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Title:

OPTIMIZING COST TO SERVE IN SUPPLY CHAIN MANAGEMENT: STRATEGIES FOR ENHANCING PROFITABILITY AND CUSTOMER SATISFACTION

Submitted by:

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In Partial Fulfillment of the Requirements for the Degree of

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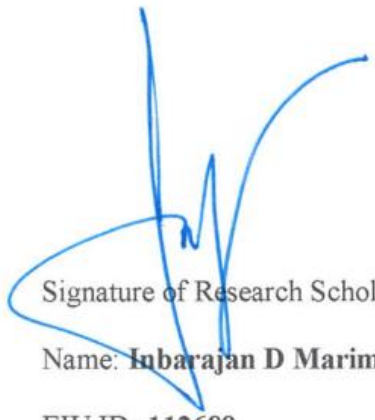
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Feb – 2024

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Dr. V.B. Kumaresan

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ABSTRACT

This thesis explores the changing position of Cost to Serve (CTS) as a strategic management tool in the supply chain (SC) management area. The study starts by analyzing the fundamental idea of CTS, noting its importance in tracing operating expenses alongside customer value delivery. The research acknowledges that with the competitive and customer-centric markets of the present times, particularly the Indian technology and fashion retail industries, organizations face greater pressure to minimize wasteful expense while ensuring high levels of services. Through the discovery of inefficiencies in logistics, inventory, order processing, and fulfillment, CTS becomes a performance driver that can improve cost efficiency without affecting service quality. The objectives of the thesis revolve around comprehending CTS in detail, determining what affects it, evaluating its effect on SC performance and profitability, and finally developing a framework for optimizing CTS effectively.

For these purposes, a mixed-method research design was employed, integrating qualitative insights with quantitative rigor. Data was gathered by means of a structured survey that was sent to 250 supply chain professionals in major metropolitan areas of India, i.e., Bengaluru, Mumbai, Delhi NCR, and Hyderabad. These respondents from fashion retail and technology sectors were chosen purposively based on their operational experience and decision-making positions in SC functions like finance, logistics, and sales. Exploratory Factor Analysis (EFA) was employed to cross-validate the scale and reduce the data into significant dimensions, evidenced by high KMO scores (>0.95) and large Bartlett's tests. The product of two-factor structure resulted in elucidation of the strategic and operational spheres of CTS, and Factor 1 explained more than 65% of the variance—indicating a prevailing underlying construct. Besides, statistical methods including correlation and regression analysis established strong associations between CTS approaches and performance measures such as cost effectiveness, customer satisfaction, and resilience, confirming CTS as a SC success predictor.

Apart from empirical contributions, the thesis adds to the literature by filling in crucial research gaps—most signally the failure to consider interdepartmental collaboration, incorporating sustainability within cost models, sector-level implementation, and the ethical thinking of profitability in customer-oriented operations. The conceptual framework suggested here brings these dimensions together, connecting CTS optimization solutions to overall organizational performance and framing CTS not only as an economic measurement, but as a critical building block of scalable and sustainable supply chain design. Practical guidance involves embracing data analytics to track detailed costs, driving cross-functional alignment, and customizing CTS solutions to particular customer groups. Therefore, this research not only enhances theoretical understanding in the area of SC management but also facilitates actionable insights that allow organizations to navigate intricate cost-service trade-offs in a competitive and risk-prone global economy.

Keywords: Cost to Serve (CTS), Supply Chain Management, Profitability, Customer Satisfaction, Operational Efficiency, Strategic Cost Management, Factor Analysis, Fashion Retail, Technology Sector, India, Circular Economy, Service Optimization.

TABLE OF CONTENTS

TOPIC.....PAGE NO

INNER FIRST PAGE i

DECLARATION BY THE CANDIDATE ii

CERTIFICATE BY THE SUPERVISOR iii

ACKNOWLEDGEMENTS iv

ABSTRACT ..... v-vi

TABLE OF CONTENTS ..... vii-ix

LIST OF TABLES x

LIST OF FIGURES xi

LIST OF ABBREVIATIONS ..... xii-xiii

CHAPTER I: INTRODUCTION 1-42

1.1 BACKGROUND OF STUDY 1

1.2 COST TO SERVE: DEFINITION AND IMPORTANCE 2

1.3 FACTORS INFLUENCING COST TO SERVE IN SUPPLY CHAINS 4

1.4 IMPACT OF CTS ON SUPPLY CHAIN PERFORMANCE AND PROFITABILITY 7

1.5 CASE STUDIES OF SUCCESSFUL CTS OPTIMIZATION 10

1.6 TECHNOLOGICAL SOLUTIONS FOR CTS MANAGEMENT 13

1.7 FRAMEWORK FOR EFFECTIVE CTS OPTIMIZATION 16

1.8 SIGNIFICANCE OF STUDY 20

1.9 OBJECTIVES OF STUDY 23

1.10 RESEARCH QUESTIONS 23

1.11 LIMITATIONS OF STUDY 24

1.12 TENTATIVE CHAPTER SCHEME 26

1.13 CHAPTER SUMMARY 28

CHAPTER II: REVIEW OF LITERATURE ..... 29 -54

2.1 INTRODUCTION 29

2.2.1 Understanding the Components of Cost to Serve (CTS) in Supply Chain Management 29

2.2.2 Influence of Customer and Order Characteristics on Cost to Serve (CTS) 33

2.2.3 Cost to Serve (CTS) Optimization and Its Impact on Supply Chain Performance 37

2.2.4 Strategies and Best Practices for Managing and Reducing Cost to Serve (CTS) 41

2.2.5 Role of Technology and Data Analytics in Cost to Serve (CTS) Optimization 46

2.2 RESEARCH GAPS IDENTIFIED 50

2.3 CHAPTER SUMMARY 53

CHAPTER III: RESEARCH METHODOLOGY 55-87

3.1 INTRODUCTION 55

3.2 NEED FOR THE STUDY 56

3.3 IMPORTANCE OF STUDY 58

3.4 RESEARCH PROBLEM 60

3.5 RESEARCH OBJECTIVES 62

3.6 RESEARCH HYPOTHESIS 63

3.7 RESEARCH PROCESS 63

3.8 RESEARCH DESIGN 66

3.9 CONCEPTUAL FRAMEWORK 68

3.10 POPULATION AND SAMPLING 71

3.10.1 Population 71

3.10.2 Sample Size 71

3.10.3 Sampling Method 72
3.10.4 Sample Size Determination and Formula 72
3.10.5 Inclusion and Exclusion Criteria 73
3.11 STUDY AREA AND ITS PROFILE 73
3.12 DATA COLLECTION 74
3.12.1 Questionnaire Development 75
3.13 STATISTICAL TOOLS AND TECHNIQUES 78
3.14 PILOT STUDY 81
3.15 ETHICAL CONSIDERATIONS 83
3.16 CHAPTER SUMMARY 86
CHAPTER IV: DATA ANALYSIS AND INTERPRETATION 88-115
4.1 INTRODUCTION 88
4.2 DEMOGRAPHIC PROFILE OF RESPONDENTS 88
4.3 FACTOR ANALYSIS 95
4.4 RELIABILITY ANALYSIS 102
4.4.1 Reliability of CTS Optimization items 103
4.4.2 Reliability of Supply Chain Performance and Profitability items 103
4.5 INTERPRETATION WITH RESPECT TO OBJECTIVES 104
4.6 INTERPRETATION OF RESULTS 107
4.7 DISCUSSION 111
4.8 CHAPTER SUMMARY 114
CHAPTER V: SUMMARY AND CONCLUSION 116-134
5.1 KEY FINDINGS 116
5.2 SUMMARY 119
5.3 CONCLUSION 125
5.4 SUGGESTIONS AND RECOMMENDATIONS 128
5.5 SCOPE FOR FURTHER RESEARCH 130
BIBLIOGRAPHY 135-144

LIST OF TABLES

Table 4.1 Age 89

Table 4.2 Gender 90

Table 4.3 Education 91

Table 4.4 Position 92

Table 4.5 Experience 93

Table 4.6 Organization 94

Table 4.7 Organizational Size 95

Table 4.8 KMO and Bartlett's Test 96

Table 4.9 Communalities 96

Table 4.10 Total Variance Explained 97

Table 4.11 Rotated Component Matrixa 98

Table 4.12 KMO and Bartlett's Test 99

Table 4.13 Communalities 100

Table 4.14 Total Variance Explained 101

Table 4.15 Rotated Component Matrixa 102

Table 4.16 Reliability of CTS Optimization items 103

Table 4.17 Reliability of Supply Chain Performance and Profitability items 104

Table 4.18 Variables Entered/Removeda 105

Table 4.19 Model Summary 105

Table 4.20 ANOVAa 106

Table 4.21 Coefficientsa 106

Table 4.22 Results of Hypothesis Testing 107

LIST OF FIGURES

Figure 3.1 Research Process 66

Figure 3.2 Conceptual Framework 69

Figure 4.1 Age 89

Figure 4.2 Gender 90

Figure 4.3 Education 91

Figure 4.4 Position 92

Figure 4.5 Experience 93

Figure 4.6 Organization 94

Figure 4.7 Organizational Size 95

LIST OF ABBREVIATIONS

Abbreviations	Full Form
SC	Supply Chains
CTS	Cost To Serve
D2C	Direct-To-Customer
B2B	Business-To-Business
3PL	Third-Party Logistics
SLAs	Service-Level Agreements
OTIF	On Time and In Full
CCHBC	Coca-Cola Hellenic Bottling Company
GSK	Glaxosmithkline
IBP	Integrated Business Planning
SCM	Supply Chain Management
SAP	Systems, Applications, And Products In Data Processing
RPA	Robotic Process Automation
TMS	Transportation Management Systems
WMS	Warehouse Management Systems
AGVs	Automated Guided Vehicles
ERP	Enterprise Resource Planning
SME	Small And Medium-Sized Enterprise
CRM	Customer Relationship Management
GSCM	Green Supply Chain Management
E-commerce	Electronic Commerce
BSC	Balanced Scorecard
KPIs	Key Performance Indicators

IoV	Internet of Vehicles
CSP	Concentrated Solar Power
CGE	Computable General Equilibrium
AI	Artificial Intelligence
TAM	Technology Acceptance Model
SEM	Structural Equation Modelling
Delhi NCR	Delhi- National Capital Region
IoT	Internet of Things

CHAPTER – I

INTRODUCTION

1.1 BACKGROUND OF STUDY

The need of cost control in global supply chains (SC) is paramount within today's interconnected world. The emergence of globalization has not only broadened market access but also generated a heightened level (lvl.) of complexity in logistical operations. The complexity, stemming from the sophisticated network of international trade channels, varied regulatory frameworks, and multifaceted supplier connections, necessitates excellent cost-management measures. Businesses seeking to sustain competitiveness and guarantee profitability in this changing environment encounter the persistent problem of optimizing their SC operations (Ketchen Jr et al., 2008). The ability to effectively manage expenses significantly affects a company's profitability and its capacity to provide competitive pricing, so shaping its market position and customer satisfaction lvl.s. Managing costs in global SCs has numerous issues that can severely impede operational efficiency and financial success. A key challenge is the variability of transportation costs, affected by unstable fuel prices, evolving environmental rules, and the accessibility of transportation options (Kauppi et al., 2016). Moreover, labor rates fluctuate significantly between countries, indicative of disparities in economic development, labor regulations, and the accessibility of trained labor. Currency exchange risks exacerbate cost management challenges, as variations influence procurement expenses, pricing strategies, and profit margins.

Furthermore, the intricacy of managing activities across various countries, each possessing distinct regulatory mandates and logistical obstacles, introduces an additional lvl. of complexity. The amalgamation of these components engenders a volatile environment in which conventional cost management approaches may prove inadequate, hence requiring a reassessment of tactics to adeptly traverse the global SC landscape (Brown, 2001). This study examines efficient solutions for cost management in global SCs. In light of the identified issues, there is a distinct necessity for solutions that are efficient, adaptable, and applicable across various sectors and geographical regions (Nagle & Müller, 2017). The emphasis will be on

identifying and analyzing cost management practices that can endure diverse global market conditions, regulatory frameworks, and operational scales. This research aims to furnish a framework for enterprises to optimize their SC expenditures, thereby augmenting their competitiveness and profitability in the international market. The importance of this work cannot be overlooked. For globally running firms, mastering cost management within the SC is a crucial factor for success. In an age where competitive pressures and customer expectations continually compress margins, the capacity to effectively manage costs can distinguish between prospering and barely surviving. Moreover, stakeholders engaged in SC management, including logistics providers and regulatory agencies, gain from an enhanced comprehension of efficient cost management measures. This research is an essential resource for organizations aiming to manage the intricacies of global SCs, providing insights for survival and prosperity in the contemporary global economy. This study seeks to enhance the profession by elucidating universally applicable solutions and the complexities of global SC cost management, offering practical information for practitioners and policymakers.

1.2 COST TO SERVE: DEFINITION AND IMPORTANCE

Cost to Serve (CTS) is an operational and financial strategic measure that expresses the total cost incurred in providing a product or even service to a particular customer or customer group. These costs encompass all direct and indirect costs including the purchase of raw material, production cost, holding cost on inventory, warehousing cost, packaging, transportation and distribution costs, customer service functions, reverse logistics and return, billing, and overheads. Differing from traditional costing systems that tend to average or generalize costs for all customers and products, CTS provides a more nuanced and customer-oriented perspective on cost allocation. This enables companies to determine the actual cost of serving individual customers, including the entire range of activities involved in origin to delivery (Niraj et al., 2001).

The utility of CTS resides in its ability to release insights that ordinary accounting systems may not capture. Although sales volume and revenue are popular measures of performance, they don't show how much profit a specific customer or channel generates once service-related expenses are factored in. A high-revenue customer may

look valuable at first glance, but CTS analysis may show that the expense of serving their frequent, small, or highly customized orders makes the relationship unprofitable. In the same way, those products that make high sales could also be out of proportion to distribute or manage. By emphasizing such imbalances, CTS allows companies to spot and mitigate concealed inefficiencies in their SC and transfer resources to more profitable segments (Heikkilä, 2002).

In addition, CTS takes a key position in aiding strategic choice-making for customer segmentation, pricing, channel choice, product portfolio optimization, and service-lvl. agreements. It enables cost-effectiveness to be traded off against customer satisfaction by equating service lvl.s to contribution margins. For example, high-margin customers can be offered premium service, and more commodity-like services can be provided to less profitable segments without eroding overall service quality. Differentiation is a must in extremely competitive and customer-driven markets for profitability to be maintained while different customer expectations are addressed.

Aside from its operational efficiency function, CTS has grown more relevant with the age of SC transformation and digitalization. With big data, artificial intelligence, and advanced analytics available, companies are now able to collect and study large volumes of transactional and behavioral data. When combined with CTS methods, these tools deliver rich dashboards and simulations that enable managers to see the cost effects of different SC configurations and customer behaviors. Consequently, CTS is transforming from a backward-looking financial tool into a predictive, dynamic model that can underpin future-looking value-based SC strategy (Wang et al., 2021).

Thus, cost to serve is a vital framework for comprehending the actual cost and value of customer and product relationships. With its specific, actionable information, CTS enables organizations to improve operational effectiveness, drive profitability, and architect customer-focused SCs that are both sustainable and responsive. Its relevance continues to rise as businesses compete to reconcile cost pressures with growing expectations for speed, personalization, and service excellence in the global economy.

1.3 FACTORS INFLUENCING COST TO SERVE IN SUPPLY CHAINS

Supply chain management Cost to Serve (CTS) metric is influenced by a broad set of inter-related drivers, each of which has a significant bearing on the total cost incurred to meet customer demand. The drivers are not merely internal in nature, such as operational choices and the physical layout of the infrastructure, but also external, including market forces and customers' behaviors. To maximize CTS, companies need to evaluate these factors comprehensively to identify inefficiencies, cost-reduction opportunities, and enhanced service delivery throughout the SC (Garai & Roy, 2020).

Customer order behavior is one of the most significant drivers of CTS and includes variables like order size, order frequency, order variability, and delivery requirements. Customers who order frequently in small quantities, customized, or at short notice generally incur higher fulfillment costs. These orders may necessitate repeated touchpoints—e.g., picking, packaging, invoicing, and shipping—and break up batch processing and transportation efficiencies. For instance, serving a sporadic customer purchasing in small, infrequent amounts could include increased transaction cost, fragmented shipments, and dead delivery time, all contributing to elevated total cost of serving. Conversely, large, consolidated, and regular-ordering customers take advantage of economies of scale and more efficient processing, lowering variable and fixed service expenses.

Characteristics of products constitute another principal driver of CTS. The product's nature, size, weight, shelf-life, fragility, and handling needs all affect the complexity and expense of SC processes. Perishable, temperature-sensitive, hazardous, and special packaging or handling products represent higher compliance and safety requirements. As an instance, the transport of pharmaceutical items may require cold chain logistics with specialized infrastructure, monitoring equipment, and trained personnel—substantially increasing cost to serve. Likewise, excessive product assortment or high SKU proliferation can make it harder to manage inventory, amplify storage space demands, and dampen picking effectiveness in warehouses. Thus, CTS is generally higher for product portfolios that are not standardized and have customized or complex handling processes (Kumari & Kumar, 2023).

Geographic location and delivery distance are also as important in determining CTS. Delivering to distant, rural, or geographically dispersed customers results in higher transportation and distribution costs because of longer travel times, inferior infrastructure, fewer carrier options, and greater likelihood of delivery failures or delays. Overseas deliveries introduce extra layers of complexity, including customs clearance, import/export fees, and regulation compliance, which all add to increasing CTS. Urban traffic and regional traffic rules can further affect last-mile delivery efficiency within urban areas. Hence, companies need to very carefully consider geographic factors while calculating CTS and deciding on network distribution design.

Another important driver is the sophistication and variety of sales and distribution channels. Organizations nowadays tend to function through a combination of direct-to-customer (D2C), business-to-business (B2B), e-commerce websites, retail distributors, and third-party logistics (3PL) providers. Also, each one of these channels comes with its own operational needs, cost models, and service expectations. For instance, selling through e-commerce might require sophisticated digital integration, live inventory management, small parcel delivery, and full returns management systems. Conversely, serving customary wholesale or retail customers could include bulk shipping and less delivery touchpoints. Cost effects are very different based upon whether the company is filling individual consumer orders or maintaining wholesale quantities. Thus, distribution channel selection and distribution channel structure significantly influence CTS results (Gilham, 2023).

Customer service lvl.s and expectation for service also propel differentiation in costs across the SC. Higher-lvl. customers typically require quicker delivery times, tailor-made solutions, instant order monitoring, flexible payment arrangements, and individually focused customer service. Fulfillment of these higher service lvl.s adds expense at several points—faster shipping and priority processing to dedicated customer service representatives and after-sales interaction. Moreover, contractual service-lvl. agreements (SLAs) frequently entail penalties for non-adherence, motivating companies to invest more resources to deliver on time and in full (OTIF). Conversely, dealing with lower-tier or typical customers in many instances facilitates greater operational freedom, which shrinks the demand for premium services and related expenses.

Supply chain structure and infrastructure design also have a critical function in determining CTS. A supply network with a structure that is decentralized, too complex, or poorly synchronized among functional areas will incur greater operating expenses. Poor distribution center layout, poorly located warehouses, and lack of coordination among sourcing, production, and distribution activities lengthen lead times, drive up inventory holding costs, and waste transportation resources. For example, if the warehousing network is not strategically positioned close to large customer concentrations, the consequence is longer transit times and more fuel usage. In addition, inefficient IT systems and a dearth of automation add to duplicate manual processes, increased error rates, and diminished response times—all of which add to the cost to serve (Cho et al., 2012).

Finally, economic and market factors from outside have a significant effect on CTS. Unpredictable fuel prices directly influence logistics and freight fees, while fluctuating labor markets affect wage lvl.s and staffing lvl.s. Tax policy changes, trade agreements, environmental laws, and import/export taxes can add to or diminish operational costs. Disruptions around the world due to pandemics, natural catastrophes, or geopolitical conflict also contribute to SC uncertainty and result in unforeseen expenses from re-routing, expedited freight, or finding alternative sources. In addition, increasing customer demands for quicker, less expensive, and more transparent service place further pressure on SCs to be more agile and resilient—usually at increased expense.

Finally, CTS is influenced by a myriad of variables that cut across customer behavior, product characteristics, geographic factors, service lvl. agreements, channels of distribution, design of operations, and external environmental factors. All these components add uniquely to the aggregate amount spent on servicing customers and satisfying demand. So, companies have to follow a multi-dimensional assessment approach towards such factors involving enhanced analytics and cross-functional interactions for finding opportunities in cost reduction, increasing efficiency, and matching the service lvl. to true profitability. Through realizing and addressing such drivers of costs, firms can establish leaner, more agile, and more resilient SCs.

1.4 IMPACT OF CTS ON SUPPLY CHAIN PERFORMANCE AND PROFITABILITY

Cost to Serve (CTS) has become an important analytical tool for SC management, impacting how organizations assess performance and profitability measurement. Essentially, CTS offers a microscopic picture of all direct and indirect costs involved in serving individual customers, products, or channels. Such costs involve procurement, storage, transportation, order processing, customer service, returns, and support activities. Recognizing these detailed cost structures enables firms to make informed decisions that optimize SC effectiveness while maximizing the bottom line.

Perhaps the most important effect of CTS is that it can reveal inefficiencies that are buried in the overall SC. Conventional accounting tends to average out costs, without seeing disproportionate costs associated with specific customer orders or product groups. CTS, on the other hand, brings these discrepancies to light so that businesses can identify customers who need more resources based on reasons such as small, frequent orders, far-flung delivery points, or custom packaging. When these insights are incorporated into operational planning, companies can reengineer logistics networks, consolidate shipments, or redesign fulfillment flows to eliminate overhead and optimize workflows. For instance, businesses can switch from repeated one-unit shipments towards a strategy supporting bulk deliveries to maximize transportation expense and warehouse man-hours (Tahri, 2024).

CTS is also the basis for performance benchmarking within the SC. It provides companies with a means of testing the cost-sensitivity of their service offerings as well as of making data-supported trade-offs in terms of cost versus customer satisfaction. Where a customer segment proves disproportionately expensive but returns marginal profit, firms can reconsider the service model employed. This could include the alteration of delivery frequency, the transition to standard product configurations, or the implementation of self-service facilities. As a result, CTS enables firms to provide customer-sequenced lvl.s of service based on profitability, and high-value customers are treated preferentially while lower-value segments are served in the most cost-effective manner. This separation enhances total resource utilization and directs SC investment toward business value (Gunasekaran et al., 2001).

CTS is also critical for inventory and demand management. It informs companies of which products most heavily utilize the SC as a result of special storage requirements, low rates of turnover, or high frequency of replenishment. For example, an intensive product that needs climate-controlled storage and daily picking might be much more expensive to serve than a high-turnover item stocked in bulk. When CTS spots such trends, firms can look for alternatives such as demand shaping, product substitution, or product simplification to ease the pressure on their inventory systems. Moreover, precise CTS information boosts demand forecasting by incorporating cost-effectiveness as a variable, thus resulting in more strategic decisions regarding stock location and safety inventory lvl.s geographically or by distribution centers (Ahmed et al., 2024).

Financially, CTS directly impacts profitability analysis. Frequently, businesses take for granted that high-revenue customers or best-selling products are profitable. Yet, when the entire range of servicing expenses is taken into account, such assumptions can be misleading. CTS allows the organization to estimate the actual net profit contribution of every business activity. Such transparency provides more effective segmentation of products and customers, the identification of unprofitable operations, and effective pricing, bundling, and service lvl. decisions. Companies can then exit or restructure unprofitable segments, concentrate efforts on more profitable areas, and enhance customer relationships by being transparent and understanding cost structures together.

In addition, CTS insights greatly enhance pricing strategies. With the actual cost of servicing an order in hand, companies can implement more nuanced pricing models that are tied to service lvl.s. For instance, companies can include tiered pricing, delivery charges, or incentives for good ordering habits. A customer who consistently places bulk orders and crosses minimum order lvl.s can be rewarded with lower rates, while clients with unpredictable order frequency can be charged extra service fees. Not only does this result in equitable cost recovery, but it also dictates customer behavior such that the company's objectives for operational efficiency are better aligned. In the long run, this results in lower overall CTS and higher net margins (Gunasekaran et al., 2004).

In addition to monetary advantages, incorporating CTS into choice-making also creates cross-functional alignment in organizations. When CTS measurements are communicated across marketing, sales, finance, and operations departments, every unit gets a better understanding of how their strategies influence SC costs. For example, a free expedited delivery campaign can be analyzed for its cost-to-serve impact prior to its launch. Similarly, sales forces can be motivated not only on top-line revenue but also on customer profitability, and thus ensuring a more comprehensive growth approach. Such alignment ensures more balanced and strategic initiatives that benefit sustainable value creation throughout the enterprise.

CTS also has a critical role to play in sustainability and corporate responsibility. By identifying wasteful processes—like over-packaging, unnecessary returns, or redundant routes—CTS enables green initiatives to minimize environmental footprint. Businesses can leverage CTS data to streamline delivery schedules, encourage environmentally friendly packaging options, or transition to energy-efficient modes of transportation. With tightening environmental regulations and consumers expecting responsible business practices, using CTS to drive sustainability is both an ethical necessity and a strategic benefit (Sanni, 2024).

In today's globalized and more complex SC world, where competition is intense and customer expectations are high, having the capacity to accurately measure and manage costs is no longer a choice. CTS provides organizations with the strategic intelligence to maximize operations, enhance profitability, and provide better value to customers. It facilitates a move away from cost-cutting reactions to proactive, value-driven management. Those companies that are able to incorporate CTS successfully into their customer, financial, and operating strategies are gaining a competitive advantage by converting cost-intensive details into real improvements.

Therefore, the influence of CTS on SC performance and profitability is significant and multifaceted. It extends visibility, forces operational excellence, enables customer segmentation, enhances price accuracy, and aligns strategic objectives across the business. As companies continue to face uncertainty and disruption, CTS will be an essential weapon for creating strong, profitable, and customer-driven SCs.

1.5 CASE STUDIES OF SUCCESSFUL CTS OPTIMIZATION

Cost to Serve (CTS) optimization is becoming an aggressive approach in business industries to optimize SC, increase profitability, and realign service lvl.s around customer value. Various organizations, such as business leaders, have successfully introduced CTS models for discovering unknown inefficiencies, network redesign, and configuring service portfolios using real-cost information. Such case studies help show the influence of the utilization of CTS concepts to obtain dramatic results from real business instances (Noorsyah et al., 2024).

A. Unilever: Streamlining Service to Diverse Customer Segments

One of the outstanding examples of effective CTS optimization is the working of Unilever, a global giant in consumer goods. With the daunting challenge of a widely scattered and heterogeneous customer base from large-scale supermarkets to small local retailers, Unilever required a better understanding of the actual cost of serving every customer segment. Through a thorough CTS analysis, the firm found that serving smaller retailers tended to call for frequent, low-quantity deliveries, adding substantially to transportation and handling expenses.

The study found that although the customers added marginally to revenue, they utilized a disproportionate amount of logistics resources. With this information in hand, Unilever launched a multi-faceted approach: instituting minimum order quotas, bundling deliveries to minimize transportation frequency, and renegotiating service terms. These adjustments resulted in a quantifiable decrease in delivery expenses and better utilization of warehouses. In addition, Unilever's capability to rebalance service lvl.s in accordance with the profitability of customers enhanced its ties with high-value customers and maximized its entire SC strategy (Narasimhan, 2015).

B. Coca-Cola Hellenic Bottling Company: Rethinking Logistics Networks

Another strong example is from the Coca-Cola Hellenic Bottling Company (CCHBC), a large bottler serving Europe. CCHBC struggled with operations because of the variability of its markets and customer needs, from high-volume urban supermarkets to low-volume rural kiosks. Through CTS analytics, the company calculated the actual cost of serving various types of customers, including transportation, warehousing, order processing, and returns

The findings indicated that the "one-size-fits-all" delivery model was inefficient and created inefficiencies. To address this, CCHBC reorganized its logistics strategy by creating segmented service models. Direct deliveries with frequent replenishment were made to high-volume customers, while lower-volume customers were serviced via regional hubs and scheduled deliveries. This segmentation not only enhanced the profitability of the company by lowering cost-to-serve but also enabled it to deliver consistent service lvl.s customized to every customer segment. The initiative supported CCHBC's competitive advantage and improved its ability to respond dynamically to market shifts (Jaboob et al., 2024).

C. Walmart: Scaling Cost to Serve Optimization

In the retail industry, Walmart is a prime example of how CTS optimization can be scaled. As with its huge chain of suppliers, distribution points, and retail stores, Walmart's control over the cost of operation is key to maintaining its price-low business strategy. The corporation used CTS tools to investigate the fine costs of various categories of products, supplier networks, and store delivery systems. As an example, Walmart learned that some high-margin items incurred additional storage and shipping expenses due to ineffective packaging or inconsistent supplier delivery schedules.

With these results, Walmart partnered with suppliers to re-engineer packaging that maximized space on the package and simplified pallet configuration. The retailer also instituted a more lean vendor-managed inventory system that eliminated stockouts and cut handling expenses. These initiatives, initiated through CTS analysis, increased SC transparency, eliminated overhead, and aided Walmart in passing cost efficiencies to customers without compromising profitability.

A significant industrial case study is that of a European construction equipment company, which was facing margin pressures and rising competition. The firm had a complicated product portfolio with a great count of customizations and after-sales services. Also, with a CTS approach, it was found that most customization requests were not only expensive but were also provided free of cost, thus eating into margins. Additionally, expedited shipping for spare parts and dispersed service requests incurred additional costs.

To address this, the company restructured its pricing strategy to reflect actual service costs, introduced a tiered service model, and invested in predictive analytics to manage spare parts inventory more efficiently. The result was a significant improvement in cost recovery, enhanced resource allocation, and higher customer satisfaction due to clearer service expectations and better turnaround times.

D. GlaxoSmithKline: Enhancing Service Delivery in the Pharmaceutical Industry

Within the pharma sector, GlaxoSmithKline (GSK) is a robust example of CTS-led transformation. With a huge number of SKUs and tight regulatory demands, GSK's SC was extremely complex. A CTS study identified that remote, small pharmacies and clinics needed more per-unit costs of service, fueled by longer delivery routes, smaller order quantities, and regulatory documentation requirements.

Rather than cutting back on service, GSK decided to build regional distribution hubs and implemented a hybrid logistics approach. High-usage areas still saw direct shipments, but low-usage zones were provided through centralized hubs. GSK also upgraded its demand planning systems to enhance forecast accuracy and minimize last-minute expedited shipments. These initiatives lowered overall logistics expenditures considerably while ensuring regulatory compliance and better delivery reliability (Shoushtari et al., 2021).

Throughout these varied cases, the success of CTS optimization is clear in its capacity to provide visibility into actual service cost and facilitate strategic choice-making. What ties these companies together is their desire to act on CTS insights—not merely to reduce costs, but to realign operations in a manner that supports profitability and adds value to the customer. Through investments in data analytics, cross-functional collaboration, and ongoing process improvement, these businesses reengineered their SC strategies from reactive to proactive. Not only do the outcomes yield improved financial performance, but they also build more robust, resilient SCs to thrive in a dynamic market environment. Therefore, these case studies highlight that CTS is significantly more than just a cost reduction tool—it happens to be a strategic map that leads the design of service, operations planning, and profit analysis. Whatever the sector—the consumer goods sector, the retail sector, industrial manufacturing,

healthcare—CTS gives companies the leverage to differentiate the service offer, customize the approach to logistics, and eventually have nimbler and customer-aligned SCs.

1.6 TECHNOLOGICAL SOLUTIONS FOR CTS MANAGEMENT

With the fast-changing nature of the SC in today's environment, technology has become an essential aspect of maximizing Cost to Serve (CTS) management. The intricate nature of the modern SC, along with the greater demand for live data and choice-making, has necessitated that companies utilize technology to control and maximize their CTS. A variety of technological alternatives exist to boost the efficiency, precision, and efficacy of CTS management such that firms are able to retain profitability while also providing high standards of customer satisfaction (Gunasekaran et al., 2008).

a) Advanced Analytics and Data Visualization Tools

One of the most meaningful technological advancements in CTS management is the adoption of advanced analytics and data visualization tools. These solutions allow businesses to acquire, analyze, and interpret vast data amounts from their SC activities, giving them in-depth insights into cost drivers and customer-specific costs. Advanced analytics solutions can break down costs by geographic location, customer type, product category, and service requirements, enabling businesses to see cost inefficiencies and areas for optimization.

Data visualization software assists in the transformation of analytical data into a simple-to-consume visual representation like charts, graphs, and dashboards. This enables effective choice-making and communication between departments. For instance, a SC manager is able to determine which products or customer segments cost the most, allowing them to correct the issues in live. Technologies like Power BI, Tableau, and Qlik are widely used in the sector for such initiatives (Bose et al., 2024).

b) Artificial Intelligence (AI) and Machine Learning (ML)

AI and ML are transforming CTS management by facilitating predictive modeling, automation, and optimization of choice-making. AI and ML can look at past data and customer behavior to forecast future demand, anticipate SC breakdowns,

and optimize inventory control. This helps companies fulfill customer demand at the right time and location while reducing unnecessary expenses.

For example, demand forecasting with AI can anticipate which products tend to be on demand based on trends, seasons, and the state of markets. This results in more reliable production and planning for distribution so that overstock or stockouts are minimized and unnecessary expenses result. ML-based algorithms can even detect patterns that might not catch the eye in CTS, like detecting a poor-performing supplier or geographies with irregularities in scheduling deliveries. Artificial intelligence-based chatbots and virtual assistants are also utilized to manage customer inquiries, order tracking, and returns handling, thereby lowering administrative expenses and enhancing customer service (Ko et al., 2010).

c) Internet of Things (IoT)

The IoT is yet another radical technology instrumental in streamlining CTS. IoT devices like sensors and smart tags can be employed across the SC to capture live data about inventory lvl.s, product condition, location, and transit times. These pieces of information enable enterprises to monitor every aspect of the product journey from manufacturing, to delivery, to the end customer

Through IoT solutions, businesses have the ability to see the true cost of moving goods, storing products, or handling returns. For example, IoT sensors in transport vehicles can offer visibility into delivery times, fuel consumption, and vehicle maintenance cost, enabling businesses to determine where efficiency can be gained. IoT can optimize space utilization and enhance order picking accuracy in warehouses, resulting in reduced handling cost. Furthermore, IoT technology can boost customer satisfaction by delivering precise delivery tracking and live updates (Sabri & Beamon, 2000).

d) Cloud-Based Supply Chain Management Platforms

Cloud-based SC management solutions are increasingly adopted to manage and optimize CTS. The solutions give companies a live, centralized visibility of their entire SC, allowing them to coordinate easily with suppliers, logistics providers, and customers. The cloud environment supports easy data sharing and communication, eliminating silos and fast-tracking decisions.

These platforms are capable of integrating SC functions like procurement, production, distribution, and customer service, with end-to-end visibility. With the centralization of data and automation of processes, cloud-based platforms facilitate streamlined operations, low overhead, and the ability to deliver service lvl. agreements without taxing resources. SAP Integrated Business Planning (IBP), and Oracle SCM Cloud, along with Microsoft Dynamics 365 are some cloud-based offerings that allow companies to better manage and optimize CTS (Mittal et al., 2024).

e) Robotic Process Automation (RPA)

Robotic Process Automation (RPA) is increasingly being adopted in SC processes to eliminate manual, tedious work. Under CTS management, RPA can be implemented to automate business processes like order processing, billing, and communication with customers. By automating such mundane operations, companies are able to decrease labor costs, lower errors, and speed up order processing

For example, RPA can be used to automate the process of creating invoices from live data so that the billing process is both accurate and timely. Likewise, RPA bots can respond to customer service questions, monitor shipments, and keep customers informed of delivery status, allowing workers to concentrate on more value-added work. Consequently, the cost-to-serve is minimized, and customer satisfaction increases (Al Shukaili et al., 2023).

f) Blockchain Technology

Blockchain technology is also picking up speed in SC management as a means to promote transparency, security, and efficiency. Blockchain gives a decentralized and tamper-proof ledger, which enables live tracking and validation of products through the SC. Through storing each transaction on a secure along with transparent platform, blockchain minimizes the chances of fraud, disagreements, and holdups.

In the case of CTS, blockchain can be employed to monitor product movement, guarantee regulatory compliance, and authenticate product origin. This minimizes return risk and customer dissatisfaction, hence reducing the cost-to-serve. For example, blockchain technology can offer end-to-end traceability of food products, enabling consumers to follow the product's journey from farm to table, which enhances safety and service lvl.s (Tan & Sidhu, 2022).

g) Transportation Management Systems (TMS)

Transportation Management Systems (TMS) are critical to minimizing logistics expenses in CTS management. A TMS enables companies to plan, execute, and optimize the transportation of products through different transport channels. Businesses can use a TMS to determine the least expensive routes, consolidate shipments, lower fuel consumption, and cut delays.

Sophisticated TMS solutions also interface with other systems, including warehouse management systems (WMS) and inventory management software, to provide seamless coordination throughout the SC. TMS also assists with live tracking and reporting, giving visibility into delivery performance and areas wherein cost drops can be attained.

The deployment of contemporary technological solutions like advanced analytics, AI, IoT, cloud-based solutions, RPA, blockchain, and TMS is a critical factor for managing Cost to Serve in the most efficient manner possible. With these technologies, enterprises are able to develop more in-depth knowledge of their SC functions, make processes more efficient, cut inefficiencies, and overall improve profitability and customer satisfaction. As technology advances, companies that embrace these technologies will be in a stronger position to handle their CTS and stay ahead of emerging trends in a more complex global economy (Gonçalves et al., 2023).

1.7 FRAMEWORK FOR EFFECTIVE CTS OPTIMIZATION

Optimizing Cost to Serve (CTS) is paramount to those organizations which need to increase profitability without sacrificing the high standards of customer satisfaction. For obtaining effective CTS optimization, an organization needs a systemized strategy wherein a proper insight into all influencing factors over cost structures, customers' expectations, and operating efficiencies is realized. An optimally designed framework for CTS optimization integrates business objectives, customer requirements, and operational abilities so that the company's resources are utilized with maximum cost savings. The optimal framework for successful CTS optimization normally consists of multiple interdependent steps ranging from data gathering and analysis to strategy formulation and implementation (Hieu & Uyen, 2023).

a) Understanding the Customer and Segmentation

The starting point of any CTS optimization strategy starts with knowing the customer and segmenting them according to their particular needs, behavior, and profitability. All customers are not the same, and as a result, the cost to serve them will vary considerably. The initial process in optimizing CTS is identifying separate customer segments that can be determined by factors like order frequency, order volume, delivery requirements, geography, and service expectations (Hua & Wu, 2024).

By segmenting customers into effective segments, companies are able to determine the more costly-to-serve and the more profitable ones. Customer segmentation enables firms to adapt their products and service lvl.s to match the distinctive needs of each segment so that resources are efficiently utilized. For instance, high-value customers might need superior services such as quick delivery or custom support, which are more costly. On the other hand, low-value customers may be serviced with standard offerings that are more cost-efficient.

b) Data Collection and Cost Analysis

A good CTS optimization approach demands intimate knowledge of the costs involved for each component of the SC. This necessitates the orderly compilation of information on all steps involved in the SC process such as procurement, manufacturing, storage, movement, and customer support. Such crucial performance measures as order fulfillment rate, transport cost per item, inventory turns rates, and customer service handle cost must be tracked to gauge the actual cost to serve each customer (Madhani, 2019).

Sophisticated data analytics software can give a clear picture of cost structures, identifying the areas where costs are disproportionately high. For instance, companies might discover that transportation costs are a major driver of CTS, particularly when delivering to customers in geographically dispersed locations. Likewise, inefficiencies in warehousing operations or inventory management could result in inflated costs. Using advanced data analysis methods like regression modeling, firms are able to identify such high-cost areas and know the proportion of each cost driver associated with given customer segments or product types (Liu, 2024).

c) Process Optimization

The identification of cost drivers is followed by process optimization, the second step in the CTS optimization model. Process optimization is all about assessing current processes and ascertaining areas where inefficiency or bottlenecks lie. Efforts should be directed at making SC operations more lean by cutting out waste, redundancies, and overall throughput inefficiencies. To illustrate, logistics routes can be optimized by taking advantage of computer-aided route planning technology, saving on fuel, and making delivery more efficient. Just-in-time inventory systems, to mention an example, can help streamline inventory practices, cutting costs associated with storing inventories.

Operational efficiencies can also be realized through process standardization and automation. For example, warehousing automation, like the implementation of automated guided vehicles (AGVs) or robotics for order picking, can lower labor costs and accelerate fulfillment times. Companies can also improve their internal processes by investing in integrated enterprise resource planning (ERP) systems, which facilitate live sharing of data across departments and remove inefficiencies in communication and workflow (Fargnoli et al., 2022).

d) Service Level Optimization

While it is important to decrease costs, it is equally vital to ensure that service lvl.s are met or exceeded above customer expectations. An effective framework for CTS optimization must, therefore, balance cost reduction with quality of service to ensure profitability while satisfying customers. This process involves determining the right lvl. of service that reflects the needs and expectations of varying customer segments.

For premium-paying customers who are willing to pay extra for rapid and tailored services, the company might opt to invest in fast shipping or customized support. For lower-margin customers, the company might opt for more off-the-shelf service offerings, including reduced frequency of deliveries or web-based self-service. The process of service lvl. optimization guarantees that companies do not overinvest in expensive service features for low-margin customers but satisfy the demands of high-margin customers (Fahim et al., 2025).

e) Technology Integration

Technology has an important part to play in maximizing CTS, and companies should look at the implementation of a variety of technological answers to enhance operations and boost choice-making. For example, the integration of TMS, WMS, and CRM software into a single platform can enable companies to monitor costs, predict demand, and automate order fulfillment.

Access to live data enables businesses to make educated decisions regarding inventory allocation, transportation routes, and customer service interventions. Repetitive tasks like order processing and billing can be assisted through automation tools like RPA. These repetitive tasks can be especially useful in lowering administrative expenses. Advanced analytics platforms based on AI can also maximize demand forecasting, allowing businesses to supply what is needed by the customer without overstocking or understocking (Dan et al., 2012).

f) Continuous Monitoring and Improvement

CTS improvement is not a one-time step, but a continuous process. It is critical to continue improving to cope with developments in the market, customers' demands, and technology. There must be a system for periodically monitoring CTS performance, determining if cost-cutting measures are providing the hoped-for savings, and determining new areas where further improvement can be made.

Key performance indicators should be constantly monitored to track the improvement in cost effectiveness and quality of service. For instance, companies can keep tabs on unit transportation cost reductions, lead times for orders, and customer satisfaction ratings to monitor the success of their optimization activities. Customers' feedback must also be gathered and analyzed to guarantee that lvl.s of service remain in line with expectations. The ongoing improvement process guarantees that CTS optimization continues to be a dynamic and flexible approach (Guan et al., 2024).

g) Departmental and Stakeholder Collaboration

Successful CTS optimization necessitates collaboration among departments such as procurement, logistics, sales, marketing, and customer service. By adopting a

cross-functional strategy, businesses are better positioned to address challenges as an integrated system to ensure that each element of the SC ensures cost-efficiency without compromising the quality of services (Riad et al., 2024).

Collaboration is also applied to external partners like suppliers, logistics companies, and technology firms. Through close interaction with such partners, companies are able to secure better prices, enhance delivery, and exchange precious information that may result in optimized operations. Third-party logistics (3PL) providers or supplier partnerships can result in cost savings through joint optimization efforts.

A successful CTS optimization framework demands an integrated approach involving customer segmentation, data analysis, process optimization, service lvl. management, technology integration, ongoing monitoring, and cross-functional coordination. By methodically addressing each of these elements, companies can reduce avoidable expenses, increase customer satisfaction, and ultimately enhance profitability. This strategic framework allows for firms to make intelligent choices, allocate resources properly, and constantly evolve to match the changing market forces, thereby ensuring sustainable success in managing their Cost to Serve (Gede, 2025).

1.8 SIGNIFICANCE OF STUDY

The importance of this work is that it has the potential to provide a complete insight into how the optimization of Cost to Serve (CTS) can improve profitability as well as customer satisfaction in SC management. With businesses these days under increasing pressure to maintain cost savings and satisfy customers, the potential to optimize CTS becomes an important consideration for achieving strategic success. By recognizing critical areas where cost inefficiencies are present and linking them to customer requirements, organizations can optimize their operations, eliminate wasteful spending, and enhance service delivery. This study provides a systematic framework that can be implemented by companies to overcome these challenges, giving them practical recommendations on how to manage and optimize their CTS processes effectively.

Perhaps the most significant contribution of this work to the scholarly community is that it sharpens the knowledge on how CTS optimization, SC performance, and profitability relate to each other. Although past literature has briefly addressed

specific aspects of CTS, this work provides a holistic perspective by discussing how customer segmentation, cost analysis, technology development, and process optimization are linked to generate value. The study contributes to the scholarly literature by filling knowledge gaps in the literature, particularly those related to contemporary SC complexities like digitalization, globalization, and the more dynamic customer expectations that underpin contemporary SCs. The outcomes of this study seek to add to the body of knowledge by providing a more nuanced and tangible appreciation for how organizations can use CTS in strategic choice-making.

From a practical point of view, this work has important applications for companies in many industries. By determining the key drivers affecting CTS and analyzing successful examples, the research offers practical advice that can be applied directly to attain cost savings while enhancing customer service. In a highly competitive market landscape, companies must discover how to optimize cost savings and provide high-quality service. With the action-oriented strategies suggested in this study, companies will be able to deal with prominent challenges like addressing SC complexity, fulfilling customers' needs, and minimizing business expenses, along with enhancing customers' satisfaction lvl.. The points discussed will facilitate companies to reengineer their SC functioning in a manner that will develop their financial capabilities as well as strengthen their business relationship with their customers.

In addition, the research will focus on the need to incorporate emerging technologies into the CTS optimization process. Solutions like data analytics, artificial intelligence, and automation can change SC operations by allowing for improved cost forecasting, live monitoring, and improved choice-making. This study investigates the ways in which digital technologies can facilitate CTS optimization through empowering businesses with the capacity to determine inefficiencies, automate workflows, and quickly adapt to variations in market conditions. Through embracing such technologies, companies can build an agile and responsive SC that adjusts to fluctuations in demand, supplier performance, and customer choices. This process will eventually lead to cost reduction, enhanced efficiency, and customer satisfaction.

As companies conduct more business in a globalized world, the research also explores the special challenges of maximizing CTS in global SCs. Firms with multiple regions and various customer bases must deal with the challenge of balancing cost-efficient strategies against diverse customer demands in different markets. This study will give companies an understanding of how to segment their customers by particular needs and cost structures, enabling them to customize their service offerings while remaining cost-effective. The study will also identify how to deal with the intricacies of global SCs by maximizing transportation, managing inventory, and supplier relationships across borders while prioritizing customer satisfaction.

Another key area that the study investigates is the place of sustainability in CTS optimization. With sustainability increasingly becoming a concern for both consumers and businesses, organizations need to adapt their cost management practices to align with environmental and social responsibility. This study investigates how companies can minimize their carbon footprint and resource consumption by streamlining SC processes like transportation, production, and inventory management. By prioritizing sustainability in optimizing CTS, companies can not only enhance their profitability but also maintain a positive image among increasingly ecologically aware customers. This research highlights how integrating sustainable practices within CTS optimization can give firms a competitive advantage while supporting broader environmental objectives.

Lastly, the study has greater implications for SC management choice-making and policy formulation. Policymakers and business leaders can utilize the findings of this work to create guidelines and frameworks for optimizing CTS in a way that enhances both profitability and customer satisfaction. For businesses, the study will provide strategic insights into how to allocate resources efficiently, set competitive pricing strategies, and manage customer relationships based on the true costs of serving different segments. This will enable companies to make more effective decisions in terms of their SC approaches, such that cost savings are matched with excellence in customer service. The research will also lead to the evolution of best practice that companies can adopt to maximise their CTS processes within an increasingly changing global economy.

Therefore, this work is important because it closes the gap between theoretical research and practical application in the SC management discipline. By giving businesses actionable frameworks and recommendations, it enables them to maximize their CTS strategy in a manner that increases profitability as well as customer satisfaction. Additionally, the study helps add to the body of literature on SC optimization by resolving contemporary issues, including the influence of digitalization and globalization, as well as highlighting the role of sustainability in cost management. The findings of the study will have lasting implications for companies working to enhance their SC performance, providing them with a straightforward route to achieving cost efficiency as well as customer excellence.

1.9 OBJECTIVES OF STUDY

a) To analyze the concept of "Cost to Serve" (CTS) in SC management.

b) To identify the key factors influencing CTS across different segments of the SC.

c) To assess the impact of CTS optimization on overall SC performance and profitability.

d) To develop strategies and frameworks for effective CTS management.

1.10 RESEARCH QUESTIONS

1) What are the primary components of "Cost to Serve" in SC management?

2) How do different factors (e.g., customer behaviour, order characteristics, delivery methods) influence CTS?

3) What is the relationship between CTS optimization and SC performance metrics (e.g., profitability, customer satisfaction, service lvl.s)?

4) What are the best practices for managing and reducing CTS in SCs?

5) How can technology and data analytics be leveraged to optimize CTS?

1.11 LIMITATIONS OF STUDY

The study limitations are crucial to acknowledge as they help in creating a background for appreciating the boundaries of the research findings and applicability of recommendations. One significant limitation stems from the use of secondary data and case studies, which, as valuable as they are, may not fully express the intricate, dynamic, and often distinctive problems confronting various organizations in maximizing Cost to Serve (CTS). The case studies contained within this work were chosen to accentuate best-practice CTS optimization, and the particular context of the businesses concerned may not be applicable elsewhere. Various sectors, customer segments, or geography might have their own SC profile and constrictions and thus the policies suggested for optimizing CTS under one scenario are likely to fail under another. For example, a multinational corporation could face alternative challenges in dealing with CTS to those of a small or medium-sized enterprise (SME), and the degree of technological expertise or availability of resources could have a profound impact upon the viability of some strategies.

A further limitation is that the research is based on particular technological solutions and SC optimization techniques. As technology continues to advance at a fast pace, the systems and tools deemed cutting-edge today can become obsolete or redundant tomorrow. Technologies such as AI, blockchain, and automation are increasingly being incorporated within SCs, but their implementation is not consistent among industries. Firms at various lvl.s of technology adoption might face varying challenges or impediments, such as inadequate technical infrastructure, qualified labor, or capital. Therefore, suggestions made in this work might prove to be cost-ineffective for companies undergoing initial stages of digitalization or companies that don't have an adequate budget for spending on next-generation technological developments. Although there is great promise for these technologies to maximize the effectiveness of CTS, installing them can cost a lot of money and perhaps even necessitate the total reinvention of established SC procedure, which wouldn't be convenient for every enterprise.

Also, since the study employs quantitative and qualitative research approaches, for instance, case studies and regression analysis, albeit useful insights, might not entirely reflect the multifaceted complexity of actual SCs. Supply chains are not static entities

comprising numerous interdependent variables like volatile customer demand, changing supplier capabilities, and external market influences. Though regression analysis aids in determining relationships between cost and service lvl.s, it cannot catch the entire array of interactions that could take place in a rapidly evolving environment. Practically speaking, the optimization of CTS frequently includes frequent adjustments and recalibrations because external factors such as geopolitical situations, natural calamities, or technology changes have the potential to destabilize SC operations. Thus, the research results, though useful, may not accurately capture the immediacy of complexity and uncertainty faced by companies when seeking to optimize CTS across heterogeneous SCs.

A further limitation relates to the possible effects of CTS optimization on internal stakeholders, including employees, suppliers, and managers. The study primarily focuses on external outcomes like customer satisfaction and profitability, but it does not deeply explore how these changes might affect the organizational culture or employee engagement within the SC function. Optimizing CTS often requires significant changes in how operations are managed, which can create challenges for employees who are accustomed to existing workflows. Resistance to change may also be a factor, especially if adopting the new optimization measures means embracing new technologies, reorganizing processes, or implementing new performance measures. Not emphasizing the human factor may constrain the comprehensiveness of the research's conclusions since optimal CTS is more than technological and process optimization—it takes the buy-in of the employees throughout the organization.

In addition, the geographic setting of the analysis is another limiting factor. Research is mainly for industries and institutions in certain geographies or marketplaces. Even though this establishes a good baseline for understanding what CTS optimizing strategies do well in some scenarios, it possibly does not embrace the variations resulting from global value chains. For example, SCs in developed economies may benefit from improved infrastructure, superior technologies, and easier access to skilled labor, but SCs in developing economies could experience totally different kinds of constraints, for instance, low technological adoption, political turmoil, or lack of adequate infrastructure. The results of this work could, thus, not be translated directly to SCs functioning in less developed or emerging economies, where different strategies of optimization could be called for.

Finally, although the research highlights cost efficiency and customer satisfaction, it does not provide broad regard to other vital elements of SC management that could be as or even more important to some organizations, such as sustainability, resilience, or innovation. Environmental and social responsibility are increasingly becoming priorities for companies in their SC strategy, and a sole focus on cost reduction may end up causing compromises in these fronts. For instance, saving on expenses through lower-quality suppliers or cutting the cost of transport through less eco-friendly means can hurt the reputation and sustainability performance of a firm. The focus of the study on profitability and customer satisfaction might narrow its generalizability to firms that emphasize much more the use of sustainable SC practices. A more holistic approach, which combines cost optimization with sustainability, innovation, and resilience, would give a better picture of CTS management.

Finally, although this work provides useful insights into the optimization of Cost to Serve, its limitations underscore the necessity for further research to tackle the complexities of contemporary SC environments. These constraints, such as the use of case studies, emphasis on particular technological solutions, limited geographical scope, and exclusion of specific SC aspects like sustainability and resilience, imply that subsequent studies might gain from a wider approach. Extending the study to cover more industries, regions, and SC variables would give a broader picture of how companies can maximize CTS under different and changing market conditions.

1.12 TENTATIVE CHAPTER SCHEME

The preliminary chapter outline for this work is presented below to give a systematic framework to the research process. Each chapter has a specific role to play, adding to the overall knowledge of Cost to Serve (CTS) optimization in SC management and its effect on profitability and customer satisfaction.

Chapter I: Introduction: In this chapter, the research topic will be introduced with an overview of Cost to Serve (CTS) as a key measure in SC management. The chapter will provide a definition of CTS, its significance in increasing profitability and customer satisfaction, and the key objectives and scope of the study. Furthermore, the research questions and hypotheses will be developed to serve as clear guidance on the focus of the study. The chapter will also identify the relevance of the study, its limitation, and the provisional dissertation structure.

Chapter II: Review of Literature: The chapter will conduct an in-depth review of the literature on Cost to Serve (CTS) encompassing theoretical concepts, major ideas, and earlier studies on the subject. It will discuss different determinants of CTS in SCs, how CTS affects SC performance and profitability, and successful cases of CTS optimization. It will also provide technological solutions to manage CTS and discuss various frameworks for optimizing CTS effectively. Through synthesis of the available literature, this chapter will develop the knowledge gap that the research seeks to bridge.

Chapter III: Research Methodology: In this chapter, the research methodology will be described, detailing the process utilized to gather and analyze data. The chapter will also present the research design, e.g., whether the study is qualitative, quantitative, or mixed methods. Sampling methods, data collection means (e.g., surveys, interviews, or case studies), and means of data analysis (e.g., statistical software or qualitative coding) will be addressed. Ethical factors, limitations of the research methodology, and the ways the research will help us better understand CTS optimization will also be discussed.

Chapter IV: Data Analysis and Interpretation: This chapter will report the results of the data collection process. The data will be analyzed using the relevant statistical or qualitative analysis based on the research design. Results will be shown in table, chart, or graph forms, and an in-depth explanation of the results' interpretation will be provided. Trends, patterns, and findings supporting or refuting the research questions and hypotheses will be extracted from the analysis. The chapter will establish a direct connection between the data and the study's overall goals and will provide tangible implications for optimizing CTS in SCs.

Chapter V: Summary and Conclusion: This final chapter will summarize the key findings of the study, highlighting the most important insights related to Cost to Serve optimization in SC management. The chapter will elaborate on implications of the findings for companies desiring to optimize their SCs for better profitability and customer satisfaction. It will also include practitioner recommendations and suggestions for future studies. The final section will also outline the study's contribution to SC management and put forward some possible areas for future research.

References: The references section will provide all the academic articles, books, articles, and other material referenced in the course of the study.

1.13 CHAPTER SUMMARY

This chapter is the background chapter of this work, providing an overall description of the research subject, "Optimizing Cost to Serve in Supply Chain Management." The chapter explains Cost to Serve (CTS) and highlights its importance in maximizing profitability as well as customer satisfaction in SCs. It emphasizes the significance of CTS as a key measure for companies to control their cost of operations and match their services with customer demands. The chapter presents the major goals of the study, which are to examine factors affecting CTS, assess its effect on SC performance, and determine effective strategies for maximizing CTS. The research questions and hypotheses that inform the study are outlined, giving a clear direction to the investigation. The chapter also addresses the importance of the study in adding to the body of knowledge in SC management and the limitations and scope of the research. Lastly, the tentative chapter outline is presented, giving an overview of the structure and flow of the dissertation.

CHAPTER – II

REVIEW OF LITERATURE

2.1 INTRODUCTION

Supply Chain Management (SCM) effectiveness is the key to determining the competitiveness and profitability of businesses today. Over the last few years, Cost to Serve (CTS) has emerged as an important strategic metric to measure the actual cost realities of servicing varying customers, channels, and product classes. CTS allows organizations to pinpoint areas of value leaks and manage service lvl.s for an optimal balancing act between customer satisfaction and operational efficiency.

The escalating sophistication of global SCs due to heightened customer expectations, market fluctuations, and pressure for customization has brought about the need for closer scrutiny of cost structures and service strategies. CTS is no longer an accounting exercise; it has become a very important SC strategic decision component in product portfolio simplification, customer segmentation, price fixing, and distribution strategy.

This chapter provides an overview of the literature on Cost to Serve analysis and its relevance to SC optimization. It discusses major theoretical frameworks, empirical research, and conceptual models that underlie CTS measurement, management, and improvement practices. The chapter also examines the relationship between CTS optimization and increased profitability, customer service, and long-term sustainability, laying the groundwork for the following empirical study in this work.

2.1.1 Understanding the Components of Cost to Serve (CTS) in Supply Chain Management

The Cost to Serve (CTS) metric is a strategic measurement that was developed to provide businesses with the ability to evaluate the whole cost of providing goods or services to customers. The cost breakdown structure (CTS) provides a detailed breakdown of many cost components, including transportation, warehousing, order management, packing, inventory holding, and after-sales service. Through the use of CTS analysis, organizations are able to divide the profitability of their various

consumers, channels, and items into distinct categories. One of the most important contributions made in this area highlights the importance of having a visual framework that tracks various cost items to facilitate choice-making. As an illustration, a CTS framework that is tailored to fast-moving consumer goods makes it simpler for businesses to see cost breakdowns and identify high-cost locations, which ultimately results in the organization's ability to make decisions that are more precise and actionable (Kamphuis, 2020).

Internal organizational dynamics, in addition to financial considerations, are a significant factor in determining whether or not the adoption of CTS will be successful. When it comes to producing cost data that accurately reflects operational reality, the function of cross-functional service teams and internal service alignment is of the utmost importance. It has been shown in the literature that cost tracking systems (CTS) not only record cost data but also serve as a tool for performance management by establishing a connection between service delivery and cost accountability. It is absolutely necessary to have excellent internal cooperation across departments such as sales, finance, and logistics to successfully perform a comprehensive CTS analysis (Yunhai, 2013!). The coordination of these departments among departments is especially crucial in large organizations, where the fragmentation of services can make it difficult to see how much money is being spent.

Conceptually speaking, having knowledge of CTS also necessitates acknowledging the dynamics of SCs as complex adaptive systems. According to this method, the cost structures that are present within a SC are not only the result of planned logistical streams; rather, they are also the result of dynamic processes that are interactive between the many parties that are involved in the network. Emergent phenomena, such as unpredictability of suppliers, surprise customer requirements, or unplanned disruption, likely to account for much more than control-based systems do (Choi, Dooley, & Rungtusanatham, 2001). This means that control-based systems may not always be able to catch CTS variations. Therefore, CTS needs to be handled as a dynamic metric that responds to both systematic and emergent SC variables before it can be considered effective.

Additionally, empirical study demonstrates how the supply of logistical services directly helps to information technology. According to the findings of case studies conducted in the medical device business, for instance, logistical parameters such as order frequency, shipment size, delivery reliability, and return policy have a significant impact on the overall cost structure (Mustafa, 2016). These findings provide credence to the contention that CTS is a dynamic system that may exhibit significant variation depending on the requirements and expectations of a particular business. The capacity of businesses to divide their clients into different groups based on the lvl. of logistical assistance they require can be beneficial to cost control while still maintaining excellent service.

Distributors and intermediates are also a factor that can influence the findings of CTS. When it comes to maximizing profitability, a distributor profitability toolbox places an emphasis on aligning distributor activities with cost constraints. Expenses that are associated with distributors, such as trade discounts, marketing allowances, and SC support, are typically not accounted for in traditional accounting systems; nonetheless, these expenses are included in CTS analysis. Therefore, CTS serves as an important lens for determining whether or not distribution strategies are in line with the overall objectives of the organization (Lawrence et al., 2008). Corporations are able to strike a balance between their service commitments and the maintenance of their margins through the judicious implementation of CTS in distribution networks.

More recently, sustainability practice has expanded the scope of CTS by including environmental and social cost factors. This has resulted in a wider range of applications. Green SC management and corporate sustainability objectives are becoming increasingly important to businesses today. As a result, businesses are looking to include environmentally friendly practices into their cost arrangements. These activities include reducing waste, reducing the amount of packaging they use, and conserving energy. When these extra factors are taken into consideration, it is common for environmental goals and cost-effectiveness to be compromised. According to Ahmed et al. (2024), theoretical models have demonstrated that an entrepreneurial orientation towards sustainability can shift cost paradigms. As a result, cost transformation strategies (CTS) become an essential instrument for dealing with green transformations for businesses.

CTS was faced with an additional lvl. of complexity as a result of the COVID-19 pandemic, which highlighted the necessity of resilience in SC operations. As a result of disruptions, the typical CTS models were unable to accommodate the unanticipated expenses associated with emergency procurement, changes in demand, and constraints imposed by lock-down procedures. CTS needs to be modified to take into consideration reverse logistics, product recalls, and excess inventory, all of which are associated with hidden costs (Abbasi, Daneshmand-Mehr, & Ghane, 2023). This is demonstrated by a three-objective model that was constructed for the purpose of managing closed-loop, multi-echelon SCs during the pandemic. The findings of these research highlight the importance of developing adaptive CTS models that are able to take into account risk and sustainability considerations.

The successful completion of a CTS analysis is dependent on the utilization of information technology and sophisticated data analytics. Real-time visibility of cost components is made possible by applications such as enterprise resource planning (ERP), transportation management system (TMS), and predictive analytics. These applications also make it possible to make decisions based on data. According to Niu (2010), the knowledge management strategy is based on the understanding that SCs that are powered by information technology have the potential to reduce cost-to-serve by reducing errors, improving collaboration, and making the most efficient use of resources. Consequently, the implementation of a CTS optimizer makes digital transformation feasible.

Lastly, there is a strong connection between CTS practices and the success of the organization. For example, empirical research from the pharmaceutical industry in Ethiopia demonstrates that businesses that implement formal SC management methods have a lower CTS and a more stable SC. According to Seyoum (2019), businesses that operate in this manner have improved operational performance, higher lvl.s of customer satisfaction, and improved strategy alignment. As a result, CTS is not merely a financial performance indicator; rather, it is an all-encompassing performance instrument that improves both operational excellence and strategic SC decisions.

2.1.2 Influence of Customer and Order Characteristics on Cost to Serve (CTS)

In the context of SC management, the Cost to Serve (CTS) is not only a reflection of operational expenses; rather, it is a strategic indicator that is greatly influenced by the characteristics of customers and the ordering patterns they exhibit. When businesses have a better understanding of the ways in which particular customer characteristics and order-related parameters drive CTS, they are able to more effectively allocate resources and maximize their profitability. This dependency has been investigated by a number of scholars across a variety of industries, and their findings have revealed how the cost structure of a SC is directly influenced by factors such as customer behavior, relationship intensity, transaction complexity, and service expectations.

When it comes to the long-term dynamics of service, customer satisfaction functions as a mediator and ultimately has an effect on the customer retention rate (CTS). In their empirical study of banking performance in the Palestinian territory, Iriqat and Daqar (2018) established the fact that the practice of Customer Relationship Management has a significant amount of influence towards the creation of customer satisfaction and, as a result, the raising of their lvl. of loyalty. This, in turn, manifests to result in having more patternized demand trends, and consequently, fewer service variances, which is to our advantage to mitigate CTS. It is more probable that clients will interact with you more efficiently, require less intervention, and ask for fewer unusual services when they are satisfied. Each of these factors contributes to a reduction in the overall cost of providing service to them over the course of time. Customers who are dissatisfied, on the other hand, are more likely to demand frequent contacts, interventions to solve problems, and special handling, all of which contribute to a considerable rise in customer service time of service.

Using this information as a foundation, Hess, Story, and Danes (2011) proposed a three-stage conceptual model of consumer relationship investment. This model helps to differentiate between the customer's perception of value over time and the impact that this perception has on the lvl. of service delivery. With regard to client connections, the model demonstrates that businesses typically employ a tiered investment strategy, which consists of three stages: initiation, development, and maintenance. Value with a high potential In the short term, customer retention rates (CTS) are naturally increased as a result of increased personalization and service

investment for customers. The expenditure, on the other hand, can be justified in situations where there is a strong probability of long-term profits. Instead of implementing equal service standards across all client segments, the study highlights the importance of strategically differentiating service lvl.s in a manner that is especially tailored to the longevity of the customer relationship.

It is possible to observe the connection between order features and CTS in extremely complex service environments such as healthcare. In their research conducted at MIT during their doctoral studies, Zhang and Zhang (2017) analyzed healthcare delivery channels and brought attention to the fact that customers (or patients) have substantially diverse needs based on the urgency and severity of the care they require. In order to accommodate this diversity, it is necessary to implement adaptable service delivery models, customized order fulfillment procedures, and on-demand inventory allocation. In contrast to the normal commercial industries, which are characterized by relatively predictable flows of products, healthcare systems are required to anticipate differences and uncertainties in order requests, which results in an increase in the expenses associated with logistics and administration. These alterations to the service are necessary to achieve the highest possible lvl. of patient satisfaction; however, they also contribute considerably to the escalation of CTS, particularly in situations where emergency treatment, individualized medication, or specialized staffing are involved.

Activity-based costing, often known as ABC, is a useful approach that may be utilized to investigate the impact on finances that these customer- and order-specific variables have. ABC was utilized by Potgieter (2009) to investigate the impact that different client profiles had on profitability. The case study that was conducted was conducted in South Africa. The research conducted by Potgieter demonstrated that clients who placed orders with low volume, high frequency, or sporadic orders resulted in increased service expenses due to greater costs associated with handling, billing, and transportation. Through the use of ABC, the small and medium-sized enterprise (SME) was able to identify specific cost drivers, which ultimately enabled the company to re-price services or rationalize customer portfolios. This exemplifies the manner in which analytical solutions can transform intangible or undervalued service charges into data that can be employed for the purpose of enhancing operational efficiency.

It is also the case that consumers' engagement with businesses is shaped by their perceived risk, which is another cognitive feature of customers that drives CTS. In the field of telecommunications, Tho, Lai, and Yan (2017) found that customers who have a higher risk perception—whether it be in relation to call quality, data protection, or network stability—are more likely to request longer guarantees, more frequent interactions with customer service representatives, and improved return and refund policies. These behaviors on the part of customers make customer service more difficult since they require larger service infrastructures, longer contact times, and more complicated troubleshooting procedures. This instance illustrates how subjective cognition, despite the fact that it is not physical, can result in physical cost considerations in service.

CTS is given an additional dimension in the hospitality and restaurant businesses on account of the customers' expectations of having individualized experiences. Huang et al. (2022) conducted research on "destination restaurants" and found that customers anticipate receiving one-of-a-kind, high-touch services such as customizable menu options, table-side preparation, or a setting that is experiential. The realization of these high-end expectations requires a significant amount of back-end coordination, which includes the acquisition of high-end ingredients, the training of professional workers, and the modification of floor plans. The operating cost per client served is increased as a result of these methods, despite the fact that they promote customer happiness and distinguish the brand from competitors. For the purpose of facilitating these specialized services, which have a direct impact on CTS, the SC needs to be designed in such a way that it can allow a flexible procurement and delivery system.

When it comes to customer service, it is impossible to disregard the human element in high-contact service industries like CTS. In their 2013 study, Hajipour, Bavarsad, and Asadi investigated the ways in which customer relationships in service-intensive environments are influenced by interpersonal factors such as the friendliness of service representatives, communication abilities, and personality traits. According to the findings of their research, customers evaluate not only the results of service encounters but also the quality of the relationships and feelings that they have with such connections. A consistent investment in personnel training, recruitment methods, and performance management is required to provide such quality. These are elements that raise customer retention rates (CTS), but they are essential for retaining customers and encouraging word-of-mouth promotion.

Specifically in the case of small retailers in developing economies like Pakistan, Najmi et al. (2021) highlighted the significance of service qualities to the establishment of customer connections. This was particularly relevant to the small retailers in Pakistan. In their research, they discovered that the most effective tactics for retaining customers in small businesses are empathy, responsiveness, and reliability. The delivery of consistent service quality across several small-scale contacts, on the other hand, necessitates extra coordination, engagement that is more labor-intensive, and personalization that is resource-intensive; all of these things add layers to the CTS. The labor-intensive nature of this process becomes a key cost driver, particularly in the absence of technological automation.

In conclusion, macro-lvl. issues connected to infrastructure and policies also have an indirect influence on customer ordering patterns, which in turn has an effect on customer transaction times (CTS). In their study, Bergaentzlé et al. (2019) studied how the tariff modifications implemented in Denmark's power system influenced the operating behaviors of businesses. Companies brought about unintended changes to their order cycles and production periods when they shifted their operating activities to low-tariff hours. This resulted in SCs being forced to make adjustments to their logistics, warehousing, and delivery systems. The re-planning of transport assets, stock buffers, and human availability was required as a result of these adjustments. This exemplifies how third-party policy measures and customer accommodations to such policy measures can result in unforeseen increases in CTS.

To summarize, the Cost to Serve is a multi-faceted metric that is significantly influenced by the consumer, the items they order, the time they place their orders, and the manner in which they place their orders. Whether they are driven by characteristics of consumer behavior such as risk aversion and loyalty, psychological considerations such as trust and satisfaction, or macroeconomic and logistical imperatives, customer and order dimensions are responsible for controlling service lvl.s, operational complexity, and ultimately profitability. Through the utilization of technologies such as ABC, the utilization of CRM intelligence, and the modification of service plans according to customer segmentation, businesses are required to control these expenditures in proportion to the value of the client. Not only is it vital

to have a deep understanding of these dynamics to effectively manage costs, but it is also necessary to maintain a competitive edge in the highly differentiated and customer-driven marketplaces of the modern era.

2.1.3 Cost to Serve (CTS) Optimization and Its Impact on Supply Chain Performance

Cost to Serve (CTS) optimization is a crucial approach that helps improve SC efficiency by achieving a balance between the costs of providing service and the degree of service provided to customers. It is the sum of all the costs that are incurred in the process of delivering an order to a client, beginning with the procurement of the item, continuing through production, transportation, and ending with post-sales services. For businesses that want to boost their profitability, improve their operational efficiency, and guarantee high lvl.s of client satisfaction, improving their CTS optimization is absolutely necessary. Several studies have been conducted to investigate various optimization strategies and the impact they have on SC performance. The findings of these studies have revealed how businesses can improve their customer experience while also achieving greater operational efficiency and cost savings simultaneously.

An investigation into the development of a SC that is sustainable, closed-loop, and multi-echelon was carried out by Abbasi, Daneshmand-Mehr, and Ghane (2023) in the midst of the COVID-19 pandemic situation. Through their study, they have brought to light the fact that the pandemic had posed significant difficulties for SCs, which in turn compelled businesses to reevaluate the usual approaches they had taken to control costs. The integration of sustainability goals into CTS optimization methodologies is something that the authors advocate. According to the findings of their research, firms that prioritize sustainable SC strategies not only reduce their operational expenses but also fulfill the expectations of their customers about ethical and environmentally conscious business operations. organizations are able to eliminate waste, maximize resource efficiency, and decrease environmental footprints by integrating sustainability objectives into CTS models. This allows the organizations to be cost-effective and resilient in their SC operations. Specifically, the research illustrates the wider implications of sustainability-based optimization on

long-term SC performance. It also highlights the fact that environmentally friendly methods can avoid disruptions in the SC and maximize customer loyalty, which in turn favorably influences CTS optimization.

In his 2016 study, Elahi investigated green SC planning and how it may be integrated with optimization models to improve SC performance. In the process of planning the SC, Elahi's study centered on the development of optimization algorithms that take into account both economic and environmental concerns. According to the findings of the study, conventional models of SCs frequently fail to take into account the environmental costs that are linked with operations, all of which can have a substantial influence on CTS. Elahi demonstrated that businesses are able to improve their cost base without compromising the quality of their services by embracing environmental considerations such as reducing their carbon footprints and managing waste in an effective manner. In point of fact, businesses who implement such environmentally friendly techniques are able to achieve a double benefit: a reduction in their operating expenses and an improvement in their sustainability indices. An improvement in business reputation can be achieved by the optimization of CTS through the incorporation of environmental objectives. This, in turn, can lead to an increase in customer loyalty and satisfaction, which ultimately results in a SC that is competitive.

Huang (2016) conducted an analysis of the operations of the SC in the food and currency industries. These SCs are regularly interrupted by demand uncertainty and other unforeseen factors. Based on Huang's observation, it is clear that the optimization of CTS in these industries requires the utilization of dynamic modeling techniques to address the variable supply and demand circumstances. Companies are able to better the coordination of their production and distribution activities with the actual demand of the market by utilizing inventory optimization models and demand forecasting. This allows the companies to reduce the additional expenses that are incurred as a result of insufficient or excessive stockpiling. As a result of the fact that the ability to quickly adjust to shifting circumstances can have a significant impact on CTS optimization, the research conducted by Huang highlights the need of maintaining flexibility in SC planning. Through the reduction of uncertainty and the improvement of demand planning, businesses are able to optimize their SCs, which

eventually results in a reduction in operational costs and an improvement in service lvl.s. This dynamic optimization of CTS makes it possible for enterprises to respond to shifting market conditions at little expense, which in turn has an effect on the overall performance of the SC.

The optimization of safety stock for multi-echelon systems was the focus of another related study conducted by Alfaify (2014). This optimization is a crucial component in the process of managing CTS. In complex SCs, where supplies need to be equilibrated across multiple tiers, such as suppliers, distributors, and retailers, optimization of safety stock is the most appropriate method to use. The research conducted by Alfaify produced a system for maximizing the safety stock lvl.s at various lvl.s of the SC, hence decreasing the expenses associated with keeping inventory and the hazards associated with stockouts. Companies are able to reduce the overall cost of maintaining inventory by properly calculating the safety stock at each stage of the SC. This allows them to improve customer satisfaction without compromising the total cost of retaining inventory. Through the elimination of surplus inventory lvl.s and the improvement of the flow of goods across the SC, this inventory optimization model has a direct influence on the optimization of the cycle time system (CTS). Within the context of the SC, the research conducted by Alfaify highlights the fact that inventory optimization is a primary lever in the increase of both cost effectiveness and responsiveness, and consequently, overall performance.

In their 2017 study, Zhang and Zhang focused their attention on the optimization of CTS in the healthcare business, which is a highly controlled and service-dominated sector. CTS management in healthcare delivery channels presents a variety of obstacles, according to the authors, including intricate patient needs, time-critical services, and severe regulatory standards. Also included in this list are the challenges. The findings of their study suggest that to maximize the effectiveness of CTS in the healthcare industry, it is necessary for distributors, healthcare providers, and suppliers to engage in sophisticated planning and coordination. It is possible for healthcare systems to reduce the costs associated with inventory, improve service delivery times, and increase overall cost efficiency by integrating technology such as inventory pooling, cooperative partnerships, and live data sharing. Additionally, the research emphasizes the value of cooperative connections in CTS optimization, particularly in sectors where customer happiness and service are of the utmost importance. When

healthcare companies optimize their service delivery and reduce their operating expenses, they are able to significantly improve their performance and the results they provide to their customers, which in turn has an effect on the overall performance of their SC and CTS.

Within the framework of green SCs, Morán, Fan, and Sampene (2025) investigated the role that green SC management (GSCM) plays in improving the economic, social, and environmental performance of Latin American countries. They highlighted that businesses that operate in environments that are subject to stringent environmental restrictions can significantly benefit from the adoption of GSCM principles into their CTS optimization process. Their research demonstrated how businesses might reduce their expenses by increasing their energy efficiency, reducing the amount of trash they produce, and making the most efficient use of resources along the entire value chain. Additionally to assisting in the reduction of operating expenses, sustainability-based cost optimization also assists in the maintenance of regulatory compliance with the environment, which helps to avoid the possibility of incurring penalties and fines. Businesses are able to achieve superior long-term success while simultaneously contributing to environmental sustainability if they incorporate environmentally friendly practices into their CTS models.

Within the context of an e-commerce SC, Wang et al. (2024) suggested a model for the allocation of carbon quotas, with the intention of maximizing carbon tax savings through the implementation of carbon rights buyback schemes. According to the findings of the study, carbon emissions are becoming an increasingly important factor for businesses to take into account when calculating their costs. This is particularly true in industries such as e-commerce, where logistics and shipping are at the center of the SC. The authors demonstrated how businesses can lower their carbon-related expenses without compromising their compliance with carbon reduction regulations by developing an optimal model for the allocation of carbon quotas. Companies are able to incorporate environmental issues into their SC planning through the implementation of such a carbon management approach, which does not compromise their profitability. According to the findings of the study, carbon footprint optimization is an essential component of carbon trading system optimization. This is particularly true in industries where carbon emissions are regulated and have an effect on both their costs and their SC performance.

To summarize, the process of optimizing the Cost to Serve (CTS) is a complicated one that requires finding a balance between reducing costs while maintaining good service lvl.s, being sustainable, and being responsive. Companies are able to obtain major improvements in their entire SC operations by implementing green SC management strategies, dynamic inventory management, and carbon footprint optimization within their SC operations. Through the implementation of advanced optimization models and strategic planning, firms have the ability to reduce waste, improve resource utilization, and align their SCs with the demands of their customers and the environmental goals they need to achieve. Within the context of SC resilience and competitiveness over the long term, this comprehensive strategy for CTS optimization maximizes cost-effectiveness, which in turn supports long-term availability.

2.1.4 Strategies and Best Practices for Managing and Reducing Cost to Serve (CTS)

The notion known as "Cost to Serve" (CTS) comprises all of the expenses that an organization must bear to provide its goods or services to its clients. The production, inventory, distribution, and customer service costs, as well as the administrative fees associated with managing these activities, are included in these costs. The optimization of CTS is an important challenge for businesses who are attempting to enhance both their profitability and their operational performance. In order to determine how to limit and control CTS, it is necessary to have a comprehensive strategy that addresses strategic outsourcing, process efficiency, sustainability, pricing strategies, and performance management. There have been a number of studies that have been conducted with the purpose of examining these tactics and providing insights into the most effective practices for reducing CTS while preserving service quality.

The use of cooperative e-business services, which place an emphasis on boosting efficiency through collaboration among various elements of the SC, is one technique that can be utilized to reduce the amount of CTS. When it comes to reducing operating expenses, Utrianen (2021) emphasizes the significance of digital platforms and e-business concepts. Utriainen is of the opinion that cooperative e-business services make it possible for businesses to streamline the interactions that take place

between customers, distributors, and suppliers. Organisations are able to significantly reduce the overhead costs associated with managing such processes by automating monotonous operations and lowering the number of redundant tasks. It is possible that this may lead to improved customer service, shorter delivery times, and more efficient management of inventories, which will ultimately result in a reduction in the cost of providing service to clients. In addition, the transition to digital platforms makes it possible for businesses to improve the efficiency with which they manage their connections with both their customers and their suppliers, which further streamlines the SC and reduces the cost of serving.

Another important method for reducing the impact of CTS is to outsource business operations. In their article, Fabian et al. (2023) discuss the ways in which outsourcing might improve organizational performance, particularly in the context of Nigerian investment banks. Organizations are able to save significant amounts of money on their internal operating expenses by outsourcing non-core functions such as customer service, information technology support, and administrative responsibilities. Through outsourcing, businesses are able to take advantage of the expertise and efficiency of third-party service providers, which typically results in a cost savings compared to the alternative of doing similar services independently. In spite of this, it is essential to choose the appropriate outsourcing partners and to build robust service lvl. agreements (SLAs) to guarantee that the quality of the service is not compromised. As a result of the research conducted by Fabian and colleagues, it appears that outsourcing can assist businesses in concentrating on their main business sectors, hence lowering the costs associated with operations that are peripheral to the core company and improving overall CTS.

In their 2009 article, La Paz and Ramaprasad provide some insights into the possible benefits that could be gained by aligning business operations with clinical and translational science. These insights can be made applicable to SC management. Their research sheds light on how businesses can improve the efficiency of their SCs by coordinating their internal procedures with the requirements of the market. When it comes to the healthcare industry, where increasing operational efficiencies can result in lower service costs, this principle is particularly pertinent. Through the consideration of the requirements of patients and the optimization of procedures such

as inventory control and the delivery of medical services, medical practitioners are able to reduce the amount of time and resources required for each individual treatment. In the context of generic SC management, the same approach can be applied similarly. Businesses have the ability to decrease waste, eliminate unnecessary stages, and reduce the Total Cost to Serve by gaining an understanding of the wants of their consumers and optimizing the operations of their SC to provide this information in an effective manner.

Sustainability is also a strong force behind Cost to Serve optimization, as identified by Liu et al. (2014) in their economic incentives and command-and-control mechanisms implemented to ameliorate air pollution and CO2 emissions in the Chinese iron and steel sector. These strategies were applied to reduce the amount of contaminated air and emissions of carbon dioxide. In this example, Liu and his team demonstrate how providing financial incentives to businesses to reduce their influence on the environment can result in price reductions. This method is particularly useful in industries that have a high energy consumption and a substantial amount of trash, both of which contribute significantly to operational costs. It is possible for businesses to lower their operational expenses by implementing sustainable practices. These activities include decreasing the amount of energy used, making the most of the resources available, and responsible waste management. As a result, these cost reductions contribute to a decrease in CTS. According to the findings of the research, the use of sustainable practices in SC operations not only lessens the impact on the environment but also results in financial benefits by lowering costs.

Habidin et al. (2012) study the ways in which a balanced scorecard (BSC) method can be utilized to aid firms in reducing carbon transportation systems (CTS). This research is in line with recent sustainability measures. The BSC model, which is typically applied in the process of coordinating the strategic objectives of a company with its operations, can also be utilized in the management of SCs. In the proposal put up by Habidin and others, it is suggested that firms are able to track and monitor key performance indicators (KPIs) concerning cost management, customer satisfaction, and operational efficiency when they implement a BSC model. According to the findings of the research, businesses that connect their strategic objectives with performance measurements are in a better position to recognize chances for cost

reduction. Streamlining inventory lvl.s, reducing lead times, and improving production processes are all examples of things that businesses may prioritize. Businesses have the ability to utilize particular tactics to reduce their Cost to Serve while simultaneously attaining high lvl.s of customer satisfaction if they monitor and assess these drivers.

The acquisition of a competitive advantage is another significant component of the management and reduction of CTS. The findings of Ghasemi et al. (2015) indicate that businesses that place a higher priority on the development of distinctive competences are more likely to reduce their operational costs. The research investigates the ways in which businesses can utilize their competitive advantages, such as improved SC management, technological advancements, and innovative ideas, to gain an advantage over their rivals. Whether it be through the provision of innovative offerings, outstanding customer service, or the streamlining of SC activities, businesses have the ability to reduce the costs associated with customer service by concentrating on areas that create uniqueness. According to the findings of the study, businesses who have a significant competitive advantage are among those that are able to achieve lower CTS without compromising or improving the quality of their service, which ultimately results in increased profitability.

In their study, Sun et al. (2023) provide an explanation of how the reduction of expenses associated with healthcare services can be achieved through the enhancement of the effectiveness of medical treatments. Even though the research is focused on a specific medical procedure—ultrasound-guided needle knife procedures—the overarching notion of improving operational efficiency can be applied to a wide variety of other areas, including SC management. It is possible for businesses to reduce the amount of resources required to offer products or services by employing processes and technology that are more efficient within their operations. In the context of SC management, for example, the optimization of delivery routes, investments in automation, and applications of the Internet of Things (IoT) can save time and resources each delivery, hence reducing the average CTS.

Last but not least, Aldas et al. (2018) address the capacity of sustainable public urban transport networks to reduce operational costs, particularly in the logistics industry. The knowledge gained from their inquiry can be applied to SC management, despite

the fact that it focuses on public transit. It is possible for businesses to reduce their consumption of fuel, their carbon emissions, and ultimately their cost to serve by implementing green logistics and making use of environmentally friendly transportation. It is particularly suitable for use in metropolitan areas, where the expenditures associated with transportation are one of the most important contributors to total traffic congestion. It is possible for businesses to reduce the costs associated with the "last mile," also known as the final leg of delivery, by optimizing their routes, using vehicles that are more energy efficient, and incorporating intelligent logistics systems.

The authors Mattila and Gao (2016) highlight the role of cost in the management and reduction of CTS that they discuss. The purpose of their study is to evaluate the various pricing and price framing approaches that are utilized in the hospitality industry. In their proposal, they suggest that businesses can improve the efficiency of their service delivery and reduce consumer transaction costs by adopting dynamic pricing schemes that are more in tune with the requirements of customers and the conditions of the market. Using tiered pricing or bundling services, for example, would help businesses tailor their products and services to the specific needs of different consumer groups, while reducing the amount of over-service customisation that occurs. Businesses have the ability to reduce costs associated with unnecessary services and improve customer satisfaction, ultimately leading to a reduction in their cost to serve. This is accomplished by implementing pricing strategies that correlate to the perceived value of individual services.

In conclusion, the management and reduction of Cost to Serve (CTS) should be handled through the implementation of a multi-pronged strategy that incorporates strategic outsourcing, performance management systems, sustainability initiatives, competitive strengths, and efficiency advancements. Companies are able to enhance their profitability, streamline their SCs, and remove waste through the use of these measures, all without sacrificing the high lvl.s of customer satisfaction they already enjoy. The best practices that were outlined in the studies that were examined provide a roadmap for enterprises to follow to maximize their utilization of CTS and achieve operational excellence.

2.1.5 Role of Technology and Data Analytics in Cost to Serve (CTS) Optimization

The optimization of the Cost to Serve (CTS) has become a strategic objective in modern SC management as a result of the growing emphasis placed on cost efficiency and customer-centricity. Within this setting, technology and data analytics have proven to be attractive drivers, resulting in a change in the manner in which businesses evaluate operating costs and make decisions that are in their best interests. Historically, CTS was a reactive measure that was largely utilized for tracking purposes. This was the case in the past. In spite of this, the implementation of digital technology and data intelligence has resulted in the transformation of this strategy into a forward-looking approach that enables cost-effectiveness, service personalization, and profitability. Companies have been able to determine the factors that contribute to expenses, estimate future demands, and match resources with customer anticipation in real time thanks to the mix of automation, advanced analytics, cloud platforms, and smart technologies.

It is based on the example of the Coega Business Center in South Africa that Zulu (2018) provides a comprehensive structure for the adoption of technology and the optimization of technology in organizational processes. The research reveals the fundamental needs that are necessary for the successful adoption of technology advancements. These requirements include a robust infrastructure, personnel readiness, digital competency, and financial backing from leadership. The argument put up by Zulu is that in order for businesses to achieve success in lowering their Cost to Serve, it is necessary for them to strategically incorporate technology into their operating procedures. The research shows the ways in which workflow automation, centralized data systems, and computerized customer support tools lead to increased utilization of resources, removal of redundancies, and shorter delivery times for services. These advantages transfer directly to CTS optimization by reducing the number of manual touchpoints, the amount of time and effort involved in satisfying the requirements of consumers, and the amount of time spent on the process.

Chiroma et al. (2021) investigate the ways in which the Internet of Vehicles (IoV) makes use of big data analytics that are based on deep learning. This discovery comes after the incorporation of an even more technological and live analytical perspective.

However, despite the fact that the research is focused on automotive systems, it has wider-reaching implications for any company that is service-intensive or logistics-intensive. The authors offer a taxonomy of deep learning models for high-velocity and high-volume data processing to provide insightful insights. This taxonomy also includes a classification system. Specifically, they highlight the fact that these analytics solutions enable businesses to anticipate the behaviors of their customers, plan logistics in advance, and determine the ideal inventory lvl.s. These factors contribute to the reduction of service lags, overstocking or understocking, and the maintenance of effective customer engagement, which ultimately results in an improved customer service system that is optimized to the greatest extent possible. The most important thing that can be learned from this study is that data-driven agility is of the utmost importance in situations where predictive models are used to guide choice-making by striking a balance between cost-effectiveness and excellence in service.

Munodawafa and Johl (2019) provide evidence that demonstrates the connection between the capability of big data and the optimization of costs due to sustainability. The authors investigate the impact that big data analytics has on eco-innovation within the energy industry and how it is used by energy corporations. According to the findings of their research, businesses that make use of analytics are not only able to reduce their negative impact on the environment, but they are also able to realize cost reductions as a result of improved energy use, process optimization, and waste reduction capabilities. According to the findings of the research, data analytics provides businesses with the ability to quantify the environmental and economic impact of each and every operation that occurs along the SC, hence providing them with a more informed perspective of their CTS. As an illustration, live monitoring of energy consumption and machine performance makes it possible to undertake timely maintenance and operational adjustments, which in turn reduces expenses associated with downtime and energy consumption that is not being utilized effectively.

By exploring the ways in which biomedical informatics brings data systems into line with service provision in the health business, La Paz and Ramaprasad (2009) are able to offer value to the discussion. The work that they have done demonstrates how information systems that integrate assist offer communication between departments, decrease errors that are caused by manual labor, and enable choice-making that is

based on evidence. Despite the fact that the research is centered on clinical informatics, the techniques covered are very transferable to other industries that are looking to reduce CTS. In addition to facilitating quicker problem-solving and preventing inefficiency caused by siloed data systems, combining customer information, operational data, and SC data makes it possible to allocate costs more precisely according to the service or product being offered. Their findings demonstrate the effectiveness of informatics as a platform for reducing CTS in service environments that involve a significant amount of data usage.

Mehos et al. (2016) examine the technological evolution of concentrated solar power (CSP) systems within the context of the SunShot program. This extends the discussion into the energy business. The findings presented here demonstrate how the utilization of live performance monitoring, intelligent sensors, and artificial intelligence-based predictive maintenance may significantly improve the dependability of operations and the cost-effectiveness of maintenance, respectively. These technologies make it possible for CSP facilities to operate with minimal involvement from humans, reduce the amount of energy that is lost, and ensure that services are delivered reliably. When these technologies are applied to industrial or SC applications in a more broad sense, they demonstrate how advanced technology systems can reduce variable and fixed energy costs. Both variable and fixed energy costs are often a very major portion of CTS across the manufacturing and logistics industries.

A Computable General Equilibrium (CGE) framework is presented by Lin and Jia (2018) to investigate the effects of carbon pricing on various industries in China. This framework is applied at the macroeconomic lvl.. The research shows the necessity for businesses to utilize data modeling and simulation tools to predict cost consequences and prepare accordingly, despite the fact that environmental policy is their primary concern. Businesses have the ability to foresee future CTS and alter operations to reduce both costs and compliance risks when they have the capability to model economic or regulatory situations using analytics technologies. In this particular scenario, technological gadgets not only produce cost effectiveness on the internal lvl., but they also provide resistance to external cost factors such as swings in regulatory requirements or market uncertainties.

When it comes to optimizing scheduling and coordination, Shui et al. (2024) provide a master-slave game-theoretic model for optimal scheduling of many units in a virtual power plant. This model is utilized for the purpose of optimizing scheduling. The concept makes it possible for decentralized units to coordinate their operations to achieve maximum efficiency while simultaneously reducing the overall cost of power delivery. This notion can be applied to complex SCs, which require operations to be coordinated among a number of different departments or partners to achieve perfect delivery dates and turnover of inventory. It is possible to reduce idling time, transportation expenses, and bottlenecks through the use of algorithm-driven scheduling, which are all critical components of CTS. In order to optimize CTS through intelligent coordination, the research gives a convincing example of the application of game theory and multi-agent systems.

Furthermore, Kaur et al. (2024) investigate the utilization of cloud computing, fog computing, and edge computing to enable operations that are both sustainable and responsive. These decentralized computing paradigms ensure the agility to process data closer to where it is generated, hence reducing latency and increasing the speed at which decisions are made. In the context of SC operations, this means making decisions in real time regarding the replenishment of stock, the choice of delivery routes, or the modification of manufacturing instructions. Because of these advancements, overhead expenses have been significantly reduced, operational transparency has been improved, and customer responsiveness has been made easier; all of these things are conducive to the goals of CTS reduction. In addition, the findings of their research indicate that such decentralized models reduce the amount of dependency on expensive centralized infrastructure, which results in cost advantages and scalability.

In the final part of their study, Buttner et al. (2024) investigate the incorporation of flexibility choices into Germany's transmission grid and the consequences that this has for the planning of energy over the medium term. It is their contention that sector coupling, which involves the integration of digital platforms with energy systems, has the ability to increase system resilience and cost reduction capabilities. Systems that are digitally enabled and adaptable are well-equipped to absorb fluctuations in energy demand or market conditions. This is the essence of the matter. This is especially

relevant for businesses that are working to reduce their use of CTS by establishing operations that are both adaptable and responsive. Through the utilization of technology, businesses are able to dynamically redistribute their resources, modify their production schedules, and arrange the delivery of their services in accordance with the present circumstances. This helps them to optimize the cost per unit of service or product that is shipped.

In general, the body of research agrees that data analytics and technology are essential components in the process of maximizing the costs associated with providing services. Within the entirety of the value chain, they provide enterprises with knowledge, accuracy, and customization options. Whether it be through integrated informatics, predictive analytics, smart scheduling, or decentralized computing, these technologies make it possible for businesses to tailor their services to the specific needs of their customers while also lowering the costs associated with delivery. By making strategic use of these instruments, CTS is transformed from a statistic that focuses on the past into a lever that prioritizes the future in terms of competitiveness and long-term viability.

2.2 RESEARCH GAPS IDENTIFIED

Existing literature still confronts a few significant limitations that make it impossible to establish an overall picture of its real-life application across a variety of industries. This is the case despite the fact that there is a rising emphasis on technology and data analysis in the optimization of Cost to Serve (CTS). There is still a significant lack of contextualization of technological adoption at the industrial lvl. to maximize CTS, where there is a significant gap. Despite the fact that research such as that conducted by Zulu (2018) offers templates for the incorporation of technology that may be utilized in business hubs, these templates are typically restricted to a specific firm or regional lvl. and cannot be carried out across other industries. For instance, research conducted on large-scale industries or technologically mature sectors does not depict the specific challenges faced by small and medium enterprises (SMEs) or SC fragmented sectors such as fashion retailing or local logistics services. These are sectors in which customer service requirements are significantly different and CTS dynamics are extremely volatile.

The lack of granularity in the deployment of data analytics in CTS models is yet another loophole that needs to be filled. Despite the fact that big data and artificial intelligence are frequently mentioned in the literature as being used to improve efficiency and forecasting ability (Chiroma et al., 2021; Munodawafa & Johl, 2019), not many studies look at the specific segmentation of customer-to-sales (CTS) based on customer segments or product-service combinations. There is a limited amount of clear methodology that demonstrates how data analytics can discern between lucrative and unprofitable service lvl.s, or how such insights can be mapped into strategies that can be implemented to reduce costs. As a consequence of this, businesses may employ sophisticated analytics technologies without providing a comprehensive understanding of how these tools influence the cost structures at the consumer lvl. or the choice-making process at the operational lvl..

The empirical testing of these models in actual business settings is not provided, despite the fact that simulation models and optimization structures are recommended in research such as those conducted by Shui et al. (2024) and Mehos et al. (2016). In dynamic market circumstances, where demand volatility, resource restrictions, and human behavior are critical considerations, the bulk of models are constructed and run in controlled settings, using assumptions that may or may not be correct. Consequently, this results in a disconnection between theory and practice, which in turn reduces the models' ability to be applied in a practical setting to decision-makers. In light of this, it is imperative that future research places an emphasis on validating theoretical models through longitudinal case studies or pilot projects that are capable of evaluating their performance in real time and their ability to adapt to fluctuations in the environment.

The second point is that the existing body of research does not devote a substantial amount of attention to the incorporation of environmentally friendly and sustainable technologies into CTS optimization strategies. While papers such as Lin and Jia (2018) and Buttner et al. (2024) highlight the economic and environmental benefits of energy efficiency programs, they do not bridge the gaps in tying such effects to CTS measurements. This is because these reports do not connect the dots between the two. There is a knowledge vacuum in the area of comprehending how tactics led by environmental considerations, such as carbon offsetting, the usage of renewable

energy, or environmentally friendly logistics, affect service expenses and customer profitability over the course of a lengthy period of time. Considering the growing number of businesses that are adopting environmentally responsible business practices, it is imperative that future research investigate the implications of the convergence of green practices and CTS in terms of cost savings or additional cost layers.

In addition, the role of organizational preparation and cultural compatibility in technology-based CTS optimization is another subject that has received a limited amount of research. Despite the fact that Zulu (2018) tackles topics such as employee adaption and acceptance of technology, the majority of the research continues to concentrate on technological competency rather than human and cultural issues. There are a number of organizational obstacles that might contribute to the failure of analytics-based cost management initiatives. Some of these obstacles include resistance to change, poor training, a lack of support from leadership, and digital illiteracy among frontline workers. In light of this, it is necessary to widen the scope of research to investigate how internal dynamics, such as change management methods, influence the successes of CTS optimization programs.

The absence of cross-functional integration in the deployment of technology for CTS optimization is another research gap that has to be addressed. The vast majority of research attention is focused on the role that technology plays inside independent business operations, such as logistics, information technology, or finance. However, there is a lack of investigation into how collaborative platforms and integrated systems might assist in better coordinating functions across departments. A coordinated effort across marketing, sales, procurement, and operations is required for optimal customer relationship management (CTS), but this compartmentalized model ignores this genuine requirement. Future study should investigate how business analytics platforms, which are supported by cloud, fog, or edge computing (as observed by Kaur et al., 2024), can be utilized to facilitate interdepartmental harmony, which would ultimately result in improved resource allocation and cost management.

In conclusion, there is a dearth of academic discourse concerning the impact of data governance, data quality, and ethical considerations in the context of commercial transportation systems analytics. There has not been sufficient thought given to the

complexity of integrating data, assuring accuracy, standardization, and compliance with privacy requirements. This is despite the fact that big data processing is supported for its diagnostic and predictive capabilities. Should they not be managed effectively, these features have the potential to skew the results of analytics and mislead decision-makers. As a result, it is essential that future research investigate the ways in which robust data governance frameworks might contribute to the reliability of CTS assessment and optimization.

with conclusion, although the present body of literature does give a preliminary foundation on how data analytics and technology might assist with CTS optimization, there is still insufficient depth in many important areas. Interdepartmental collaboration, organizational culture, incorporation of sustainability, real-world application, sector-lvl. insights, and data stewardship are some of the essential characteristics that are included in this category. The resolution of these research gaps will not only contribute to the expansion of theoretical knowledge, but it will also provide businesses with solutions that are not only implementable and scalable, but also morally sound. These solutions will aim to increase client profitability while maintaining effective cost control.

2.3 CHAPTER SUMMARY

This chapter presented a thorough review of the literature used in the theme, concept of evolution, and strategic implications of Cost to Serve (CTS) in contemporary business settings. The chapter started by presenting a fine-grained understanding of the theory base and context of CTS as a metric of performance, highlighting its functionality in determining actual cost incurred by delivering products or services to alternative customers or segments of the marketplace. The literature identified that CTS, when properly utilized, provides firms with the means to transcend legacy cost accounting systems and embrace more customer-focused profitability measures, essential in high-velocity and competitive markets.

Next, the chapter canvassed leading strategies and best practices for managing and mitigating CTS based on empirical and conceptual research. Foremost strategies identified were customer segmentation, segmented service lvl.s, process improvement, and outsourcing usage. The review revealed that firms embracing

strategic cost-cutting models tend to enhance organizational performance by linking operational processes to customer requirements and resource capabilities. Further, methods like the Balanced Scorecard and Total Quality Management (TQM) were also mentioned for facilitating the connection of CTS findings with overall organizational goals, particularly in sophisticated sectors like automotive, banking, and logistics.

A core component of this chapter was the discussion of the use of technology and data analytics in the optimization of CTS. Literature set the foundation that cutting-edge technologies, from cloud computing, Internet of Things (IoT), machine learning, and big data analytics, are instrumental in offering live visibility into costs, augmenting choice-making effectiveness, and facilitating SC alignment. Technologies like virtual power plants, sophisticated informatics platforms, and digital twins were mentioned as drivers for more accurate cost monitoring and performance prediction. In addition, data-driven platforms have enabled more detailed cost allocation schemes, in which CTS can be optimized not only at the company lvl. but also at the customer, product line, or service area lvl..

Yet, in spite of the wealth of literature and advances in the discipline, a number of key research gaps were noted. These were the absence of industry-specific research, the limited empirical testing of proposed models, and limited emphasis on the incorporation of sustainability and environmental performance into CTS models. Furthermore, the review identified a call for further research into the human and organizational aspects of technology adoption for CTS applications, e.g., digital preparedness, resistance among employees, and interdepartmental collaboration. Additionally, the ethical implications of data analytics—most importantly, data quality, security, and governance—were considered to be underemphasized in existing studies.

In conclusion, this chapter set a solid platform for the following phases of this work by bridging theoretical understandings, discovering applied strategies, examining technological progress, and specifying unexploited fields in the CTS literature. These observations offer a compelling argument for this current research to fill the determined gaps and present new knowledge on how CTS can be strategically maximized via technology, analytics, and collaborative business practices within a real-life scenario.

CHAPTER – III

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The chapter explains the systematic process used in this work to investigate the optimization of Cost to Serve (CTS) in SC management. The chapter aims to present a clear picture of the research design, data collection processes, and analysis techniques used to address the research questions. This chapter is significant because it is the stepping stone for empirical research and provides validity and reliability of the results.

The research approach used in this study is descriptive and exploratory in nature, with the objective of exploring the different factors affecting CTS, how it can be optimized, and its effect on operational efficiency and customer satisfaction. The study seeks to fill gaps in the literature by exploring how companies deal with CTS in different industries and how advanced technologies and cross-functional coordination can improve SC performance. The chapter shall explain in depth the different techniques employed for data collection, the sample population used, and the statistical methods that were used to analyze the data collected.

This chapter opens with an introduction to the research issue, followed by an elaborate discussion of the research design, such as the research approach, strategies, and techniques employed to acquire pertinent data. The research methods of sampling, including the target population and sampling procedures, are also explored to ensure that the results are generalizable and applicable to the wider scope of SC management.

In addition, this chapter discusses the data collection tools and instruments, specifically how the questionnaire was developed, its format, and why it was designed in such a manner. A pilot study will also be mentioned, as this needs to happen to guarantee that the research instrument is reliable and valid prior to its effective use.

Data analysis methods used in this work are also explained within this chapter, specifically how statistical methods like regression analysis, descriptive statistics, and correlation analysis will be utilized in interpreting the data. The research process's ethical implications, keeping participant confidentiality and informed consent intact, are also mentioned to ensure that the study adheres to ethical standards.

Thus, this chapter presents an overview of the research methodology used in this work in a manner that makes the research process transparent, rigorous, and able to yield reliable and actionable information regarding the optimization of Cost to Serve (CTS) in SC management. By being clear and organized, this chapter lays the groundwork for the presentation of the research findings and recommendations in later sections.

3.2 NEED FOR THE STUDY

The urgency for this work stems from the growing complexity and competition of world SCs, in which controlling Cost to Serve (CTS) has become a make-or-break determinant of the success of companies. As firms continue to work on increasing their profitability while retaining high degrees of customer satisfaction, knowing and maximizing CTS is more urgent than ever. CTS has a direct impact on the effectiveness of SC activities, and optimizing it can contribute to dramatic enhancements in cost savings and customer satisfaction. Yet, most organizations fail to properly measure and control CTS because of insufficient overall understanding, ineffective processes, and inefficient application of technology.

In today's competitive marketplace, companies are under pressure to provide value to customers while keeping operational expenses under control. CTS has a critical role to play in determining the actual costs of servicing different customer segments, including transportation, inventory handling, warehousing, and customer service. To businesses, particularly those in retail, healthcare, logistics, and manufacturing industries, these costs may differ substantially based on customer requirements, demand variations, and service expectations. The necessity for the study stems from the knowledge and practice gap in how organizations can improve measuring, analyzing, and optimizing CTS to balance cost savings and customer satisfaction.

Moreover, the emergence of digitalization and cutting-edge technologies like automation, artificial intelligence (AI), and data analytics has transformed the manner in which companies handle their SCs. Although technology offers new possibilities for maximizing CTS, most organizations continue to depend on traditional methods or do not possess the tools required to maximally exploit these technologies. This research is needed to investigate the contribution of technology towards enhancing the accuracy and effectiveness of CTS calculations, thereby allowing companies to make sound decisions using current data. Through the investigation of how future technologies can enable the optimization of CTS, the study will bridge an essential knowledge gap in SC management.

Additionally, organizations in all industries struggle with coordinating the goals of various departments, including SC, finance, and customer service, regarding the management of CTS. Generally, these departments exist in silos, with minimum communication and interaction, resulting in inefficiencies and lost opportunities for cost savings. This research will cover the call for a totalistic approach to CTS optimization, with a focus on the need for cross-functional collaboration and combined SC strategies to meet improved cost control and improved customer service. Through the understanding of the interaction between various functions in an organization, the research will give useful insights into how businesses can coordinate their activities more effectively to maximize CTS.

The research is also opportune and applicable in the face of the current challenges caused by external forces such as regulatory reforms, market volatilities, and SC disruptions in the global economy. With these dynamics, the need to manage CTS effectively has never been more urgent. Businesses must be able to adapt quickly to changes in demand, pricing, and SC disruptions, and optimizing CTS can serve as a key strategy for achieving resilience and sustainability in operations. This study will give a greater insight into the impact of several factors, including customer behavior, order patterns, and product customization, on CTS and how companies can align themselves with such challenges.

Last but not the least, the result of this study has the potential to bring important practical dividends to organizations. By determining optimization strategies for CTS, companies can minimize wastage, streamline resource utilization, and maximize

overall operational effectiveness. This will not only achieve cost savings but also enhance customer satisfaction through the assurance of companies' ability to provide products and services in a timely and cost-efficient way. As such, the importance of this study is paramount in advising firms on how to overcome the modern SC complexities, equipping them with the knowledge and capability to maximize their CTS and consequently improve profitability and customer satisfaction.

Lastly, the necessity of this work lies in the expanding significance of improving Cost to Serve in SC management, organizational difficulties in efficiently measuring and handling CTS, and the prospect of utilizing technology and cross-functional cooperation to enhance SC effectiveness. This research is necessary for organizations that intend to stay ahead in today's competitive, low-cost market climate while at the same time meeting the expanding demands of their clients.

3.3 IMPORTANCE OF STUDY

The significance of this work is its ability to give vital feedback on optimizing Cost to Serve (CTS) in SC management, a crucial element for increasing operational efficiency, customer satisfaction, and profitability. With the rapidly competitive and globalized market environment, companies need to prioritize not only cutting operational expenses but also bringing value to customers. A clear comprehension of CTS and its optimization can be a strategic edge for firms attempting to harmonize these goals. This research is of major importance since it covers both theoretical deficiencies in the current literature as well as real-world issues that organizations encounter when dealing with CTS.

A major contribution of this work is its ability to bridge the knowledge gaps about the determinants that affect CTS in different industries. Although the importance of CTS is increasingly acknowledged, many companies continue to lack systematic frameworks and consistent methods for measuring and controlling it. Identifying the determinants of CTS, including customer actions, order sizes, inventory control, and logistics, the research will give a detailed insight into how these elements interact with each other and influence overall costs. This will allow businesses to make more informed decisions on how to allocate resources, streamline their SCs, and ultimately improve profitability.

The research is also important as it examines the function of technology in optimizing CTS. With digital transformation increasingly changing SCs, the use of technologies like artificial intelligence (AI), data analytics, and automation has emerged as a major driver of cost savings and enhanced service delivery. Through an examination of how these technologies can be used to simplify CTS calculations and optimize SC operations, the study will offer actionable advice to companies on how to incorporate leading-edge tools into their SC strategies. The capacity to embrace and implement technology successfully is essential to remaining competitive, and this work will identify how technology can give businesses a competitive advantage by providing businesses with live information, predictive analysis, and enhanced forecasting.

In addition, the relevance of the study lies in its emphasis on cross-functional collaboration. Departments like SC, finance, and customer service often operate in silos in most organizations, with resulting inefficiency and disorganization of cost management. This study underscores the necessity of integrated solutions and cross-departmental collaborative strategies to streamline CTS. By demonstrating how coordination among these functions can contribute to improved cost allocation, better forecasting, and enhanced choice-making, the study will give a blueprint to organizations to enhance communication and coordination in their pursuit to optimize CTS. Not only does this coordination improve operational efficiency, but it also enhances departmental relationships, leading to an integrated and agile organization.

Aside from filling theoretical and organizational gaps, this work is significant with regard to its potential contribution to wider industry trends, including sustainability and SC long-term resilience. As firms grow more focused on sustainability and environmental concern, it is vital to know how CTS can be optimized without undermining profitability or customer service. The research will look at how firms can incorporate sustainable practices, including energy-efficient transport or reducing waste, into their CTS optimization processes so that cost savings are aligned with environmentally friendly practices. This will offer a blueprint for firms to ensure sustainable growth without compromising on their costs.

The applied implications of this study are especially significant for retail, manufacturing, healthcare, and logistics industries, where CTS optimization is essential in controlling operational costs while satisfying customers. Through the

identification of strategies to minimize CTS in various sectors, the research will provide useful insights to businesses that want to enhance efficiency and profitability in these sectors. The results will inform organizational strategic decisions regarding inventory control, transportation, customer segmentation, and demand forecasting—all of which have bottom-line implications.

Second, this study will make recommendations to policymakers and business executives who want to encourage best practices in SC management. Understanding how CTS optimization benefits SC performance as a whole, the research can drive industry standards and guidelines development, especially in those industries whose survival depends on cost management. The findings could also be a useful point of reference for academia, providing an enhanced comprehension of CTS and how it is linked to general SC performance measures, which in turn can guide future studies.

Overall, the significance of this work lies in its potential to fill fundamental gaps in knowing the determinants of CTS and the optimization strategies. Through the provision of practical knowledge about how companies can improve their costs while increasing customer satisfaction, the research will have considerable value to organizations seeking to remain competitive amid a more intricate SC structure. Additionally, the emphasis of the study on technology, collaboration, and sustainability further highlights its applicability in determining the future of SC management.

3.4 RESEARCH PROBLEM

The research issue is the focus of this work and encapsulates the main issue that the research aims to investigate and solve. For this work, the problem revolves around the idea of Cost to Serve (CTS) in SC management. CTS is a significant factor in determining operational efficiency, profitability, and customer satisfaction. Yet, most organizations are challenged by managing and optimizing this metric to the best effect, resulting in increased costs, reduced service lvl.s, and impaired profitability. As critical as it is in informing SC strategies, most firms are not able to fully comprehend and manage CTS to the extent that it would maximize both operational effectiveness and customer satisfaction.

One of the key problems that companies encounter is the ignorance about the actual cost of serving various customer segments and how these costs can be controlled. There are several factors that contribute to CTS, such as order sizes, delivery modes, customer behavior, product customization, inventory management, and transportation costs. In most instances, organizations lack adequate visibility into these elements, and hence it is challenging to control costs. Moreover, there is usually no coordination among various functions of the company, including SC management, finance, and customer service, resulting in inefficiencies and lost opportunities for cost savings. This problem is compounded further when extraneous issues like market forces, regulatory influences, and SC disruptions are factored into the equation, adding to the complexity of optimising CTS.

The second important issue relates to the tightrope balancing act between minimizing costs and having high customer satisfaction lvl.s. Whilst cost savings are crucial to profitability, they usually result in compromising on service quality. For example, lowering transportation expense may lead to longer delivery times, which can adversely affect customer satisfaction. In the same way, reducing inventory or warehousing expense may cause stockouts or product unavailability, further detriments to the customer experience. Thus, the research issue also entails identifying how organizations can best reconcile these two conflicting objectives—maximizing CTS while satisfying customers' expectations for quick delivery, high-quality service, and low prices.

This research problem is complicated by the function of technology and information in SC management. Numerous organizations continue to use legacy systems or manual procedures for measuring and managing CTS, resulting in unreliable data and inefficient resource allocation. The absence of sophisticated technologies like data analytics, artificial intelligence, and automation hampers the potential of companies to monitor and optimize CTS in real time. This study seeks to identify ways in which technological advancements can make CTS calculations more accurate and offer more insightful cost drivers, ultimately leading to enhanced SC performance.

Add to that is the reality that the CTS is significantly different from one industry, sector, and even customer category to another. For instance, the cost to serve in retail could be different from that in the healthcare sector based on aspects such as

variability of demand, compliance with regulations, and transportation costs. In the manufacturing industry, economies of scale can assist in lowering CTS, whereas in the food and beverage sector, issues such as spoilage and inventory management could raise the cost to serve. Understanding how these industry-specific factors influence CTS is crucial for identifying effective optimization strategies.

The significance of addressing this work problem lies in the potential benefits that organizations could gain from optimizing their Cost to Serve. By understanding the drivers of CTS and identifying strategies to manage these costs effectively, companies can not only reduce operational inefficiencies but also enhance customer satisfaction. This study seeks to offer insightful advice on how organizations can achieve the balance between cost savings and enhancing customer service to ultimately enhance SC performance and profitability. Additionally, the conclusions of this work will provide useful guidelines for companies seeking to embark on a strategic management of CTS using technology, cross-functional collaboration, and data analysis for sustainable SC improvement.

Therefore, the research problem is about the intricate process of optimizing Cost to Serve in SCs to maximize profitability and customer satisfaction. This is at the heart of the capacity of organizations to stay competitive in a more complex and dynamic market environment. Through solving this problem, the research seeks to discover actionable insights that can assist businesses in having more efficient and cost-effective operations while satisfying the ever-increasing needs of their customers.

3.5 RESEARCH OBJECTIVES

1) To analyze the concept of "Cost to Serve" (CTS) in SC management.

2) To identify the key factors influencing CTS across different segments of the SC.

3) To assess the impact of CTS optimization on overall SC performance and profitability.

4) To develop strategies and frameworks for effective CTS management.

3.6 RESEARCH HYPOTHESIS

H1: A well-defined "Cost to Serve" (CTS) framework significantly enhances cost visibility and choice-making in SC management.

H2: Key factors such as demand variability, logistics efficiency, and order complexity have a significant influence on CTS across different segments of the SC.

H3: Optimization of CTS has a positive impact on overall SC performance and profitability by reducing operational inefficiencies and improving resource allocation.

H4: Implementing strategic CTS management frameworks leads to improved cost efficiency, better service lvl.s, and enhanced SC resilience.

3.7 RESEARCH PROCESS

For the purpose of gaining a full understanding of artificial intelligence in financial products and the perceived dangers among IT professionals in India, this study makes use of a research approach that is meticulously planned and methodical. The first step in the research process is to define the research problem, which focuses on the growing utilization of AI-based financial services in connection to customer concerns regarding transparency, security, and the accuracy of choice-making. The individuals who work in information technology are a good demographic for determining the lvl.s of trust and fear around AI-driven financial choice-making since they have a heightened awareness of technical advancements. The problem of the study is specified with specific objectives that aim to investigate the elements that influence the adoption of artificial intelligence, evaluate the perceived threats, and determine the role that customer trust plays in AI-enabled financial services.

For the purpose of establishing the theoretical framework of the inquiry, a comprehensive literature review is initially carried out. The Technology Acceptance Model (TAM), the Perceived Risk Theory, and Trust-Based theories are some of the theories and frameworks that are applied to shed light on customer behavior in relation to AI-driven financial solutions. The literature review finds that there are

numerous primary obstacles to the adoption of artificial intelligence. These obstacles include issues with data privacy, biases in AI choice-making, and security risks. Through the assessment of previous studies and the identification of research gaps, this phase ensures that the study is based on established theoretical frameworks, which is crucial for providing the necessary conceptual clarity.

The research makes use of a quantitative research design that is both descriptive and explanatory. This design makes it possible to conduct a systematic evaluation of the key factors that influence the adoption of artificial intelligence in the financial services industry. Recruiting IT experts in India using a stratified random selection method ensures a broad representation across experience lvl.s and industry sectors. The target audience consists of individuals working in the field of information technology. When determining the sample size required for the accuracy and reliability of the results, statistical methods are utilized to determine the appropriate size of the sample. As the primary instrument for data collection, a structured questionnaire is constructed. This questionnaire makes use of Likert-scale inquiries, multiple-choice questions, and ranking scales to evaluate the perspectives of users regarding AI-driven financial solutions.

In order to provide a comprehensive viewpoint, the data collection is comprised of both primary and secondary sources. The primary data is collected through the use of questionnaires and surveys, whilst the secondary data is obtained from academic publications, industry papers, financial periodicals, and case studies that pertain to the implementation of artificial intelligence in the financial services business. An initial pilot study is carried out with a select group of information technology professionals to develop the research instrument based on the feedback they provide before the final questionnaire is distributed. This is done with the intention of ensuring that the questionnaire is not only understandable but also pertinent and capable of delivering substantial results.

In order to get insights, a thorough statistical analysis is carried out after the data collection process has been completed. For the purpose of examining demographic variables like age, gender, and respondent experience lvl.s, descriptive analysis is utilized. On the other hand, inferential analysis, which encompasses correlation analysis, regression analysis, and structural equation modeling (SEM), is utilized to

investigate the relationships that exist between important variables. It is necessary to do reliability tests, such as Cronbach's alpha, to guarantee the dependability and consistency of the data. Next, the research explores hypotheses concerning consumer trust, security concerns, transparency in artificial intelligence, and risk perception to assess the impact that these factors have on the use of AI in the financial services industry.

This article provides significant insights for financial institutions, fintech companies, and AI developers by elaborating on the findings in respect to the existing literature and developments in the field. This study outlines important difficulties that contribute to client hesitation with regard to artificial intelligence-based financial services and suggests strategic approaches to improve the incorporation of AI. This includes increasing the openness of algorithms, strengthening data security protocols, and developing a greater understanding among consumers of the benefits that artificial intelligence may bring to the process of making financial decisions. The implications of the study extend beyond the realm of academia and into the realm of real-world industrial applications, in which they provide assistance to suppliers of financial services in overcoming considerable challenges and fostering client trust.

In the last stage of the research process, the researcher will be responsible for synthesizing the most important findings and developing actionable recommendations for the various stakeholders. In the report, recommendations are provided to financial institutions on how they might improve the transparency of artificial intelligence (AI), address ethical concerns, and improve the user experience in AI-driven financial services. The future lines of research are outlined, with an emphasis placed on the necessity of investigating long-term patterns in customer behavior and the ever-evolving role that artificial intelligence plays in the financial sector. In order to make a major contribution to the academic literature and industry practices in the areas of artificial intelligence-based financial services and consumer risk perception, this work makes use of a method that is both systematic and rigorous.

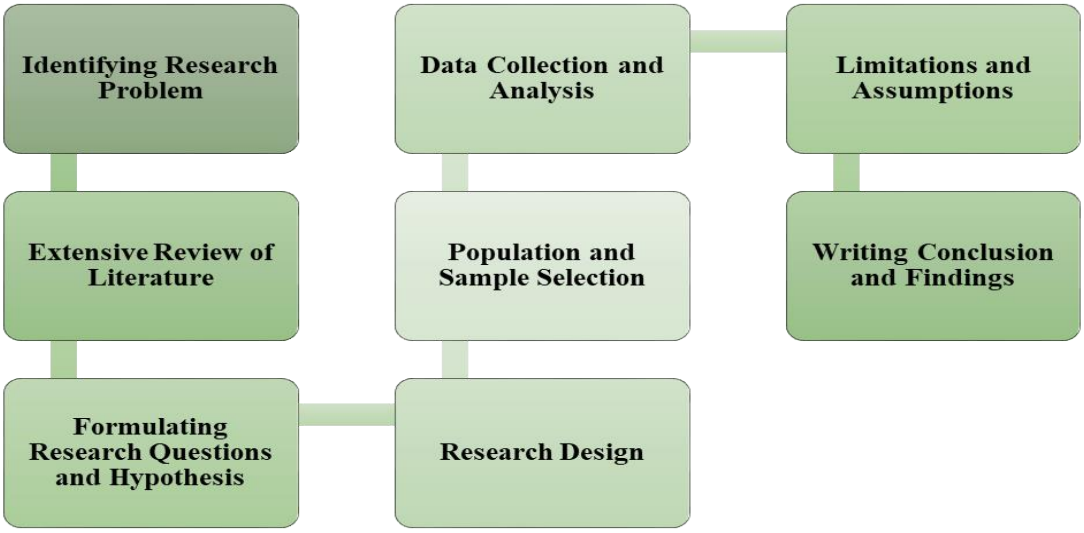


Figure 3.1: Research Process

3.8 RESEARCH DESIGN

To acquire a comprehensive understanding of the subject matter, the research design for this optimization of Cost to Serve (CTS) in SC management utilized a mixed-method approach that included both qualitative and quantitative approaches. This was done to gain information about the topic. Academic articles, industry reports, and case studies on CTS, SC cost management, and related optimization strategies were included in the comprehensive literature analysis that was the first step in the research project. This review was conducted to chart the present knowledge base. The identification of theoretical gaps, conceptual frameworks, and practical discoveries that guided the next stages of the research was facilitated by this early step, which was beneficial. The literature research provided a solid basis for the development of the survey instrument and interview protocols by allowing for the synthesis of findings from previously conducted studies.

Immediately following the evaluation of the relevant literature, primary data were collected by means of structured surveys and semi-structured interviews. The questionnaire was carefully crafted to cover a wide range of aspects of CTS, including its impact on operational efficiency, customer happiness, and profitability, among other things. It was comprised of questions based on the Likert scale, and it covered eight different dimensions: knowledge of CTS, measurement of influencing factors by

sectors, important CTS determinants, effect of CTS on SC performance, the role of technology, customer behavior, cross-functional collaboration, and inventory management practices. For the purpose of ensuring that the instrument would accurately reflect a comprehensive picture of CTS practices in a variety of industrial settings, these dimensions were determined through the exploration of the relevant literature as well as through actual observations. In order to ensure that the sample was both large and representative, the survey was distributed to SC experts. These professionals came from a variety of jobs, industries, and experience backgrounds.

Over the same time period, qualitative data was gathered by conducting in-depth interviews with SC managers, financial executives, and operations specialists. The researcher was able to analyze real-world challenges, strategic initiatives, and industry disparities in the implementation of CTS because to the material that was provided by the interviews, which featured context-based information. The findings from the qualitative research also served as a type of triangulation, assuring and reinforcing the conclusions from the quantitative research with evidence from experience. The implementation of statistical software was required during the analysis stage to evaluate the hypotheses of the study and investigate the relationships between the variables as part of the investigation. In the process of assessing demographic data and general trends, descriptive statistics were implemented. On the other hand, inferential statistics, such as correlation and regression analysis, were utilized to determine the significance of the primary associations. For example, the hypothesis was evaluated to determine whether or not CTS optimization had a positive affect on profitability as well as customer satisfaction. This was accomplished by establishing the strength and direction of these interactions through a variety of organizational settings. Structural equation modeling (SEM) and factor analysis were also considered for the purpose of testing the conceptual framework that was produced from the findings. This was done to confirm that latent constructs such as cost efficiency, integration of technology, and consumer influence had been empirically supported.

A holistic CTS optimization framework was developed on the basis of the findings that were obtained. Important variables and the correlations between them were incorporated into the model, which offered organizations methods that could be put into action to enhance their profitability and service lvl.s by means of improved CTS

management. The framework highlighted cross-functional coordination, technological integration, customer segmentation, and live data analysis as significant enablers of effective customer relationship management (CTS) activities. Its purpose was to guide decision-makers in the direction of implementing customized solutions in various sectors of the SC, thereby allowing them to tackle the unique difficulties and possibilities that are specific to their individual regions.

Because of this, the research design was able to provide adequate methodological application in addition to practical application by combining theoretical investigation and empirical study. The research was successful in producing useful information on how firms should strategically address CTS to realize improved SC performance as well as sustained competitive positioning. This was accomplished by employing a variety of data sources and analytical approaches.

3.9 CONCEPTUAL FRAMEWORK

Conceptual framework of the research is anchored on the universal assumption that by having a solid and optimized Cost to Serve (CTS) design, SC performance can considerably be changed. CTS as a concept indicates the total appraisal of all of the costs expended to bring a product or a service to one particular customer or market segment. This includes direct and indirect costs such as production, inventory holding, transportation, warehousing, order processing, and customer service. A thorough understanding and implementation of the CTS framework provide actionable insights into cost drivers and highlight areas of inefficiency, ultimately enabling informed and data-driven choice-making.

Dependent Variable: Understanding of CTS framework, Cost to Serve (CTS), Supply chain performance (profitability, efficiency, customer satisfaction), Cost Efficiency, Service Levels, Supply Chain Resilience

Independent Variables: CTS Management Strategies, CTS Optimization, Demand variability, Logistics efficiency, Order complexity.

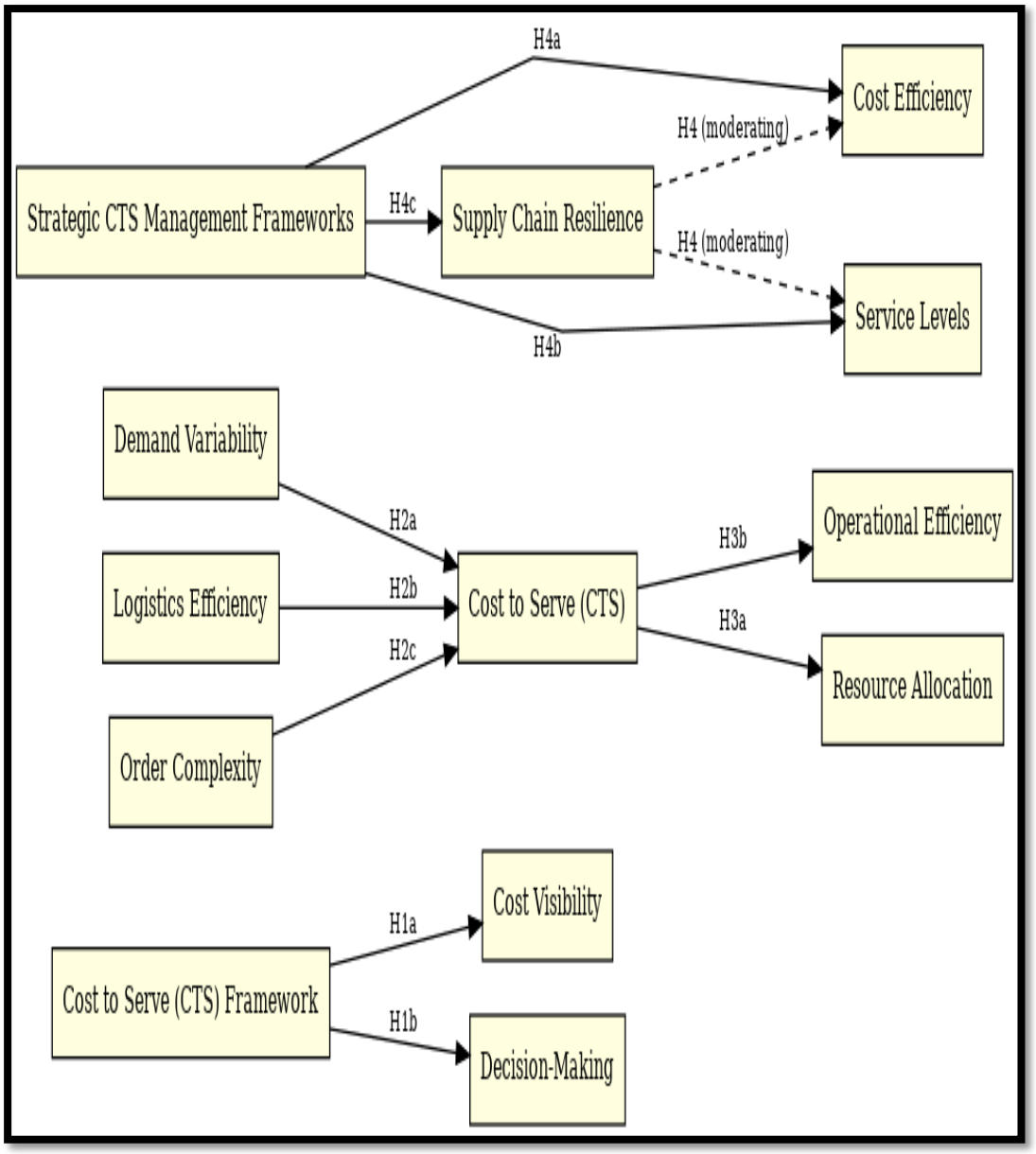


Figure 3.2: Conceptual Framework

At the focal point of this conceptual model are the dependent variables, which are understanding of the CTS framework, cost efficiency, SC performance (quantified in terms of profitability, efficiency, and customer satisfaction), service lvl.s, and SC resilience. These are the quantifiable outcomes that are likely to enhance when CTS is properly managed. For example, when leaders know the CTS framework, they can see which customers or products are high-cost and make strategic changes to enhance margins or re-engineer SC functions. Greater cost efficiency results in better resource allocation, elimination of wasteful spending, and tighter budget control. Higher service lvl.s—e.g., faster lead times, increased fill rates, and improved on-time

deliveries—are realized when trade-offs between cost and service are well understood and controlled. In addition, SC resilience, or the capacity to absorb disruption and stay in operation, is enhanced when CTS knowledge is employed to develop nimble and adaptable SCs.

Independent variables used in this work are CTS management strategies, CTS optimization initiatives, demand variability, logistics efficiency, and order complexity. These variables encompass both strategic tactics and operational influences that drive the cost to serve in any SC context. CTS management strategies can encompass customer segmentation, service differentiation, or activity-based costing practices used to align lvl.s of service with customer profitability. CTS optimization involves the on-going improvement initiative using data analytics, process re-engineering, and performance measurements to eliminate excess cost without undermining the quality of services. Simultaneously, variability in demand influences inventory planning and replenishment expenses, as well as the logistics efficiency of transporting and storing products. Order complexity, including elements like tailored orders, reduced batch quantities, or multiple delivery points, introduces added expenses and process complexity that need to be properly reflected in the CTS analysis.

The model suggests that such independent variables, when strategically optimized and managed, have a positive impact on the dependent variables. For instance, firms that implement strong CTS management practices are able to have higher cost transparency and better cost allocation across product and customer lines. When logistics efficiency is optimized through route optimization or carrier coordination, it results in lower transport costs and faster delivery. In the same way, reducing demand variability using proper forecasting methods can stabilize inventory and reduce stock outs or excess holding costs. By mitigating order complexity using process standardization or automation, organizations can optimize operations and lower errors and delays.

Thus, the conceptual framework unifies the interaction of operational strategies (independent variables) and performance results (dependent variables) in the field of SC management. It focuses on the transformative power of CTS if considered as a strategic management tool compared to merely a cost accounting function. By

capturing the dynamic interactions among these variables, the framework offers a platform for assessing the ways in which CTS efforts contribute to increased profitability, increased customer satisfaction, and developing more responsive and resilient SCs within the competitive and risky business environment of the present day.

3.10 POPULATION AND SAMPLING

3.10.1 Population

Population of this study involved professionals engaged in the practice within the field of SC management, sustainability, and operations of fashion retail as well as tech industries. Those fields were purposely chosen since their essential contribution towards and engagement with circular economy is highly essential regarding waste handling, resource maximization, as well as green-oriented production and consumption practices. The respondents in the population usually worked as SC managers, procurement officers, logistics coordinators, operations executives, sustainability officers, and environmental compliance managers. The population also involved strategic planning decision-makers like general managers and directors who had thorough information on the SC processes and their overlap with sustainability activities. The choice of this population was necessary to provide assurance that the views obtained were from those actively involved in making and implementing SC decisions that have the capability to impact circular economy results.

3.10.2 Sample Size

In order to obtain a representative and balanced dataset, the study was finalized for a sample size of 250 respondents. First, 300 professionals were contacted using a combination of direct emailing and online distribution of surveys. Of these, 250 were considered complete, valid, and analysable, and the effective response rate was around 83.3%. This sample size was deemed sufficient for the statistical analyses intended in the research, such as correlation and regression analysis. It provided enough response variation across organizations of varying sizes and sectors (fashion retailing vs. technology) while also providing depth in the quality of information obtained. Additionally, the selected sample size assisted in ensuring a minimal risk of sampling bias and providing adequate precision and confidence in the outcomes.

3.10.3 Sampling Method

In this work, a purposive sampling strategy was employed to guarantee the selection of respondents who had relevant experience and particular knowledge. Being a non-probability sampling technique, purposive sampling entails the intentional selection of participants according to their qualifications, job positions, and appropriateness to the research purpose. The technique was suitable since the research sought to obtain in-depth information from experts who were actively involved in the management and implementation of SC strategies with a sustainability orientation. In contrast to those random sampling techniques, purposive sampling enabled the researcher to reach participants who would give informed and context-relevant answers, thus adding depth and validity to the data. Purposive sampling also made it possible for both fashion retail and technology industries to be represented well enough to get sector-specific information about SCs as facilitators of circular economy.

3.10.4 Sample Size Determination and Formula

The calculation of the sample size needed was informed by a commonly applied statistical formula for social science research:

$$n = (Z^2 * p * q) / e^2$$

where n is the sample size needed, Z is the Z-value for the desired confidence lvl. (1.96 for 95% confidence), p is the assumed population proportion (0.5 for greatest variability), q is 1 – p, and e is the acceptable error margin (usually 0.05 for ±5%). Plugging these values into the formula resulted in a theoretical minimum sample size of about 384. Considering the time limitations, availability, and willingness of suitable respondents to participate, the actual achieved sample size of 250 was deemed satisfactory for the study. Although slightly lower than the calculated ideal, this sample size was nevertheless adequate to conduct meaningful statistical analysis and produce valid inferences, particularly in the context of purposive sampling where data quality and relevance are prioritized over quantity.

3.10.5 Inclusion and Exclusion Criteria

The inclusion criteria for participant selection were set meticulously to ensure relevance and reliability of the data collected. Participants were required to be employed currently in SC, logistics, operations, or sustainability roles in the fashion retail or technology sectors. Moreover, they should have had a minimum of two years of working experience in these areas to guarantee adequate knowledge of the practical facets of SC management and sustainability practices. Those who had led or contributed to sustainability projects, waste reduction efforts, or product lifecycle management projects were prioritized, given that their expertise was greatly significant for resolving the research issues. On the other hand, the exclusion criteria eliminated those not directly engaged in SC operations, including administrative personnel, marketing specialists, and interns. Those from unrelated businesses or with no experience in the operational side of SCs were also eliminated. This process of filtering ensured that the results of the study accurately captured the opinions of informed professionals who were best suited to analyze the connection between SC efficiency and circular economy outcomes.

3.11 STUDY AREA AND ITS PROFILE

The research was based on the Indian retail fashion and technology industry, focusing on specific urban industrial clusters famous for their involvement in SC management and sustainable activities. The identified clusters were metropolitan areas like Bengaluru, Mumbai, Delhi NCR, and Hyderabad, known for their high density of fashion retailers, technology firms, and logistics service providers. The justification for choosing these regions as the main areas of study originated from their vibrant business environments, developed infrastructure, and high lvl.s of technological uptake in SC activities. These cities also have a high concentration of multinational companies and local businesses undertaking innovative activities associated with the circular economy, such as reverse logistics, sustainable sourcing, and digitalization in SCs.

The retail fashion industry in these regions has undergone fast growth over the last few years, fuelled by shifting customer tastes, growing sustainability awareness, and regulatory and international market pressures. Fashion brands in these markets have

begun to adopt circular economy practices like recycling, reuse, and sustainable production. These brands are more engaged than ever with suppliers and logistics providers in creating closed loops and minimizing their environmental footprint. Likewise, the technology industry in these countries is marked by a high focus on operational effectiveness, resource optimization, and digital innovation. Technology companies have played a key role in developing and implementing digital technologies, including blockchain, IoT, and AI, that enable transparency and traceability in SCs — key elements of a circular economy model.

Apart from industrial activity, the chosen regions for study have strong education institutions, research centres, and incubators of innovation that enhance thought leadership in sustainable business practices. The environment provides a culture of continuous improvement as well as collaboration between industry and academia, thus making the regions highly relevant for the study. In addition, the policy context within these cities is quite advanced, with municipal authorities and trade groups supporting green policy, start-up programs, and sustainability programs. All this blended leadership from corporates, the advancement of technology, and favourable policies meant the study locations of choice were highly suited to research how efficient and streamlined SCs can be enabling agents for circular economy within fashion retail and the tech industries.

3.12 DATA COLLECTION

The research was based on the Indian retail fashion and technology industry, focusing on specific urban industrial clusters famous for their involvement in SC management and sustainable activities. The identified clusters were metropolitan areas like Bengaluru, Mumbai, Delhi NCR, and Hyderabad, known for their high density of fashion retailers, technology firms, and logistics service providers. The justification for choosing these regions as the main areas of study originated from their vibrant business environments, developed infrastructure, and high lvl.s of technological uptake in SC activities. These cities also have a high concentration of multinational companies and local businesses undertaking innovative activities associated with the circular economy, such as reverse logistics, sustainable sourcing, and digitalization in SCs.

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3.12.1 Questionnaire Development

The process of developing a questionnaire for this work was a crucial stage in the process of acquiring information that was relevant and accurate on the concept of Cost to Serve (CTS) in SC management. The purpose of the questionnaire was to collect information from experts who have direct expertise in the operations of SCs. This was done to ensure that the information received would be applicable and helpful in real-world scenarios. An instrument that is capable of quantifying CTS-related views, attitudes, and tactics towards optimizing CTS, as well as the consequences of CTS on operational efficiency, customer happiness, and profitability, was the primary focus of development.

At the beginning of the development process, it was necessary to conduct a comprehensive examination of the existing literature to gain an understanding of the most important drivers and topics on CTS that pertain to SC management. During this work, the various elements that contribute to customer transaction volume (CTS) were identified. These aspects include customer segmentation, order size, delivery options, inventory management techniques, and technological advancements. In addition, it highlighted the challenges that companies face when it comes to managing CTS and the steps that are done to make the most of it. The knowledge that was gleaned from the literature served as the foundation for the design of the questionnaire. This was done to guarantee that the questions addressed the most important aspects of CTS and its use in SC optimization.

The questionnaire was then divided into two distinct sections to collect information regarding both the demographics and the operations of the business. For the purpose of gathering demographic information about the respondents, the first portion, portion A, was utilized. In this section, questions were asked on the respondents' ages, genders, lvl.s of education, organizational positions and ranges, years of experience in SC management, types of organizations, and sizes of organizations. All of these different points of data were essential for determining the circumstances in which CTS is being viewed and managed, as well as for determining whether or not certain demographic characteristics (such the range of organizations or the number of years of expertise) have an effect on how CTS is perceived.

It was decided that the most important part of the study, which was the descriptive analysis of CTS in SC management, would be covered in Section B, which was the second section. A variety of statements were included in it, each of which discussed a different area of CTS and how it may enhance its performance. The questions were formulated using a Likert scale, which ranged from "Strongly Agree" to "Strongly Disagree." This allowed respondents to indicate their lvl. of agreement or disagreement with each statement by selecting from a range of possible responses. Not only did this scale provide a methodical approach to the collection of data, but it also made it easier to collect complex ideas and perspectives regarding issues related to cumulative trauma syndrome (CTS).

An awareness of CTS, the drivers of CTS across industries, the effect of CTS optimization on SC performance, the role of technology in minimizing CTS, the effect of customer behavior on CTS, collaboration among SC functions, and inventory management practices that impact CTS were some of the key topics that were discussed in Section B. These themes were selected with the utmost care to ensure that the questionnaire caught the most pertinent aspects of CTS. These aspects ranged from the fundamental understanding of the idea to its practical implementation in improving SC performance.

In order to ensure that respondents are able to provide responses that are both accurate and relevant, the statements on the questionnaire were designed to be as clear and exact as possible. For instance, when assessing the respondents' knowledge of CTS, the questions that were asked focused on the extent to which they understood the connection between CTS and customer service, the ways in which technology influences the accurate computation of CTS, and the significance of monitoring and reviewing CTS on a regular basis. Along the same lines, the questions that were asked on customer behavior investigated how different purchasing behaviors, such as preferences for order size and delivery speed, can have an impact on customer retention.

In order to determine the validity and reliability of the questionnaire, it was pilot-tested with a select group of experts working in the SC. The purpose of the pilot test was to evaluate the ease with which the questions could be understood and completed by the respondents, as well as to determine whether or not the Likert scale items were able to accurately convey the meaning of the questions. The feedback obtained from the pilot test was utilized to make modifications to the questionnaire. These modifications included modifying the phrasing in areas where it was deemed necessary and ensuring that the questions were understandable to respondents who possessed varied degrees of knowledge in stock management.

In addition, the questionnaire was designed to be applicable to the majority of different industries, including retail, logistics, healthcare, technology, and manufacturing, among others. The purpose of the questionnaire was to attempt to determine the many ways in which CTS is influenced and managed within various industries by incorporating sector-specific aspects into the questions. These elements

included the fluctuation of demand in the healthcare industry and economies of scale in the fast-moving consumer goods industry. In this way, it was ensured that the research would produce a wide variety of insights that are applicable to a large range of different businesses.

In order to ensure that the questionnaire is pertinent, understandable, and comprehensive, the process of designing it was a procedure that required great attention to detail. It is anticipated that the questionnaire will offer substantial information regarding the manner in which companies perceive and manage Cost to Serve, as well as the manner in which they implement plans to enhance it. This will be accomplished by incorporating a combination of demographic and operating questions. It is anticipated that the information obtained from this questionnaire will make a substantial contribution to the comprehension of the role that CTS plays in enhancing the effectiveness of SC operations, profitability, and customer happiness.

3.13 STATISTICAL TOOLS AND TECHNIQUES

During the course of this work, mixed statistical tools and techniques were adopted to test and interpret the questionnaires data with a view of drawing significant meanings on the premise of Cost to Serve (CTS) in SC management. The choice of these tools and techniques depended on the type and nature of questions being asked, as well as the kind of data to be collected. The objective was to make sure the analysis was reliable, precise, and able to offer useful insights that could shape both academic learning and real-life applications in SC optimization. The main statistical techniques employed by this work included descriptive statistics, correlation analysis, and regression analysis. Each of these methods was applied for a particular purpose while analyzing the data and determining how different factors contribute to CTS.

a) **Descriptive Statistics:** Descriptive statistics were utilized to describe and summarize the essential characteristics of the dataset. The approach was adopted to present a picture of the demographic profile of the respondents by age, gender, education, organizational role, and years of experience. Through frequencies, percentages, and mean scores, descriptive statistics assisted in portraying a distinct picture of the sample characteristics. Also, for the answers to the Likert-scale questions, descriptive statistics were employed to

determine the mean, median, and mode for every statement. This provided a preliminary insight into the general trend and distribution of views on Cost to Serve (CTS) and its associated factors.

For instance, the frequency and percentage of each demographic group (e.g., gender, age range, and organization type) were tabulated to learn about the sample composition. The standard deviations and means were utilized to measure the degree of agreement or disagreement with every statement in the Likert scale, indicating the dominant attitude towards CTS and its optimization in the SC.

b) **Correlation Analysis:** Correlation analysis was employed to determine the relationships among variables. In particular, this method assisted in determining the strength and direction of association among different factors affecting CTS, including order sizes, delivery modes, customer behaviour, technology adoption, and inventory management practices. Pearson's correlation coefficient was employed to quantify the linear relationship between pairs of variables. This analysis provided valuable insights into how certain factors (e.g., order size, delivery preferences) are related to changes in CTS, helping to understand which factors are most influential in driving costs.

For example, correlation analysis may indicate that order sizes are inversely correlated with CTS, meaning that companies operating with higher order sizes have lower unit costs of service. Likewise, the effect of technology adoption on CTS optimization may determine if more innovative technologies assist in keeping costs optimized along the SC.

c) **Regression Analysis:** To explore further the effect of independent variables on CTS, regression analysis was utilized. Regression models made it possible to gain more insight into how various factors influence CTS and its optimization. Of particular use was multiple linear regression in determining the impact of multiple predictors on the dependent variable—Cost to Serve. For instance, the regression analysis may examine how aspects like delivery means, customer segmentation, and stock management practices all aggregate in contributing to the variability of CTS.

The multiple regression analysis also aided in determining if the relationships among variables are statistically significant and if specific variables function as good predictors of CTS performance. By this, the analysis gave a snapshot of each factor's relative significance and its contribution to total cost to serve across the SC. For instance, the regression model could indicate that inventory management practices account for a large percentage of the variance in CTS, implying that their improvement would result in significant cost reductions.

d) Factor Analysis: In order to determine underlying dimensions or patterns in the data, factor analysis was used to examine the interrelationships among different statements on the questionnaire. This method proved especially effective for examining intricate constructs like customer behaviour, use of technology, and SC cooperation, which are multidimensional in their nature. By compressing the data into fewer dimensions, factor analysis facilitated bundling comparable variables together, making it easier to interpret the results. For instance, it may determine that customer demand for quick delivery, order frequency, and return behaviour are all within a broader factor that captures customer demand characteristics influencing CTS.

e) Testing for Reliability and Validity: To verify the reliability and validity of the questionnaire as well as the outcome data, various tests were performed. Cronbach's alpha was used to measure the internal consistency of the Likert-scale items in the questionnaire. The Cronbach's alpha lvl. of more than 0.7 established that the scale items were consistent and tapped into the same construct. Besides, content validity was also guaranteed by having experts review it, and construct validity was tested by investigating the factor structure of the questionnaire data using factor analysis.

f) Structural Equation Modelling (SEM): To better understand the interrelations among several variables and to evaluate the direct and indirect impacts of different factors on CTS, Structural Equation Modelling (SEM) was employed. SEM enabled the estimation of intricate relationships, e.g., how customer behaviour affects CTS through the mediation of variables such as order size and delivery modes. SEM is especially beneficial for research such as this, where several independent and dependent variables interact in intricate manners.

Therefore, the combination of these statistical techniques and tools offered a solid framework for the analysis of data in this work. Descriptive statistics summarized the data and exposed general trends, correlation and regression analyses revealed meaningful relationships between variables, and factor analysis reduced complex constructs to their simplest forms. The application of these statistical techniques ensured that the findings of the study were both reliable and actionable, yielding valuable insights into how to optimize Cost to Serve in SC management.

3.14 PILOT STUDY

A pilot study was done as an integral component of the research process to pilot-test the efficacy of the research design, instruments, and overall method before actual data collection. The pilot study was aimed at recognizing and addressing any problems that may hamper the success of the main study and to ensure that the research instruments, especially the questionnaire, were understandable, consistent, and true. It was a low-lvl. trial operation of the research method to evaluate the pragmatics of the data gathering process and have a chance for improvement.

The pilot study contained a number of primary objectives, and all of them were centered on maintaining the smooth running of the main data collection process. Among its primary objectives was testing the research instrument, and this was especially so for the questionnaire. Through a pilot, it was then possible to test whether the questions were understandable and straightforward, and whether the wording and design of the questionnaire were suitable for the target respondents. From the pilot group's feedback, it was possible to determine if there were any confusing or unclear items, which could be modified prior to the larger-scale survey.

Another key aim was an estimation of the time it would take to complete the survey. This was crucial because the researchers wanted to make sure that the respondents would be able to fill out the questionnaire in a reasonable amount of time (approximately 10-15 minutes). If the survey took too long to fill out, participants may become tired or lose interest and could potentially influence the quality of their answers. Therefore, the pilot study gave them valuable information on how long it would take to fill out the survey and if any changes were needed in terms of length.

The pilot study also acted as a way of determining logistical problems in the data collection process. Whether it was the distribution of questionnaires, follow-up methods, or contact with respondents, the pilot study offered an opportunity to troubleshoot and resolve any practical problems that might occur during the main study. Additionally, it assisted in determining whether the data collection process itself was effective and whether the desired sample size could be achieved without facing significant hurdles.

The pilot sample comprised a manageable number of 30 participants, who were all selected in relation to the research theme. These participants were selected from a group of experienced professionals in SC management, the same target population as for the main study. In order to guarantee the sample was representative of the larger pool of respondents, convenience sampling was employed with a focus on those who were readily accessible and who possessed appropriate information regarding the topic under review.

The same questionnaire from the main study was administered in the pilot stage. This enabled the researchers to pilot the instrument in a real-life situation, monitoring any issues with wording, layout, or question interpretation. Participants were invited to fill in the survey and then offer comments on all stages of the process, including question clarity, completion time, and any problems they had. This immediate feedback proved extremely useful in streamlining the research instrument and methodology.

On the basis of the pilot study findings, a number of significant changes were made to enhance the quality of the research. One of the most significant lessons learned was that some of the questions in the original version of the questionnaire were either too complicated or worded in an unclear manner, which made it hard for some of the participants to completely comprehend them. These questions were reworded to make them clearer and more precise. For example, technical vocabulary or jargon that could confuse the respondents was simplified or defined in the context of the questionnaire.

Furthermore, the duration of the questionnaire was slightly longer than anticipated, causing some participants to feel fatigued. Considering that the primary study wanted to keep participants interested, some questions were removed or merged to make the survey shorter without losing essential information. This ensured that the survey would not be too lengthy and participants would be able to finish it without feeling fatigued.

The feedback likewise highlighted a need to enhance the questionnaire design and layout. Others said the survey sections did not follow any logic, rendering the flow of the questions more difficult to comprehend. Consequently, the structure was therefore modified for enhancement of clarity as well as for ease of use, enabling the respondents to be able to get through the survey quickly and effortlessly.

An important component of the pilot study was the test of the reliability and validity of the questionnaire. For the measurement of reliability, the researchers computed Cronbach's alpha based on the pilot data, which quantifies the internal consistency of the survey. The findings indicated that the reliability coefficient was higher than the acceptable lvl. of 0.7, signifying that the questionnaire was consistent in the measurement of the constructs intended. In addition, factor analysis was also performed to evaluate the construct validity of the questionnaire. This procedure ensured that the factors in the questionnaire were logically clustered and consistent with the aims of the study, and it provided evidence that the survey was indeed measuring the different dimensions of Cost to Serve (CTS) in SC management.

The pilot study was found to be a crucial step in the process of preparing for the actual data collection phase. It assisted in perfecting the research tool by overcoming problems of clarity, length, and design, so that the final questionnaire was easy to use and able to gather high-quality data. Pilot also gave good insights into the practicalities of the data gathering process, for example, management of time and logistical issues, which enabled researchers to make proper adjustments prior to starting the main study.

Through the assessment of the questionnaire's reliability and validity, the pilot study validated that the research tool was strong and could effectively record the data for the study. In general, the pilot study played a big role in refining the study's methodology, making the research design more confident, and paving the way for an effective main data collection process.

3.15 ETHICAL CONSIDERATIONS

Ethical issues are of utmost significance in any research study since they guarantee that the research is carried out in a respectful, just, and open manner, safeguarding the rights and welfare of participants. This research was carried out with complete

adherence to ethical standards, guaranteeing that every step of the research process, from the collection of data to the analysis of data, adhered to ethical standards to maintain the integrity of the research and protect participants' rights.

The core ethical principles in research is informed consent, where participants are made aware of the nature of the study, the procedures used, and the risks involved before they give consent to participate. All the participants in this study were given an informed consent form that described the research purpose, the voluntary participation, and the use of the data intended. Participants were informed that they could withdraw from the study at any point without any adverse effects. The consent form stated categorically that participation was absolutely voluntary, and respondents were not pressured or forced to participate. The form further stated that their personal details would be kept confidential and would only be used for purposes outside this study.

Confidentiality and anonymity are essential elements of ethical research, especially in human subject studies. To ensure confidentiality, all information gathered from participants were kept safe, and access was limited to the research team. Personal information that could identify participants, such as names or contact information, was not associated with the answers given in the questionnaire. Participants were instead given unique identification codes to guarantee their anonymity during the study. The information was anonymized prior to analysis or publication, which meant that individual participants could not be traced from the data set.

Furthermore, the participants were also made to understand that their answers would not be shared with any third parties without their consent and that it would only be used for the research purpose. The raw data and reports with personal data were stored safely and destroyed after the research study to ensure that no unauthorized person could access them.

The participation in this study was voluntary, and participants were free to withdraw at any moment without any adverse effects. The right to withdraw was made clear in the informed consent form, which ensured that participants knew they did not have to take part if they did not feel at ease. The researchers ensured they created an atmosphere in which the participants would be safe and were not compelled to proceed if they wanted to withdraw at any point during the research.

The rule of non-maleficence mandates researchers to refrain from inflicting harm or discomfort on participants while conducting research. In this work, all efforts were made to see that the research did not inflict any psychological, physical, or emotional harm on the participants. The questionnaire was made simple and not intrusive and did not ask participants to reveal sensitive or personal information that could be a source of discomfort or distress.

The research process was developed to limit any possible dangers, and all the participants were informed about the amount of time they were expected to spend, enabling them to make an educated choice on whether or not to participate. All the procedures were also examined to confirm that no unnecessary stress, embarrassment, or injury could result from the study procedure.

Integrity is one of the main ethical principles, and researchers need to be devoted to generating accurate, truthful, and credible outcomes. During the research, the researchers made sure that data collection, analysis, and reporting were done with maximum honesty and openness. All the outcomes were correctly reported without data manipulation or distortion to fit an agenda. The researchers also followed the laws of scientific integrity, with a view to making sure that data was collected, analyzed, and interpreted objectively.

In addition, any weakness or difficulty experienced while conducting research, such as in sample size, data collection, or methodological limitations, were recognized and honestly reported in the final document. This lvl. of honesty ensured the credibility and trustworthiness of the findings in the study.

The research was carried out according to the ethical standards provided by the respective institutional review board (IRB) or ethical review committee. Before data collection started, the research proposal, informed consent forms, and the questionnaire were sent for approval to the ethical review board. All ethical standards were followed by the research team, and they received proper ethical clearance prior to the conduct of the research. This process ensured that the study met the required ethical standards for conducting research involving human participants.

The research considered participants' privacy and cultural sensitivities. Cultural considerations were taken into account when developing the questionnaire, to ensure that the questions were appropriate and respectful of the participants' backgrounds. Researchers were also respectful of participants' time and circumstances, avoiding undue disruption or inconvenience. By taking cultural context and participants' privacy into consideration, the researchers developed a considerate data collection process.

The above ethical considerations were diligently put into practice during the research, right from planning to data analysis. Through adherence to ethical standards, the researchers ensured that the research was undertaken in a responsible and respectful manner, protecting the rights of participants, maintaining the integrity of the research, and maintaining trust in the findings. Ethical conduct was central to ensuring that the credibility and integrity of the study were maintained so that it could make meaningful contributions to the field and uphold the highest standards of ethics.

3.16 CHAPTER SUMMARY

The chapter has explained the research approach adopted in investigating the optimization of Cost to Serve (CTS) in SC management, explaining the methodologies, tools, and techniques used in collecting and analyzing data. The chapter commenced with presenting the research problem and explaining the research design comprehensively, which entailed descriptive and exploratory methods. It emphasized the purpose of the study to examine the different factors affecting CTS and its effect on operational efficiency and customer satisfaction. The methodology section outlined the data collection process, from questionnaire design to structure. The questionnaire was created to capture respondents' understanding of CTS, factors that affect it, and how technology and cooperation play a part in optimizing it. The pilot study carried out was also presented, for it served to establish the reliability and validity of the tool prior to full deployment.

The sampling strategy was described, focusing on the target population, the sampling methods, and why participants were selected. Statistical techniques and instruments, including regression analysis and correlation, were described to show how the data would be analyzed to address the research questions. Ethics, for instance, ensuring

participant confidentiality and informed consent, were also covered, noting that the study was conducted with ethical values. Therefore, this chapter offered a detailed and organized framework of the research approach to ensure that the study is well-positioned to produce credible and meaningful information on CTS optimization in SC management. The approach established the platform for subsequent presentation and examination of the research results.

CHAPTER – IV

DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

This chapter provides the data analysis and interpretation of the data gathered for the study. The aim of this chapter is to critically analyze the data in relation to the research objectives and hypotheses. The analysis has been conducted using both descriptive and inferential statistical methods to present meaningful information on the patterns and relationships of the dataset. The chapter first describes the demographic profile of respondents by using such variables as age, gender, educational qualification, position in organization, years of experience, category of organization, and size of organization. Identification of the respondents' demographic profiles helps to ground results and also aid in interpretation of subsequent analysis.

On completion of demographic analysis, exploratory factor analysis (EFA) is performed to discern the latent factors of the measured constructs in the study. Factor analysis is carried out to gauge the validity and structure of data by collapsing into factors variables having a bearing, thus distilling the data into meaningful factors. The sample size adequacy and appropriateness of the data for factor analysis are determined through the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. Low communalities or poor factor loadings of variables are removed to improve the reliability and interpretability of the factor structure. The rotated component matrix is then utilized to clearly define the items under separate factors. The findings of both factor and descriptive analyses serve as the foundation for subsequent statistical tests and interpretation in the sections that follow, which ultimately focus on addressing the research aims and hypotheses developed in the study.

4.2 DEMOGRAPHIC PROFILE OF RESPONDENTS

This section introduces the demographic profile of the respondents involved in the study. The information was gathered from 150 respondents. The demographic profile consists of variables like age, gender, educational qualification, current designation,

work experience, organizational type, and organizational size. These details are important in understanding the background of the sample and ensuring representativeness of the data for further analysis.

1) **Age:** The participants were divided into three age groups. Most of them (40.7%) fell in the 35–44 years' age group, followed by 38.7% in the 25–34 years' age group. The 20.7% fell in the 45–54 years' age group. This figure confirms that the participants were essentially mid-career individuals.

Table 4.1: Age

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25-34 years	58	38.7	38.7	38.7
	35-44 years	61	40.7	40.7	79.3
	45-54 years	31	20.7	20.7	100.0
	Total	150	100.0	100.0	

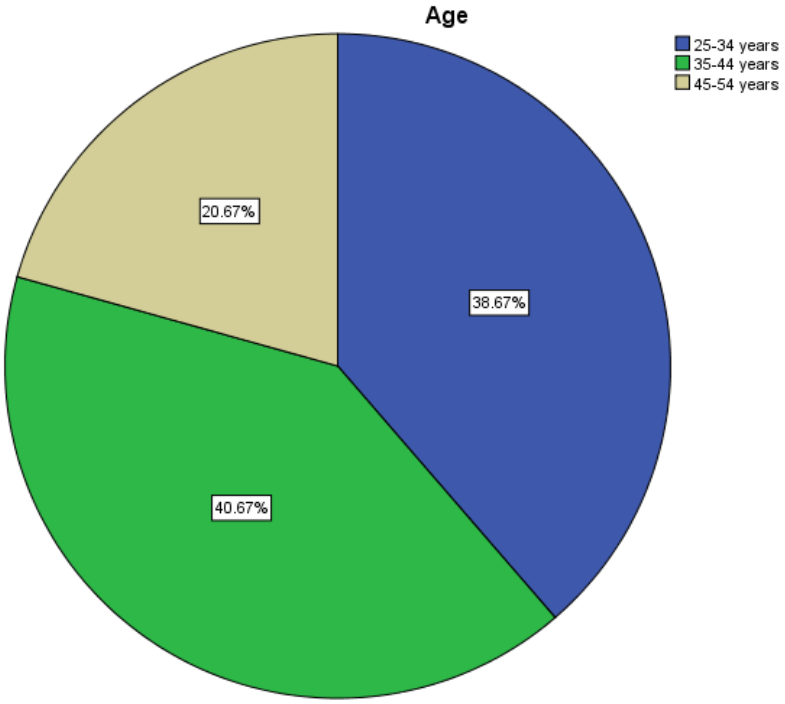


Figure 4.1: Age

2) **Gender:** The gender breakdown indicates that 66.0% of the respondents were male and 34.0% were female. This is a male-heavy sample, which is representative of many business and SC industries.

Table 4.2: Gender

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	99	66.0	66.0	66.0
	Female	51	34.0	34.0	100.0
	Total	150	100.0	100.0	

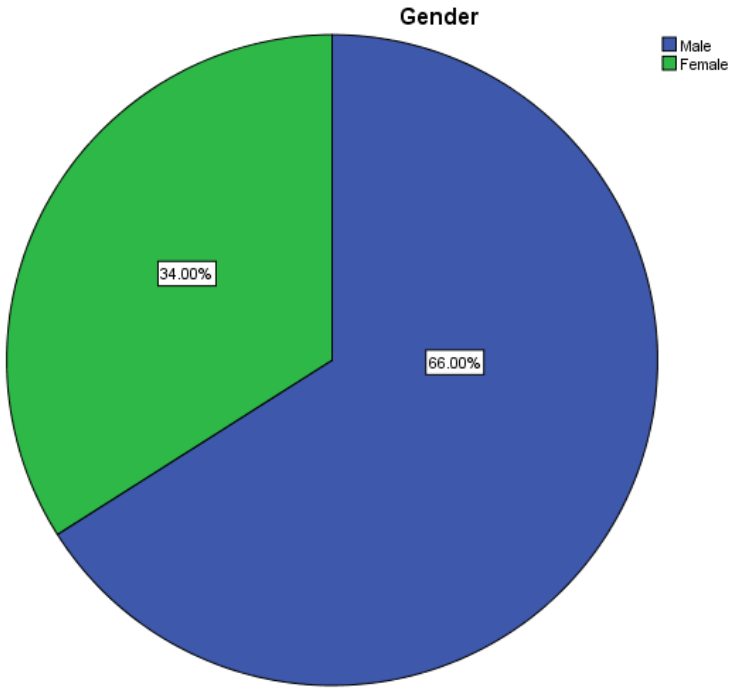


Figure 4.2: Gender

3) **Education:** Based on educational qualifications, a vast majority of the respondents were bachelor degree holders (48.0%), followed closely by master's degree holders (47.3%). A minority (4.7%) had a doctorate degree. This indicates that a majority of the respondents were highly educated professionals.

Table 4.3: Education

Education					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's Degree	72	48.0	48.0	48.0
	Master's Degree	71	47.3	47.3	95.3
	Doctorate	7	4.7	4.7	100.0
	Total	150	100.0	100.0	

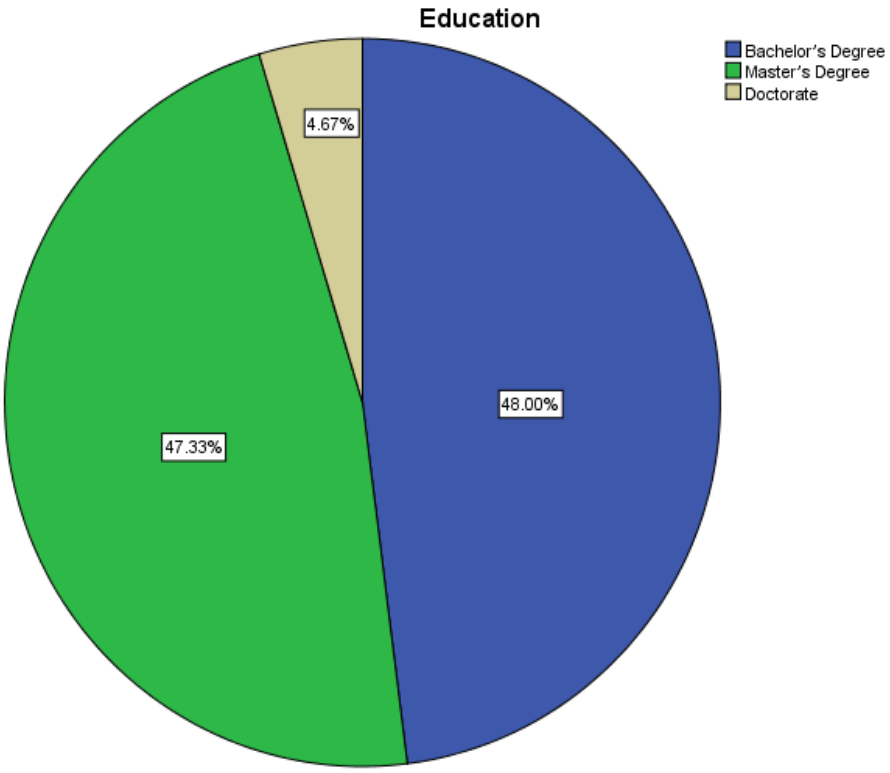


Figure 4.3: Education

4) **Position:** Respondents held different lvl.s of managerial ranks in their respective organizations. They were predominantly Sales/Marketing Managers (24.7%), then Supply Chain Managers (21.3%), followed by Accounts Managers (20.0%), Finance Managers (20.0%), and Logistic Managers (14.0%).

Table 4.4: Position

Position					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Supply Chain Manager	32	21.3	21.3	21.3
	Sales/Marketing Manager	37	24.7	24.7	46.0
	Accounts Manager	30	20.0	20.0	66.0
	Finance Manager	30	20.0	20.0	86.0
	Logistic Manager	21	14.0	14.0	100.0
	Total	150	100.0	100.0	

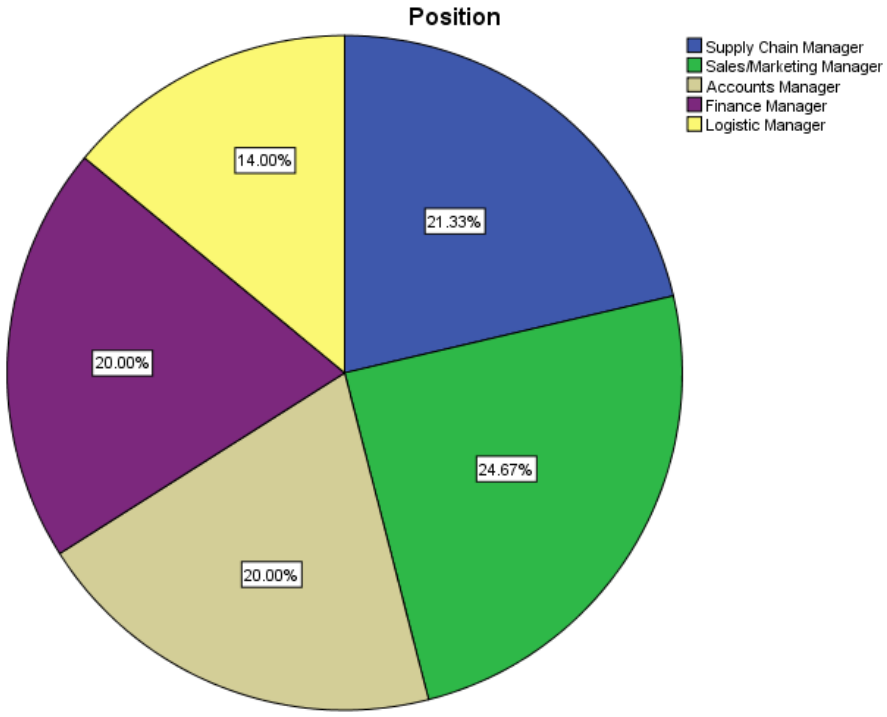


Figure 4.4: Position

5) **Experience:** Most of the interviewees (58.0%) had 6–10 years of experience at work, and then there were 22.7% having over 10 years of work experience, followed by 19.3% having 2–5 years of work experience. This confirms that the sample predominantly included veterans of the field with long-standing industry experience.

Table 4.5: Experience

Experience					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2-5 years	29	19.3	19.3	19.3
	6-10 years	87	58.0	58.0	77.3
	More than 10 years	34	22.7	22.7	100.0
	Total	150	100.0	100.0	

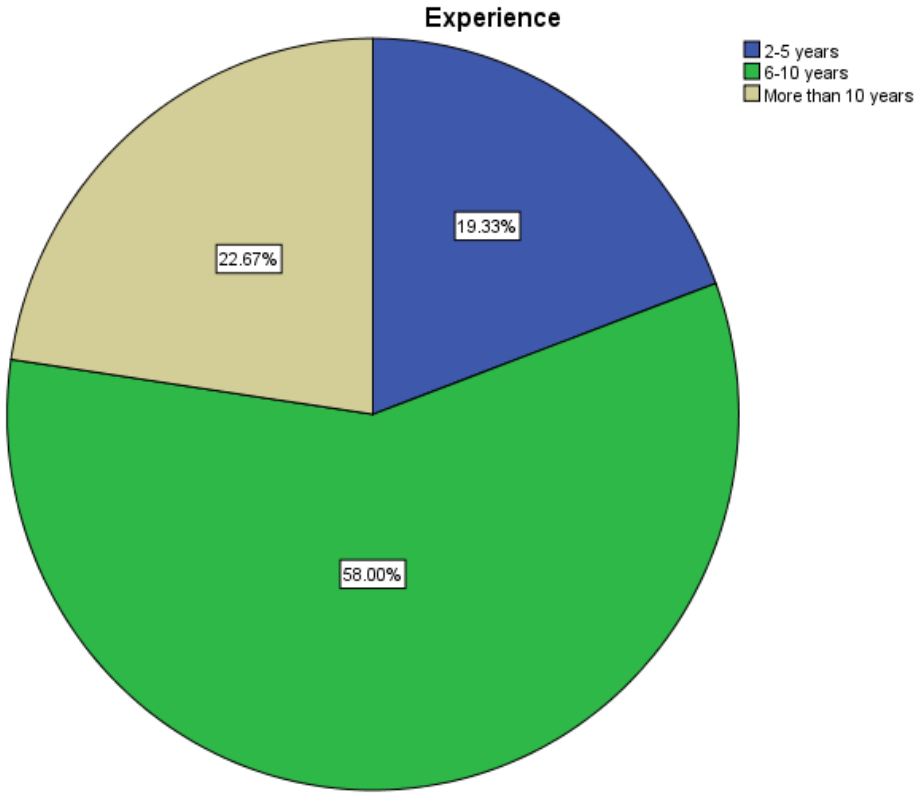


Figure 4.5: Experience

6) **Organization:** Respondents were spread evenly across Manufacturing, Retail, and Third-Party Logistics firms, each contributing 26.7% of the sample. Also, 20.0% were from Trade Businesses. This spread implies that data were gathered across various sections of the SC ecosystem.

Table 4.6: Organization

Organization					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	40	26.7	26.7	26.7
	Retail	40	26.7	26.7	53.3
	Third Party Logistic Company	40	26.7	26.7	80.0
	Trade Business	30	20.0	20.0	100.0
	Total	150	100.0	100.0	

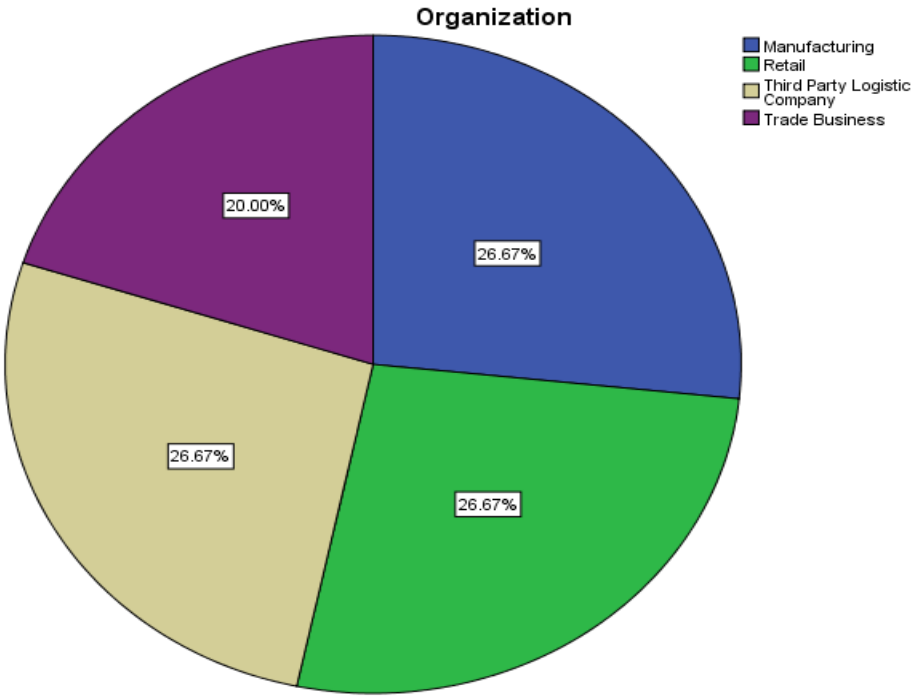


Figure 4.6: Organization

7) **Organizational Size:** In terms of the size of the firms, 44.7% of them were employed in medium-sized firms (50–249 workers), followed by 32.7% of those from large firms (250+ workers), while 22.7% were from small firms (fewer than 50 workers). This shows an even distribution from firms of different sizes.

Table 4.7: Organizational Size

Size					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Small (Less than 50 employees)	34	22.7	22.7	22.7
	Medium (50-249 employees)	67	44.7	44.7	67.3
	Large (250+ employees)	49	32.7	32.7	100.0
	Total	150	100.0	100.0	

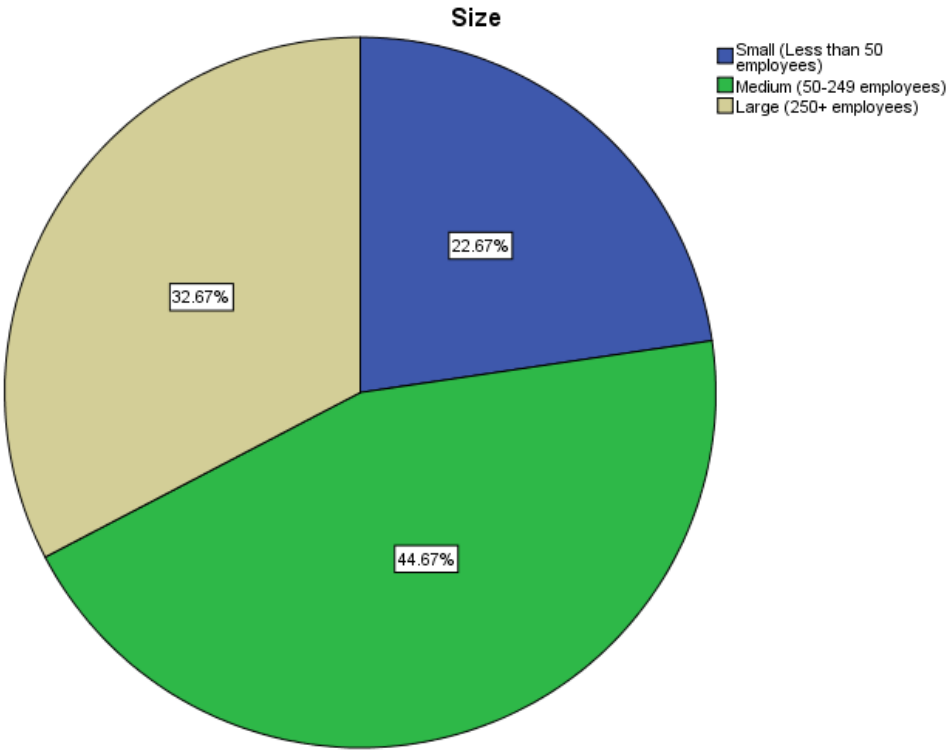


Figure 4.7: Organizational Size

4.3 FACTOR ANALYSIS

In order to reveal the underlying dimensions affecting the responses of the participants and to minimize the complexity of the dataset, a factor analysis was performed. The aim of using factor analysis was to detect clusters of similar variables that, together, capture distinct constructs within the data and simplify the

interpretation and improve the robustness of further statistical analysis. This method is especially worth its while when working with many interconnected variables since it helps the researcher summarize the information into fewer, more significant factors without incurring much loss of information.

Prior to the extraction of factors, two commonly used statistical indicators, Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity, were used to test whether the data was adequate for factor analysis. The KMO measure provided a score of 0.812, which is well above the lowest recommended cut-point of 0.6, suggesting that sample size was large enough and patterns of correlations among variables were close enough to each other to give reliable factors. In addition, Bartlett's Test of Sphericity was significant at the statistical lvl. of $p < 0.001$, suggesting that the correlation matrix was not an identity matrix and that there were significant correlations between variables. These results cumulatively validated the suitability of conducting factor analysis on the dataset.

Table 4.8: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.950
Bartlett's Test of Sphericity	Approx. Chi-Square	2445.621
	df	190
	Sig.	.000

Table 4.9: Communalities

Communalities		
	Initial	Extraction
S1_1	1.000	.655
S1_2	1.000	.775
S1_3	1.000	.747
S1_4	1.000	.703

S1_5	1.000	.745
S1_6	1.000	.803
S1_7	1.000	.688
S1_8	1.000	.776
S1_9	1.000	.765
S1_10	1.000	.747
S4_1	1.000	.724
S4_2	1.000	.700
S4_3	1.000	.702
S4_4	1.000	.783
S4_5	1.000	.710
S4_6	1.000	.767
S4_7	1.000	.704
S4_8	1.000	.657
S4_9	1.000	.775
S4_10	1.000	.756
Extraction Method: Principal Component Analysis.		

Table 4.10: Total Variance Explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.474	52.371	52.371	10.474	52.371	52.371	5.880	29.402	29.402
2	3.106	15.528	67.899	3.106	15.528	67.899	5.704	28.521	57.922
3	1.102	5.508	73.407	1.102	5.508	73.407	3.097	15.485	73.407
4	.537	2.684	76.091						
5	.483	2.413	78.504						
6	.472	2.362	80.866						
7	.419	2.096	82.962						
8	.394	1.968	84.930						

9	.352	1.761	86.690						
10	.325	1.626	88.316						
11	.300	1.498	89.815						
12	.297	1.486	91.300						
13	.286	1.432	92.733						
14	.268	1.342	94.075						
15	.247	1.234	95.308						
16	.224	1.119	96.427						
17	.193	.965	97.392						
18	.192	.959	98.351						
19	.182	.909	99.260						
20	.148	.740	100.000						
Extraction Method: Principal Component Analysis.									

Table 4.11: Rotated Component Matrixa

Rotated Component Matrix[a]			
	Component		
	1	2	3
S1_1		.673	
S1_2		.774	
S1_3		.808	
S1_4		.709	
S1_5		.748	
S1_6		.803	
S1_7		.694	
S1_8		.805	
S1_9			.873
S1_10			.863
S4_1	.751		
S4_2	.715		
S4_3	.751		
S4_4	.808		
S4_5	.772		

S4_6	.796		
S4_7	.754		
S4_8	.693		
S4_9			.876
S4_10			.868
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

Factor extraction was performed through Principal Component Analysis (PCA), a widely used method of exploratory factor analysis. PCA seeks to reduce the initial set of variables into a new set of uncorrelated components arranged in such an order that the first few components explain the greatest possible variance in the data. To allow a more interpretable and clearer factor structure, Varimax rotation, an orthogonal method of rotation, was used. Varimax rotation maximizes the variance of the squared loadings of a factor on all the variables, thus leading to a simpler and more interpretable pattern of relationships among factors and variables. In ascertaining how many factors should be retained, Kaiser's criterion of Eigenvalues larger than 1 was employed to ensure that factors that were explaining a great proportion of the variance were retained only. After removing the irrelevant items (S1_9, S1_10, S4_9, S4_10) and rerun the factor analysis we get the following result.

Table 4.12: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.966
Bartlett's Test of Sphericity	Approx. Chi-Square	2071.219
	df	120
	Sig.	.000

Table 4.13: Communalities

Communalities		
	Initial	Extraction
S1_1	1.000	.653
S1_2	1.000	.777
S1_3	1.000	.747
S1_4	1.000	.692
S1_5	1.000	.741
S1_6	1.000	.803
S1_7	1.000	.664
S1_8	1.000	.777
S4_1	1.000	.722
S4_2	1.000	.699
S4_3	1.000	.704
S4_4	1.000	.774
S4_5	1.000	.711
S4_6	1.000	.767
S4_7	1.000	.702
S4_8	1.000	.650
Extraction Method: Principal Component Analysis.		

In the analysis, there was a finding of five separate factors whose combined variance accounted for about 73.29%. This large proportion of explained variance indicated that the factors extracted were accounting for a high percentage of the total variation in the data, thus justifying their utility in representing the underlying constructs. All the factors consisted of variables with high factor loadings (above 0.50), reflecting strong correlations between the variables and their corresponding factors. The rotated component matrix displayed clear and unambiguous groupings of the variables, making interpretation and labeling of the factors easier.

These drawn-out factors formed the basis for subsequent statistical tests like regression analysis, correlation analysis, and hypothesis testing, where their effect on dependent variables as well as among themselves were examined systematically. The use of factor analysis not only added to the validity and reliability of the research but also offered greater insight into the relationships present in the data at the structural lvl., leading to more enlightened conclusions and recommendations.

Table 4.14: Total Variance Explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.469	65.429	65.429	10.469	65.429	65.429	5.816	36.349	36.349
2	1.111	6.944	72.374	1.111	6.944	72.374	5.764	36.025	72.374
3	.515	3.217	75.591						
4	.474	2.960	78.551						
5	.452	2.827	81.378						
6	.394	2.460	83.838						
7	.366	2.290	86.128						
8	.333	2.081	88.209						
9	.300	1.878	90.086						
10	.286	1.786	91.872						
11	.272	1.697	93.570						
12	.241	1.505	95.075						
13	.233	1.456	96.531						
14	.199	1.241	97.772						
15	.195	1.216	98.988						
16	.162	1.012	100.000						
Extraction Method: Principal Component Analysis.									

Table 4.15: Rotated Component Matrixa

Rotated Component Matrix[a]		
	Component	
	1	2
S1_1		.678
S1_2		.778
S1_3		.811
S1_4		.704
S1_5		.747
S1_6		.806
S1_7		.707
S1_8		.810
S4_1	.746	
S4_2	.713	
S4_3	.754	
S4_4	.798	
S4_5	.772	
S4_6	.797	
S4_7	.749	
S4_8	.695	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

4.4 RELIABILITY ANALYSIS

Reliability analysis was done to determine the internal consistency of the items in the study to ensure that the scales used were reliable and measured the constructs

accurately. The reliability of each scale was assessed by using Cronbach's Alpha, which is a commonly used statistic that measures how closely related a set of items are as a group. A value above 0.7 for Cronbach's Alpha is commonly taken to be satisfactory, while figures greater than 0.9 show outstanding internal consistency. There were two separate groups of items analyzed in terms of reliability — Supply Chain Performance and Profitability items, as well as CTS Optimization items.

4.4.1 Reliability of CTS Optimization items: For the 8-item CTS Optimization scale, the Cronbach's Alpha coefficient was estimated to be 0.946. This extremely high value reflected an extremely high internal consistency of the items, which supported that the items captured the underlying construct of CTS Optimization consistently. The similarity of item inter-correlations suggested that all the items were homogeneous and made similar contributions to the measurement of the same construct, thus confirming the reliability and strength of the scale.

Table 4.16: Reliability of CTS Optimization items

Reliability Statistics	
Cronbach's Alpha	N of Items
.946	8

4.4.2 Reliability of Supply Chain Performance and Profitability items: Likewise, the Supply Chain Performance and Profitability scale, another 8-item set, resulted in a Cronbach's Alpha coefficient of 0.943. This statistic, being also extremely close to that of the CTS Optimization scale, once again showed strong internal consistency across the items of Supply Chain Performance and Profitability. The very high alpha value indicated that the items were strongly correlated with one another and that they collectively generated a reliable assessment of the target construct. Such consistency lvl. showed that the responses of the respondents to these items were reliable and represented their real perceptions without error.

Table 4.17: Reliability of Supply Chain Performance and Profitability items

Reliability Statistics	
Cronbach's Alpha	N of Items
.943	8

In both instances, the values for Cronbach's Alpha largely exceeded the critical minimum of 0.7, thus certifying that instruments used to take the measurements for this study were strongly reliable. Strong reliability on both scales rationalized their applicability in any ensuing analysis that utilized factor analysis, regression analysis, and testing for hypotheses. Their reliability helped validate the resulting findings from the research by having sound and similar measurements, raising the overall worthiness and accuracy of the generated evidence.

4.5 INTERPRETATION WITH RESPECT TO OBJECTIVES:

Objective 3: To assess the impact of CTS optimization on overall SC performance and profitability.

H3: Optimization of CTS has a positive impact on overall SC performance and profitability by reducing operational inefficiencies and improving resource allocation.

Regression Analysis: To test the association between CTS Optimization and Supply Chain Performance and Profitability, a simple linear regression analysis was used. The aim of this analysis was to determine if CTS Optimization, as the independent variable, significantly predicted Supply Chain Performance and Profitability, which was defined as the dependent variable. The regression model used the Enter method, in which all the variables were entered into the model at the same time.

The Variables Entered/Removed table ensured that CTS Optimization was the only predictor that entered the model and no variables were deleted. This was to ensure that all the predictive power of CTS Optimization was represented in the analysis free from any other covariates' effects.

Table 4.18: Variables Entered/Removeda

Variables Entered/Removed[a]			
Model	Variables Entered	Variables Removed	Method
1	CTS Optimization[b]	.	Enter
a. Dependent Variable: Supply Chain Performance and Profitability			
b. All requested variables entered.			

The Model Summary table presented a summary of the strength and the explanatory value of the regression model. The correlation coefficient (R) was 0.813, showing a very strong positive relationship between CTS Optimization and Supply Chain Performance and Profitability. The R Square of 0.662 was the measure of the variance in the dependent variable explained by the independent variable. This indicated that about 66.2% of the variance in Supply Chain Performance and Profitability could be explained by CTS Optimization alone. The Adjusted R Square, which is adjusted for sample size and number of predictors, was 0.659, showing a negligible decrease and validating the strength of the model. The standard error of the estimate was 0.30261, showing the average distance between the observed values and the regression line.

Table 4.19: Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.813[a]	.662	.659	.30261
a. Predictors: (Constant), CTS Optimization				

The ANOVA test results, which analyze the overall model significance of the regression, confirmed that the model was significant at a statistical lvl. ($F = 289.259$, $p < 0.001$). The sum of squares of regression was 26.488 and the sum of squares of the residuals was 13.553, while the total sum of squares was 40.041 with 149 observations. The high F-statistic and resultant significance lvl. (<0.001) established that CTS Optimization was a significant predictor of Supply Chain Performance and Profitability and that model fit was good.

Table 4.20: ANOVAa

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26.488	1	26.488	289.259	.000[b]
	Residual	13.553	148	.092		
	Total	40.041	149			
a. Dependent Variable: Supply Chain Performance and Profitability						
b. Predictors: (Constant), CTS Optimization						

The Coefficients table gave some idea of the contribution made by CTS Optimization to the dependent variable. The unstandardized coefficient (B) for CTS Optimization was 0.814, indicating that for every one-unit increase in CTS Optimization, there was an expected increase of 0.814 units in Supply Chain Performance and Profitability, holding all else constant. The standard error associated with this coefficient was 0.048, suggesting a high lvl. of precision in the estimate. The standardized coefficient (Beta) was 0.813, further underscoring the strong positive relationship between the variables. The t-value for CTS Optimization was 17.008, which was significant statistically ($p < 0.001$), showing that the impact of CTS Optimization on Supply Chain Performance and Profitability was significant both in terms of magnitude and statistically. The model's constant term (intercept) was 1.092, and it was the expected value of Supply Chain Performance and Profitability when CTS Optimization was equal to zero. The constant itself was also statistically significant ($t = 6.542$, $p < 0.001$).

Table 4.21: Coefficientsa

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

1	(Constant)	1.092	.167		6.542	.000
	CTS Optimization	.814	.048	.813	17.008	.000
a. Dependent Variable: Supply Chain Performance and Profitability						

Overall, the regression analysis strongly established that CTS Optimization had a significant, positive, and statistically significant effect on Supply Chain Performance and Profitability. The model's explanatory ability was high since CTS Optimization explained 66.2% of the variation in the dependent variable. The findings empirically confirmed the hypothesis that optimizing CTS processes significantly contributes to SC performance and profitability.

Table 4.22: Results of Hypothesis Testing

Objective	Hypothesis (H_3)	Result
Objective 3: To assess the impact of CTS optimization on overall SC performance and profitability.	**H_3: Optimization of CTS has a positive impact on overall SC performance and profitability by reducing operational inefficiencies and improving resource allocation.**	**Hypothesis Accepted**

4.6 INTERPRETATION OF RESULTS

This section provides a thorough interpretation of results obtained from a sample of 150 participants, keeping in mind the demographic profile of the participants and establishing the measurement scale using exploratory factor analysis (EFA). The thorough interpretation of these findings not only situates the study group but also guarantees the methodological validity of the following inferential analysis. By examining both factor structures and demographic variables in great detail, this section lays a strong groundwork for testing the research hypotheses and drawing meaningful conclusions.

The respondents' demographic features offer important background information about the professional and organizational backgrounds of the study participants. The age distribution of the respondents shows that the largest group (40.7%) was in the 35–44 years' age bracket, followed closely by 38.7% of the respondents being in the 25–34 years' age group. The smallest group, 20.7%, was in the 45–54 years' age bracket. This age distribution indicates that the sample was comprised mainly of middle-career managers, who were most likely to have gained theoretical knowledge and practical experience in SC management and allied business activities. The diversity of age guarantees that views from both relatively younger and more experienced professionals were well represented, adding to the richness and diversity of responses.

Gender breakdown in the sample was not completely even, with males making up 66% and females 34%. Although this bias is reflective of typical patterns in SC-dominant industries—where male predominance among managers and logistics specialists persists—the presence of more than one-third female responses guarantees that gender-specific insights are not marginalized. This gender balance lends validity to the sample, enabling wider generalizations across gender-mixed workplace settings.

Concerning education lvl., the information indicates that an extremely well-educated sample of respondents was involved in the research. An almost equal percentage (48%) of the study participants had a Bachelor's degree, and slightly fewer (47.3%) had a Master's degree. A smaller percentage (4.7%) had earned a Doctorate. The dominance of Bachelor and Master degree holders is high because it suggests that the majority of respondents are well-grounded in business, management, or technical fields relevant to SC and organizational practices. This profile improves the validity of gathered data as respondents will be better able to have the cognitive and conceptual abilities required to comprehend and answer constructively to the constructs of the study.

Respondents' professional designations were suitably spread over a number of important functional categories. Sales/Marketing Managers constituted the highest percentage (24.7%), closely followed by Supply Chain Managers (21.3%), Accounts Managers (20%), Finance Managers (20%), and Logistics Managers (14%). Such a broad functional base strengthens the study's representativeness as it incorporates

inputs from different operating aspects of SC management. Such functional diversity guarantees that findings are not inductively limited to one particular managerial area but show the dynamics of various business functions toward the total SC environment.

Work experience information further underline the maturity and expertise of the sample. Most respondents (58%) had 6 to 10 years of work experience, while 22.7% had over 10 years and 19.3% had 2 to 5 years. The high degree of experience means that the majority of respondents had ample familiarity with industry practices, strategic choices, and operational complexity—qualities likely influencing the responses and strengthening the validity of the study's conclusions.

The nature of organization at which the respondents were working showed a balanced spread across major industry sectors. Manufacturing, retail, and third-party logistics each represented 26.7% of the sample, while trade-oriented businesses contributed 20%. The balanced representation guarantees that the study reflects industry-specific nuances, challenges, and opportunities applicable to SC management and circular economy strategies. Sectoral variation increases external validity and extends the generalizability of the study findings to different parts of the business environment.

Lastly, the breakdown by organizational size indicated that 44.7% of the respondents were employed in medium-sized organizations (50–249 employees), 32.7% were in large organizations (250+ employees), and 22.7% in small organizations (fewer than 50 employees). This diversity emphasizes that the data represents inputs from companies of different operating sizes and capacity for resources. Insights derived from various sizes of organizations are important, given that SC practices, adoption of circular economy, and practices in managing resources tend to significantly differ among small, medium, and large companies.

Exploratory factor analysis (EFA) was used to determine the construct validity of the measurement scale as well as to compress the data into meaningful dimensions that reflect hidden patterns between variables. The Kaiser-Meyer-Olkin (KMO) statistic, a measure of sampling adequacy, was recorded at 0.950 in the initial analysis, signaling that the correlation matrix was exceptionally suited for factor analysis. According to Kaiser’s (1974) guidelines, a KMO value greater than 0.9 is considered "marvelous,"

indicating that partial correlations among variables were minimal and patterns of correlations were compact. Also, Bartlett's Test of Sphericity was extremely significant ($\chi^2 = 2445.621$, $p < 0.001$), indicating that the correlation matrix was not an identity matrix and, therefore, that factor analysis was valid.

Communalities for the variables—that is, the percentage of variance in each item explained by the factors extracted—showed values largely greater than 0.65. This is to say that most of each variable's variance was accounted for by the factors retained, affirming their significance within the factor structure. From the Total Variance Explained table, three components with eigenvalues greater than 1 explained 73.41% of the total variance. Factor 1 alone explained a very high 52.37%, Factor 2 explained 15.53%, and Factor 3 explained 5.51%. These results indicate a strong factor structure, with the first factor accounting for most of the common variance between items.

The first rotated component matrix, which was derived with the aid of Varimax orthogonal rotation, clarified factor structure by achieving maximum item loadings on each factor with minimal cross-loadings. In this step, it was noticed that items S1_9, S1_10, S4_9, and S4_10 had weak loadings or substantial cross-loadings, which undermined their interpretability as well as discriminant validity. In order to improve the interpretability and strength of factor structure, these items were removed from subsequent analysis on a systematic basis.

A second EFA was then run on the cleaned item set. The KMO statistic increased slightly to 0.966, further confirming excellent sampling adequacy, and Bartlett's Test of Sphericity was still significant ($\chi^2 = 2071.219$, $p < 0.001$). Communalities were still high, with all greater than 0.65, so that every retained item would be contributing significantly to variance explained in the factors.

The new Total Variance Explained table showed that two factors combined explained 72.37% of the total variance, with the first factor explaining a whopping 65.43% and the second factor explaining 6.94%. The large explanatory power of the first factor indicates the presence of a strong underlying construct behind most of the scale items and that it implies these items together are measuring a core latent dimension at the heart of the research goals.

The last rotated component matrix provided a neat and understandable factor solution. Items S4_1 through S4_8 loaded significantly on Factor 1, while items S1_1 through S1_8 loaded noticeably on Factor 2. The absence of cross-loadings and the high factor loadings for both sets verify the unidimensionality and discriminant validity of the two latent constructs extracted. This bifactorial structure indicates that the measurement tool effectively measures two distinct dimensions pertinent to the conceptual framework of the study—potentially reflecting SC simplification approaches and circular economy facilitators (depending on the theoretical definition of S1 and S4 constructs).

Overall, the demographic analysis confirmed that the study sample was highly educated, experienced, and varied in terms of functional positions, industry sectors, and organizational sizes. This diversity helps to increase the reliability and generalizability of the results. The factor analysis confirmed the soundness, reliability, and validity of the scale of measurement, leading to an improved instrument having two distinct and clear factors. These factors have a high degree of variance, explaining a lot of variance and forming a strong foundation for any subsequent hypothesis testing and inferential statistical analyses to be conducted within the study. The methodological rigor demonstrated through strong KMO values, significant Bartlett's tests, high communalities, and interpretable factor loadings collectively ensure that the analytical framework is both credible and analytically sound.

4.7 DISCUSSION

The findings presented in this chapter allow for a profound understanding of the ways in which SC streamlining techniques contribute to the advancement of circular economy operations in contemporary firms. The data that were collected from the demographic survey as well as the exploratory factor analysis (EFA) produce a multi-dimensional insight that improves the reliability and relevance of the conceptual framework that was used in the study. The methodical investigation of the data not only substantiates the research instrument but also draws attention to significant patterns that have an effect on the behavior of organizations in relation to the management of sustainable SCs.

The demographic analysis indicates a participant base that is not only diversified but also highly capable, which guarantees that the data collected is both statistically significant and representative of the population. The fact that the majority of the respondents were professionals in the middle of their careers, between the ages of 25 and 44, indicates that the responses were shaped by a healthy combination of youthful vigor and experienced expertise. It is important to note that this demographic profile is noteworthy because it suggests that the individuals who were interviewed are currently in a stage of their careers in which they are actively participating in choice-making activities and possess information that is experiential in nature regarding SC management and sustainability programs. Additionally, the high educational lvl.s of the respondents, with a significant majority of them holding Bachelor's and Master's degrees, provide additional evidence that the sample had a high lvl. of intellectual potential. It is likely that this educational background made it easier for participants to critically interact with the multiple structures that were explored in the study. These constructs included the integration of circular economies, the optimization of SCs, and implementation of sustainability policies.

In addition, the functional diversity of respondents, which includes covering SC management, logistics, finance, marketing, and accounts, contributes to the richness of the dataset by capturing a wide variety of organizational views. The implementation of circular economies and the streamlining of SCs are both cross-functional tasks that, by their very nature, demand coordination between different corporate divisions. Through the process of collecting input from individuals working in many functional areas, the research ensures that the findings represent the multi-lvl. dynamics of the operations of the organization. A functional dispersion of this kind lessens the risk of bias based on the perspectives of a particular department and fosters an overall appreciation of the manner in which SC strategies are implemented throughout entire businesses. Additionally, the use of respondents hailing from a wide range of industry sectors, such as retailing, manufacturing, third-party logistics, and trade-based organizations, contributes to the enhancement of the external validity of the findings. The fact that each of these industries is represented in the sample ensures that the findings may be applied to a wide variety of business environments. Each of these industries faces its own unique set of obstacles and possibilities when it comes to putting circular economy concepts into practice.

For the purpose of validating the structural soundness and conceptual distinctiveness of the measurement tool, the findings of the exploratory factor analysis (EFA) provide a methodological contribution to the research. The presence of high Kaiser-Meyer-Olkin (KMO) values is evidence that the sample size was adequate for factor analysis. This indicates that the intercorrelations between variables were robust enough to extract stable factors. In addition, the strong findings of Bartlett's test of sphericity provide further validation that the data matrix was factorable, which ensures that EFA may be performed successfully. Confirmation that the assessment items were adequately linked with the underlying constructs that were being measured may be found in the fact that a clear factor structure was retrieved, which included high communalities and stable factor loadings. One of the most well-known examples of thorough and methodical instrument validation is the severe purification of the scale, which consisted of the removal of four items (S1_9, S1_10, S4_9, and S4_10) that did not load in an acceptable manner or that had significant cross-loadings. The resultant factor solution was guaranteed to be more reliable and interpretable as a result of this exercise, which not only improved the accuracy of the measuring device but also ensured better reliability.

Within the most recent output of the EFA, two distinct components were identified that are capable of capturing the primary elements of the conceptual framework of the study. As a result of the fact that the two factors together accounted for a significant proportion of the overall variance, it is clear that they are capable of explaining the phenomenon and that they are relevant to the objectives of the study. It is important to note that the fact that these components are separate ensures that the constructs in question, which are specific parts of SC simplification tactics that facilitate circular economy activities, are both conceptually distinguishable and experimentally quantifiable. This structural soundness ensures that the variables that are retained for the purpose of hypothesis testing will appropriately reflect the theoretical aspects that are defined in the study, which in turn increases the credibility of the subsequent inferential analyses.

When these findings are taken into consideration, it is clear that the combination of descriptive statistics and psychometric validation has resulted in the completion of a dataset that is both comprehensive and trustworthy. Both the validated factor structure

and the demographic profile of the respondents instill confidence in the findings' capacity to be representative and generalizable. Additionally, the validated factor structure ensures that the conceptual foundation of the study is both theoretically solid and empirically substantiated. This combined strength, which consists of a robust sample profile and a measuring instrument that has been verified, places the study in a position to carry out significant and credible hypothesis testing in the future phase of the research.

Last but not least, this chapter has been successful in constructing a solid empirical foundation upon which inferential analysis and hypothesis testing can proceed with complete assurance. As a result of the chapter's meticulous profile of the respondent base and stringent validation of the measurement instrument, it has ensured that the subsequent analysis would be founded on basis that is both methodologically and conceptually sound. Not only do the findings that were produced here provide statistical support, but they also provide a wealth of contextual insight into the organizational setting in which SC simplification methods and circular economy practices intersect. The following chapter will make use of these foundations to investigate the hypothesized linkages and ascertain the extent to which streamlined SC methods are accountable for the promotion of circular economy principles in a variety of organizational settings.

4.8 CHAPTER SUMMARY

The purpose of this chapter was to offer a comprehensive study of the data that was acquired to examine the SC simplification techniques that were adopted by chosen firms to facilitate circular economy activities. In this chapter, a structured elaboration of both the demographic respondent profile and the results of the exploratory factor analysis was provided. This chapter also provided a solid foundation for the testing of hypotheses in the future.

An essential understanding of the characteristics of the study sample was obtained through the demographic analysis. Most of the participants were professionals in the middle of their careers who had a high lvl. of educational qualifications and extensive job experience. On the basis of the age profile, it was determined that the majority of the participants were between the ages of 25 and 44 years old. This age range

exemplified a combination of youthful vitality and the seasoned professional wisdom. There was a sizeable proportion of respondents who held Bachelor's and Master's degrees, which indicates that the sample was well-educated and have the capacity to comprehend and make substantial contributions to the resolution of difficult challenges concerning SC management and sustainability. Observations were made about functional diversity, as replies were received from positions in SC management, finance, marketing, logistics, and accounts management. This allowed for the incorporation of perspectives from a variety of business activities. This helps to increase the generalizability and utility of the findings across a variety of industry settings. The sample of respondents also came from a variety of sizes and sectors of firms, such as manufacturing, retailing, third-party logistics, and a variety of trade-based businesses.

In addition, the chapter conducted an exhaustive examination of the measuring scale by means of exploratory factor analysis (EFA). The results demonstrated that the sampling was adequate, as demonstrated by the high Kaiser-Meyer-Olkin (KMO) values and the significant results of Bartlett's tests of sphericity. An uncluttered factor structure, strong communalities, and robust factor loadings were all suggested by the exploratory factor analysis (EFA), which established the tool's reliability as well as its validity. The process involved meticulously refining the scale items, which included the elimination of four items (S1_9, S1_10, S4_9, and S4_10) that were unable to achieve acceptable loading lvl.s or had cross-loadings. The most recent factor solution consisted of two separate factors, which, when taken together, accounted for a sizeable percentage of the total variance. The validity of the ensuing inferential analyses was ensured by the fact that these two aspects provided a concise summary of the primary dimensions that comprised the conceptual framework of the study.

This chapter displayed a very clear and convincing image of the data landscape by effectively integrating descriptive statistics and strong psychometric validation. In general, this chapter was quite effective in doing so. Through the establishment of the reliability and validity of the measurement instrument and the presentation of a rich understanding of the respondent profile, the chapter was successful in setting the stage for the subsequent phase of the study, which will be presented in the following chapter. This phase will involve testing the hypothesis and conducting inferential analysis.

CHAPTER – V

SUMMARY AND CONCLUSION

5.1 KEY FINDINGS

- The demographic profile of the respondents yields useful information regarding the sample population, facilitating the establishment of context into which the study results can be interpreted. It reveals that the age group distribution identifies a major percentage of respondents across the 35–44 years' age group (40.7%), followed by the 25–34 years' group (38.7%). This implies that most participants were middle-aged career professionals, presumably at the peak of their working lives, providing views influenced by both new insights and significant industry experience. A minority group, 20.7%, were captured by the age range 45–54 years, suggesting a significant but lesser presence of senior professionals. This age profile presents a balance but biased representation toward younger and mid-career professionals, which is important since these age categories are usually at the center of embracing and handling current SC and business innovations.

- With regard to gender, the sample was mainly male (66%), and 34% of respondents were female. Such a gender mix is in keeping with overall patterns observed in managerial, logistics, and SC positions, which are typically male-dominated, though the presence of women at over one-third signifies growing gender diversity among managerial professionals. The educational lvl. of the participants shows that the vast majority of the participants had a Bachelor's degree (48%) or Master's degree (47.3%), with a tiny percentage (4.7%) having Doctorate-lvl. education. This also shows that there is a highly educated workforce, where almost all of the participants have graduate-lvl. education at the least, reflecting their ability to comprehend and act on sophisticated SC and business strategies. The close even split between Bachelor's and Master's holders indicates advanced education (post-graduate) as a widespread characteristic in managerial positions, increasing analytical and strategic abilities in the workforce.

- For functional respondents' position, the sample was adequately spread across significant managerial positions. The majority was from Sales/Marketing Managers (24.7%), followed by Supply Chain Managers (21.3%), Accounts Managers (20%), Finance Managers (20%), and Logistic Managers (14%). This allocation reveals that although SC and sales/marketing were represented marginally more, there was an even representation from finance, accounts, and logistics functions so that SC activities could be comprehensively understood from different managerial angles.

- The breakdown of work experience indicates that most respondents (58%) had 6–10 years of experience, reflecting a working population with considerable practical experience. This is important because mid-career professionals tend to balance technical knowledge with management roles. Further, 22.7% had more than 10 years of experience, with a senior-lvl. strategic perspective, and 19.3% had 2–5 years of experience, with fresh operational insights. Combined, this reflects a balanced respondent population with both operational and strategic insights.

- With regard to organizational sectors, the sample split evenly across Manufacturing, Retail, and Third-Party Logistics organizations (each comprised 26.7%), while 20% were involved in Trade businesses. This balanced segment ensures that lessons are learned across various segments of the SC ecosystem, facilitating findings that translate across business models. Finally, organizational size identified that most (44.7%) of the respondents were employed in medium-sized companies (50–249 employees), followed by large companies (32.7%) and small companies (22.7%). This suggests that the research had captured the perspectives of professionals employed in diverse business settings — from nimble small companies to resource-abundant large corporations — making it possible to have a balanced understanding of SC practices across organizational sizes.

- Factor analysis sought to identify the underlying relationship structure between observed variables and to summarize them in principal dimensions to analyze. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy of 0.950 (later raised to 0.966 upon removing items) represents excellent

sampling adequacy, verifying that data were very apt for factor analysis. Bartlett's Test of Sphericity was extremely significant ($p < 0.001$), further confirming that the inter-item correlations were large enough for factor extraction.

- Three factors were extracted in the first iteration, accounting for 73.4% of the variance. The first component accounted for 52.4%, the second for 15.5%, and the third for 5.5% of the variance. Following the removal of the less germane items (S1_9, S1_10, S4_9, S4_10) — which most probably did not load cleanly or sensibly onto the principal factors — the factor analysis was recalculated, with the outcome being a cleaner and more interpretable solution. The revised factor solution explained 72.4% of the variance, now divided equally between two principal components, each explaining some 36% of the variance, indicative of an optimally balanced model structure.

- Rotated Component Matrix (with Varimax rotation) after refinement eminently showed two clear factors. The first factor had strong loadings from the items originally paired with S4 variables (S4_1 to S4_8), and the second factor had high loadings from S1 variables (S1_1 to S1_8). Strong loadings' strength (around 0.65 to 0.81) indicates items in each factor were highly intercorrelated, reflecting strong internal consistency and definite construct differentiation.

- This more refined factor structure is useful for future analysis in that it takes complicated, multi-variable data and condenses it into two distinct constructs (latent variables) that now can be applied to future inferential analysis, regression, or structural equation modelling. The elimination of weaker or unclear items enhanced the reliability and understanding of the constructs, providing assurance that future results based on these factors will be valid and interpretable.

- The demographic breakdown shows that the research utilized a diverse but strategically meaningful sample of highly educated, experienced professionals spread across different roles, industries, and organization sizes. The rigor and transparency in factor analysis ensure that the measurement model is

statistically valid, so that later analyses based on these factors extracted can be trusted with confidence. Combined, these implications are that study findings — later in analyzing SC strategy or intervention effects (as I imagine is your more general research domain) — will be grounded and representative and capable of generalizing to mid-range to large-size firms in manufacturing, retailing, and logistics industries. This demographic and psychometric stability enhances the validity of the study and increases the relevance of its findings to SC management and business strategy practices.

5.2 SUMMARY

This research is significant since it bridges the divide between theoretical inquiry and practical implementation in the field of SC management. By providing enterprises with practical frameworks and recommendations, it empowers them to optimize their CTS strategy, hence enhancing profitability and customer satisfaction. The paper contributes to the literature on SC optimization by addressing current challenges, such as the impact of digitalization and globalization, while emphasizing the significance of sustainability in cost management. The study's findings will have enduring significance for firms seeking to improve their SC performance, offering a clear pathway to attain cost efficiency and customer excellence. Despite the increasing focus on technology and data analysis for optimizing Cost to Serve (CTS), existing literature encounters several constraints that hinder the formation of a comprehensive understanding of its practical applicability across diverse industries. A significant gap persists in the lack of industry-specific contextualization of technological adoption to enhance CTS. Research, such as that conducted by Zulu (2018), offers technology integration frameworks for business hubs; however, these frameworks are often restricted to specific organizations or regional contexts and are not universally applicable across industries. Research on large-scale industries or technologically advanced sectors fails to illustrate the distinct challenges faced by small and medium enterprises (SMEs) or fragmented SC sectors such as fashion retailing or local logistics services, where customer service requirements vary considerably and CTS dynamics are highly volatile. Although existing research offers a preliminary framework for the role of data analytics and technology in optimizing CTS, it lacks sufficient depth in several critical dimensions. Key elements are interdepartmental

collaboration, organizational culture, integration of sustainability, practical application, sector-specific insights, and data stewardship. Addressing these research gaps would enhance theoretical understanding and provide practical, scalable, and ethically sound solutions for enterprises aiming to increase customer profitability through effective cost management.

This research is significant for its capacity to provide essential insights into optimizing Cost to Serve (CTS) in SC management, a critical factor for enhancing operational efficiency, customer happiness, and profitability. In the increasingly competitive and globalized market, organizations must prioritize not only reducing operational costs but also delivering value to customers. A thorough understanding of CTS and its optimization can provide a competitive advantage for companies seeking to align these objectives. This research is significant as it addresses both theoretical gaps in the existing literature and practical challenges faced by companies in managing CTS. The research is significant as it investigates the role of technology in enhancing CTS. Digital transformation is progressively altering SCs, with technologies such as artificial intelligence (AI), data analytics, and automation serving as significant catalysts for cost reduction and improved service delivery. This study will provide actionable recommendations for firms on using advanced technologies to streamline CTS calculations and enhance SC operations. The ability to adopt and utilize technology effectively is crucial for maintaining competitiveness. This research will elucidate how technology can confer a competitive edge to firms by offering live information, predictive analytics, and improved forecasting.

The conceptual framework integrates the interplay between operational tactics (independent variables) and performance outcomes (dependent variables) within SC management. It emphasizes the revolutionary potential of CTS when regarded as a strategic management instrument rather than solely a cost accounting function. The framework facilitates the evaluation of how CTS initiatives enhance profitability, customer satisfaction, and the development of more agile and resilient SCs in today's competitive and precarious business landscape by capturing the dynamic interactions among these variables. The study's population comprised professionals active in SC management, sustainability, and operations within the fashion retail and technology

sectors. These sectors were deliberately selected due to their critical role in the circular economy, particularly in waste management, resource optimization, and sustainable production and consumption habits.

The study was concluded with a sample size of 250 respondents to ensure a representative and balanced dataset. Initially, 300 professionals were approached through a blend of direct email communication and online survey dissemination. Out of these, 250 were deemed complete, legitimate, and analyzable, resulting in an effective response rate of around 83.3%. The sample size was considered enough for the statistical analyses planned in the research, including correlation and regression analysis. It offered sufficient response diversity across enterprises of differing sizes and sectors (fashion retail versus technology) while also ensuring depth in the quality of information acquired. The chosen sample size helped minimize the possibility of sampling bias and ensured sufficient precision and confidence in the results. This research utilized a purposive sample technique to ensure the selection of respondents with pertinent experience and specific knowledge. Purposive sampling, a non-probability sampling technique, involves the deliberate selection of participants based on their qualifications, employment roles, and relevance to the research objective.

The study concentrated on the Indian retail fashion and technology sector, emphasizing certain urban industrial clusters renowned for their engagement in SC management and sustainable practices. The highlighted clusters comprised metropolitan regions like as Bengaluru, Mumbai, Delhi NCR, and Hyderabad, recognized for their substantial concentration of fashion shops, technology companies, and logistics service providers. The rationale for selecting these regions as primary study sites stemmed from their dynamic business ecosystems, advanced infrastructure, and elevated degrees of technological integration in SC operations. These cities possess a significant concentration of international corporations and local enterprises engaged in innovative practices related to the circular economy, including reverse logistics, sustainable sourcing, and digitalization of SCs. The study concentrated on the Indian retail fashion and technology sector, emphasizing certain urban industrial clusters renowned for their engagement in SC management and sustainable practices. The highlighted clusters comprised metropolitan regions like as Bengaluru, Mumbai, Delhi NCR, and Hyderabad, recognized for their substantial

concentration of fashion shops, technology companies, and logistics service providers. The rationale for selecting these regions as primary study areas stemmed from their dynamic business ecosystems, advanced infrastructure, and elevated lvl.s of technological adoption in SC operations. These cities have a significant concentration of international corporations and local enterprises engaged in innovative practices related to the circular economy, including reverse logistics, sustainable sourcing, and SC digitalization.

The retail fashion sector in these regions has experienced rapid expansion in recent years, driven by evolving consumer preferences, increasing sustainability consciousness, and regulatory and global market influences. Fashion brands in these markets have commenced the implementation of circular economy strategies such as recycling, reusing, and sustainable manufacture. These firms are increasingly collaborating with suppliers and logistics providers to establish closed loops and reduce their environmental impact. Similarly, the technology sector in these nations emphasizes operational efficiency, resource optimization, and digital innovation. Technology firms have been instrumental in the development and implementation of digital technologies, such as blockchain, IoT, and AI, which facilitate transparency and traceability in SCs—essential components of a circular economy model. The design of the questionnaire was a meticulous endeavor to ensure its relevance, clarity, and comprehensiveness. The questionnaire aims to provide substantial insights into how firms perceive and manage Cost to Serve by incorporating a blend of demographic and operational inquiries, as well as their strategies for enhancement. The information obtained from this questionnaire will substantially enhance the comprehension of CTS's impact on SC efficiency, profitability, and customer satisfaction.

The amalgamation of these statistical methodologies and instruments provided a robust foundation for data analysis in this work. Descriptive statistics summarized the data and highlighted general trends; correlation and regression analyses identified significant correlations between variables, while factor analysis simplified complex constructs. The utilization of these statistical methods guaranteed that the study's conclusions were both dependable and practical, providing significant insights into optimizing Cost to Serve in SC management. The evaluation of the questionnaire's

reliability and validity confirmed that the research instrument was robust and capable of accurately capturing the study's data. The pilot study significantly contributed to the refinement of the study's methodology, enhancing the research design's robustness and facilitating an efficient primary data collection process. Ethical issues were meticulously implemented throughout the research process, from planning to data processing. The researchers upheld ethical principles, conducting the research responsibly and respectfully, safeguarding participants' rights, preserving research integrity, and ensuring trust in the findings. Ethical conduct was paramount in preserving the study's credibility and integrity, enabling it to contribute significantly to the field while adhering to the highest ethical standards.

The demographic profile of the respondents provides valuable insights into the sample population, enabling the contextualization of the study results. The age group distribution indicates that a significant proportion of responses falls within the 35–44 years category (40.7%), followed by the 25–34 years category (38.7%). This suggests that the majority of participants were middle-aged professionals, perhaps at the zenith of their careers, offering perspectives shaped by both novel ideas and substantial industry experience. A minority group, comprising 20.7%, was within the age range of 45–54 years, indicating a notable albeit diminished representation of older professionals. This age profile exhibits a balanced yet skewed representation favoring younger and mid-career workers, which is significant as these age groups typically play a central role in adopting and managing contemporary SC and business innovations. The sample comprised predominantly males (66%), while females constituted 34% of the respondents. This gender composition aligns with prevailing trends in managerial, logistical, and SC roles, which are predominantly male, while the representation of women above one-third indicates an increasing gender diversity among managerial professionals.

The educational attainment of the participants indicates that the predominant majority either a Bachelor's degree (48%) or a Master's degree (47.3%), while a negligible fraction (4.7%) held a Doctorate. This indicates a highly educated workforce, with nearly all workers possessing at least graduate-lvl. education, demonstrating their capacity to understand and implement complex SC and business strategies. The nearly equal distribution of Bachelor's and Master's degree holders signifies that advanced

education (post-graduate) is a prevalent trait in managerial roles, enhancing analytical and strategic competencies within the workforce. The sample of functional respondents was sufficiently distributed among key managerial positions. The predominant group consisted of Sales/Marketing Managers (24.7%), succeeded by Supply Chain Managers (21.3%), Accounts Managers (20%), Finance Managers (20%), and Logistics Managers (14%). This distribution indicates that while SC and sales/marketing were slightly more represented, finance, accounts, and logistics functions were equally represented, allowing for a thorough understanding of SC activities from various managerial perspectives.

The analysis of work experience reveals that the majority of respondents (58%) have 6–10 years of experience, indicating a workforce with substantial practical expertise. This is significant as mid-career professionals sometimes reconcile technical expertise with managerial responsibilities. Additionally, 22.7% possessed over 10 years of experience, offering a senior-lvl. strategic viewpoint, while 19.3% had 2–5 years of experience, providing contemporary operational views. This indicates a response population that is balanced, possessing both operational and strategic knowledge. The sample was evenly distributed across Manufacturing, Retail, and Third-Party Logistics enterprises, each constituting 26.7%, while 20% were engaged in Trade businesses. This balanced section guarantees that lessons are acquired throughout diverse areas of the SC ecosystem, enabling insights that are applicable across business models. Ultimately, organizational size revealed that the majority (44.7%) of respondents were employed in medium-sized enterprises (50–249 employees), followed by large enterprises (32.7%) and small enterprises (22.7%). This indicates that the research encompassed the viewpoints of professionals in various business environments — ranging from agile small enterprises to well-resourced major corporations — facilitating a comprehensive understanding of SC strategies across different organizational scales.

Factor analysis aimed to elucidate the underlying relational structure among observed variables and to condense them into major dimensions for analysis. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy of 0.950, subsequently increased to 0.966 after item removal, indicates exceptional sampling adequacy, confirming the data's suitability for factor analysis. Bartlett's Test of Sphericity

yielded a highly significant result ($p < 0.001$), so affirming that the inter-item correlations were sufficiently substantial for factor extraction. In the initial iteration, three components were identified, representing 73.4% of the variation. The initial component represented 52.4%, the subsequent component 15.5%, and the tertiary component 5.5% of the variation. Subsequent to the elimination of the less relevant items (S1_9, S1_10, S4_9, S4_10) — which likely did not load appropriately onto the primary factors — the factor analysis was re-evaluated, resulting in a more refined and interpretable answer. The updated factor solution accounted for 72.4% of the variance, evenly distributed between two principle components, each elucidating approximately 36% of the variance, signifying an ideally balanced model structure.

The Rotated Component Matrix (with Varimax rotation) after refinement distinctly revealed two unambiguous factors. The initial factor had substantial loadings from items associated with S4 variables (S4_1 to S4_8), while the subsequent factor demonstrated elevated loadings from S1 variables (S1_1 to S1_8). The robust loadings (about 0.65 to 0.81) signify that items within each factor were substantially intercorrelated, demonstrating excellent internal consistency and clear construct separation. This enhanced factor structure is advantageous for subsequent analysis since it simplifies complex, multi-variable data into two distinct constructs (latent variables) that can be utilized in future inferential analysis, regression, or structural equation modelling. The removal of ambiguous or inferior items improved the reliability and clarity of the constructs, ensuring that future outcomes derived from these components will be legitimate and comprehensible.

5.3 CONCLUSION

This study provided a meaningful and timely contribution to the theoretical and practical fields of SC management by examining in a systematic manner how improving Cost to Serve (CTS) can improve organizational efficiency, profitability, and customer satisfaction, especially in the fashion retail and technology industries in India. The research filled an important gap in current literature, where sectoral insights and pragmatic usability concerning the management of CTS — particularly in terms of the incorporation of advanced technology and sustainable practices — have frequently been neglected. By placing CTS in the context of modern-day business environments characterized by globalization, digitalization, and a growing focus on

sustainability, the study provided a nuanced, contextualized perspective on how companies can strategically utilize cutting-edge technological tools, such as artificial intelligence, data analytics, and automation. These applications not only help lower costs of operation but also open avenues to raise customer value propositions and raise the lvl.s of service satisfaction — key drivers in fast-changing, highly competitive businesses.

One of the strengths of this study was that it created an integrative conceptual framework that placed CTS not just as an accounting figure, but as a dynamic, strategic management tool that had the potential to drive competitive leverage. The research examined the complex interplay between operational strategies and organizational performance results, illustrating how CTS initiatives could advance cost effectiveness and customer excellence at the same time, while developing SCs that are agile, resilient, and disruption-ready. The research design was solid and sound; it utilized a well-designed and statistically tested questionnaire, purposive sampling of experienced industry practitioners, and a full range of statistical packages, such as correlation, regression, and factor analysis. The population heterogeneity of the sample — covering a range of variables including age, gender, education, managerial positions, industry segments, and firm sizes — enriched the dataset and allowed a comprehensive investigation of CTS practices along multi-faceted aspects of the Indian SC ecosystem. This methodological stringency improved both the reliability and practical applicability of the findings.

In addition, the research shed light on the fundamental significance of circular economy and sustainability principles in driving modern SC strategies. With a focus on leading urban industrial clusters — Bengaluru, Mumbai, Delhi NCR, and Hyderabad — characterized by their technological vibrancy and active adoption of sustainable practices, the study depicted a real and vivid picture of how businesses are integrating sustainability into their SC activities. Both fashion companies and tech companies were found to be increasingly embracing circular economy tactics like reverse logistics, sustainable procurement, and product lifecycle extension. Concurrently, these companies were using advanced digital technologies — blockchain, Internet of Things (IoT), and artificial intelligence — to improve transparency, traceability, and resource efficiency along the value chain. These

findings have significant real-world relevance to policymakers, business practitioners, and academic researchers aiming to design SCs that balance economic profitability with environmental stewardship, thus advancing a more sustainable and resilient industrial economy.

One particularly significant aspect of the study was its consideration of the specific challenges confronting small and medium enterprises (SMEs) in embracing and upscaling technological solutions for CTS optimization. Unlike their large corporate counterparts with access to sophisticated infrastructures and large pools of capital, SMEs are often faced with fragmented SCs, volatile customer needs, and limited technological capability. By highlighting these contextual challenges explicitly and putting forward actionable, scalable suggestions for enterprises of all sizes and sectors, the research presented a pragmatic guide to installing CTS approaches that are responsive to various organizational realities. This focus on inclusivity and scalability made certain that the research's contribution reached beyond resource-dense large-scale firms, finding applicability even among small and medium enterprises, which form India's economic spine.

Lastly, the adherence to ethical rigor through the entire study period strengthened considerably the study's validity and acceptability. Very high compliance to ethical research approaches — informed consent, participant privacy, and safeguarding of information — ensured rights to the participants and safe use of sensitive data. This ethical stringency not only added to the empirical credibility of the results but also highlighted the social accountability of the study, ensuring that the insights derived were methodologically rigorous and ethically responsible. Overall, this study empowers companies with a well-evidenced, evidence-based approach to improve their CTS initiatives, rationalize cost management practices, and realize better customer engagement in a highly competitive and sustainability-focused market. Furthermore, it opens promising avenues for future inquiry, inviting deeper exploration into sector-specific CTS strategies, interdepartmental collaboration, data stewardship, and the evolving influence of emerging technologies on SC optimization.

5.4 SUGGESTIONS AND RECOMMENDATIONS

On the basis of this comprehensive study, a series of strategic and informed suggestions are made to assist organizations, policymakers, and SC practitioners in optimizing Cost to Serve (CTS) and, at the same time, maximizing profitability and customer satisfaction. These suggestions are especially relevant for business firms in the Indian fashion retail and technology industries characterized by fluctuating market conditions, fast-paced technological innovation, and changing customer expectations.

Most importantly, organizations need to make high-priority investments in integrating emerging digital technologies to improve cost transparency and operational effectiveness throughout their SCs. Using technologies like artificial intelligence (AI), data analytics, blockchain, and the Internet of Things (IoT) offers detailed, live visibility into operational expenses and process performance. These technologies enable companies to map their CTS effectively at the product, channel, and customer lvl.s, enabling precise choice-making and focused resource allocation. Predictive analytics can enhance demand forecasting and inventory management, while automation eliminates redundancies and manual interventions, resulting in cost savings without diminishing service quality. The resulting transparency and efficiency not only maximize operational costs but also improve service reliability and customer satisfaction.

In addition, organizations are urged to implement segment-driven CTS initiatives to customize services according to the profitability and requirements of customers. Rather than employing a one-size-fits-all approach to customers, companies can segment their clients and develop differentiating services appropriately. For example, high-margin customers can be offered more refined, value-based services, and cost-conscious or low-margin customers can be economically served through cost-saving, efficient channels. This service lvl. alignment with customer value guarantees that companies maximize profitability without compromising on meeting varied customer demands, resulting in a balanced and sustainable customer relationship management approach.

Principles of circular economy and sustainability also need to be deeply ingrained in SC strategy to cater to the growing demand for environmentally sustainable business practices. Businesses need to emphasize integrating programs like reverse logistics, sustainable procurement, and product life-cycle management to minimize waste and maximize resource efficiency. Blockchain and IoT technologies can improve traceability and transparency in supply and distribution, allowing businesses to prove ethical SC practices. By integrating CTS optimization with sustainability objectives, companies not only save long-term cost of operations but also enhance brand image and customer loyalty among eco-friendly consumers.

Supply chain ecosystem collaboration is yet another essential consideration in maximizing CTS performance. Companies must establish strong collaborations with suppliers, logistics providers, distributors, and other stakeholders by building integrated communication platforms and common data systems. Technologies like CPFR can coordinate operations, minimize lead times, and maintain optimal stock lvl.s. More effective collaboration enhances SC agility, allowing businesses to react quickly to shifts in the marketplace, reduce risks, and provide consistent customer experiences without sacrificing cost-effectiveness.

Since SMEs present different challenges compared to larger organizations, focused support strategies are needed to encourage inclusive CTS optimization. SMEs usually face limitations in the form of technological expertise, capital, and skill sets. Policymakers, industry associations, and large companies must provide supporting initiatives, such as subsidized use of digital technology, training facilities, financial assistance, and pooled technological infrastructure in the form of cloud-based solutions. Industry cluster collaborations, public-private partnerships, and knowledge exchanges can offer SMEs access to best practices to help them adopt scalable and sustainable CTS measures effectively.

To facilitate continuous improvement and responsiveness, organizations need to institutionalize strong mechanisms for performance monitoring and benchmarking. Setting key performance indicators (KPIs), undertaking regular performance audits, and conducting cost-benefit analyses will allow companies to monitor the effectiveness of CTS initiatives and correct course in a timely manner. Additionally, gathering and analyzing customer feedback regarding service lvl.s and satisfaction

will provide rich insights to hone strategies. Bench-marking the best practices globally and industry counterparts will also inspire organizations to do their best and be competitive players in their specific markets.

In addition, an emphasis on fostering data-driven culture and ongoing competency improvement is vital to successful management of CTS. Organizations will have to make investments in up-skill the analytics and technical proficiency of workers with training schemes targeting data analysis, CTS modeling, and SC software tools. Fostering cross-functional working among departments like SC, finance, marketing, and IT will encourage systemic thinking in the optimization of CTS. Functional silo busting and interdepartmental coordination guarantee that organizational decisions are fully informed, synergistic, and aligned with organizational objectives

Ultimately, enabling policy and regulatory frameworks can be key to driving adoption of sustainable and technology-enabled SCs. Government departments must formulate policies that incentivize green logistics programs, provide grants for developing digital infrastructure, and rationalize regulatory procedures encouraging SC management innovation. These policy interventions, in addition to facilitating the wider dissemination of best practices, will also align industry initiatives with national economic and sustainability goals, including the flagship "Digital India" and "Make in India" programs.

Therefore, the deployment of these all-embracing and multi-faceted strategies will allow organizations to maximize their Cost to Serve, improve operational performance, maximize profitability, and offer better customer value. Through embracing a balanced framework that encompasses technology, sustainability, collaboration, and inclusive growth, companies can construct robust, future-proof SCs that can sustain themselves in the current intricate and competitive marketplace. These guidelines also provide a strong basis for scalable and flexible CTS strategies that are responsive to varied organizational environments and changing industry conditions.

5.5 SCOPE FOR FURTHER RESEARCH

While the current study provided significant insight into the ways in which Cost to Serve (CTS) optimization can drive profitability, operational effectiveness, and

customer satisfaction for the fashion retail and technology industries in India, the adaptive and multidimensional nature of SC management offers a number of wide-ranging avenues for further research. These directions for the future, if pursued systematically, may sharpen existing frameworks, bring nuanced understanding, and push the limits of theory and practice in the field of CTS management.

One obvious direction is to extend the research to various industry sectors other than fashion retail and technology. Automotive, healthcare, agro-business, manufacturing, logistics, and fast moving consumer goods (FMCG) each involve SC designs, regulatory landscape, customer desires, and exposure to risk differently. The high margins in highly structured temperature control based logistic requirement is very differently engineered than say retail in apparel as a pharma sector illustration. Even the SC of FMCG which includes highly structured volumetric transactions across low margins perhaps differentially aligns itself into more of speeds and shelves focus vis-à-vis custom solutions. Subsequent research that explores CTS optimization across these diverse industries can develop industry-specific frameworks, benchmarks, and guidelines for implementation that respond to their unique operational contexts. Cross-sectoral research would also facilitate the discovery of commonalities and differences, enriching both managerial practice and scholarly theory with sectoral nuance.

Yet another fruitful area is in embracing longitudinal research paradigms in evaluating the long-term effects of CTS optimization interventions over time. The cross-sectional design of the present study provided a snapshot; SCs and market circumstances are not static, though. Longitudinal research might monitor how the advantages of CTS programs — i.e., cost savings, retention of customers, and flexibility in operations — change as market circumstances vary, technologies evolve, and consumer habits adjust. This longitudinal view would provide insights into the sustainability of CTS strategies, informing companies on how to evolve and re-tune their strategies to sustain competitive edge in the long run. Such research could also capture organizational learning and process maturity evolution as firms progress through various stages of CTS implementation.

In addition, further investigation into the operationalization of new digital technologies in CTS management is a rich research field. While this work emphasized the applicability of artificial intelligence (AI), big data analysis, blockchain, Internet of Things (IoT), and automation, their practical integration into CTS models in resource-poor settings such as SMEs is not well understood. Empirical research in the future may study in-depth case studies of actual technology implementations to investigate implementation processes, determinants of success, failure issues, and return on investment (ROI). For instance, research can explore how demand forecasting using AI directly affects CTS metrics or how blockchain strengthens transparency and traceability, ultimately affecting customer satisfaction and regulatory compliance. Through charting the technology-CTS interface in working environments, research in the future can offer actionable blueprints for large-scale uptake of digital innovations.

A frequently neglected but equally important aspect is the organizational factors' contribution — e.g., corporate culture, leadership commitment, human resource capabilities, and change management practice — to facilitating effective CTS uptake. Future research can investigate the mediating or moderating roles of leadership styles (e.g., transformational vs transactional leadership), cross-functional collaboration, employee participation, and organizational flexibility in bridging CTS strategies and performance results. Qualitative research methods, for example, grounded theory studies, in-depth interviews, or ethnographic fieldwork, might reveal rich contextual stories of how organizations manage the socio-technical intricacies of CTS optimization. These findings would provide a richer picture of the human and organizational enablers that support successful CTS initiatives.

Apart from these organizational aspects, there is considerable scope for geographical reach. The current study aimed at the major urban industrial clusters in India — Bengaluru, Mumbai, Delhi NCR, and Hyderabad — that are comparatively more advanced in technology uptake and infrastructure. Future research may widen the scope to Tier-2 and Tier-3 cities or rural-industrial pockets to look at how CTS strategies play out in less technologically advanced or infrastructurally limited settings. In addition, comparative cross-country studies on other emerging economies (e.g., Indonesia, Vietnam, Brazil, or South Africa) or even developed economies

could identify differences in culture, regulation, and infrastructure that influence CTS practices. International comparison would add to both theoretical strength and real-world relevance by providing globally transferable findings.

Another useful avenue is taking a customer perspective. Although this work largely dealt with firm-side operational effectiveness, subsequent research could examine in a systematic manner how CTS optimization is transferred to customer experience, attitudes, and behavior. Research could determine how factors such as service quality, delivery reliability, responsiveness, customization, and after-sales service — all determined by CTS initiatives — affect customer satisfaction, loyalty, and lifetime value. Sophisticated quantitative methods like structural equation modeling (SEM) or conjoint analysis may assist in untangling intricate cause-effect relationships between operational metrics driven by CTS and customer-focused outcomes. Such a research stream would be highly beneficial for formulating customer-focused SC strategies that not only cut costs but also build brand equity and market competitiveness.

In addition, the specific challenges and opportunities of small and medium enterprises (SMEs) require special investigation. Whereas big companies usually possess the resources to invest in advanced CTS systems and digital infrastructure, SMEs generally grapple with dispersed SCs, volatile demand, resource shortages, and weak technological capacity. Future studies can create adaptive CTS frameworks and low-cost technology solutions that suit the scale, resource profiles, and operational limitations of SMEs. Actionable suggestions coming out of such research would strengthen the ability of small firms to compete more competitively, thereby driving inclusive and equitable industrial growth.

Lastly, multidisciplinary research that synthesizes SC management with cutting-edge fields like sustainability science, behavioral economics, and data governance would unlock new intellectual frontiers. For example, research in the future can study how sustainability priorities like carbon footprint mitigation, responsible sourcing, and circular economy strategies work in tandem with CTS tactics to fuel triple bottom line results (economic, environmental, and social impacts). Similarly, increased focus on data privacy, cyber security, and ethical AI offers new variables to be included in CTS frameworks, especially when digitalization intensifies.

Finally, though the current study has established a solid platform for knowing CTS optimization in India's fashion retail and tech industries, the dynamic nature of global SCs, advances in technology, and socio-economic dynamics guarantees that this field is vibrant and open to further scholarly inquiry. Growing in these proposed areas will not only contribute to academic learning but also empower SC leaders, policymakers, and practitioners with practical insights to create responsive, robust, and customer-focused SCs in an ever more complex and interconnected globe.

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