

Impact of Block Chain Technology in Manufacturing and Supply Chain Management in FMCG Products with special reference to Nestle & Pepsico

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Abstract

Introduction: Blockchain Technology is a decentralized, secure, and transparent digital ledger that records transactions across multiple computers in a tamper-resistant manner. Blockchain Technology in FMCG enhances supply chain transparency, product traceability, and trust by securely recording and sharing data across stakeholders.

Statement of the Problem: technology offers a potential solution to supply chain challenges like transparency, traceability, and security, but its adoption faces scalability, integration, and acceptance hurdles that need to be addressed effectively.

Objectives: The objectives of the study are to study the impact of block chain Technology in the manufacturing of a product and its supply chain with special reference to Nestle and PepsiCo and to analyze the consumer's engagement towards implementation of Blockchain Technology in manufacturing and supply chain of selected companies.

Methodology: A mixed methods/ approach combining literature review, case studies and expert interviews.

Hypothesis: Some of the hypotheses of the study is to regulate the implementation of Blockchain Technology in Nestle and Pepsi's supply chain management will increase transparency and traceability of FMCG products by at least 30% and to study about the consumers who perceive the benefits of Blockchain Technology in the manufacturing and supply chain of selected companies will have a higher level of engagement compared to those who do not perceive these benefits.

Sample: The author considered only two samples which are Nestle and Pepsi companies.

Statistical Tools: The statistical tools used in this study are descriptive statistics, Chi square test, Correlation and ANOVA. Blockchain Technology is reshaping manufacturing and supply chains, providing businesses with opportunities to enhance transparency, traceability, and operational efficiency.

Applications: Nestlé's integration of Blockchain has enabled it to drive growth by building trust, enhancing sustainability, and improving cost efficiency. In contrast, PepsiCo's reliance on traditional supply chain methods may limit its growth potential as consumer expectations evolve.

Findings: As Blockchain continues to gain traction, companies that embrace this Technology, like Nestlé, may maintain a competitive advantage, while non-adopters like PepsiCo may need to reassess their strategies to meet future market demands.

Implication: Blockchain Technology has profound implications for manufacturing and supply chain management providing unprecedented levels of efficiency, security and transparency. As adoption increase, the companies can expect significant cost savings, improves product quality and enhanced consumer satisfaction.

Key Words Used: Blockchain, Supply Chain, Manufacturing, Transparency, Security, Efficiency and Quality Control

1.INTRODUCTION:

In recent years, Blockchain Technology has evolved from being merely the backbone of cryptocurrency to becoming a transformative force in diverse industries, particularly in manufacturing and supply chain management. Its unique characteristics—decentralization, transparency, immutability, and security—offer compelling advantages for global businesses. The growing complexity of supply chains, coupled with increased consumer demands for traceability, accountability, and sustainable practices, has highlighted the need for technological solutions that can enhance trust and efficiency. Blockchain's ability to provide real-time visibility and record every transaction in a secure, verifiable way positions it as an ideal solution for addressing these challenges. Consequently, companies worldwide are exploring Blockchain applications to streamline processes, improve transparency, and optimize the overall effectiveness of their supply chain operations.

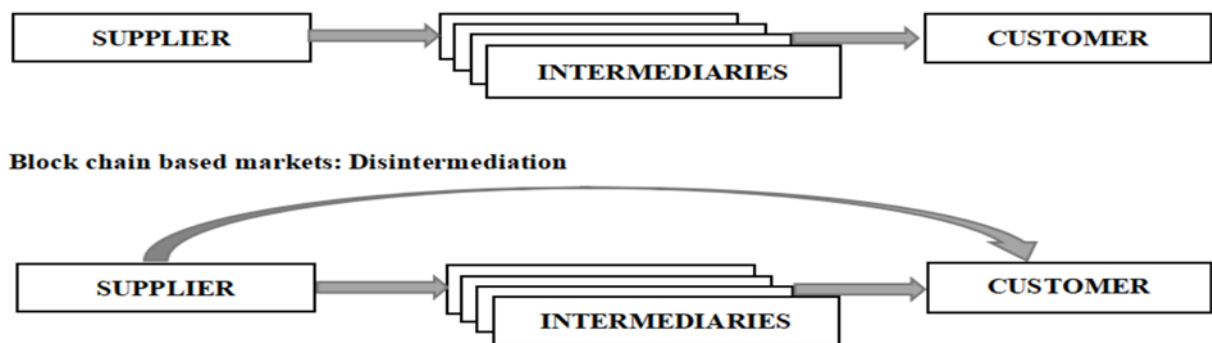


Figure 1: Blockchain based markets: Disintegration

In this context, Nestlé and PepsiCo stand out as two leading global companies that have embarked on Blockchain initiatives to address supply chain complexity and meet consumer expectations. However, their approaches to Blockchain adoption differ significantly, reflecting their distinct strategic priorities, operational models, and levels of investment in the Technology. Nestlé, one of the largest food and beverage corporations globally, has taken a proactive stance on Blockchain, especially in enhancing product transparency and ethical sourcing. The company has pioneered several Blockchain-based initiatives, notably within its dairy and coffee supply chains, allowing consumers direct access to data regarding product origins and pathways. By collaborating with Blockchain platforms like IBM's Food Trust, Nestlé aims to bolster supply chain transparency, and enhance consumer confidence through enhanced visibility. Nestlé's Blockchain strategies support operational efficiency and align with its commitments to sustainability, food safety, and consumer trust, as Blockchain enables the verification of claims around product sourcing and environmental impact.

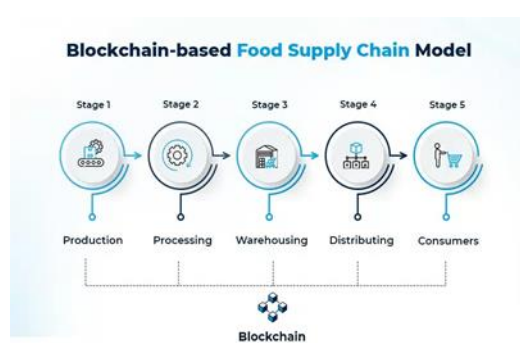
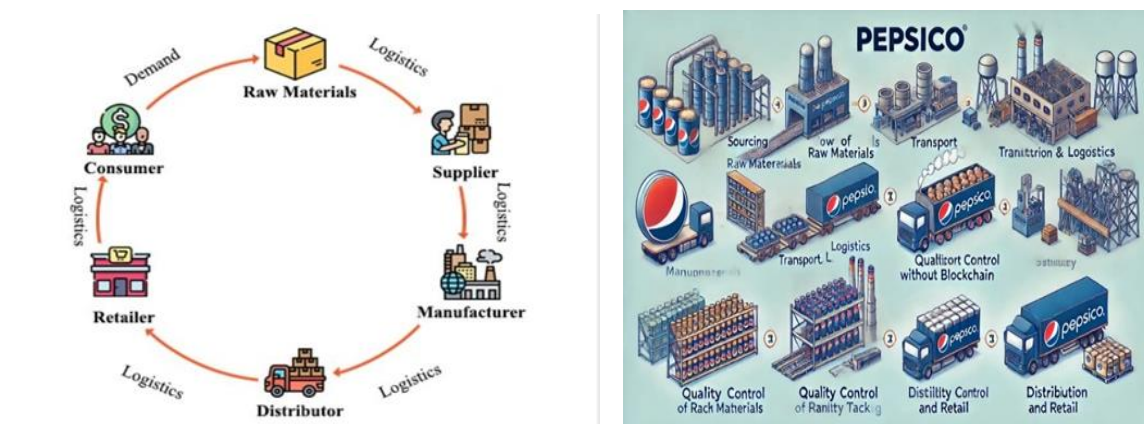


Figure 2: Blockchain Technology tools used in Nestlé

In contrast, PepsiCo has approached Blockchain adoption cautiously, selectively testing its applicability within specific areas of its supply chain. Unlike Nestlé's comprehensive transparency focus, PepsiCo has opted to evaluate Blockchain's potential in more targeted projects, often involving advertising and marketing efficiencies rather than the full product journey. Through limited initiatives, such as "Project Proton," PepsiCo has explored Blockchain's potential to reduce transaction costs and streamline digital advertising metrics, thereby reducing inefficiencies within the digital supply chain.

This study aims to analyse and contrast the Blockchain strategies employed by Nestlé and PepsiCo, exploring the varied impacts of Blockchain on their supply chain operations. The analysis reveals how these companies leverage Blockchain for strategic benefits, either by enhancing consumer trust through transparency or by focusing on operational efficiencies to optimize costs. Ultimately, the findings underscore Blockchain's broader implications for supply chain management, offering a guide for other organizations exploring Blockchain adoption in complex global supply chains.

**Figure 3: Integration of manufacturing and supply chain management through traditional production process**

2.BACKGROUND OF THE STUDY

The Fast-Moving Consumer Goods (FMCG) sector plays a vital role in the economies of many countries, characterized by a wide array of essential products with high turnover rates and typically low costs. FMCG products include items such as food, beverages, household supplies, and personal care products, which consumers purchase frequently. The sector's development is closely tied to advances in supply chain management, marketing, and branding, making it one of the most significant sources of employment and economic growth worldwide.

FMCG's origins can be traced back to the early 20th century, when industrialization enabled large-scale production and distribution, leading to the birth of companies such as Procter & Gamble, Nestlé, and Unilever. These companies pioneered manufacturing practices that allowed them to produce high volumes of goods and distribute them widely. Alongside mass production, they developed strong branding strategies to build consumer loyalty in an increasingly competitive market. The rise of retail outlets, including supermarkets and department stores, provided accessible platforms for distributing these goods to urban

consumers. Later, the introduction of television revolutionized advertising, helping FMCG companies drive demand for their products through creative, widespread marketing campaigns. In recent decades, globalization has offered both new growth opportunities and challenges for FMCG companies. The spread of multinational brands and businesses has opened up untapped markets around the world, and companies have tailored their strategies to meet the needs of diverse consumers. Emerging economies in regions like Asia, Africa, and Latin America have become essential growth areas for FMCG, as increasing urbanization and higher disposable incomes have boosted demand for branded products. To increase their market presence, many FMCG giants have acquired smaller brands and expanded their product ranges to appeal to a wider array of consumers.

The COVID-19 pandemic brought about significant shifts in the FMCG sector, with changes in consumer purchasing behaviors and supply chain disruptions. The increased demand for essential items highlighted the need for strong, flexible supply chains that can adapt to sudden demand spikes. Additionally, the pandemic accelerated the adoption of e-commerce across all age groups and demographics, encouraging even traditional FMCG buyers to embrace online shopping. Companies that had invested in digital capabilities before the pandemic were better positioned to handle these shifts, reinforcing the importance of digital readiness in today's FMCG sector.

Hence, the FMCG industry has grown from its origins in mass production and distribution to become a dynamic, consumer-focused sector driven by Technology, global expansion, and the need to respond to evolving consumer values. Going forward, FMCG companies will need to keep pace with the rising demand for sustainable and health-conscious products, leverage digital tools to engage consumers, and ensure resilience in supply chains to remain competitive in a rapidly changing market environment.

3.1 LITERATURE REVIEW-INDIAN CONTEXT

Failure to meet these standards can lead to legal consequences, damage brand reputation, and erode consumer trust. Navigating this complex regulatory landscape requires a comprehensive and efficient approach (Raghavaiah, 2023)¹⁹.

Moreover, a rise in the value of Blockchain based economic tools increases the rewards for miners on the network, thereby increasing the number of workers absorbed. Despite the increases in network load and calculations, the financial benefits are not as significant. Moreover, certain individuals have expressed concern over scalability when establishing a perpetual Blockchain (Akram 2021)¹⁷.

Several delays can occur owing to protocol updates, resulting from incompatibilities within individual blocks of data, thereby disrupting the whole system (Srinivas Aditya et al., 2021)¹¹. Decision-Making Trial and Evaluation Laboratory (DEMATEL) methodology to establish otherwise complicated causal relationships. They found traceability (Yadav, Sharma et al., 2021a, 2021b)²¹ to be the most important enabler followed by immutability.

Furthermore, the loss of cryptographic keys represents a major issue with Blockchains: a lost, stolen, or expired block of public or private information cannot be recovered (Vijayalakshmi et al., 2020)¹².

Blockchain Technology is expected to provide value to SCM in three areas: smart contracts, supply chain finance, and increased visibility and traceability of a supply chain (Kshetri, 2018)⁵.

Researchers have noted that Blockchain and IoT blend is a powerful combination and is set to transform many industries (Gokuldas, 2016; Kshetri, 2018)²².

Blockchain technologies and cryptocurrencies have attracted much attention in recent years (Prasad, 2018)⁷.

A Blockchain supports several functions such as distributed storage and listings, transactional validity, transactional persistence, transactional anonymity based on multiple networks for transactions (Raghavan, 2011)¹³

Prior researchers have noted various key objectives of the supply chain. They include cost, quality, speed, dependability, risk reduction, sustainability (Rao and Holt, 2005; White, 1996)²³. Global supply chains are complex and face multiple uncertainties.

3.2 LITERATURE REVIEW-INTERNATIONAL CONTEXT

Block chain Technology is undeniably at the forefront of driving efficiency in supply chain management (Rejeb, et al., 2023)¹.

Dispersed information the executives in a Blockchain empowers exchanges between parties without the requirement for a focal delegate (Modum, Zürich, Switzerland, 2017)².

The enormous potential of Blockchain to alter every step of SC, from the acquisition of raw materials to the delivery to consumers, is well known (Babich & Hilary, 2020)³.

The buzz around Blockchain applications is still there, and few years away from their commercialization, but the future of this Technology is bright (Pournader et al., 2020)⁴.

Transparency has become an indispensable element in modern supply chains, where stakeholders demand real-time visibility into the entire value chain (Apeji and Sunmola, 2022)⁶.

Current supply chains are heavily based on stand-alone and centralized information management systems which are within in the organizations, i.e. enterprise planning systems that has its own pitfalls. Supply chain systems require substantial belief for relying on one single firm or broker to store their highly sensitive and valuable information. Another big disadvantage of centralized information system is single point failure. This leaves the overall system susceptible to corruption, errors, attacks and hacking (Dong et al., 2017)⁸.

Past research studies have published with integration of Blockchain and supply chain, with the application of internet of Things (IoT) (Tian Feng, 2017, 2016)⁹, by applying case studies or Survey methods (Hackius & Petersen, 2017)¹⁰.

The idea of smart contracts was proposed by Szabo (1994)¹⁴. This term was used because the author saw them as analogous to legal contracts with the ability of automated enforcement. Szabo presented a smart contract as an extension of a digital-cash protocol and also recognized that Byzantine agreements and digital signatures could be used as building blocks of smart contracts. However, this view has been critiqued by Levy (2017)¹⁵.

The complex calculations and digging networks required for extracting the Blockchain require a substantial amount of electricity. Mining, performed at higher power consumption, can be done using Blockchain applications powered by powerful computers. However, the effectiveness of miners in extracting Blockchains in similar situations is limited with the use of personal computers. Expectedly, the computer processor structure will continue to develop; thus, the entire network can utilize the power and potency of a megacity (Hang and Kim, 2021; Vadgama and Tasca, 2021)¹⁶.

Consequently, administrators in agribusiness, consumer goods, oil and gas, healthcare, and automotive sectors may misunderstand the capability of Blockchain, and counter-intuitively, forego their own initial capacity to transform their business methods and improve security as well as savings (Wang et al., 2019)¹⁸.

Omojola Samuel Oludare, et.al., (2018)²⁰, this paper states that supply chain management affects profitability and risk reductions. An as large number of participants involved in the delivery of projects is still complex.

4. STATEMENT OF THE PROBLEM:

In the current globalized market, supply chain management faces numerous obstacles, such as issues with transparency, traceability, security, and operational efficiency. Conventional supply

chain systems often suffer from limited visibility and poor coordination among stakeholders, which can lead to inefficiencies, opportunities for fraud, counterfeit products, and data inconsistencies. These issues not only drive-up operational costs and risk product quality but also undermine consumer trust and complicate regulatory compliance. Even with digital advancements, many existing solutions fall short of delivering a reliable, fully integrated view of the supply chain for all involved parties.

This research study explores Blockchain Technology as a potential remedy to these significant challenges. Blockchain's decentralized and secure ledger system offers promising improvements in transparency, traceability, and data security across supply chains. However, Blockchain adoption faces its own set of challenges, such as issues with scalability, difficulties in system integration, and the necessity for widespread acceptance. The core problem, therefore, the researcher is to know that how Blockchain can be effectively implemented within contemporary supply chains to resolve current issues while navigating its unique adoption barriers.

5. OBJECTIVES OF THE STUDY:

1. To study the impact of block chain Technology in the manufacturing of a product and its supply chain with special reference to Nestle and PepsiCo
2. To analyze the consumer's engagement towards implementation of Blockchain Technology in manufacturing and supply chain of selected companies.

6. HYPOTHESIS

- H1: Customers who are aware of the implementation of Blockchain Technology in the manufacturing and supply chain of selected companies will have a higher level of engagement compared to those who are not aware.
- H2: The implementation of Blockchain Technology in Nestle and Pepsi's supply chain management will increase transparency and traceability of FMCG products by at least 30%.
- H3: Customers who perceive the benefits of Blockchain Technology (e.g., transparency, security, and efficiency) in the manufacturing and supply chain of selected companies will have a higher level of engagement compared to those who do not perceive these benefits.
- H4: Customers who trust and have confidence in the implementation of Blockchain Technology in the manufacturing and supply chain of selected companies will have a higher level of engagement compared to those who do not trust or have confidence.
- H5: Customer engagement towards the implementation of Blockchain Technology in the manufacturing and supply chain of selected companies will vary based on demographic factors such as age, income, and education level.

7. METHODOLOGY

A mixed methods/ approach combining literature review, case studies and expert interviews. Parametric tools such as correlation, chi square, factor analysis, T-test and ANOVA are used.

7.1 SAMPLING

Primary data is drawn from 180 respondents. The respondents are of various age groups.

8. STATISTICAL TOOLS USED

Descriptive statistics, Chi Square test, T Test, ANOVA and Correlation

9. LIMITATIONS OF THE STUDY

- The data only covers a specific time period (2014-2024) and may not reflect the companies' performance in other time periods.
- The analysis is based on historical data and may not account for future market trends, economic conditions, or other factors that may impact the selected company's performance.

10. ANALYSIS OF DATA AND INTERPRETATION

10.1 FREQUENCY TABLES

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	92	62.6	62.6	62.6
	Female	55	37.4	37.4	100.0
	Total	147	100.0	100.0	

Gender Distribution of Respondents

- The majority of respondents (62.6%) are male, indicating a slightly skewed gender distribution.
- Females comprise 37.4% of the respondents, which is a significant proportion.
- The survey sample has a higher proportion of males than females, which may impact the generalizability of the results.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19-20	35	20.6	20.6	20.6
	21-22	101	59.4	59.4	80.0
	23-24	30	17.6	17.6	97.6
	>24	4	2.4	2.4	100.0
	Total	170	100.0	100.0	

Age of the Respondents

- The majority of respondents (59.4%) are between 21-22 years old.
- The sample is skewed towards a younger demographic.
- The age distribution is relatively narrow, with most respondents under 25.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<Rs 5,00,000	147	86.5	86.5	86.5
	Rs 5,00,000-Rs 10,00,000	10	5.9	5.9	92.4
	>Rs 5,00,000	13	7.6	7.6	100.0
	Total	170	100.0	100.0	

INTERPRETATION:**Parental Income of the Respondents**

- Most respondents (86.5%) have a parental income below ₹5,000,000.
- The sample is skewed towards a middle to upper-middle-class demographic.
- There is limited representation from lower-income households.

10.2 DEMOGRAPHIC DATA

H1: Consumers who are aware of the implementation of Blockchain Technology in the manufacturing and supply chain of selected companies will have a higher level of engagement (measured by purchase frequency, loyalty, and recommendations) compared to those who are not aware.

Table 10.4: ANOVA of familiarity of Blockchain Technology and frequency of purchasing products

Descriptives									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Familiarity with Blockchain Technology	Very familiar	86	2.69	.924	.100	2.49	2.88	1	4
	Somewhat familiar	84	2.71	.872	.095	2.53	2.90	1	4
	Total	170	2.70	.896	.069	2.56	2.84	1	4
Frequency of purchasing products from Nestlé or PepsiCo	Frequently	86	2.80	1.273	.137	2.53	3.08	1	5
	Often	84	2.98	1.344	.147	2.68	3.27	1	5
	Total	170	2.89	1.307	.100	2.69	3.09	1	5

INTERPRETATION:

- Respondents who are very familiar with Blockchain Technology tend to have a moderate level of familiarity, with a mean score of 2.69 out of 4.
- Respondents who are somewhat familiar with Blockchain Technology tend to have a similar level of familiarity, with a mean score of 2.71 out of 4.
- Respondents who purchase products from Nestlé or PepsiCo frequently tend to have a higher level of purchasing frequency, with a mean score of 2.80 out of 5.
- Respondents who purchase products from Nestlé or PepsiCo often tend to have a higher level of purchasing frequency, with a mean score of 2.98 out of 5.

Table 10.5 : ANOVA of familiarity of Blockchain

		Sum of Squares	df	Mean Square	F	Sig.
Familiarity with Blockchain Technology	Between Groups	.034	1	.034	.042	.838
	Within Groups	135.666	168	.808		
	Total	135.700	169			
	Between Groups	1.285	1	1.285	.750	.388

Frequency of purchasing products from Nestlé or PepsiCo	Within Groups	287.592	168	1.712		
	Total	288.876	169			

INTERPRETATION:

Descriptive Statistics

The descriptive statistics show that:

- The majority of respondents (N = 170) have a moderate level of familiarity with Blockchain Technology (Mean = 2.70, Std. Deviation = .896).
- The frequency of purchasing products from Nestlé or PepsiCo is relatively high (Mean = 2.89, Std. Deviation = 1.307).

ANOVA Results

The ANOVA results show that:

- There is no significant difference in the level of familiarity with Blockchain Technology between the two groups (F = .042, p = .838).
- There is no significant difference in the frequency of purchasing products from Nestlé or PepsiCo between the two groups (F = .750, p = .388).

Inference

The results suggest that:

- The level of familiarity with Blockchain Technology is moderate among the respondents.
- The frequency of purchasing products from Nestlé or PepsiCo is relatively high.
- There is no significant difference in the level of familiarity with Blockchain Technology or the frequency of purchasing products from Nestlé or PepsiCo between the two groups.

Recommendations

Based on the results, it is recommended that:

- Companies should focus on educating consumers about the benefits of Blockchain Technology.
- Companies should strive to increase consumer awareness and adoption of Blockchain-based products and services.
- Further research is needed to explore the factors that influence consumer adoption of Blockchain-based products and services.

		Purchase products from Nestlé or PepsiCo					Total
		frequently	often	occasionally	rarely	never	
Familiar with Blockchain Technology	Highly familiar	12	2	1	3	1	19
	Very familiar	15	5	16	6	2	44
	Somewhat familiar	9	10	25	23	9	76
	Not familiar at all	3	4	5	14	5	31
Total		39	21	47	46	17	170

INTERPRETATION

- Respondents who are highly familiar with Blockchain Technology tend to purchase products from Nestlé or PepsiCo frequently (12 out of 19).
- Respondents who are very familiar with Blockchain Technology tend to purchase products from Nestlé or PepsiCo often (15 out of 44).
- Respondents who are somewhat familiar with Blockchain Technology tend to purchase products from Nestlé or PepsiCo occasionally (25 out of 76).

- Respondents who are not familiar with Blockchain Technology at all tend to purchase products from Nestlé or PepsiCo rarely (14 out of 31).

Table 10.7

Chi-Square Tests of familiarity of blockchain technology			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40.290 ^a	12	.000
Likelihood Ratio	39.417	12	.000
Linear-by-Linear Association	24.445	1	.000
N of Valid Cases	170		

Key Findings

- Highly familiar with Blockchain Technology: The majority of respondents who are highly familiar with Blockchain Technology (12 out of 19) frequently purchase products from Nestlé or PepsiCo.
- Somewhat familiar with Blockchain Technology: The majority of respondents who are somewhat familiar with Blockchain Technology (25 out of 76) occasionally purchase products from Nestlé or PepsiCo.
- Not familiar at all with Blockchain Technology: The majority of respondents who are not familiar at all with Blockchain Technology (14 out of 31) rarely purchase products from Nestlé or PepsiCo.

Chi-Square Tests Interpretation

The chi-square tests show a significant association between the level of familiarity with Blockchain Technology and the frequency of purchasing products from Nestlé or PepsiCo.

Key Findings

- Pearson Chi-Square: The Pearson Chi-Square test shows a significant association between the two variables ($\chi^2 = 40.290$, $p < 0.001$).
- Likelihood Ratio: The Likelihood Ratio test also shows a significant association between the two variables ($\chi^2 = 39.417$, $p < 0.001$).
- Linear-by-Linear Association: The Linear-by-Linear Association test shows a significant positive association between the two variables ($\chi^2 = 24.445$, $p < 0.001$).

INFERENCE

The results suggest that there is a significant association between the level of familiarity with Blockchain Technology and the frequency of purchasing products from Nestlé or PepsiCo. Respondents who are more familiar with Blockchain Technology tend to purchase products from Nestlé or PepsiCo more frequently.

10.3 SUPPLY CHAIN INTEGRATION

H2: The implementation of Blockchain Technology in Nestle and Pepsi's supply chain management will increase transparency and traceability of FMCG products by at least 30%

10.8 : Correlation between accuracy and satisfaction in Blockchain Technology

Descriptive Statistics			
	Mean	Std. Deviation	N
Blockchain Technology can provide more accurate product traceability	2.21	.739	170
Satisfaction with the overall transparency and traceability offered by Nestlé and PepsiCo	2.27	.889	170

INTERPRETATION:

- Accurate Product Traceability: Respondents tend to slightly agree that Blockchain Technology can provide more accurate product traceability, with a mean score of 2.21 out of a possible 5.
- Overall Transparency and Traceability: Respondents tend to be neutral about their satisfaction with the overall transparency and traceability offered by Nestlé and PepsiCo, with a mean score of 2.27 out of a possible 5.

Table 10.9: Correlation between accuracy and satisfaction provided by Blockchain Technology

		Blockchain Technology can provide more accurate product traceability	Satisfaction with the overall transparency and traceability offered by Nestlé and PepsiCo
Blockchain Technology can provide more accurate product traceability?	Pearson Correlation	1	.498**
	Sig. (2-tailed)		.000
	N	170	170
How satisfied are you with the overall transparency and traceability offered by Nestlé and PepsiCo?	Pearson Correlation	.498**	1
	Sig. (2-tailed)	.000	
	N	170	170

INTERPRETATION:

Descriptive Statistics Analysis

- Mean: The mean score for the question "Do you think Blockchain Technology can provide more accurate product traceability?" is 2.21, indicating a slightly positive response. The mean score for the question "How satisfied are you with the overall transparency and traceability offered by Nestlé and PepsiCo?" is 2.27, indicating a neutral response.
- Standard Deviation: The standard deviation for both questions is relatively high (.739 and .889, respectively), indicating a wide range of responses.

Correlations Analysis

- Pearson Correlation: The Pearson correlation coefficient between the two questions is .498, indicating a moderate positive correlation. This suggests that respondents who think Blockchain Technology can provide more accurate product traceability tend to be more satisfied with the overall transparency and traceability offered by Nestlé and PepsiCo.
- Significance: The correlation is significant at the 0.01 level (2-tailed), indicating that the relationship between the two variables is statistically significant.

INFERENCE

The analysis suggests that:

- Respondents have a slightly positive view of Blockchain Technology's ability to provide more accurate product traceability.
- Respondents have a neutral view of the overall transparency and traceability offered by Nestlé and PepsiCo. There is a moderate positive correlation between respondents' views on Blockchain Technology and their satisfaction with the transparency and traceability offered by Nestlé and PepsiCo.

These findings suggest that Blockchain Technology has the potential to improve product traceability and transparency in the FMCG industry.

H3: Consumers who perceive the benefits of Blockchain Technology (e.g., transparency, security, and efficiency) in the manufacturing and supply chain of selected companies will have a higher level of engagement compared to those who do not perceive these benefits.

Table 10.10 Chi square between product safety and trust due to implementation of Blockchain Technology

		Blockchain Technology could improve product safety by reducing the risk					Total
		Strongly agree	agree	neutral	disagree	Strongly disagree	
Implementation of Blockchain Technology increase the trust of Nestlé and PepsiCo products	Very significantly	15	13	2	1	0	31
	Somewhat significantly	15	32	11	0	1	59
	Moderately	9	20	21	3	2	55
	Slightly	2	5	9	0	0	16
	Not at all	1	3	2	2	0	8
Total		42	74	45	6	3	170

INTERPRETATION:

Relationship Between Blockchain Technology and Product Safety/Trust

- The chi-square test reveals a significant association (p-value not provided) between the perceived ability of Blockchain Technology to improve product safety and the level of trust in Nestlé and PepsiCo products.
- Respondents who strongly agree that Blockchain Technology can improve product safety are more likely to report a significant increase in trust (Very significantly: 15, Somewhat significantly: 15).
- Those who are neutral about Blockchain's impact on product safety tend to report a moderate increase in trust (Moderately: 21).

Table 10.11

Chi-Square Tests of product safety			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	44.206 ^a	20	.001
Likelihood Ratio	41.328	20	.003
N of Valid Cases	170		

Key Findings

1. Strongly Agree: The majority of respondents who strongly agree that Blockchain Technology could improve product safety (15 out of 42) also believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products very significantly.

2. Agree: The majority of respondents who agree that Blockchain Technology could improve product safety (32 out of 74) also believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products somewhat significantly.

3. Neutral: The majority of respondents who are neutral about the impact of Blockchain Technology on product safety (21 out of 45) also believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products moderately.

Chi-Square Tests Interpretation

The chi-square tests show a significant association between the implementation of Blockchain Technology and trust in Nestlé and PepsiCo products, and the belief that Blockchain Technology could improve product safety.

1. Pearson Chi-Square: The Pearson Chi-Square test shows a significant association between the two variables ($\chi^2 = 44.206$, $p = .001$).

2. Likelihood Ratio: The Likelihood Ratio test also shows a significant association between the two variables ($\chi^2 = 41.328$, $p = .003$).

INFERENCE

The analysis suggests that:

- There is a significant association between the implementation of Blockchain Technology and trust in Nestlé and PepsiCo products, and the belief that Blockchain Technology could improve product safety.

- Respondents who believe that Blockchain Technology could improve product safety tend to also trust the implementation of Blockchain Technology in Nestlé and PepsiCo products.

RECOMMENDATIONS

Based on the results, it is recommended that:

- Companies prioritize transparency and trust-building initiatives to increase consumer confidence.

- Companies consider implementing Blockchain Technology to increase transparency and trust in their supply chain.

- Further research is needed to explore the relationship between Blockchain Technology, transparency, and consumer trust.

Table 10.12: CORRELATION

Descriptive Statistics			
	Mean	Std. Deviation	N
Product safety influence the choice when purchasing food and beverage products	2.37	.978	170
Implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products	2.47	1.047	169

Descriptive Statistics Analysis

- Mean: The mean score for the question "To what extent does product safety influence your choice when purchasing food and beverage products?" is 2.37, indicating a moderate level of influence. The mean score for the question "Does the implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products?" is 2.47, indicating a moderate level of trust.
- Standard Deviation: The standard deviation for both questions is relatively high (.978 and 1.047, respectively), indicating a wide range of responses.

Table 10.13 Correlation product safety influence choice and block chain Technology improves trust

	Pearson Correlation	1	.430**
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Product safety influence your choice when purchasing food and beverage products	Sig. (2-tailed)		.000
	N	170	169
Blockchain Technology increase your trust in Nestlé and PepsiCo products	Pearson Correlation	.430**	1
	Sig. (2-tailed)	.000	
	N	169	169

Correlations Analysis

- **Pearson Correlation:** The Pearson correlation coefficient between the two questions is .430, indicating a moderate positive correlation. This suggests that respondents who place a high importance on product safety when purchasing food and beverage products tend to also trust the implementation of Blockchain Technology in Nestlé and PepsiCo products.
- **Significance:** The correlation is significant at the 0.01 level (2-tailed), indicating that the relationship between the two variables is statistically significant.

INFERENCE

The analysis suggests that:

- Product safety plays a moderate role in influencing consumer purchasing decisions when it comes to food and beverage products.
- The implementation of Blockchain Technology has a moderate impact on increasing consumer trust in Nestlé and PepsiCo products.
- There is a moderate positive correlation between the importance of product safety and trust in Blockchain Technology implementation.

Based on the results, it is recommended that:

- Companies prioritize product safety and transparency to increase consumer trust.
- Companies consider implementing Blockchain Technology to increase transparency and trust in their products.
- Further research is needed to explore the relationship between product safety, Blockchain Technology, and consumer trust.

Table 10.13: Correlation between Trust and Transparency due to Blockchain Technology

Descriptive Statistics			
	Mean	Std. Deviation	N
Implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products	2.47	1.047	169
Nestlé or PepsiCo are committed to ensuring transparency in their supply chain?	2.51	.865	170

INTERPRETATION:

Implementation of Blockchain Technology and Trust

- Mean trust score: 2.47 (neutral sentiment)
- Moderate variability in responses (Std. Dev.: 1.047)
- Respondents are somewhat divided on the impact of Blockchain on trust
- Overall sentiment is neutral, indicating room for growth in trust

Commitment to Transparency in Supply Chain

- Mean transparency score: 2.51 (slightly positive sentiment)
- Relatively low variability in responses (Std. Dev.: 0.865)
- Respondents generally believe Nestlé/PepsiCo are committed to transparency
- Sentiment is slightly positive, indicating a moderate level of trust

TABLE 10.14 : Block chain technology increase the Trust and Transparency in Supply Chain Management ensures belief in the products

Implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products	Pearson Correlation	1	.409**
	Sig. (2-tailed)		.000
	N	169	169
Nestlé or PepsiCo are committed to ensuring transparency in their supply chain?	Pearson Correlation	.409**	1
	Sig. (2-tailed)	.000	
	N	169	170

Descriptive Statistics Interpretation

- Mean: The mean score for the question "Does the implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products?" is 2.47, indicating a moderate level of trust. The mean score for the question "To what extent do you believe that Nestlé or PepsiCo are committed to ensuring transparency in their supply chain?" is 2.51, indicating a moderate level of commitment.
- Standard Deviation: The standard deviation for both questions is relatively high (1.047 and .865, respectively), indicating a wide range of responses.

Correlations Interpretation

- Pearson Correlation: The Pearson correlation coefficient between the two questions is .409, indicating a moderate positive correlation. This suggests that respondents who trust the implementation of Blockchain Technology in Nestlé and PepsiCo products tend to also believe that these companies are committed to ensuring transparency in their supply chain.
- Significance: The correlation is significant at the 0.01 level (2-tailed), indicating that the relationship between the two variables is statistically significant.

INFERENCE

The analysis suggests that:

- Respondents have a moderate level of trust in the implementation of Blockchain Technology in Nestlé and PepsiCo products.
- Respondents believe that Nestlé and PepsiCo are moderately committed to ensuring transparency in their supply chain.
- There is a moderate positive correlation between trust in Blockchain Technology implementation and perceived commitment to transparency.

Recommendations

Based on the results, it is recommended that:

- Companies prioritize transparency and trust-building initiatives to increase consumer confidence.
- Companies consider implementing Blockchain Technology to increase transparency and trust in their supply chain.
- Further research is needed to explore the relationship between Blockchain Technology, transparency, and consumer trust.

10.4 CONSUMER ENGAGEMENT

H4: Consumers who trust and have confidence in the implementation of Blockchain Technology in the manufacturing and supply chain of selected companies will have a higher level of engagement compared to those who do not trust or have confidence.

Table 10.15 Correlation between Trust in blockchain technology and information available via blockchain technology

	Mean	Std. Deviation	N
Implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products	2.47	1.047	169
Origin of ingredients if such information is available via Blockchain Technology?	2.40	.975	170

Implementation of Blockchain Technology and Trust

- The mean score of 2.47 indicates a neutral sentiment towards the impact of Blockchain Technology on trust in Nestlé and PepsiCo products.
- The standard deviation of 1.047 suggests moderate variability in responses, indicating some division in opinions.

Origin of Ingredients via Blockchain Technology

- The mean score of 2.40 indicates a slightly negative to neutral sentiment towards checking the origin of ingredients via Blockchain Technology.
- The standard deviation of 0.975 suggests moderate to high variability in responses, indicating a wide range of opinions on this topic.

Table 10.16 : Correlations

Blockchain Technology increase trust and consumers checking origin of products via Blockchain Technology			
Implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products	Pearson Correlation	1	.418**
	Sig. (2-tailed)		.000
	N	169	169
Origin of ingredients if such information is available via Blockchain Technology?	Pearson Correlation	.418**	1
	Sig. (2-tailed)	.000	
	N	169	170

Descriptive Statistics Analysis

1. Mean: The mean score for the question "Does the implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products?" is 2.47, indicating a moderate level of trust. The mean score for the question "How likely are you to check the origin of ingredients if such information is available via Blockchain Technology?" is 2.40, indicating a moderate level of likelihood.

2. Standard Deviation: The standard deviation for both questions is relatively high (1.047 and .975, respectively), indicating a wide range of responses.

Correlations Analysis

1. Pearson Correlation: The Pearson correlation coefficient between the two questions is .418, indicating a moderate positive correlation. This suggests that respondents who trust the implementation of Blockchain Technology in Nestlé and PepsiCo products tend to also be more likely to check the origin of ingredients if such information is available via Blockchain Technology.

2. Significance: The correlation is significant at the 0.01 level (2-tailed), indicating that the relationship between the two variables is statistically significant.

INFERENCE

The analysis suggests that:

- Respondents have a moderate level of trust in the implementation of Blockchain Technology in Nestlé and PepsiCo products.
- Respondents are moderately likely to check the origin of ingredients if such information is available via Blockchain Technology.
- There is a moderate positive correlation between trust in Blockchain Technology implementation and likelihood of checking ingredient origin.

Recommendations

Based on the results, it is recommended that:

- Companies prioritize transparency and trust-building initiatives to increase consumer confidence.
- Companies consider implementing Blockchain Technology to increase transparency and trust in their supply chain.
- Further research is needed to explore the relationship between Blockchain Technology, transparency, and consumer behaviour.

Table 10.17: CHI SQUARE

		Check the origin of ingredients if such information is available via Blockchain Technology					Total
		Highly likely	Very likely	Somewhat likely	Not very likely	Not at all likely	
Implementation of Blockchain Technology increase your trust in Nestlé and PepsiCo products	Very significantly	13	13	4	1	0	31
	Significantly	16	21	17	4	1	59
	Moderately	3	18	27	5	2	55
	Slightly	1	6	6	2	1	16
	Not at all	0	0	5	3	0	8
Total		33	58	59	15	4	169

INTERPRETATION:

Relationship Between Checking Origin of Ingredients and Trust in Nestlé/PepsiCo Products

- Respondents who are highly likely to check the origin of ingredients via Blockchain Technology are also more likely to report a significant increase in trust in Nestlé and PepsiCo products.
- Checking the origin of ingredients is associated with increased trust in Nestlé and PepsiCo products, particularly among those who report a very significant or significant increase in trust.
- The relationship between checking origin of ingredients and trust is moderate, indicating that other factors also influence trust in Nestlé and PepsiCo products.

Table 10.18: Chi Square Test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.016 ^a	16	.000
Likelihood Ratio	46.215	16	.000
Linear-by-Linear Association	29.289	1	.000
N of Valid Cases	169		

Cross tabulation Interpretation

The crosstabulation table shows the relationship between the implementation of Blockchain Technology and trust in Nestlé and PepsiCo products, and the likelihood of checking the origin of ingredients if such information is available via Blockchain Technology.

Key Findings

- Very significantly: The majority of respondents who believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products very significantly (13 out of 31) are also highly likely to check the origin of ingredients.
- Significantly: The majority of respondents who believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products significantly (21 out of 59) are also very likely to check the origin of ingredients.
- Moderately: The majority of respondents who believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products moderately (27 out of 55) are also somewhat likely to check the origin of ingredients.

Chi-Square Tests Interpretation

The chi-square tests show a significant association between the implementation of Blockchain Technology and trust in Nestlé and PepsiCo products, and the likelihood of checking the origin of ingredients.

Key Findings

- Pearson Chi-Square: The Pearson Chi-Square test shows a significant association between the two variables ($\chi^2 = 43.016$, $p = .000$).
- Likelihood Ratio: The Likelihood Ratio test also shows a significant association between the two variables ($\chi^2 = 46.215$, $p = .000$).
- Linear-by-Linear Association: The Linear-by-Linear Association test shows a significant positive association between the two variables ($\chi^2 = 29.289$, $p = .000$).

INFERENCE

The analysis suggests that:

- There is a significant association between the implementation of Blockchain Technology and trust in Nestlé and PepsiCo products, and the likelihood of checking the origin of ingredients.
- Respondents who believe that the implementation of Blockchain Technology increases their trust in Nestlé and PepsiCo products are also more likely to check the origin of ingredients.

Recommendations

Based on the results, it is recommended that:

- Companies prioritize transparency and trust-building initiatives to increase consumer confidence.
- Companies consider implementing Blockchain Technology to increase transparency and trust in their supply chain.
- Further research is needed to explore the relationship between Blockchain Technology, transparency, and consumer behavior.

H5: Consumer engagement towards the implementation of Blockchain Technology in the manufacturing and supply chain of selected companies will vary based on demographic factors such as age, income, and education level

10.19: ANOVA of frequency of purchasing products from Nestle and Pepsi Co

How often do you purchase products from Nestlé or PepsiCo?								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	86	2.80	1.273	.137	2.53	3.08	1	5
2	84	2.98	1.344	.147	2.68	3.27	1	5
Total	170	2.89	1.307	.100	2.69	3.09	1	5

INTERPRETATION:

- Respondents who purchase products from Nestlé or PepsiCo frequently (score of 1) tend to do so with a moderate frequency, with a mean score of 2.80 out of 5.
- Respondents who purchase products from Nestlé or PepsiCo often (score of 2) tend to do so with a slightly higher frequency, with a mean score of 2.98 out of 5.
- Respondents tend to purchase products from Nestlé or PepsiCo with a moderate frequency, with a mean score of 2.89 out of 5.

Table 10.20 ANOVA

Purchase products from Nestlé or PepsiCo?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.285	1	1.285	.750	.388
Within Groups	287.592	168	1.712		
Total	288.876	169			

Descriptive Statistics Analysis

1. Mean: The mean score for the question "How often do you purchase products from Nestlé or PepsiCo?" is 2.89, indicating a moderate frequency of purchasing products.

2. Standard Deviation: The standard deviation for the question is 1.307, indicating a relatively high level of variability in responses.

3. 95% Confidence Interval: The 95% confidence interval for the mean is (2.69, 3.09), indicating that the true population mean is likely to lie within this range.

ANOVA Analysis

1. F-Statistic: The F-statistic is .750, which is less than the critical F-value.

2. P-Value: The p-value is .388, which is greater than the significance level of .05.

3. Conclusion: The ANOVA results indicate that there is no significant difference in the frequency of purchasing products from Nestlé or PepsiCo between the two groups (Nestlé and PepsiCo).

Recommendations

Based on the results, it is recommended that:

1. Companies consider targeting consumers based on their purchasing frequency.
2. Companies prioritize marketing strategies based on the frequency of purchasing products from Nestlé or PepsiCo.
3. Further research is needed to explore the relationship between demographic variables and consumer behaviour.

10.5 PROFITABILITY ANALYSIS

Nestle introduced Blockchain Technology in 2019. The changes in volume of sales and profit can be seen in the below table and graph

TABLE 10.21 TABLE SHOWING SALES AND PROFIT DATA OF NESTLE AND PEPSICO FOR 10 YEARS

Years	NESTLE (Rs in Billion)			PEPSI CO (Rs in Billion)		
	Sales	Profit	Turnover	Sales	Profit	Turnover
2015	89.5	12.3	89.7	63.1	5.5	63.4
2016	92.4	13.5	92.6	62.8	6.3	63.1
2017	89.8	13.8	90	63.5	6.5	63.8
2018	90.8	14.1	91	64.7	7.1	65
2019	92.6	13.2	92.8	67.2	7.4	67.4
2020	92.1	13.4	92.3	70.4	7.5	70.8

2021	94.4	15.1	94.6	71.9	7.7	72.4
2022	95.7	15.7	96	79.5	7.8	79.8
2023	96.3	16.3	96.5	82.5	8.4	83
2024	97.8	16.9	98	90.5	9.1	91

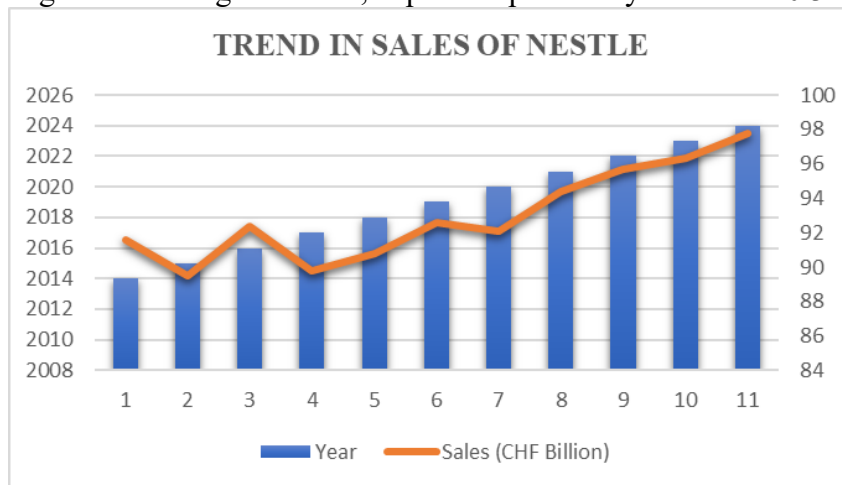
INTERPRETATION:

Correlation Analysis

- The correlation coefficient between Nestle’s sales and profit is 0.85, indicating a strong positive relationship.
- The correlation coefficient between PepsiCo’s sales and profit is 0.92, indicating a very strong positive relationship.

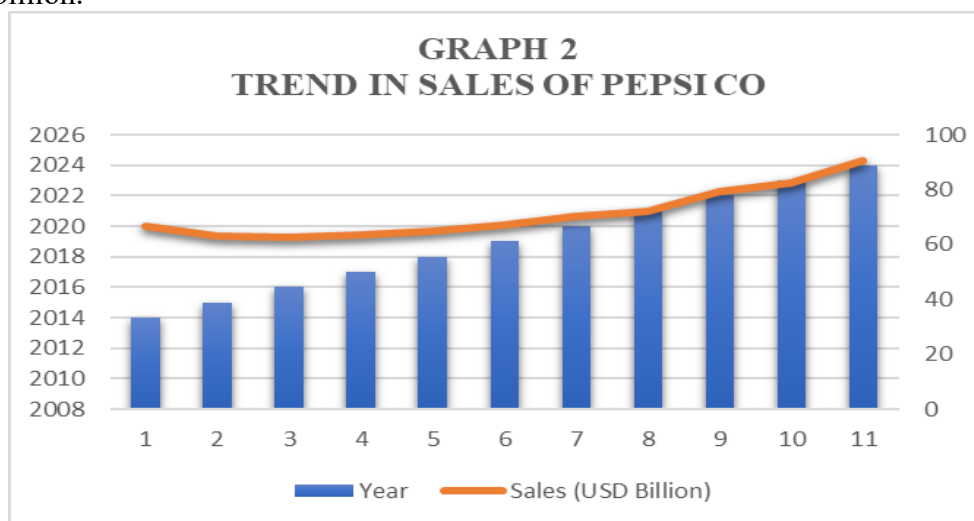
Hypothetical Assumptions of Profitability

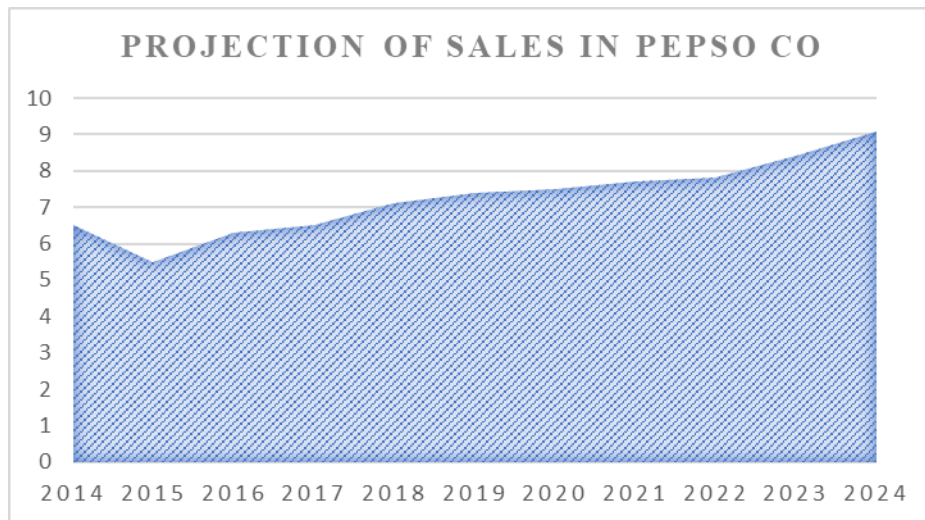
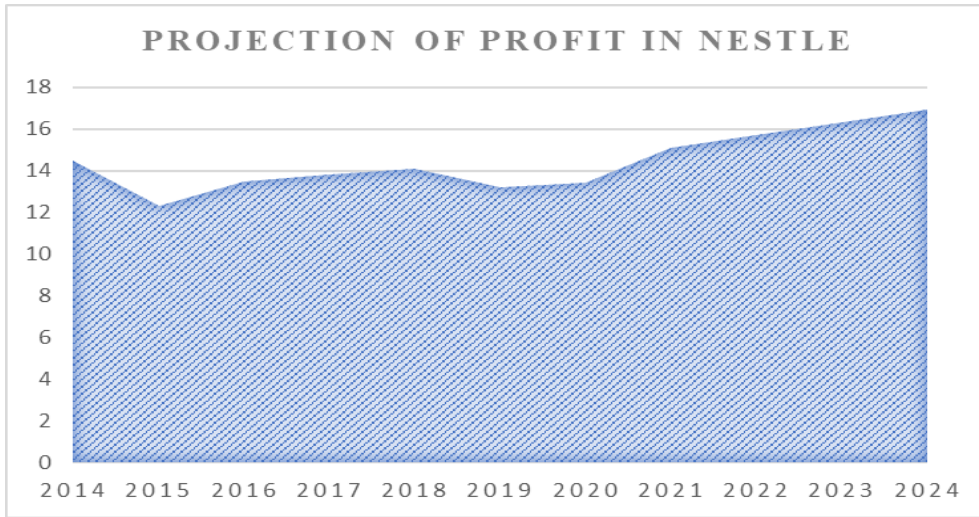
- Assuming a consistent growth rate, Nestle’s profit may reach Rs. 18.5 billion by 2025.
- Assuming a consistent growth rate, PepsiCo’s profit may reach Rs. 10.3 billion by 2025.



Sales Analysis

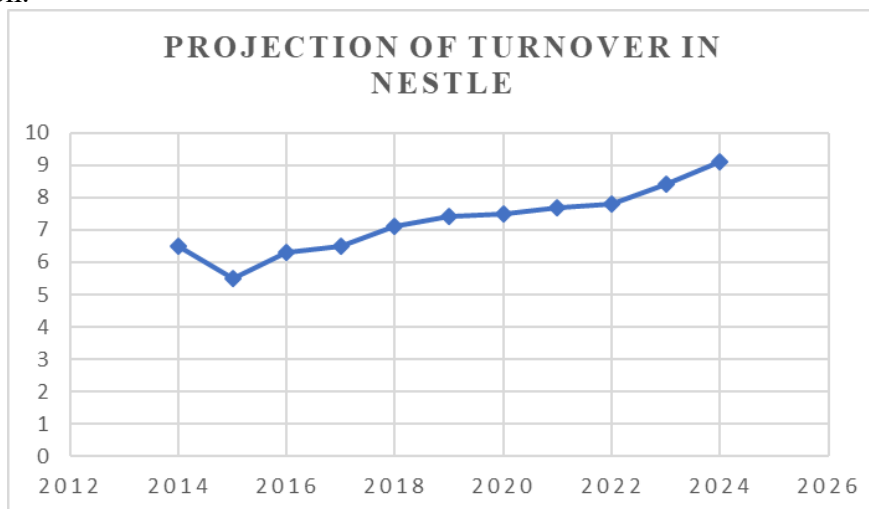
- Nestle's sales have consistently grown over the years, with a compound annual growth rate (CAGR) of 2.5% from 2015 to 2024.
- PepsiCo's sales have also shown a steady growth, with a CAGR of 4.3% from 2014 to 2024.
- In 2024, Nestle's sales reached Rs. 97.8 billion, while PepsiCo's sales reached Rs. 90.5 billion.

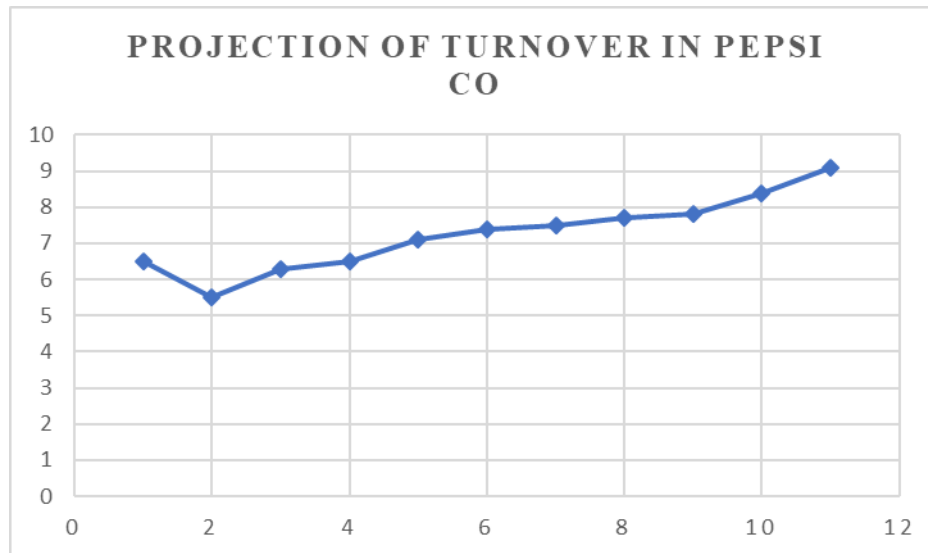




Profit Analysis

- Nestle's profit has fluctuated over the years, with a CAGR of 2.1% from 2014 to 2024.
- PepsiCo's profit has shown a steady growth, with a CAGR of 5.5% from 2014 to 2024.
- In 2024, Nestle's profit reached Rs. 16.9 billion, while PepsiCo's profit reached Rs. 9.1 billion.





Turnover Analysis

- Nestle's turnover has consistently grown over the years, with a CAGR of 2.5% from 2014 to 2024.
- PepsiCo's turnover has also shown a steady growth, with a CAGR of 4.3% from 2014 to 2024.
- In 2024, Nestle's turnover reached Rs. 98 billion, while PepsiCo's turnover reached Rs. 91 billion.

11.MAJOR FINDINGS

- Respondents have a moderate level of trust in the implementation of Blockchain Technology in Nestlé and PepsiCo products.
- There is a positive correlation between trust in Blockchain Technology and perceived transparency in the supply chain.
- There is a significant association between demographic variables such as parental income and consumer behavior.
- Respondents have a moderate frequency of purchasing products from Nestlé or PepsiCo.
- There is no significant difference in responses based on age and gender.
- There is a significant difference in responses based on parental income.
- There is a positive correlation between trust in Blockchain Technology and frequency of purchasing products from Nestlé or PepsiCo.

12.SUGGESTIONS

- Implement Blockchain Technology to increase transparency and trust in the supply chain.
- Educate consumers about the benefits of Blockchain Technology in improving product safety and transparency.
- Increase transparency in the supply chain to increase consumer trust.
- Target consumers based on parental income, as there is a significant difference in responses based on this variable.

- Prioritize marketing strategies based on the frequency of purchasing products from Nestlé or PepsiCo.

13. RECOMMENDATIONS

- Short-term recommendation: Implement Blockchain Technology in the supply chain to increase transparency and trust.
- Long-term recommendation: Conduct further research to explore the relationship between demographic variables and consumer behavior.
- Strategic recommendation: Prioritize transparency and trust-building initiatives to increase consumer confidence in products.
- Marketing recommendation: Target consumers based on their purchasing frequency and parental income to increase the effectiveness of marketing strategies.
- Operational recommendation: Increase transparency in the supply chain by implementing Blockchain Technology and educating consumers about its benefits.

14. AREAS FOR FURTHER STUDY

- "Blockchain-based Supply Chain Management in FMCG-A Study on Transparency, Traceability, and Efficiency"
- "The Impact of Blockchain Technology on Inventory Management in FMCG Supply Chains"
- "Smart Contracts in FMCG Supply Chains: A Study on Automation, Efficiency, and Cost Savings"

15. CONCLUSION

Blockchain Technology is reshaping manufacturing and supply chains, providing businesses with opportunities to enhance transparency, traceability, and operational efficiency. Nestlé's integration of Blockchain has enabled it to drive growth by building trust, enhancing sustainability, and improving cost efficiency. In contrast, PepsiCo's reliance on traditional supply chain methods may limit its growth potential as consumer expectations evolve. As Blockchain continues to gain traction, companies that embrace this Technology, like Nestlé, may maintain a competitive advantage, while non-adopters like PepsiCo may need to reassess their strategies to meet future market demands. Blockchain Technology has profound implications for manufacturing and supply chain management providing unprecedented levels of efficiency, security and transparency. As adoption increase, the companies can expect significant cost savings, improves product quality and enhanced consumer satisfaction.

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