Improving FMCG Distribution Efficiency through Route Optimization

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***Abstract*—Purpose: This study focuses on improving the distribution of Fast-Moving Consumer Goods (FMCG) from warehouses to customers. In an industry with low profit margins and high demand, traditional experience-based logistics often lead to higher fuel costs and delivery delays. The study aims to develop a distribution model that reduces logistics costs while ensuring timely and efficient delivery.**

Methodology: The research adopts a case-based approach using a simulated dataset. It combines basic mathematical optimization with practical route-planning techniques to improve distribution efficiency. The study considers key factors such as vehicle routing, warehouse locations, and delivery paths, treating them as part of an integrated distribution system.

Key Findings: Based on existing research, the proposed approach is expected to significantly improve logistics performance. The model aims to reduce distribution costs by approximately 3% to 12% and improve delivery efficiency by over 20%. These improvements are achieved by reducing unnecessary travel distance and improving vehicle utilization. Practical and Theoretical Implications: This study provides practical guidance for managers to improve distribution systems using simple and effective strategies. It also contributes to academic understanding by demonstrating how optimization techniques can be applied in real-world FMCG logistics to enhance efficiency and competitiveness.

***Index Terms*—FMCG distribution, logistics optimization, route planning, supply chain management, cost reduction, delivery efficiency**

I. INTRODUCTION

1.1 Background and Context

The Fast Moving Consumer Goods (FMCG) industry plays an important role in the economy, as it deals with products that are used in everyday life such as food items, personal care products, and household goods. These products need to be available at the right place and time, which makes distribution a key factor for success. In a country like India, managing this distribution efficiently is a major challenge due to large demand and wide geographical coverage.

Since FMCG products have low profit margins, companies cannot afford inefficiencies in transportation and logistics. Therefore, having a fast, reliable, and cost-effective distribution network is essential for maintaining competitiveness.

1.2 Research Problem

Many FMCG companies still rely on traditional methods for managing their distribution networks. Delivery routes are often planned based on past experience rather than data, which leads to longer travel distances, higher fuel consumption, and delays in delivery. These small inefficiencies, when repeated daily, result in significant operational costs.

The main problem addressed in this study is how to replace these traditional methods with more efficient, data-based approaches that can reduce cost and improve delivery performance.

1.3 Motivation and Relevance

In today's business environment, rising fuel costs and increasing customer expectations make efficient logistics more important than ever. Even a small improvement in route planning can lead to noticeable cost savings and better service levels. This study is relevant because it shows how simple analytical techniques can help FMCG companies, especially small and medium businesses, improve their distribution systems and remain competitive in the market.

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1.4 Research Gap

Although there is a large amount of research on supply chain optimization and advanced technologies, many studies focus on complex models that are difficult to implement in real-world situations. There is a lack of practical and easy-to-use approaches that managers can apply without requiring advanced technical knowledge.

This study aims to bridge this gap by developing a simple and practical optimization approach using a case-based method with hypothetical data.

1.5 Objectives of the Study

The main objective of this study is to develop an efficient distribution model for FMCG products. Specifically, the study aims to:

- Analyze inefficiencies in existing distribution systems
- Apply basic optimization techniques to improve routing
- Reduce transportation cost and delivery time
- Develop a practical model for better decision-making

1.6 Structure of the Paper

The report is organized into the following sections:

- Introduction: Overview of the study and problem
- Literature Review: Review of existing research
- Problem Formulation: Identification of key issues
- Methodology: Explanation of approach and data used
- Results and Conclusion: Findings and recommendations

II. LITERATURE REVIEW

2.1 Theoretical Foundations

The concept of distribution network optimization in the FMCG sector is based on achieving a balance between minimizing logistics costs and maintaining high service levels. Previous studies highlight that efficient supply chain performance depends on proper coordination of transportation, warehousing, and inventory management.

One of the key challenges in distribution planning is the trade-off between cost and service efficiency. Faster delivery often increases transportation cost, while cost reduction may lead to delays. Therefore, the objective is to find an optimal balance that ensures both efficiency and customer satisfaction.

FMCG distribution systems are inherently complex due to high demand frequency, large product volumes, and wide geographical coverage. Managing such systems requires structured planning and analytical decision-making rather than relying solely on experience-based methods.

2.2 Review of Key Empirical Studies

Several studies have demonstrated the benefits of optimizing distribution networks in the FMCG sector. Cintron et al. (2010) showed that redesigning a distribution network can significantly reduce costs, with one case achieving a reduction from 12% to 3% of net sales. Similarly, Senevirathne and Samarasinghe (2024) applied optimization algorithms to routing problems and achieved cost reductions of over 20% while improving delivery performance.

Research by Adikari and Amalan (2019) highlighted the role of big data analytics and machine learning in improving logistics efficiency. Their findings show that data-driven decision-making helps reduce vehicle usage and optimize route planning. Chauhan et al. (2023) further emphasized that digitalization plays a crucial role in enhancing overall logistics performance.

Nguyen et al. (2024) demonstrated that integrating routing, scheduling, and resource allocation leads to better results compared to solving these problems separately. Their study highlights the importance of adopting an integrated approach in distribution network optimization.

2.3 Critical Synthesis of Literature

The overall analysis of literature indicates that optimization techniques significantly improve distribution efficiency and reduce logistics costs. Most studies agree that transportation cost is the major component of logistics expenses, and optimizing routing can lead to substantial savings.

The literature also shows that the use of modern technologies such as data analytics, machine learning, and digital systems has become essential for improving supply chain performance. Companies that adopt these technologies are able to make better decisions and respond quickly to changing market conditions.

However, effective optimization requires a holistic approach that considers all aspects of the distribution network, including transportation, warehousing, and inventory management.

2.4 Identification of Gaps

Despite the availability of advanced optimization techniques, several gaps still exist in the current research.

Most studies focus on specific aspects such as routing or warehouse location rather than providing integrated solutions. Additionally, many models are highly technical and difficult for managers to implement in real-world situations.

There is also a lack of practical, case-based studies that demonstrate how optimization techniques can be applied using simple tools and realistic assumptions.This study aims to address these gaps by developing a practical and easy-to-understand optimization approach using a hypothetical dataset, making it suitable for real-world application in FMCG distribution systems.

III. RESEARCH GAP AND CONTRIBUTION

3.1 Research Gap

Based on the review of existing literature, it is clear that there is a gap between theoretical research and its practical implementation in the FMCG sector.

Many studies focus on advanced optimization techniques and complex algorithms that require specialized knowledge and expensive technology to implement. At the same time, some business-level studies discuss efficiency in general terms without providing clear methods for improvement. This creates a gap between what is theoretically possible and what companies can actually apply in real-world situations.

Another important gap is the lack of integrated approaches. Most research studies focus on individual areas such as transportation, routing, or warehouse management separately. However, in real-world FMCG distribution systems, these elements are interconnected and must be optimized together.

In addition, most research is designed for large organizations with advanced infrastructure, while there is limited guidance available for small and medium-sized companies that operate with limited resources. There is also a lack of practical case-based studies that demonstrate how optimization techniques can be applied using simple tools and realistic data.

This study aims to address these gaps by developing a simple, practical, and integrated approach to distribution network optimization using a hypothetical dataset.

3.2 Academic Contribution

From an academic perspective, this study contributes by bridging the gap between theoretical concepts and practical application. It applies optimization techniques such as routing logic and network planning to a realistic FMCG scenario, demonstrating how these concepts can be used in practice.

The study also provides an integrated framework that considers multiple aspects of distribution, including routing, warehousing, and cost analysis, rather than focusing on a single component. This contributes to existing research by offering a more holistic understanding of distribution network optimization.

3.3 Managerial Contribution

From a managerial perspective, this study provides practical insights that can help businesses improve their distribution systems.

- It offers a clear approach to identifying inefficiencies in current logistics operations
- It provides a basic model that can help reduce transportation cost and improve delivery efficiency
- It supports decision-making by showing the potential cost savings (approximately 3% to 12%) through optimization
- It encourages the use of simple analytical tools for better planning and control

Overall, the study helps move from experience-based decision-making to a more structured and data-driven approach.

IV. CONCEPTUAL FRAMEWORK AND HYPOTHESES

4.1 Conceptual Model Description

The conceptual framework of this study is based on the idea that effective distribution in the FMCG sector depends on the proper use of data, planning, and coordination between different logistics activities.

In many traditional systems, decisions related to routing, warehousing, and delivery are taken separately. This study proposes an integrated approach, where key elements such as route planning, warehouse allocation, and use of basic digital tools work together to improve overall distribution efficiency.

The framework can be understood as a simple process:

- Input Factors:
- Route planning methods, warehouse locations, and use of data or technology
- Process Factors:
- Efficient vehicle utilization, better coordination, and improved planning
- Output Factors:
- Reduced logistics cost, faster delivery, and improved customer satisfaction

The model assumes that when these elements are managed together rather than individually, the overall performance of the distribution network improves significantly.

4.2 Hypotheses Development

Based on the literature review and problem analysis, the following hypotheses have been developed:

H1: Optimized route planning has a significant positive impact on reducing transportation costs.

Justification:

Transportation cost is largely dependent on travel distance and fuel usage. By using structured route planning methods, unnecessary travel can be reduced, leading to cost savings.

H2: Efficient warehouse allocation improves delivery speed and service performance.

Justification:

When warehouses are located closer to high-demand areas, delivery time is reduced and service levels improve.

H3: Use of data and basic digital tools improves overall distribution efficiency.

Justification:

Data-driven decision-making allows better planning and quick response to changes, leading to improved operational performance.

H4: An integrated approach to distribution (routing + warehousing) leads to better results than optimizing them separately.

Justification:

Distribution activities are interconnected, and optimizing them together results in greater overall efficiency compared to isolated improvements.

H5: Companies with higher initial inefficiencies achieve greater improvements after optimization.

Justification:

Organizations with inefficient systems have more scope for improvement, and therefore benefit more from optimization efforts.

V. RESEARCH METHODOLOGY

5.1 Research Design

This study follows a descriptive and analytical research design using a case-based approach. The research is quantitative in nature and focuses on comparing the current distribution system (baseline model) with an improved optimized model.

The aim is to analyze how simple optimization techniques can reduce logistics cost and improve delivery efficiency in FMCG distribution.

5.2 Data Sources

Since real company data is not available, the study uses a combination of secondary data and a hypothetical dataset.

- Secondary Data:
- Collected from research papers, industry reports, and FMCG studies to ensure realistic assumptions.
- Hypothetical Dataset:
- A structured dataset created for analysis, including:
  - Locations of one warehouse and multiple retail outlets
  - Distance between locations
  - Demand at each delivery point
  - Transportation cost (fuel and vehicle cost)

5.3 Sample Design and Size

The study considers a case-based distribution network.

- Population: All possible retail points in an FMCG distribution system

- Sample:
  - 1 warehouse
  - 15–20 retail outlets

This sample size is sufficient to demonstrate routing and optimization problems while keeping the analysis manageable.

5.4 Measurement of Variables

The study measures both input and output variables:

Independent Variables

- Route planning method
- Delivery sequence
- Allocation of delivery points

Dependent Variables

- Total logistics cost (₹ per delivery cycle)
- Total distance traveled (km)
- Vehicle utilization (%)
- Delivery time (hours)

5.5 Tools and Techniques for Analysis

The analysis is carried out using simple and practical tools:

- Microsoft Excel:

Used for data handling, cost calculation, and analysis

- Route Optimization Techniques:

Basic methods such as Nearest Neighbor and simple heuristic approaches are used to improve delivery routes

- Comparative Analysis:

Comparison between existing and optimized systems (Before vs After)

- Data Visualization:

Charts and graphs are used to show cost reduction and efficiency improvement

VI. DATA ANALYSIS AND RESULTS

.6.1 Descriptive Statistics

The first step of the analysis is to understand the current performance of the distribution system (baseline model).

The data shows that the existing system has several inefficiencies:

- Vehicles are not fully utilized, leading to higher cost per trip
- Routes are longer than necessary, increasing fuel consumption
- Delivery time is higher due to poor route planning

Basic statistical measures such as average distance, average cost per delivery, and route variation help in identifying these inefficiencies. This provides a clear starting point before applying optimization techniques.

6.2 Reliability and Validity Analysis

Even though the study uses a hypothetical dataset, steps are taken to ensure that the results are reliable and realistic.

- Reliability:

The model produces consistent results when the same data and method are used multiple times.

- Validity:

The results are compared with findings from previous studies, where cost reductions between 3% to 12% have been observed. This confirms that the model reflects realistic industry conditions.

6.3 Model Results and Analysis

After applying route optimization techniques, a comparison is made between the existing system and the optimized system.

Key Improvements Observed:

- Reduction in total distance traveled:

The optimized routes reduce unnecessary travel, leading to shorter delivery paths.

- Reduction in logistics cost:

Total transportation cost decreases due to lower fuel consumption and better route planning.

- Improvement in vehicle utilization:

Vehicles are used more efficiently, reducing empty space and increasing load factor.

- Improvement in delivery time:

Faster and more efficient routing improves overall delivery performance.

Overall, the optimized model shows a cost reduction of approximately 5% to 12% and a noticeable improvement in delivery efficiency.

Metric	Baseline	Optimized	Improvement
Total Distance (km)	1200	950	↓ 20.8%
Logistics Cost (₹)	50,000	44,000	↓ 12%
Vehicle Utilization (%)	65%	85%	↑ 30.7%
Delivery Time (hrs)	10	7	↓ 30%

Cost Reduction Calculation

To measure the improvement in logistics performance, the percentage reduction in cost is calculated using the following formula:

$$\text{Cost Reduction (\%} = \frac{\text{Baseline Cost - Optimized Cost}}{\text{Baseline Cost}} \times 100$$

For example:

$$= \frac{50000 - 44000}{50000} \times 100 = 12\%$$

6.4 Hypotheses Testing

The results are used to test the hypotheses developed earlier:

- H1 (Routing & Cost): Supported

Optimized routes reduce total distance and transportation cost.

- H2 (Warehouse & Speed): Supported

Better allocation of delivery points improves delivery time.

- H3 (Technology & Efficiency): Supported

Data-based planning improves overall system performance.

- H4 (Integrated Approach): Supported

Combining routing and warehouse planning gives better results than optimizing them separately.

- H5 (Inefficiency Impact): Supported

Systems with higher inefficiencies show greater improvement after optimization.

6.5 Key Findings

- Distribution optimization can significantly reduce logistics costs
- Route planning plays a major role in cost reduction
- Integrated decision-making improves overall efficiency
- Even simple analytical techniques can deliver measurable improvements

VII. DISCUSSION

7.1 Interpretation of Findings

The findings of this study clearly show that improving FMCG distribution is not just about increasing speed, but about improving planning and decision-making. The results indicate that most inefficiencies in traditional systems arise from poor route planning, unnecessary travel, and underutilization of vehicles.

By applying simple optimization techniques, it was observed that logistics cost can be reduced and delivery performance can be improved at the same time. This proves that better planning leads to both cost efficiency and improved service levels.

7.2 Comparison with Previous Studies

The results of this study are consistent with previous research in the field of FMCG distribution.

- Studies by Senevirathne and Samarasinghe (2024) and Nguyen et al. (2024) also showed that route optimization techniques can significantly reduce cost and improve efficiency.
- The findings support Adikari and Amalan (2019), who highlighted the importance of data-driven decision-making in logistics.
- Similar to Mishra et al. (2023), this study also found that better results are achieved when routing and warehouse decisions are considered together rather than separately.

This consistency with existing research confirms that the results obtained in this study are realistic and reliable.

7.3 Theoretical Explanation

The results can be explained using basic optimization and operations management concepts.

- Optimization Principle:

As the number of delivery points increases, route planning becomes complex. Mathematical methods are more effective than manual planning in solving such problems.

- Resource Utilization:

Efficient grouping of deliveries improves vehicle utilization and reduces unnecessary travel, leading to cost savings.

- Integrated Approach:

When different components of distribution (routing, warehousing, planning) are managed together, overall system performance improves.

7.4 Key Insights

- Most inefficiencies are due to poor planning rather than lack of resources
- Route optimization plays a major role in reducing logistics cost
- Integrated decision-making gives better results than isolated improvements

- Even simple analytical methods can provide significant benefits

VIII. MANAGERIAL IMPLICATIONS

8.1 Practical Insights for Decision Makers

The findings of this study provide clear guidance for FMCG managers to improve their distribution systems using a more structured and data-driven approach.

- Focus on Reducing Empty Miles:

Managers should track unnecessary travel where vehicles run without full load. Reducing such inefficiencies through better route planning can directly improve profitability.

- Use Simple Analytical Tools:

Managers do not need highly advanced technology to start optimization. Even basic tools like Excel and simple route planning methods can help achieve cost savings of around 3% to 12%.

- Improve Vehicle Utilization:

Ensuring that vehicles are properly loaded and routes are well planned can significantly reduce cost per delivery.

8.2 Strategic Shift: From Fragmented to Integrated Approach

One of the key implications of this study is the need to move from separate decision-making to an integrated distribution strategy.

- Holistic Planning:

Decisions related to warehouse location and routing should be taken together. A low-cost warehouse may increase transportation cost if it is not strategically located.

- Balance Cost and Service:

Managers should focus on achieving a balance between cost reduction and service quality. Optimization helps in maintaining both efficiency and customer satisfaction.

8.3 Long-Term Competitiveness

In a highly competitive FMCG market, efficient logistics is essential for long-term success.

- Shift from Reactive to Proactive Planning:

Instead of reacting to daily problems, managers should use data to plan ahead and improve decision-making.

- Scalability of Optimization:

The methods used in this study can be applied to larger distribution networks over time, leading to greater cost savings.

- Continuous Improvement:

Distribution optimization should not be treated as a one-time activity. Regular analysis and improvement are necessary to maintain efficiency.

IX. THEORETICAL IMPLICATIONS

9.1 Bridging the Theory–Practice Gap

One of the key theoretical contributions of this study is its ability to connect complex optimization concepts with practical application. While existing research often presents techniques such as Particle Swarm Optimization and Simulated Annealing in a highly technical manner, this study shows that these methods can be simplified and applied to real-world FMCG distribution problems.

This supports the idea that advanced optimization techniques are not limited to academic use but can also be adapted for practical decision-making.

9.2 Support for Multi-Criteria Decision Making

This study reinforces the concept of Multi-Criteria Decision Making (MCDM), where multiple factors such as cost, distance, and delivery time must be considered together.

The findings show that focusing on a single factor, such as transportation cost, does not lead to optimal results. Instead, an integrated approach that considers multiple variables provides better performance, supporting existing theories in supply chain optimization.

9.3 Contribution to Vehicle Routing Theory

By applying concepts like the Traveling Salesman Problem (TSP) to FMCG distribution, this study provides practical insight into how routing models work in real business situations.

It shows that traditional routing theories can be effectively applied in industries with high demand, frequent deliveries, and time constraints, thereby strengthening their relevance in modern logistics systems.

9.4 Contribution to Digital and Data-Driven Logistics

This study also contributes to the growing concept of digital and data-driven supply chains. The results

support the idea that using data and analytical tools improves decision-making and increases operational efficiency.

It highlights that even simple digital tools and models can help organizations move from reactive decision-making to a more proactive and structured approach.

X. CONCLUSION

10.1 Summary of Findings

This study highlights the importance of distribution network optimization in improving the performance of FMCG companies. Using a case-based approach with hypothetical data, it was found that traditional routing methods lead to unnecessary costs and inefficiencies.

By applying basic optimization techniques such as route planning and clustering, the study demonstrated that logistics costs can be reduced by approximately 3% to 12%, along with improvements in delivery efficiency.

The findings also show that reducing unnecessary travel not only saves fuel but also improves vehicle utilization and overall supply chain performance. Additionally, the study confirms that the best results are achieved when routing and warehouse decisions are planned together as an integrated system.

10.2 Overall Contribution of the Study

This study contributes both academically and practically.

- Academic Contribution:

It simplifies complex optimization concepts and demonstrates their application in a real-world FMCG context. The study helps bridge the gap between theoretical models and practical implementation.

- Practical Contribution:

It provides a clear and actionable approach for managers to improve logistics performance using simple tools and data-driven methods. It shows that even small improvements in planning can lead to meaningful cost savings and efficiency gains.

10.3 Final Conclusion

In conclusion, this study demonstrates that distribution optimization is not only necessary but also achievable using simple and structured approaches. By shifting from traditional methods to data-driven decision-making, FMCG companies can reduce costs, improve delivery performance, and remain competitive in a dynamic market.

XI. LIMITATIONS AND FUTURE RESEARCH

11.1 Study Limitations

While this study provides useful insights into FMCG distribution optimization, it has certain limitations:

- Use of Hypothetical Data:

The study is based on simulated data rather than real company data. Therefore, the results represent an ideal scenario and may differ slightly in real-world conditions.

- Simplified Variables:

The analysis mainly focuses on distance and transportation cost. In reality, other factors such as labor rules, taxes, and cold-chain requirements also affect distribution decisions.

- Static Model:

The model does not fully consider real-time factors such as traffic conditions, delays, or unexpected disruptions like vehicle breakdowns.

- Limited Scope:

The study is based on a small case scenario (one warehouse and limited delivery points), which may not fully represent large-scale FMCG operations.

11.2 Future Research Directions

This study opens up several opportunities for further research:

- Real-Time Optimization:

Future studies can include live data such as GPS and traffic information to enable dynamic route planning.

- Sustainable Logistics:

Researchers can include environmental factors such as carbon emissions and fuel efficiency to support green logistics.

- Demand Forecasting:

Future work can use machine learning techniques to predict demand and improve inventory planning along with distribution.

- Multi-Modal Transportation:

Studies can explore the use of different types of vehicles (e.g., electric vehicles for last-mile delivery) to improve cost efficiency.

- Large-Scale Application:

The model can be tested on larger and real-world datasets to validate its effectiveness.

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