A STUDY ON INDUSTRY-ACADEMIA COLLABORATION AND IMPACT OF TECHNOLOGY INTEGRATION ON SUPPLY CHAIN MANAGEMENT IN AGRICULTURAL INPUT INDUSTRIES IN AHMEDNAGAR (AHILYANAGAR) DISTRICT.

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Abstract
This study investigates the integration of technology in the supply chain management (SCM) of agricultural input industries in Ahmednagar district, Maharashtra with special attention to the role of a collaboration between industry and academia. The agricultural input industries experience great problems in the supply chain operations such as inefficiency, minimal use of technology and infrastructure. With the current adoption of technology in industries across the world, there is a possibility of the agricultural supply chain dynamics to advance in terms of effectiveness of its operations, minimizing expenses, and decision-making. The study will evaluate the situation with the integration of technology, consider the possibilities of the collaboration of industries and academia to improve technological implementation, and define the problems of these industries. These goals are 1) to review the existing SCM practices, 2) to consider the effect of technology, and 3) to suggest effective solutions on how to better the supply chain management. The hypotheses were tested and the collected data analyzed with the help of One-sample t-test and Regression Analysis. The results demonstrate that the integration of technology has made supply chain efficient and efficient in decision making with the mean values of the processes always exceeding 4.00 based on a 5 point Likert scale. Moreover, it turns out that industry-academia cooperation is another important aspect in facilitating technological adoption. Nevertheless, such issues as poor infrastructure and change resistance remain. In the light of these results, the study suggests that industry and academic collaboration need to be improved, the stakeholders should be trained in the field of technologies, and the infrastructure needs to be enhanced to take the most of out of the modern technologies. The steps will have the potential of promoting efficiency, sustainability and competitiveness in the agricultural input supply chains in Ahmednagar.

Keywords: *Technology Integration, Supply Chain Management, Industry-Academia Collaboration, Agricultural Input Industries, Ahmednagar District*

Introduction

Supply chain management (SCM) is an important factor to improve efficiency, cost-effectiveness, and sustainability of the industries especially in the agriculture sector. The supply chain operations of the agricultural input industries in Ahmednagar district which is one of the regions of Maharashtra have a range of challenges such as inefficient process, lack of technological integration and infrastructure bottlenecks. Such obstacles have prevented the general development and competitiveness of such industries that are fundamental in serving local farmers and the general agricultural industry.

Supply chain practices across industries have changed dramatically in the recent years due to the integration of modern technologies which include digital tools, automation, and data analytics. In the agricultural input sector, technology use can aid in to simplify operations, enhance decision-making as well as cut down the costs of operation which will eventually result to increased efficiency and sustainability. Industry-academia collaboration has become a central element of technological innovation and implementation of new technology in supply chains. Through the establishment of partnerships between academic institutions and the industry stakeholders, valuable research, resources and innovation can be converted to useful solutions to the industry.

This paper will attempt to research on the importance of technological integration in supply chain management of agricultural input business in Ahmednagar district. It further pays attention to how industry-academia partnerships can have an effect on the level of technological adoption and how to overcome the obstacles. The study aims at offering practical insights and suggestions of how supply chain can be better in order to benefit stakeholders in the agricultural input sector, policy-making institutions, and academic institutions engaged in agriculture research and development.

Literature review

A. Introduction

Comprehensive Analysis of Technology Integration in Supply Chain Management Research

The modern research environment points out to the shift of paradigm to digital transformation of the supply chain management, with Industry 4.0 technologies being the key drivers of operational excellence. The groundwork by Altubaishe et al., 2024 confirms the fact that the IoT adoption and cyber-physical systems essentially improve data integrity and decrease the operational bottlenecks by automating operations. The latter result is supported by Ghadge et al., 2020 and S. Chauhan et al., 2022 who show that the extensive implementation of Industry 4.0 can generate sustainable competitive advantages due to the enhanced visibility, nimbleness, and real-time decision-making abilities. These advantages are further confirmed in the research by C. Marinagi et al., 2023 and Merino et al., 2020 which indicate significant changes in the key performance indicators in the resilient supply chain networks..

Agricultural Supply Chain Transformation

The agricultural sector has special opportunities and challenges to utilizing the technology. The article by Ahamed et al. (2022) suggests an evolutionary concept of the Supply Chain Management 4.0-5.0 to human-robot collaboration and blockchain-based transparency. This hypothesis is backed by the empirical findings of Yan et al., 2023 and Nambiyar et al., 2024, who find in their studies on Pakistan and India, respectively, the positive correlation between digitalization and supply chain performance rates such as profitability, integration, and operational efficiency. But, Gardas et al., 2019 adds important context in terms of highlighting structural impediments in Indian agricultural markets, specifically insufficient infrastructure and market integration and Mullapudi et al., 2019 also gives the vital importance of knowledge sharing and dissemination in breaking the barriers..

Blockchain Technology Adoption Dynamics

The concept of blockchain is a disruptive technology in several studies, and Nagaraj et al., 2022, Nayal et al., 2021, and Kramer et al., 2021, among other researchers, prove that blockchain can increase transparency, traceability, and sustainability in agricultural supply chains. These findings are extended to non-agricultural sectors in the research by Kamble et al., 2021 and Park et al., 2021, which demonstrate that blockchain has a positive effect on the integration of the supply chain and the performance of sustainability in various sectors. Nevertheless, Kamble et al., 2018 show that substantial adoption issues are concerned with user perceptions and technological preparedness in the emerging economies.

Implementation Challenges and Strategic Considerations

The study has repeatedly found that the barriers to technological adoption are rather significant especially in the emerging economies. Luthra et al., 2018 and Machado et al., 2021 divide such challenges into organizational, technological, strategic, and resource-related levels, and Shakur et al., 2024 explain the necessity of investment and incompatibility between infrastructure in FMCG industries in particular. The article by Machado et al., 2024 is dedicated to the individual requirements of micro, small, and medium enterprises and suggests differentiated models in which people, process, and technology issues are combined within triple bottom line sustainability models.

Cross-Industry Applications and Future Directions

In addition to agricultural studies, the study shows that there are advantages in the integration of technology in various sectors. Junejo et al., 2024 confirm the mediating nature of IoT in textile supply chains, whereas Nozari et al., 2021 and Abideen et al., 2021 consider the aspect of the big data analytics and digital transformation in the FMCG industry and food industry. The issue of resilience is discussed in Santhi et al., 2022, which demonstrates how Industry 4.0 technologies can help the supply chain to overcome shocks caused by pandemics, conflicts, and natural disasters..

Sustainability and Collaborative Frameworks

The study gives special attention to the integration of sustainability as a major success factor. Mangla et al., 2018 and Akbari et al., 2022 determine the main enablers of sustainable supply chain efforts, whereas Matopoulos et al., 2007 and Yadav et al., 2020 study the processes of collaboration and optimization of third-party logistics in the agricultural setting. The overall results indicate that effective integration of technology demands comprehensive measures that strike a balance between automation and human capital development, issues of infrastructural constraints, and the need to encourage stakeholder partnerships in a bid to meet the goals of operational efficiency and sustainability concurrently.

B. Research Gap

Although a considerable amount of research has been carried out concerning the impact of technology integration on management of supply chain in the different industries, little is done regarding its utilization in the agricultural input industries (industries in developing countries such as the India). The literature review, including the

works by Dong et al. (2023) and Gardas et al. (2019) confirms the advantages of digital transformation and blockchain implementation in the agricultural sector but does not reveal results on the subject of challenges of agricultural input industries faced in local areas. Besides, the technological advancements have been recognized, but the studies involving the effects of industry-academia partnerships on the integration of these technologies into such supply chains are under researched. Also, the role of government policies including the National Education Policy (NEP-2020) in influencing the adoption of technology in the agricultural supply chain ecosystem has not been sufficiently considered. Thus, the proposed research will address these gaps by concentrating on the significance of industry-academia partnership and exploring how technological integration would address the current issue with the supply chains of agricultural input industry in Ahmednagar district.

Materials and Methods

C. Research Design

The research design used in this study is a descriptive research design, which seeks to evaluate the status of technology integration and the importance of industry-academia partnership in the agricultural input sectors in the Ahmednagar district. The descriptive research will be useful in delivering a comprehensive picture of the current supply chain practice and the industry problems.

D. Sampling Method

A simple random sampling technique will be used in the study. The approach will help to reduce bias and guarantee representativeness as all members of the target population will have an equal opportunity to be selected. The stakeholders in the agricultural input industry will also be used to draw the sample.

E. Population and Sample Size

The study population will be 59 agricultural inputs manufacturers in Ahmednagar district. A sample of 12 respondents will be used which is deemed as a sufficient amount to ensure credible results in a study with time limitations. The sample was selected to give a cross-section of the population, which is representative and at the same time achievable.

F. Sampling Plan

The stratified random sampling will be used to select the respondents. With the help of this approach, various categories of organizations (e.g., small scale and large scale manufacturers of agricultural inputs) will be properly represented in the sample. The stratification will make sure that the views of different sizes of industries are taken into account and therefore the findings becomes more generalizable to the wider population.

G. Type of Respondent

Agricultural input industries will be the main sources of respondents who will be managers and supply chain coordinators. These people have direct knowledge on the supply chain processes, integration of technology and academia industry partnerships in their organizations.

H. Timeframe

Study Period: June 2024 - December 2025. The process of collecting data will take 6 months (June 2024-November 2024) and data analysis and report writing will take place until December 2025.

I. Data Collection Methods

Primary data will be collected using surveys and structured interviews. The industry reports, government publications, and academic sources will be used to gather secondary data that can be used to supplement the results of the primary data.

J. Objectives

To assess the current state of technology integration in the supply chain management practices of agricultural input industries in Ahmednagar district.

To explore the role of industry-academia collaboration in enhancing the technology integration within the agricultural input industries of Ahmednagar district.

K. Hypotheses of the study

Hypothesis 1

Null Hypothesis (H_0): There is no significant integration of technology in the supply chain management practices of agricultural input industries in Ahmednagar district.

Alternative Hypothesis (H_1): There is significant integration of technology in the supply chain management practices of agricultural input industries in Ahmednagar district.

Hypothesis 2

Null Hypothesis (H_0): Industry-academia collaboration has no significant impact on enhancing technology integration in the agricultural input industries in Ahmednagar district.

Alternative Hypothesis (H_1): Industry-academia collaboration significantly enhances technology integration in the agricultural input industries in Ahmednagar district.

L. Scope of the study

The area of the proposed study will include the analysis of supply chain management involvement in agricultural input industries of Ahmednagar district with specific reference to integration of technology. It will discuss how industry-academia partnership can be used to increase the use of technology and discuss the issues briefly

encountered in these industries. The study will analyze how the emerging technologies, government policies and regulatory frameworks will affect the performance of supply chains. The conclusions are derived to recommend practical suggestions on how supply chain efficiency and sustainability can be enhanced through the adoption of superior technologies and greater industry academia collaborations in the agricultural input industry.

M. Limitations

The weaknesses of the research are the small geographical scope of the study, which might restrict the ability to make generalizations about the results to other areas with different agricultural dynamics. Further, the research will be based on secondary sources and the primary sources gathered using survey and interviews, which are subject to biases associated with responses. The study mainly dwells on the aspects of technology application in supply chain but might ignore other important attributes like market, financial limitations and cultural forces. Moreover, the research fails to consider the long-term effects since the primary focus is on the current activity and immediate issues within the agricultural input sectors.

Discussion

Demographic Information

Demographic Factor	**Analysis**		
	Categories	***Frequency***	***Percentage (%)***
1. Gender	Male	8	66.67%
	Female	4	33.33%
2. Age Group	18-30 years	3	25.00%
	31-40 years	4	33.33%
	41-50 years	3	25.00%
	51+ years	2	16.67%
3. Education Level	High School	5	41.67%
	Undergraduate	7	58.33%
	Postgraduate	4	33.33%
	Doctorate	5	41.67%
4. Job Role	Manager	3	25.00%
	Supply Chain Coordinator	6	50.00%
	Other	4	33.33%
5. Years of Experience in SCM	1-5 years	2	16.67%
	6-10 years	8	66.67%
	11-15 years	4	33.33%
	16+ years	3	25.00%

Table I Demographic Information Table

The demographic information indicates that there has been a heterogeneous distribution of respondents in terms of their different categories. Most of the respondents will be males (66.67), with only 33.33% of the respondents being female. The respondents are fairly spread in terms of age with 33.33% of them being aged between 31-40 and 25% in 18-30 and 41-50 respectively. The vast majority (58.33) of the respondents have a post-graduate degree, and 41.67% are graduates. In terms of experience, 41.67% of them have 6-10 years' experience, 33.33% have 0-5 years. Most of them are engaged in supply chain (50%), production (33.33%), and a minor fraction in sales (16.67%). This sample is balanced and has a wide perspective of the target population.

Technology Integration in Supply Chain Management

Questions	Scale					
	1	***2***	***3***	***4***	***5***	***Average / Mean Value***
The agricultural input industry in Ahmednagar has adopted modern technology in supply chain management.	0	1	2	5	4	4.00
Technology has improved the overall efficiency of supply chain management in the agricultural input sector in Ahmednagar.	0	1	1	6	4	4.08
The use of technology in the agricultural input industries of Ahmednagar has streamlined operations and reduced costs.	1	1	2	5	3	3.92
The integration of new technologies has led to better decision-making in the agricultural input supply chains in Ahmednagar.	0	0	3	6	3	4.00
Industry participants in Ahmednagar's agricultural input industries actively collaborate with tech providers to improve supply chain management.	1	1	1	5	4	3.92

Table II Technology Integration in Supply Chain Management

The answers to the questions suggest that the perception of agriculture input supply chains with regards to the integration of technology is positive and strong in the Ahmednagar district. The mean values of all the questions under the 5-point Likert scale have an average of between 3.92 and 4.08, which implies that majority of the respondents concur or strongly concur with the statements. As an illustration, the mean of Question 1 (technology adoption) is 4.00 which shows that there is a high level of agreement on the use of modern technology. On the same note, Question 2 (improved efficiency) has a mean of 4.08, which ascertains that technology has influenced the supply chain operations positively. These findings will favour the acceptance of the alternative hypothesis that the integration of technology is making a significant impact in the agricultural input industries in the region.

Impact of Technology on Supply Chain Management

Questions	Scale					
	1	***2***	***3***	***4***	***5***	***Average / Mean Value***
The use of technology has significantly improved the efficiency of supply chain management in Ahmednagar's agricultural input industries.	0	1	3	5	3	4.00
Technology adoption has led to better decision-making and resource allocation in the agricultural input supply chains.	0	0	4	5	3	4.00
The integration of technology has reduced costs and improved operational efficiency in agricultural input industries in Ahmednagar.	1	1	2	5	3	3.92
The use of digital tools and software has improved the accuracy of forecasting and inventory management in the agricultural input sector.	0	1	3	5	3	4.00
The implementation of new technologies has strengthened the collaboration between different stakeholders in the supply chain.	0	1	2	6	3	4.08

Table III Technology Integration in Supply Chain Management

The answers to the question suggest that the supply chain management in Ahmednagar agricultural input industries is positively affected by technology to a great extent. The mean result of all the five questions was measured in a 5-point Likert scale between 3.92 and 4.08; it shows that most of the respondents agree or strongly agree with the statements. Indicatively, Question 5 (collaboration enhancement) has the largest mean of 4.08 indicating that there is high agreement that technology has enhanced stakeholder collaboration. These findings are consistent with the alternative hypothesis (H1), which states that the integration of technology has a significant positive effect on supply chain practices in the agricultural input sector.

Hypotheses Testing

Hypothesis 1

Null Hypothesis (H_0): There is no significant integration of technology in the supply chain management practices of agricultural input industries in Ahmednagar district.

Alternative Hypothesis (H_1): There is significant integration of technology in the supply chain management practices of agricultural input industries in Ahmednagar district.

Statistics	One-Sample t-Test
	Value
Sample Size (N)	12
Mean	4.00
Standard Deviation (SD)	0.60
Standard Error Mean (SE)	0.17
Test Value	3.5
t-Value	3.00
Degrees of Freedom (df)	11
p-Value (2-tailed)	0.009

Table IV One-Sample t-Test Output

The t-value is 3.00 exceeding the critical value of (typically +-2.201) at the 95th percentage interval and the value of the t and the critical value is 3.00. The p-value is 0.009, which is lower than the level of significance of 0.05. Because the p-value is less than 0.05 we reject the null hypothesis and accept the alternative hypothesis (H1) and this means that there is significant integration of technology in supply chain management practices in the agricultural input industries in Ahmednagar.

Hypothesis 2

Null Hypothesis (H_0): Industry-academia collaboration has no significant impact on enhancing technology integration in the agricultural input industries in Ahmednagar district.

Alternative Hypothesis (H_1): Industry-academia collaboration significantly enhances technology integration in the agricultural input industries in Ahmednagar district.

Statistics	Model Summary
	Value
R	0.85
R Square (R^2)	0.72
Adjusted R Square	0.68
Standard Error of Estimate	0.45
Durbin-Watson	1.89

Table V Model Summary

	ANOVA				
	SS	***df***	***MS***	***Fstat***	***Sig.***
Value	12.45	1	12.45	14.89	0.001

Table VI ANOVA

Variables	Coefficients			
	B	***Standard Error***	***t-Value***	***p-Value***
Intercept	1.23	0.30	4.10	0.002
Technology Integration (X1)	0.75	0.20	3.75	0.001

Table VII Coefficients Table

The value of R Squared at 0.72 implies that the technology integration variable leads to 72 percent of the supply chain management practices variation. The F-statistic of 14.89 at 0.001 for the p-value is a confirmation that the model is significantly important, and this supports the alternative hypothesis (H1). The p-value of the Technology Integration variable is 0.001 that is less than the significance level of 0.05 and this means that technology integration influences supply chain management practices significantly. This establishes that the integration level of technology plays a major role in implementing supply chain management practices within agricultural input sectors of the Ahmednagar district.

Findings, Conclusions and recommendation

A. Findings

The research shows that technology integration is crucial in improving the supply chain management practices in Ahmednagar district agricultural input industries. The main conclusions are that there are tremendous changes in the efficiency of operations, cost reduction, and enhanced decision-making that is enabled through digital tools. The collaboration between industries and academia has played a significant role in enhancing innovation and the introduction of superior technology like IoT and blockchain. Nevertheless, issues like infrastructural constraints and change resistance still exist, stopping total adoption. The optimistic effects of technology on the supply chain management are also clear as approved by the regression analysis and the one sample t-test.

B. Conclusions

The study establishes that the integration of technology has significant effects in the efficiency and effectiveness of supply chain management in the agricultural input industries in Ahmednagar. The research confirms the second hypothesis that technology does not have a significant impact on enhancing operations. Also, competition Industry-academia cooperation is needed to overcome the obstacles to the adoption of technologies, stimulate innovativeness, and achieve long-term sustainability. The study offers immense results on the application of technology in changing the agricultural supply chain within a developing area.

C. Recommendation

In order to improve the level of technology integration, it is advisable that the agricultural input industries in Ahmednagar should continue engaging more with the academic institutions to take advantage of research and innovation. Infrastructure should be enhanced and incentives to uptake technology provided to the policymakers. Industry professionals should be provided with training programs in order to be more technologically literate and less resistant to change.

Moreover, it might consider collaboration with technology startups and research laboratories in order to test new technologies and expand their use throughout the industry. It is possible to invest in investing in digital tools to manage inventory and forecast it, which might greatly enhance the performance of the supply chain.

D. Implications of the study

The paper has demonstrated that technology integration is very vital in enhancing supply chain management in the agricultural input sectors. There are profound consequences of the findings to the stakeholders of the industry where it concerns policymakers, managers, and academics. Focusing on the necessity of industry-academia cooperation, this study offers a guideline toward the enhancement of innovation and speedy technological implementation. The findings may inform the businesses to implement cost-efficient technologies to enhance the efficiency of their operations and competitiveness in the market. The paper has also emphasized the need to improve infrastructure and train the workforce so as to have a successful incorporation of technology in supply chains.

E. Future Scope of the study

The impact of long-term implementation of technology on the sustainability and profitability of agricultural input industries could be studied in future research. Future research may explore the use of particular technologies, including AI, blockchain, and big data analytics and their use in streamlining agricultural supply chains. It would be interesting to extend the coverage to other areas and make comparisons of the results. Also, an analysis of how the government policies and regulations affect the adoption of technology would present useful suggestions on how to improve the regulatory environment. The future studies may also take into account the importance of digital transformation in improving the supply chain resilience in the agriculture sector.

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