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"A Study On The Impact Of Supply Chain Optimization"

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Abstract: This study examines the impact of supply chain optimization on organizational performance and operational efficiency. Supply chain management is essential for the operational and financial success of the manufacturing sectors, especially in the paper and packaging industry. As global supply chains grow more complex, the need for efficient financial coordination has become increasingly vital. SCF bridges the gap between a buyer's desire to extend payment terms and a supplier's need for immediate cash flow, often through third-party financial institutions. The research explores the key areas of a supply chain that require development, evaluates the effectiveness of existing practices, and suggests possible strategies to enhance supply chain optimization and achieve cost savings.

Keywords: Supply chain optimization, Operational Efficiency, Supply chain Finance(SCF), Structural Equation Modeling, Manufacturing Sector

I. INTRODUCTION

In today's highly competitive and globally interconnected markets, efficient financial management of the supply chain is critical to maintaining operational resilience and fostering strategic growth. Supply Chain Finance (SCF) refers to a collection of financial solutions that aim to improve business cash flow and reduce financing costs by optimizing the financial relationship between buyers and suppliers. As global supply chains grow more complex, the need for efficient financial coordination has become increasingly vital. SCF bridges the gap between a buyer's desire to extend payment terms and a supplier's need for immediate cash flow, often through third-party financial institutions. In industries such as paper and packaging, where raw material procurement, production, and logistics are capital-intensive, SCF plays a crucial role as an environmentally conscious and operationally complex organization. Optimizing supply chain finance is essential for maintaining both financial stability and production efficiency.

BENEFITS OF SUPPLY CHAIN OPTIMIZATION

Cost Reduction: Efficient supply chain operations and responsible environmental resource management lead to significant cost savings for companies. By minimizing waste, optimizing inventory levels, and reducing energy consumption, organizations can lower operational costs and improve overall financial performance.

Enhanced Efficiency: Adopting modern tools, technologies, and methodologies enhances the efficiency of supply chain processes. Streamlined workflows, automation, and real-time data tracking help eliminate bottlenecks, reduce delays, and improve coordination among various departments and stakeholders.

THE ROLE OF ARTIFICIAL INTELLIGENCE (AI)IN SUPPLY CHAIN OPTIMIZATION

AI in Demand Forecasting

AI-powered predictive analytics provide accurate demand estimates by analyzing historical sales data, market trends, and external factors. This enables proactive stock adjustments and smarter production planning.

AI for Route Optimization

AI algorithms evaluate multiple transportation variables to determine the most efficient routes. This reduces fuel consumption, lowers transportation costs, and speeds up delivery times, leading to improved customer service.

I. RESEARCH METHODOLOGY

The methodology section outlines the plan and method which the study is conducted. This includes the Universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The details are as follows;

3.1Population and Sample

The research design used for this study is a Descriptive research design. Observing and recording current circumstances, behaviors, or attitudes without changing any factors is the main goal of descriptive research, The sample size is taken as 132 for this study. The sample size is determined through the Morgan table for sample size. Data collection follows quantitative methods, and since the data is not normally distributed, non-parametric tools were applied for analysis.

3.2 Data and Sources of Data

In this study, primary data is collected through a Questionnaire. Primary data are those which are collected afresh and for the very first time and thus happens to be original in the character. Primary data collection refers to the process of directly obtaining data from original sources using techniques such as surveys. In this study, secondary data is obtained from Research Publications and journals. Secondary data are those which are already collected by someone else and that have been passed through statistically process. Secondary data collection refers to the utilization of pre-existing data that has been gathered and examined by another researcher for a different objective**.**

3.3 Statistical tools

The following statistical tools are used for analysing the data

- Mann-Whitney U Test
- Kruskal Wallis H Test
- Spearman's rank correlation
- STRUCTURAL EQUATION MODELS

3.3.1 Descriptive Statistics

The research design used for this study is a Descriptive research design. Descriptive research design is the research design technique employed in this research. A technique used in research to characterize and describe the features of a population or phenomenon under study is called descriptive research design. Observing and recording current circumstances, behaviors, or attitudes without changing any factors is the main goal of descriptive research. Rather than exploring the reasons behind specific phenomena, it aims to provide answers to questions like "What, Who, Where, When, How".

3.3.2 MANN-WHITNEY U TEST

The Mann-Whitney U test is a non-parametric statistical test used to compare differences between two independent groups when the data is not normally distributed. The Mann-Whitney U Test is used to determine whether there is a statistically significant difference between two independent groups on a continuous or ordinal variable. It is an alternative to the independent samples t-test, especially when the data does not meet the assumption of normality. Instead of comparing means (like a t-test), it compares the ranks of the values.

$$U = n_1n_2 + (n_1(n_1 + 1))/2 - R_1$$

3.3.3 KRUSKAL WALLIS H TEST

The Kruskal-Wallis test (H test) is a non-parametric statistical test used to compare three or more independent groups to determine if there are statistically significant differences between them. It is an extension of the Mann- Whitney U test, which is used for comparing two groups. It is the non-parametric alternative to one-way ANOVA, and it's used when the data is not normally distributed.

$$H = 12 / (N(N+1)) * \Sigma (R^2i / ni) - 3(N+1)$$

3.3.4 STRUCTURAL EQUATION MODELING (SEM)

Structural Equation Modeling (SEM) is a multivariate statistical technique used to analyze complex relationships among observed and latent variables. It combines elements of factor analysis and multiple regression and is used to test theoretical models involving causal relationships. SEM is suitable for studies where the goal is to understand how different constructs influence each other, even when some constructs are not directly measurable.

IV. RESULTS AND DISCUSSION

4.1 Results of Demographics information

Table 4.1: Demographic information

Categories	Sub categories	No. of respondents	Percentage (%)
Age	Less than 25	36	8.3
	26-30	29	22
	31-35	19	14.4
	36-40	40	30.3
	Above 40	33	25
Gender	Male	62	47
	Female	70	53
Education	UG	39	29.5
	PG	63	47.7
	CA	3	2.3
	CMA	8	6.1
	Others	19	14.4
Experience	Below 2 Years	12	9.1
	2-5 Years	34	25.8

	6-10 Years	40	30.3
	Above 10 Years	46	34.8
Job Role	Finance	31	23.5
	Supply chain	25	18.9
	Procurement	30	22.7
	Production	25	18.9
	IT specialist	21	15.9
Total	**All categories**	**132**	**100**

INFERENCE

- It is inferred that the majority of respondents are female, 53%.
- It is inferred that 30.3 of respondents belong to the age group of 36-40.
- It is inferred that 47.7% of respondents are PG graduates.
- It is inferred that 34.8 % of respondents have 10 years of experience.

4.2 Results of the MANN-WHITNEY U TEST

NULL HYPOTHESIS(H0): There is no significant difference between the mean ranks between employees' job roles with respect to factors such as Coordination between procurement, production, and logistics departments, Production and Delivery Timelines, and the use of technology in the supply chain.

Alternative Hypothesis (H_1): There is a significant difference between the mean ranks between employees' job roles with respect to factors such as Coordination between procurement, production, and logistics departments, Production and Delivery Timelines, and the use of technology in the supply chain.

Ranks

Test Statistics[a]

	Coordination between procurement, production, and logistics departments.	Production and Delivery Timelines.	The use of technology in the supply chain
Mann-Whitney U	363.500	367.000	369.500
Wilcoxon W	688.500	692.000	694.500
Z	-.689	-.385	-.339
Asymp. Sig. (2-tailed)	.491	.700	.735

a. Grouping Variable: Job role

INFERENCE

The p-values (0.491, 0.700, and 0.735) are all greater than the significance level of 0.05, indicating that the null hypothesis is accepted in each. So, there is no significant difference between the mean ranks between employees' job roles with respect to factors such as Coordination between procurement, production, and logistics departments, Production and Delivery Timelines, and the use of technology in the supply chain.

4.3 Results of KRUSKAL-WALLIS TEST

Null Hypothesis (H_0): There is no significant difference between the mean ranks of age groups with respect to factors such as Coordination between procurement, production, and logistics departments, Production and Delivery Timelines, and Sustainable practices.

Alternative Hypothesis (H_1): There is significant difference between the mean ranks of age groups with respect to factors such as Coordination between procurement, production, and logistics departments,

Test Statistics[a,b]

	Coordination between procurement, production, and logistics departments	Production and Delivery Timelines.	Sustainable practices
Chi-Square	6.831	3.684	6.011
df	4	4	4
Asymp. Sig.	.145	.450	.198

a. Kruskal-Wallis Test

b. Grouping Variable: Age group (in years)

Production and Delivery Timelines, and Sustainable practices

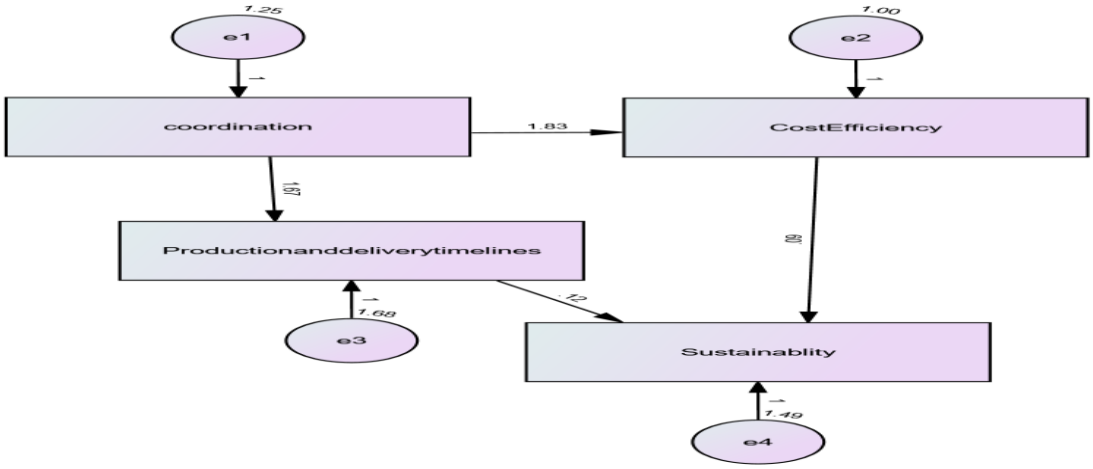
INFERENCE

The p-values (0.145, 0.450, and 0.198) are all greater than the significance level of 0.05, indicating that the null hypothesis is accepted in each. So, there is no significant difference between the mean ranks of age groups with respect to factors such as Coordination between procurement, production, and logistics departments, Production and Delivery Timelines, and Sustainable practices.

4.4 Results of STRUCTURAL EQUATION MODELS

MODEL FIT

The model fit indices used to evaluate the model's overall fit are CMIN (Chi square p value), Chi Square/ degrees of freedom (CMIN/df), RMSEA (Root Mean Square of Approximation), CFI (Comparative Fit Index), GFI (Goodness of Fit Index), AGFI(Adjusted Goodness of Fit Index), NFI (Normed Fit Index) RFI (Relative Fit Index).



Test	Standard	Result	Model Fit Verification
CMIN (Chi-Square p-value)	> 0.05	0.099	Good Fit
CMIN/df	< 5	2.311	Good Fit
RMSEA	< 0.08	0.100	Close Fit
CFI	> 0.9	0.993	Good Fit
GFI	> 0.9	0.983	Good Fit
AGFI	> 0.9	0.915	Good Fit
NFI	> 0.9	0.988	Good Fit
RFI	> 0.9	0.964	Good Fit

INFERENCE

The chi-square p-value(0.099) is greater than 0.05, indicating there is no significant difference between the observed and estimated covariance matrices, thus confirming a good model fit.

The CMIN/df value (2.311) is well below the recommended maximum of 5, indicating the model's adequacy.

Indices like RMSEA (0.100), CFI(0.993), GFI (0.983), NFI(0.9880, and RFI (0.964) all meet commonly accepted benchmarks, which suggests a good model fit.

Although the AGFI (0.915)is slightly above the 0.90 threshold, showing that the model fits well, although there is a small margin for improvement.

Most fit indices meet the recommended thresholds, suggesting that the model has good fit to the data.

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