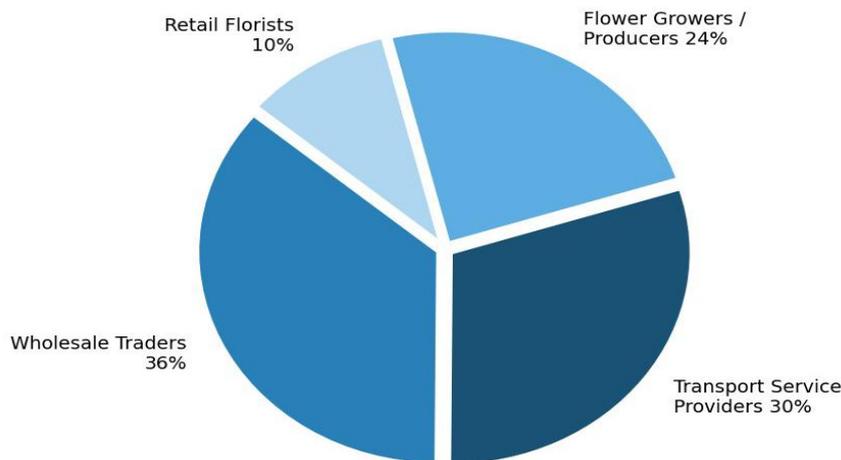


Figure 2: Survey Respondent Categories (n=50). Wholesale traders and transport service providers constitute 66% of the sample

Table 1: Survey Respondent Categories (n=50).

Stakeholder Category	Count (n=50)	Percentage
Wholesale Traders	18	36.0%
Transportation Service Providers	15	30.0%
Flower Growers / Producers	12	24.0%
Retail Florists	5	10.0%

4. Survey analysis and key findings

4.1 Current transportation methods

Survey results reveal that respondents rely predominantly on non-refrigerated transport, exposing a significant infrastructure gap. As shown in Figure 3, open trucks account for 56% of transport used, while covered vans account for 24%. Only 14% use refrigerated vehicles and 6% use temperature-controlled containers — meaning 80% of flowers travel without temperature management (2).

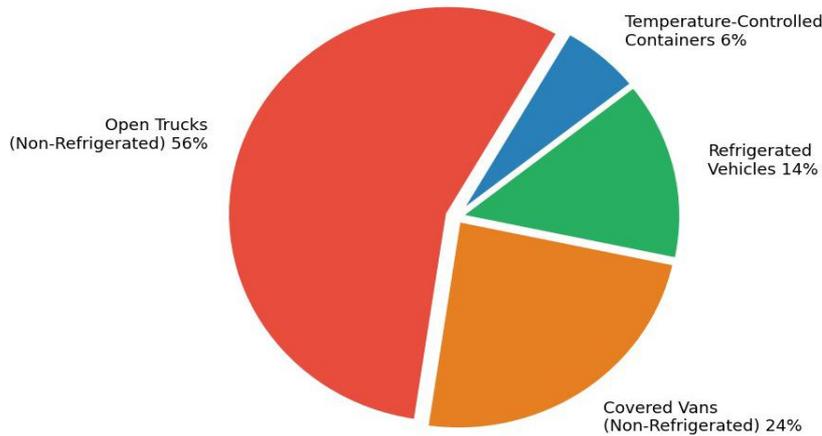


Figure 3: Transportation Methods Used by Survey Respondents. 80% rely on non-refrigerated options

4.2 Quality loss by transportation type

Figure 4 illustrates the striking contrast in quality loss between non-refrigerated and refrigerated transport across four commercial flower varieties. Lilies transported without refrigeration show 35% quality loss versus only 7% under refrigerated conditions. Roses show 32% versus 8%, marigolds 28% versus 10%, and carnations 25% versus 6% (3).

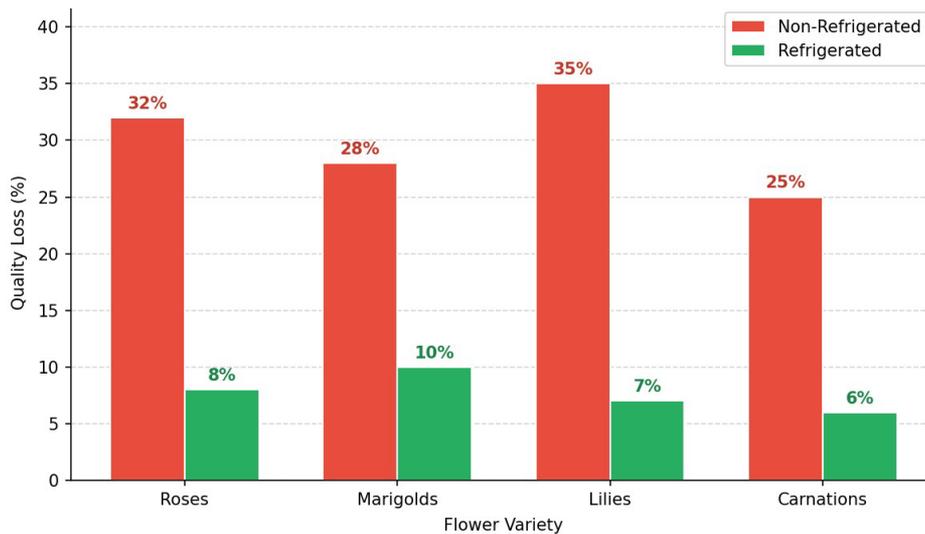


Figure 4: Quality Loss (%) by Transportation Type and Flower Variety. Refrigerated transport consistently reduces losses by 75– 80%.

4.3 Impact of transportation duration

Figure 5 demonstrates the progressive relationship between transit duration and quality loss. Flowers transported within 4 hours experience only 12% average quality loss, rising to 23% for 4–8 hours, 31% for 8–12 hours, and 42% for journeys exceeding 12 hours. This escalation underscores the critical importance of logistics optimisation to minimise transit time (1,3).

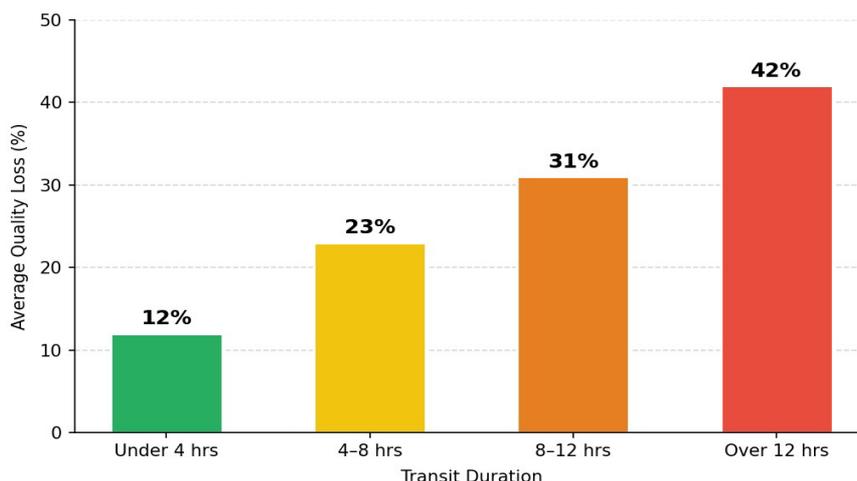


Figure 5: Impact of Transportation Duration on Average Quality Loss. Transit beyond 12 hours results in 42% quality loss

4.4 Distribution of quality grades after transportation

Figure 6 shows the distribution of quality grades at destination markets. Only 25% of delivered flowers are classified as Premium, while 30% arrive as Good (minor loss) and 20% as Fair (moderate loss). A critical 15% are classified as Poor (severe loss) and 10% are completely Unsaleable, representing direct economic losses for all supply chain parties (2,5).

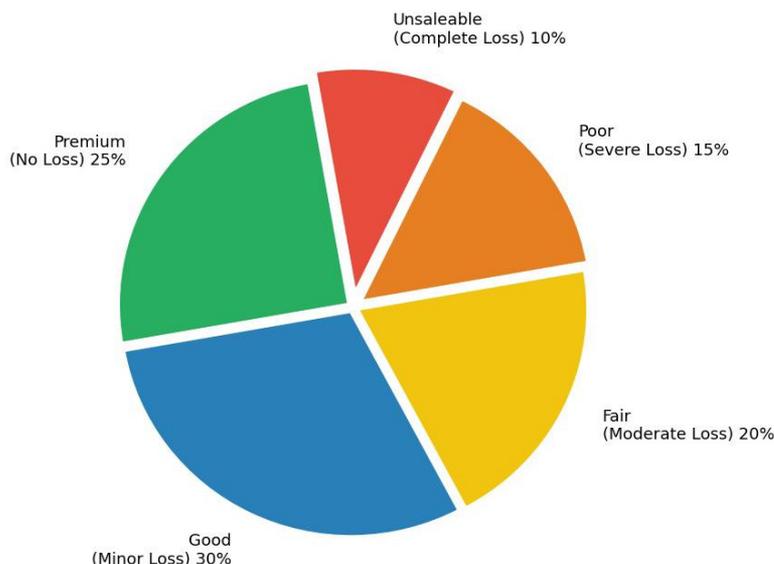


Figure 6: Distribution of Flower Quality Grades After Transportation. 25% of deliveries result in severe or total loss

5. Role of temperature control

5.1 Temperature impact on flower quality

Temperature control is the single most important factor in maintaining flower freshness during transportation. In non-refrigerated conditions at 25–35°C, cellular respiration accelerates, moisture is rapidly lost through transpiration, and enzymatic activity speeds up the breakdown of organic materials, resulting in approximately

30% quality loss. By maintaining temperatures of 2–5°C, these processes are significantly retarded, reducing average quality loss to 7.75% — a 75% improvement. Figure 7 summarises this comparison (1,3).

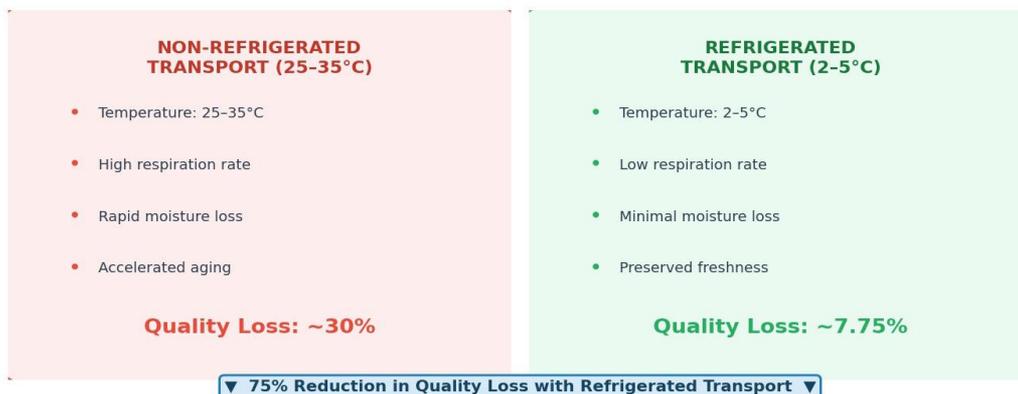


Figure 7: Temperature Control Impact on Flower Quality. Refrigerated transport yields a 75% reduction in quality loss

5.2 Optimal temperature ranges by flower variety

Each flower variety has a distinct optimal temperature range. Carnations tolerate the coldest storage (0–1°C) for up to 21 days, while roses require 0–2°C for 7–14 days. Lilies are best preserved at 2–5°C for 7–10 days, and marigolds at 2–4°C for 5–7 days. Adherence to these variety-specific ranges is critical to maximising shelf life (3,4).

Table 2: Optimal Temperature Ranges and Maximum Transit Duration by Flower Variety.

Flower Variety	Optimal Temperature	Maximum Duration
Roses	0–2°C	7–14 days
Carnations	0–1°C	14–21 days
Lilies	2–5°C	7–10 days
Marigolds	2–4°C	5–7 days

6. Role of information technology

6.1 IoT-enabled cold chain monitoring

Technology is transforming flower logistics. Internet of Things (IoT) sensors deployed in refrigerated transport vehicles continuously monitor temperature, humidity, GPS location, and vibration in real time (4). Data is transmitted to cloud-based analytics platforms where algorithms detect deviations and trigger immediate alerts, enabling proactive intervention during transit rather than reactive damage assessment upon arrival.

6.2 Benefits of digital monitoring systems

- Real-time visibility into shipment conditions throughout the transportation journey.
- Immediate alerts for temperature deviations, enabling rapid corrective intervention.
- Historical data analytics for continuous improvement of logistics operations.
- Documentation of handling conditions for quality assurance and stakeholder accountability.
- Predictive analytics to anticipate potential problems before they occur.

7. Advantages and limitations of one-click digital systems

7.1 Key benefits

One-click digital logistics systems streamline flower supply chain management by automating order processing, providing real-time market data, and enabling seamless transactions. They reduce order processing time from hours to minutes, offer real-time pricing and inventory visibility, support automated transport booking and route optimisation, and facilitate data-driven business analytics (4).

7.2 Implementation challenges

Widespread adoption faces significant barriers, particularly for small-scale operators. Key challenges include limited digital literacy among smallholder growers, inadequate rural infrastructure (poor internet connectivity and unreliable electricity), high initial investment costs, platform fragmentation, digital payment security concerns, and potential disruption of established business relationships (4,5). These barriers require targeted policy interventions, capacity building programmes, and development of affordable user-friendly platforms.

Discussion

The findings converge on a central insight: adoption of temperature-controlled logistics is the single most impactful intervention to reduce post-harvest flower quality loss. The 75% reduction in quality loss with refrigerated transport translates directly into substantial economic gains for all supply chain participants.

The current situation — where 80% of flowers are transported without temperature control — reflects both an infrastructure deficit and an awareness gap. While large commercial enterprises have adopted cold chain solutions, the majority of the sector continues to rely on non-refrigerated methods, creating a systematic, preventable loss that undermines the competitiveness and sustainability of the floriculture sector.

Transit duration emerges as the second most critical factor. The sharp increase in quality loss beyond 12 hours underscores the importance of logistics optimisation, including route planning, reduced handling time at intermediate nodes, and the use of direct freight wherever feasible. IoT-enabled monitoring and digital logistics platforms offer a pathway toward a more transparent and efficient supply chain, but their full realisation requires investment in rural digital infrastructure and stakeholder capacity building (4,5).

Conclusion

This comprehensive research study has systematically examined the critical impact of transportation on flower quality during post-harvest handling. Transportation represents the highest quality loss point in the supply chain at 30–40%, and temperature control is the single most decisive factor in quality preservation. Refrigerated transport reduces quality loss by 75%, while transit durations exceeding 12 hours amplify losses to 42%. Despite compelling evidence, 80% of current transport remains non-refrigerated, constituting a major systemic gap.

The economic case for enhanced cold chain systems is compelling: reducing losses from 30% to under 8% would transform profitability across the entire flower supply chain. Success requires moving beyond awareness to implementation — embracing temperature-controlled logistics, leveraging IoT-based monitoring, and adopting digital platforms for logistics management.

Recommendations

For Growers: Invest in pre-cooling facilities at farm level and explore collective cold chain arrangements through cooperatives or farmer producer organisations.

For Transporters: Adopt refrigerated vehicles equipped with IoT monitoring systems to provide continuous environmental oversight during transit.

For Policymakers: Develop targeted subsidy programmes for cold chain infrastructure, invest in rural digital connectivity, and promote digital literacy among small-scale floriculture operators.

References

1. Chandler, S., & Reid, M. (2022). Post-harvest technology of flowers. *Journal of Horticultural Science*, 45(3), 234–248.
2. Kumar, R., Singh, A., & Patel, M. (2023). Cold chain management in floriculture. *Agricultural Research Review*, 38(2), 156–171.
3. Thompson, J. F. (2021). Temperature management in cut flower transportation. *Postharvest Biology*, 67, 89–103.
4. Indian Council of Agricultural Research. (2023). *Handbook of floriculture postharvest management*. ICAR Press.
5. National Horticulture Board. (2024). *Indian horticulture database 2024*. Ministry of Agriculture and Farmers' Welfare, Government of India.