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"Enhancing Supply Chain Efficiency through Inventory and Distribution Coordination: A Statistical and Comparative Study"

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Abstract

In today's globally connected market, supply chain management plays a vital role due to rising globalization and intense competition. Businesses face constant pressure to use their resources wisely while still meeting the high expectations of customers in terms of service quality and product satisfaction. With consumers becoming more aware of both prices and service levels, companies must carefully balance cost efficiency with delivering excellent service. To stay profitable, supply chains need to optimize costs without lowering the quality of service. One of the biggest challenges in achieving this is the lack of coordination between key areas, especially inventory management and distribution. These two functions have often been managed separately, causing delays, waste, and higher costs. However, today's successful supply chains focus on integrating these functions to work more efficiently together. This study explores how better coordination between inventory and distribution affects supply chain performance. A descriptive survey was conducted among leading companies, revealing that four main performance measures improved significantly with strong coordination between these functions. A statistical comparison using t-tests also showed that companies that align inventory and distribution efforts perform much better than those that don't. These results highlight the clear advantages of an integrated approach, showing that better coordination not only reduces costs but also boosts overall supply chain effectiveness. In a competitive business world, this kind of smart integration is essential for companies aiming to stay ahead.

1. Introduction

Globalization has significantly elevated the importance of efficient supply chain management, compelling businesses to optimize resources amidst fierce competition and heightened customer expectations. As service quality and pricing sensitivity grow, maintaining profitability necessitates minimizing operational costs without compromising service levels. A primary challenge lies in the lack of coordination across key supply chain functions such as production, inventory, distribution, and information flow. This study focuses on enhancing the integration between inventory and distribution to address these inefficiencies. By examining the relationship between selected supply chain entities, the research highlights how effective coordination and alignment of objectives can improve overall performance. Disruptions often stem from conflicting goals or miscommunication across independently managed stages, leading to suboptimal decisions and increased costs. Addressing these issues through synchronized efforts and shared goals is vital for building a resilient and high-performing supply chain.

2. Literature Review

In Recent literature survey it has been found that there has been increase in research related to study on impact of supply chain integration. Droge (2004) has analyzed the overall influence of integration on performance, with various researchers further exploring its specific impacts at different organizational levels. While some studies have focused on firm-level performance (Droge et al., 2004; Vickey et al., 2004), others have distinguished between internal (Stock et al., 1998) and external (Gimenez and Ventura, 2005) integration within the supply chain (SC). Additional research has targeted specific performance areas such as plant operations (Swink et al., 2007) and new product development (Koufteros et al., 2005). Effective SC integration involves harmonizing business processes internally and externally, where the "arc of integration" concept (Frohlich and Westbrook, 2001) illustrates that while internal integration is more manageable, external integration-often seen in practices like Third Party Logistics (3PL)-presents greater challenges. Literature suggests that many organizations still struggle with both internal and external integration, especially in the sharing and coordination of information between focal firms. Effective supply chain coordination (SCC) is essential among various channel members and intermediaries. Xie et al. (2006) enhanced the traditional R, S inventory control system for serial supply chains by introducing a two-level coordination algorithm that adjusts R and S values, which are typically set through local optimization. Their numerical experiments demonstrated that these adjustments led to improved supply chain performance. Similarly, Al-Rifai and Rossetti (2007) developed a heuristic

optimization model for determining control parameters in an (s, Q) system within a one warehouse/multi-retailer supply chain. Their objective was to minimize inventory investment by optimizing average annual order frequency and the expected number of backorders. Seifbarghy and Akbari Jokar (2006) also analyzed the continuous review (s, Q) inventory policy in a supply chain comprising a central warehouse and multiple identical retailers facing independent Poisson demand. They proposed an approximate cost function to determine reorder points at each location, assuming a fixed batch size.

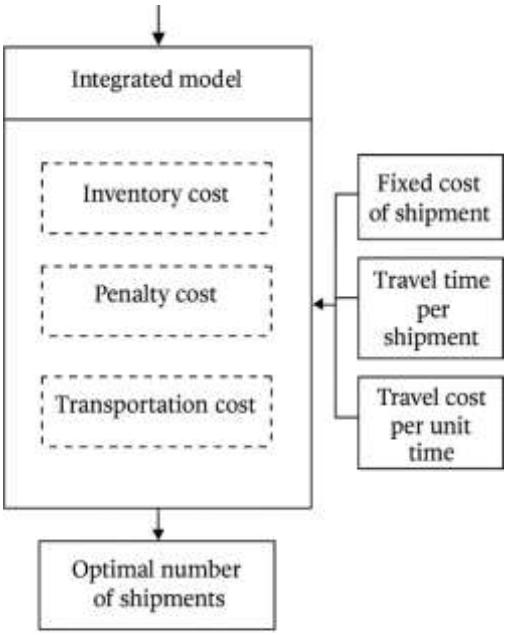

Figure 2.1 IDC Integrated Model

3. Research Methodology

After collecting the research data, the results were analyzed to identify meaningful patterns and relationships relevant to the study's objectives. This analysis aimed to construct an empirical model to draw valid inferences. The chapter presents tables and graphs detailing respondents' demographic profiles and their perceptions of inventory and distribution coordination within the supply chains of Central India (Indore, Pithampur, Dewas, Jabalpur and Bhopal region).

3.1 The Research Design

This research explores the strategic enabling factors of distribution coordination in supply chain management, focusing on their impact on firm performance. Conducted in the manufacturing and logistics sectors, it uses a descriptive approach based on preliminary field data collected through structured questionnaires. The study offers insights into the key factors influencing coordination and is validated through existing literature. Targeted respondents were selected from identified manufacturing and logistics units.

3.2 Research Approach

This research follows a deductive approach, where hypotheses are formulated based on defined objectives and tested using statistical tools. Both qualitative and quantitative methods are applied—qualitative to explore service-related factors of distribution coordination, and quantitative to measure variables and analyze results. The study builds its conclusions through hypothesis testing grounded in a structured framework.

3.3 Research Strategy

In this study, the researcher follows a positivist approach and deductive reasoning. It is evident that the researcher independently selects the universe and problem statement, with no influence from personal attitudes or opinions (Johnson & Duberley, 2000).

The steps undertaken to complete the research process include:

- First, the use of both quantitative and qualitative methods.

- Second, the application of these methods to a large population to formulate the findings.
- Third, the use of statistical tools to test hypotheses, with decisions to accept or reject based on the results.
- Next, the researcher attempts to measure and draw conclusions from the specific data in the relevant area.
- Finally, generalizations are drawn from the sample studied, with the analysis conducted at a 5% error and 95% confidence level, representing the population.

3.4 Sampling Plan

The study was limited to the region of Madhya Pradesh. Since the research targets the manufacturing sector, which is vast, the focus was narrowed to Inventory Distribution Coordination, a key component of logistics operations. The study included all major manufacturing units in Madhya Pradesh.

Focus: Managers of the Logistics Department and Manufacturing Units.
Sampling Unit: A total of 300 respondents were chosen for the research and got 281 completed responses. The questionnaire technique was used to gather primary data from the targeted respondents.
Sampling Techniques: The study utilized purposive, convenience, and random sampling techniques.

3.5 Scaling

The five point Likert scale, by using clearly marked responses such as Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. These responses are coded numerically, with values assigned to each option (e.g., Strongly Agree = 5, strongly Disagree = 1). Data analysis using the Likert scale involves coding the responses, distinguishing between ordinal and interval data, calculating means, and applying both descriptive and inferential statistical methods to interpret the results.

3.6 Pilot Study

According to Zikmund et al. (2010), a pilot study serves as a preliminary test, similar to a small trailer, allowing researchers to identify challenges and opportunities in data collection. It helps refine the thesis or dissertation by addressing issues in detail, ensuring that the process mirrors the full study for accurate results.

3.7 Data Analysis Tools

The primary data was collected through a self-structured questionnaire using a 5-point Likert scale, which contained 20 questions that were designed, tested for reliability, and validated. The self-structured questions focused on various strategic factors, such as:

- Performance level relative to competitors
- Efforts in information integration
- Distributor selection process
- Evaluation of distributor performance
- Customer service and satisfaction (relationship building)

Secondary data for this study was collected from journals, periodicals, and reports, helping the researcher understand distribution coordination in supply chain management. A survey with a structured questionnaire assessed factors like performance relative to competitors, integration efforts, distributor selection, and customer satisfaction. The study primarily used primary data from close-ended questions, which allowed for quick responses and simplified data analysis (Sekaran, 2003).

3.8 Statistical Analysis of Data

The data was coded in MS Excel and analyzed using SPSS 20.0 with descriptive statistics. Frequency analysis and item-total correlation were performed to check scale variation, followed by reliability and validity tests using Cronbach's Alpha and correlation analysis. Statistical techniques like T-tests, correlation, and linear regression were then applied to segment respondents and identify key descriptors. Correlation Analysis (To check the relationship among the inventory distribution coordination and supply chain performance.) Regression Analysis (To examine the impact of variables (customer service and satisfaction, evaluation of distributor's performance, selection criteria, supply chain performance, information integration efforts etc. Analysis of Variance (ANOVA) is a statistical test used to determine if there are differences among the means of two or more independent samples. It is suitable for K independent groups measured on an interval scale (Dillon, Madden, & Firtle, 1994; Churchill, 1995; Zikmund, 1995). Unlike the t-test, ANOVA can compare more than two groups simultaneously. The technique helps identify whether

groups within a sample differ regarding the independent variable, with the F-test assessing whether there is greater variability in one group compared to others.

$$F\text{- ratio} = \frac{\text{MSB (Between)}}{\text{MSW (Within)}}$$

The value of r ranges from -1 to +1, with +1 indicating a perfect positive linear relationship and -1 indicating a perfect negative relationship (Harris, 1995). A value of 0 suggests no linear relationship between the variables.

4. Objectives of the Study

The objectives of this study are formulated based on the research framework to provide accurate outcomes on supply chain performance dimensions. These objectives guide the study and ensure a clear direction for achieving the desired results.

- Looking at how enabling factors are related to a company's performance,
- Checking if companies that work with distributors perform differently from those that don't, and
- Finding out if companies that work with distributors value these factors differently than those that don't.

5. Data Analysis & Interpretation

Once the responses were collected they were converted into the useful data that can be used for statistical analysis by using SPSS 20.0 software Tables and Graphs on the factors of Inventory-Distribution Coordination are generated with the help of the SPSS 20.0.

5.1 Test of Normality

The normality of the data was tested using the Kolmogorov-Smirnov (K-S) and Shapiro-Wilk tests to determine if the distribution significantly deviated from a normal distribution (Carver & Nash, 2006). The results showed that the p-value for the K-S test was 0.355 (greater than 0.05), and for the Shapiro-Wilk test, it was 0.326 (greater than 0.05). These values suggest that the distribution of the final scores does not significantly differ from a normal distribution, validating the assumption of normality for the sample. (The table for the first normality test is provided below.)

Table 5.1(A) : Tests of Normality

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Factors of Inventory Distribution Coordination	.092	565	.355	.958	565	.326

Table 5.1 (B) : Table Showing Skewness & Kurtosis

		Statistic	**Std. Error**
Mean		3.6941	.02842
95% Confidence Interval for Mean	Lower Bound	3.6382	
	Upper Bound	3.7500	
5% Trimmed Mean		3.7146	
Median		3.6522	
Variance		.279	
Variance		.52781	
Minimum		1.65	
Maximum		4.91	
Range		3.26	
Inter quartile Range		.65	
Skewness		**-.760**	**.131**
Kurtosis		**1.801**	**.262**

Skewness and Kurtosis were also calculated to check for any deviation from normality. These measures help determine if the data falls within an acceptable range. According to George and Mallery (2009), values between +2 and -2 are considered acceptable, indicating that the data follows a normal distribution. In this study, the Skewness value was -0.760 and the Kurtosis value was 1.801, both within the acceptable range, confirming that the data is normally distributed.

5.2 Reliability of Instruments

Reliability ensures consistent and repeatable results under similar conditions, measured here using Cronbach's Alpha Test. A high score of 0.976 indicates strong internal consistency, exceeding the acceptable threshold of 0.7.

Table 5.2(A) Reliability Statics

Cronbach's Alpha	N of Items
0.976	20

Cronbach's alpha is .976 so it may be concluded that there is a high level of internal consistency. Thus, the scale can be considered as a reliable scale.

Table 5.2(B) Item Wise Descriptive Statistics

	Mean	Std. Deviation
VAR00001	3.4256	1.28201
VAR00002	3.4897	1.27408
VAR00003	3.3641	1.28811
VAR00004	3.3667	1.27896
VAR00005	3.3564	1.26101
VAR00006	3.5385	1.25579
VAR00007	3.5795	1.23668
VAR00008	3.5795	1.17934
VAR00009	3.4410	1.20308
VAR00010	3.6179	1.23378
VAR00011	3.5513	1.12699
VAR00012	3.7128	1.16557
VAR00013	3.7282	1.13581
VAR00014	3.4692	1.09355
VAR00015	3.3769	1.22226
VAR00016	3.5308	1.25797
VAR00017	3.5308	1.17507
VAR00018	3.5410	1.21139
VAR00019	3.6821	1.08575
VAR00020	3.7051	1.08162

5.3 Factor Analysis

This analysis begins with the preliminary tests to examine the aptness of factor analysis Bartlett's test of Sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA). Bartlett's test of sphericity is a statistical test for the examining of correlations among variables. It defines the significant or insignificant of the hypothesis.

Table 5.3 (A) KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.754
Bartlett's Test of Sphericity	Approx. Chi-Square	3136.717
	Df	566
	Sig.	.000

Table 5.3(B) Communalities

	Initial	Extraction
VAR00001	1.000	.685
VAR00002	1.000	.681
VAR00003	1.000	.672
VAR00004	1.000	.686
VAR00005	1.000	.686
VAR00006	1.000	.647
VAR00007	1.000	.666
VAR00008	1.000	.659
VAR00009	1.000	.632
VAR00010	1.000	.674
VAR00011	1.000	.673
VAR00012	1.000	.668
VAR00013	1.000	.748
VAR00014	1.000	.666
VAR00015	1.000	.703
VAR00016	1.000	.669
VAR00017	1.000	.684
VAR00018	1.000	.680
VAR00019	1.000	.679
VAR00020	1.000	.648

Extraction Method: Principal Component Analysis.

Table 5.3 (C) Rotation Sum of Squared Loadings

Component	Extraction sum of squared loadings			Rotation sum of squared loadings		
	Total	% of variance	Cumulative	Total	% of variance	Cumulative
VAR001	11.407	45.628	45.628	5.288	21.153	21.153
VAR002	2.584	10.334	55.963	4.290	17.162	38.315
VAR003	1.704	6.815	62.778	4.140	16.559	54.873
VAR004	1.590	6.632	69.139	2.420	9.681	64.555
VAR005	1.270	5.080	74.29	2.46	9.665	74.219
VAR006						
VAR007						
VAR008						
VAR009						
VAR010						
VAR011						
VAR012						
VAR013						
VAR014						
VAR015						
VAR016						
VAR017						
VAR018						

VAR019						
VAR020						

6. Results and Conclusions

1) Information Integration Efforts have a substantial impact on a firm's performance, accounting for 55.4% of the variation observed in overall performance outcomes.

2) Relationship Building has a notable influence on a firm's performance, with around 40% of the variation in performance attributed to efforts in building strong relationships.

3) Distributor Selection Criteria have a strong and significant impact on a firm's performance, explaining approximately 83.9% of the variation in performance outcomes.

4) Distributor Performance Evaluation has a significant influence on a firm's performance, accounting for roughly 73.33% or nearly three-fourths of the variation in performance outcomes.

6.1 Conclusions

This study highlights four key focus area-Distributor Selection, Performance Evaluation, Relationship Building, and Information Sharing-that significantly enhance firm performance. By treating Distributors as strategic partners and integrating them into supply chain processes, firms can improve coordination, build trust, and boost efficiency. This collaborative approach not only reduces costs but also strengthens the supply chain's resilience and competitiveness.

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