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Assessment of Ai Based Digital Tools for Automated Operation of Supply Chain System for Fmcg Sector

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Abstract- This study explores the effect of AI-powered technologies on productivity, cost reduction, and decision-making within the "Supply Chain Management (SCM)" of "Fast-Moving Consumer Goods (FMCG)". It aims to explore the ways in which AI enhances operational performance and sustainability. Academic research identifies inadequate infrastructure, particularly in underprivileged regions, high implementation costs, and data privacy concerns as significant challenges. This study reached conclusions by utilizing both primary and secondary data through a combination of research methods. AI solutions enhance logistics, inventory management, and resource allocation, minimizing waste and errors while boosting cost efficiency. The use of AI in predictive analytics and real-time decision-making enhances strategic planning and improves supply chain agility. The advantages of AI surpass its disadvantages, including integration with legacy systems and significant upfront expenses. The results show that AI enhances the resilience and sustainability of FMCG supply chains. There is a need for research on data security, implementation methods, and scalability to fully realize its potential. AI has the ability to revolutionize supply chains entirely, making it crucial for organizations to stay competitive in the ever-evolving global market.

Index Terms- AI-based tools, supply chain efficiency, FMCG sector, cost reduction, decision-making.

I. INTRODUCTION

Sustainability issues related to food & (FMCG) screw threads are increasingly being addressed by technological progress and innovations. Through a combination of means, specifically resource shortages, pollution, unproductive transport and production are all associated with the hazardousness of the food and FMCG supply chains. Since they are massive polluters, have turnover rate and a wide network their regulation is affected by these such issues (Nair et al., 2022). Several possible technical approaches for the infusion of blockchain, AI, and "Internet of Things" solutions may improve sustainability in different spheres. The increased visibility and traceability of blockchain technology will allow more transparent and responsible supply chain management and will bring about greener procurement. Meanwhile, the ultra-reliable data-analytics and the real-time monitoring features through IoT devices can drastically improve the resource utilization and the environmental impacts in return.
Sustainability and manufacturing are designed to create goods, processes, and services that give sustainability, social equity, and the economic viability which are the main aims. It places the primary focus on reducing the adverse environmental impacts, enhancing efficiency in resource use, and developing sustainable solutions that are beneficial both to humans and the planet in the long term. Innovation in the field of technology plays a massive role in the sustainability of food and FMCG supply chains, contributing to society, the economy, and the ecosystem. The supply chain is gradually becoming a sustainable one by the use of cutting-edge technologies including blockchain, AI, IoT, big data analytics, automation, robots, and renewable energy solutions (Abdulla, 2022).

As can be seen in the case of Walmart, the successful integration of the blockchain technology can be considered as a notable instance in efforts to amplify the transparency and traceability in the food supply chains. Walmart and IBM) started the implementation of a blockchain-based system to trace the origin of the leafy greens supply chain (Wang et al., 2022). Through the application of this technology, consumers will be able to track and trace products in real time from the farms to the stores. This addition advances the food safety issue and simplifies recalls if necessary. Along with improving traceability, this application has also minimized food waste and improved supply chain efficiency by decreasing product tracing times (Afza, 2023).

Technological Innovations in Supply Chain Management (SCM)

The management of supply chains is influenced by technologies such as AI, blockchain, IoT, and automation into the integration tool. The introduction of these emerging technologies for the purpose of optimizing inventory tracking, improving logistics, and demand forecasting, enhancing efficiency and transparency of supply chain processes, as well as increasing supplier collaboration, is a trend. Technologies such as cloud computing, IoT, AI, and robotics are driving the digital shift of the SCM function, which is the backbone of supply chains. Technologies like cloud computing, the Internet of Things, artificial intelligence, and robotics are the driving force behind digitization in the SCM function. Instead, it is a simple way of this entire process (Khayer et al. 2022). Embedded systems, effectors, sensors, and the internet are

such devices fastened by IoT architecture that allowed mechanized agricultural processes. The combination of a blockchain and IoT allows systems to become tamper-proof and highly secure, this, in turn, protects businesses and corporations from data breaches. The Internet of Things makes supply chain management efficient and optimized through interconnected devices that transmit data in real-time and collect data to support decision-making and monitoring (Kamakela, et al., 2023).

Alterations in SCM are happening thanks to new innovations and trends in these technologies. AI-based applications are becoming more and more efficient with machine learning algorithms aiding in demand forecasting and inventory management (Rafi, 2023). To reduce waste and overproduction, AI will be able to check the back data and predict how people will buy in the future. Smart contract is a new thing about block chain technologies that automates the process of committing to contracts and enforces them without having a third party in between, thus, verificating and eliminating errors. Another great IoT advantage is the superb sensor technology which regulates the supply chain and checks the temperature and the humidity in almost all cases (Zhao et al., 2023).

Technology advancement and its impact on FMCG Sector

The FMCG segment is one of the industries that highly benefit from the technological advancements, which morphed production methods, marketing strategies, and customer relations. Through automation, AI, and big data analytics, both production processes and decision-making mechanisms have been greatly advanced. AI algorithms are now being used to forecast demand, optimize the supply chain, and manage inventory for the attainment of the lowest waste and highest product availability. The ability to adapt quickly to the market changes provides the FMCG companies with a competitive edge in today's ever-changing business landscape (Sadeghi et al. 2023).

According to the use of more sophisticated robots for automation has resulted in increased production, greater product uniformity, and a reduction in human error. Automated logistics and warehouse systems lead to lesser expenses and quicker delivery. These developments have given companies an advantage in scaling their operations and managing them efficiently and, thus, have led to an increase in revenue. The digital transformation and its implications for FMCG firms are striking as it has substantially modified the interaction between companies and customers (Reza, 2020).
Consequently, companies' continuous development largely relies on tons of customer-related data that highlights their preferences and purchasing behavior. This in-depth knowledge allows enterprises to concentrate on distinct segments of their target markets when designing the right mix of products and suitable promotional strategies. Enterprises can respond quickly to changes in the market and the customer preferences by making use of real-time data analytics. Supply chains can be even more durable due to blockchain technologies which enable retailers to monitor the entire supply chain and assurance of the source of the product, thus, consumers can have more trust. In this era of the digital revolution, smart packaging and eco-friendly product have been on the rise with FMCG companies prioritizing the green issues in the packaging sector (George, & George, 2023).

To fully automate FMCG supply chain operations, more research into digital tools based on AI is required. Few studies have investigated how these technologies improve operational efficiency, decision-making, and scalability in the complex FMCG supply chains that are unique to these industries. Most of the existing research focuses on more generalized applications (Tripathi, 2020).

The study is divided into 6 sub-sections. The Section 1, present the overview of the title and explain why AI-based solutions are important for FMCG supply chains. In Section 2, survey the relevant literature, drawing on it to identify existing research and generate ideas on how AI may improve decision-making, cut costs, and streamline the supply chain. The model, variables, and techniques for collecting data are detailed in Section 3, which also addresses the study approach. The data analysis findings in Section 4. The findings and an analysis of the effects of AI technologies are presented in Section 5. Lastly, a list of references is followed by Section 6, which finishes with concerns, constraints, and suggestions for additional study.

II. LITERATURE REVIEW

Igwe, A. N., et al., (2024) stated how technological advancements can improve the sustainability of supply chains for food and FMCG. The study points to the importance of blockchain, AI, and IoT in enhancing traceability, streamlining supply chain operations, and decreasing waste, all of which contribute to sustainability.

Hirsch, K., et al., (2024) enumerated the FMCG business can strengthen its supply chain resilience through the use of AI and information technologies, within the context of the present disruptions such as the COVID-19 pandemic. The results show that FMCG supply chains are more susceptible to interruptions caused by demand volatility and unpredictable commodity markets.

Olutimehin, D. O., et al., (2024) enumerated the study of FMCG operations management, the methods that proved to integrate management of different tasks, crew scheduling, and logistic which is very influential in enhancement of professionalism and aim at the utmost performance, are

developed. The possibilities of process improvement were included, as well as techniques for conflict management and the dynamics of cross-functional teams that resulted in amazing customer experience and higher sales of products, were issues in this case that were focused on.

Shakur, M. S., et al., (2024) observed the "Poorly structured value chain," "incompatible technological infrastructure," and the "requirement for substantial investment and resources" ranked high among the FMCG industry's most formidable implementation hurdles. Study like these helped make the FMCG supply chain more robust, environmentally friendly, transparent, trackable, and responsive.

Sreekanthaswamy, N., & Hubballi, R. B. (2024) observed the FMCG industry stands to benefit greatly from the integration of AI and blockchain technology, which could potentially lead to revolutionize customer journey mapping by shedding light on consumer behavior, decision-making, and targeted marketing. The study aimed to learn how these techs could solve persistent problems like data protection and customer trust.

Nozari, H., et al., (2022) examined to identify the most significant obstacles that the AIoT-powered supply chain faced by gathering information from FMCG industry experts through interviews. The two significant issues that confronted the supply chain relying on the AIoT were identified as cybersecurity and an inadequate infrastructure.
Najafi, S. E., et al., (2022) examined the industrial companies, particularly in the FMCG industry, relied heavily on their supply chains, and this study laid out a plan for implementing this technology into those chains. The many messages conveyed by those developing technologies along the supply chain had a defined course thanks to that framework.
Kumar, C. P. (2022) observed the FMCG industry may enhance decision-making and streamline corporate operations through the combination of automation, AI, and IoT. The study focuses on how companies are revamping their organizational structures to improve decision-making and forecast market trends in the wake of Industrial Revolution 4.0.

A relatively new area of focus in the field of FMCG SC operations has been the incorporation of digital solutions based on AI. There is a significant lack of studies that evaluate these AI technologies for automated SC operations in the FMCG sector. The use of AI in SCM in general has been the subject of much theoretical discussion, but empirical study on the effects of AI on FMCG efficiency in operations, decreased in costs, and precision in decision- making is few. Furthermore, there is a lack of context-specific insights since most study either look at AI's function in general supply chain operations or concentrate on sectors other than FMCG. In addition, there is a lack of study on the scalability, integration difficulties, and practical implementation of AI solutions in the complicated FMCG SC. This is a great chance to study the pros and cons of various tools in practical settings.

III. RESEARCH METHODOLOGY

A mixed-methodologies strategy, including “qualitative and quantitative methods”, was used to thoroughly evaluate digital technologies based on AI in FMCG supply chains. Research participants included supply chain experts, managers, and executives from FMCG companies based in the Delhi NCR area. The sample size was 150 participants, selected via stratified random sampling to guarantee varied representation. A descriptive and exploratory research design was used to examine the status of AI technologies and how they affected supply chain operations. Data was collected by the use of a standard questionnaire consisting of important subject areas like decision-making practices, the efficiency of the supply chain, AI-based solutions, and cost-reduction. Both primary and secondary data from surveys and previous publications and studies, were used to make the research. They also used SPSS and MS Excel tools to analyze the data. They utilized various statistical tools such as regression, standard deviation, and mean to find trends and find the relationships between the variables.

- **Research question**
  How do AI-based tools influence supply chain efficiency in the FMCG sector?
  What is the impact of AI-based tools on cost reduction in the FMCG supply chain?
  iHow do AI-based tools enhance decision-making processes in the FMCG sector?

- **Objectives**
  To examine the impact of AI-based tools on supply chain efficiency in the FMCG sector.
  To examine the impact of AI-based tools on cost reduction in the FMCG sector.
  To examine the impact of AI-based tools on decision-making processes in the FMCG sector.

- **Hypothesis**
- **H1:** AI-based tools have a significant impact on supply chain efficiency in the FMCG sector.
- **H2:** AI-based tools have a significant impact on cost reduction in the FMCG sector.
- **H3:** AI-based tools have a significant impact on decision-making processes in the FMCG sector.

IV. RESULTS

- **Objective 1:** To examine the impact of AI-based tools on SC efficiency in the FMCG sector.

- **H1:** AI-based tools have a significant impact on SC efficiency in the FMCG sector.

Table 1: Regression Analysis

Hypothesis	Regression Weights	Beta Coefficient	R2	F	t-value	p-value	Hypothesis Result
H1	AI-based Tools > Supply Chain Efficiency	.321	0.103	17.012	4.125	0.000	Supported

Regression analysis for Hypothesis H1 showed that FMCG supply chain efficiency was positively and significantly correlated with AI-based tools. Tools based on artificial intelligence had a moderately good effect on supply chain efficiency, as demonstrated by the beta coefficient of 0.321. With a R^2 value of 0.103, AI-based technologies could explain 10.3% of the supply chain volatility. Results showing a "t-value of 4.125 for a p-value of 0.000 and an F-value of 17.012" lend credence to the hypothesis concerning AI-based tools for supply chain management efficiency.

Objective 2: To examine the impact of AI-based tools on cost reduction in the FMCG sector.

H2: AI-based tools have a significant impact on cost reduction in the FMCG sector.

Table 2: Regression Analysis

Hypothesis	Regression Weights	Beta Coefficient	R2	F	t-value	p-value	Hypothesis Result
H2	AI-based Tools > Cost Reduction	.326	0.106	17.573	4.192	0.000	Supported

The findings from the regression investigations reveals a robust positive correlation between AI-based technologies and cost reduction in the FMCG sector, supporting Hypothesis H2. Tools based on artificial intelligence have a moderately positively impacting cost reduction, as shown by the "beta coefficient of 0.326. With a R^2 value of 0.106", may deduce that AI-powered solutions account for 10.6% of the variation in savings. Both the F-statistic and the t-value are 17.573 and 4.192, respectively. The results are statistically valid because it comes out to be 0.000. Thus, the idea is backed by the fact that AI-based tools help cut costs in the FMCG supply chain significantly.

Objective 3: To examine the impact of AI-based tools on decision-making processes in the FMCG sector.

H3: AI-based tools have a significant impact on decision-making processes in the FMCG sector.

Table 3: Regression Analysis

Hypothesis	Regression Weights	Beta Coefficient	R2	F	t-value	p-value	Hypothesis Result
H3	AI-based Tools > Decision-making Processes	.321	0.103	17.012	4.125	0.000	Supported

There is a favorable link between AI- powered resources and methods for determining decisions in the FMCG sector, according to the regression analysis for Hypothesis H3. There is a moderately good effect of AI- powered resources and methods for determining, as shown by the beta coefficient of 0.321. Tools based on artificial intelligence can account for 10.3% of the variation in decision-making processes, according to a R^2 value of 0.103. Statistically, the results are robust because the "F-statistic is 17.012 with a t-value of 4.125 and a p-value of 0.000". The theory is correct, as AI-powered solutions greatly enhance the FMCG supply chain's decision-making process.

V. FINDINGS & DISCUSSION

The assessment of AI-based digital tools for automating operations in FMCG supply chain systems highlights substantial enhancement to the decision-making, cost-cutting, and efficiency processes. Regression analysis supports the hypothesis (H1) that AI tools positively impact SC efficiency, with a beta coefficient of 0.321 and a statistically significant p-value of 0.000. While the "R^2 value of 0.103 suggests that AI accounts for 10.3%" of the variation in efficiency, the strong F-value of 17.012 reinforces the reliability of this

relationship. Similarly, Hypothesis H2, examining AI's impact on cost reduction, is validated with a beta coefficient of 0.326, an R^2 value of 0.106, and a p-value of 0.000, indicating a 10.6% contribution to cost savings through better resource allocation and minimized errors. Furthermore, Hypothesis H3 demonstrates AI's role in enhancing decision-making processes, supported by a beta coefficient of 0.321 and an R^2 value of 0.103. These findings affirm the pivotal role of AI in improving agility and accuracy in FMCG SC decisions.

VI. CONCLUSION

FMCG supply chains should leverage AI to enhance sustainability, boost operational efficiency, reduce costs, and improve decision-making. AI technologies enhance supply chain efficiency by 10.3% through better inventory management, minimizing human errors, and streamlining logistics. AI lowers expenses through enhanced resource allocation, better demand forecasting, and minimized waste, contributing to 10.6% of variance. Alongside enhancing supply chain performance, AI technologies enable more informed and timely decision-making. Research on scalability is essential to address these challenges, particularly the benefits that surpass the significant deployment costs, data protection issues, and system integration. AI-based solutions in FMCG supply chains need to address implementation challenges to achieve success and ensure long-term efficiency and robustness. AI digital technologies enhance the efficiency, effectiveness, and decision-making within the FMCG supply network.

The research shows that AI-powered digital solutions have significant potential to automate FMCG supply chain operations, resulting in improved efficiency and enhanced decision-making. Nonetheless, challenges such as elevated installation expenses, apprehensions regarding data security, and a lack of qualified personnel impede broad adoption. Future research should concentrate on the interaction between AI and other technologies such as blockchain and the IOT, as well as the impact of this interaction on the long-term sustainability of supply chains. Exploring human factors like worker readiness and creating cost-effective solutions for SMEs could enhance the understanding of AI's potential uses in the FMCG sector.

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