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Digital Transformation in Agricultural Input Supply Chains: Impact of Technology Adoption on Operational Efficiency in Ahilyanagar (Ahmednagar) District, Maharashtra, India.

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***Abstract*— Digital transformation is playing a growing role in agricultural supply chains because it facilitates access to information, the handling of inventories, procurement planning, and distribution processes. Agricultural input businesses such as seeds, fertilizers and pesticides have a crucial function in guaranteeing timely availability of agricultural resource to farmers. Yet issues like inventory imbalance, lagged deliveries, order processing inefficiency, and lack of information sharing persist in the performance of supply chain. This work focuses on the effect of technology use in the efficiency of operational agricultural input supply chains, specifically in Ahmednagar district in Maharashtra, India.**

This study is quantitative type research that employed a structured questionnaire to agricultural input business owners and managers. A sample of 400 respondents is proposed which includes the businesses in urban, semi-urban and rural areas of the district. Primary data is used for collection by questionnaires and secondary data is used for the research publication, government report and industry sources. The proposed analysis will include descriptive statistics, correlation, multiple regression, and ANOVA which will focus on operational efficiency and technology adoption relationship. Digital inventory management, digital order processing, information sharing, technology integration and data-driven planning are all dimensions of technology adoption in the research framework. The efficiency of operation is reviewed under inventory management, order processing, delivery and cost efficiency.

The study using simulated data suggests that technology use is positively correlated with the operational efficiency. Digital inventory management and information sharing becomes an important dimension linked to the better supply chain operations. The study emphasizes the relevance of low-cost digital technologies, staff education, seamlessly linked information systems and data-driven purchasing planning. It offers practical information for agricultural input dealers, distributors, manufacturers and policymakers to enhance digital capabilities and boost supply chain performance. Prior to collecting the responses from the proposed sample, actual empirical conclusions will need to be validated.

Keywords*— *Digital Transformation, Agricultural Input Supply Chain, Technology Adoption, Operational Efficiency, Inventory Management.

I. INTRODUCTION

Digital transformation has become an important factor of change in the agriculture supply chain, affecting agriculture inputs procurement, storage, marketing, tracking and distribution. The agricultural input industries contribute greatly to agricultural productivity by providing farmers with timely availability of the agricultural inputs such as seeds, pesticides and fertilizers. But these companies often struggle to manage their operations, e.g. imbalance of inventory, stock shortage, delay in delivery, slow order processing, lack of information sharing, etc., and lack coordination among the participants of the supply chain. Digital systems and solutions like enterprise management systems, mobile applications, digital inventory platforms, electronic transactions, data analytics, and the Internet of Things (IoT) can help to enhance visibility, coordination and operational efficiency across the supply chain in an increasingly competitive, technology-driven business environment.

Adoption of digital tools in the agricultural sector is rising in India, but subject to the availability of infrastructure, finance, technological savvy, and managerial skills. The need for digital awareness, training and infrastructure in the agricultural input enterprises are highlighted in various studies (Argade et al. 2018; Jadhav and Ingole 2026). Likewise, Sharma et al. (2020) point out various technological infrastructure and adoption barriers in India's agriculture and allied sectors. The impact of digital technology adoption on operational gains in agricultural input businesses, however, is not widely studied. Agricultural activities, input dealers and distributors network in Ahmednagar district is a relevant geographical context. This study is therefore focused on the impact technology adoption has on operational efficiency, namely inventory management, order processing, information sharing and delivery performance.

A. Theoretical Background of the Study

The theory foundation of the study is based on the Resource-Based View (RBV) theory and Technology-

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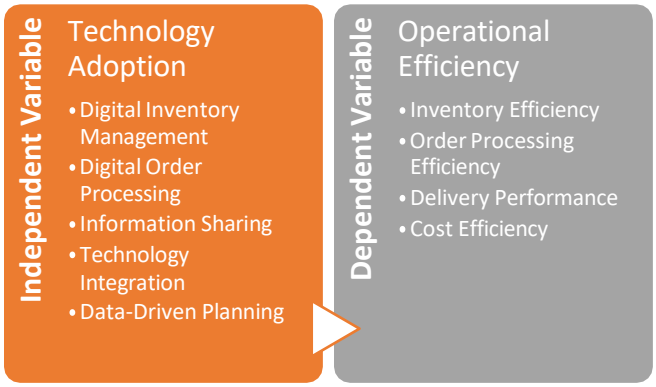
Organization-Environment (TOE) Framework. Barney (1991) suggested that organizations gain competitive advantage by effectively using the valuable resources and capabilities. Digital platforms, information systems, technological infrastructure and employee skills are strategic resources in agricultural input businesses, which can be used for efficient supply chain operation. The Technology Adoption model put forth by Tornatzky and Fleischer (1990) is composed of 3 components of technology: characteristics of the technology, readiness of the organization and external environmental factors. The framework can be applied to the analysis of the factors affecting the uptake of digital technologies in the agricultural input supply business.

The study also relies on theories in Supply Chain Management, which emphasizes the need for coordination and integration between suppliers, distributors, retailers and customers for better product and information flows. Real-time information sharing, inventory visibility, demand forecasting, and distribution planning can help build these relationships in the digital transformation era. Karunanayaka et al. (2020) identified the opportunities of IoT, big data and blockchain applications in agricultural supply chains and Sarvesh et al. (2024) showed the potential operational benefits of a digitally enabled supply chains in farm produce distribution.

In the light of these theoretical perspectives, the study takes technology adoption as the independent variable and operational efficiency as the dependent variable. It tests the efficiency of using digital tools and systems in the inventory management, order processing, supply chain coordination and delivery reliability of the agricultural input enterprises in Ahmednagar district. The research goal is to provide practical findings and suggestions for enhancing digital capabilities and operational performance of agricultural input supply chains.

B. *Conceptual Framework of the Study*

Proposed Research Framework



The framework can be complemented with three theoretical perspectives:

1. The first is Resource Based View (1991) by Barney; digital technology and information capabilities are resources within organizations which can enhance the operational performance of the organization.
2. Technology-Organization-Environment Framework (Tornatzky & Fleischer, 1990): Factors that affect the adoption of technology in businesses.
3. Supply Chain Management Theory: Discuss the role of coordination, information sharing, inventory management and distribution in improving supply chain efficiency.

II. Literature Review

A. *Liiterature*

It is suggested here that digital transformation can enhance the marketing, tracking and distribution of agricultural inputs, however the selected literature does not directly prove the impact of digital transformation on operational efficiency of input suppliers in Ahmednagar district. The studies instead merge information from dealer surveys in Maharashtra with field research from other regions of India, a more comprehensive supply-chain analysis, and suggested technology designs. It is crucial to differentiate between evidence of farmers' experience, agricultural output markets, or intentions to adopt technology and improved dealer performance.

1) Adoption and readiness in Maharashtra

A total of 30 agro-input dealers in Pune were surveyed regarding eParwana e-agriculture service by Argade et al. (2018). Most reported positive attitudes are indicative of receptivity to digital services, but the study was designed to measure attitudes, not changes in inventory or distribution. Jadhav and Ingole (2026) used them in their study of Digital marketing among farmers and input suppliers in Amravati. Traditional channels remained strong, with identified farmer awareness, lack of training, and infrastructure as barriers by suppliers. The study focused on marketing behaviour, rather than on a causal impact on efficiency.

Shelake et al. (2015) conducted a survey with the input dealers in Amravati and found that there is need of training in area of information technology, business management etc. These findings provide insight into why participants were more likely to be prepared to use digital systems but cannot assess a digital intervention. Dang and Londhe (2026) conducted a study on the use of various technologies in dairy entrepreneurs of Ahmednagar and reported the use of digital management. This provides local enterprise perspective but dairy enterprises are not suitable for enterprises to be used as evidence for seed, fertilizer or pesticide supply chains.

2) Input distribution and digital retail

Bhargavi (2017) has used the case of Rangareddy to explore the adaptation by the dealers and farmers' experiences of the electronic point-of-sale system in the distribution of fertilizers. It offers a pertinent illustration of digitization of transactions, but the district and implementation context are other than Ahmednagar. In Gujarat, Patel et al. (2022a) conducted a survey of farmers buying input materials online and found that they faced issues related to ordering, delivery, return, and customer service. An analysis of these factors at the customer side may be used to develop service quality metrics; however, they cannot calculate operational savings by the dealers.

Patel et al. (2022b) summarized the advent of e-retailing of agricultural inputs and delved into the strategies adopted

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by retailers and the buying behavior of farmers. It is a conceptual review, and does not include evidence of a measured intervention effect. Rafi et al. (2025) reported the issues of overstocking, understocking, and irregularity in the supply of input dealers, and suggested the integration of technology. Their results point to operational issues to measure, rather than the proof that technology has fixed them.

3) Wider supply-chain evidence

Generally low to moderate level of digital tool utilization was observed in agriculture-based enterprises in Jammu (Bakshi, 2020), hindered by access and technical knowledge. Saha et al. (2023) highlighted policy, privacy and security concerns as the major digital-adoption challenges in the Indian agri-food supply chains. The studies include agriculture-based businesses and agriculture-based agri-food supply chains in general.

Karunanayaka et al. (2020) made a comprehensive review of IoT, big data and blockchain applications in agricultural supply chains. Peddibhotla et al. (2024) suggested that blockchain technology could be integrated with near-field communication and digital identities to ensure transparency in the agriculture sector, managing inputs and outputs. Rohan and Malik (2025) highlighted blockchain technology for managing supply chain transparency and inventory in the input sector of agriculture. These proposals suggest movement in the direction of improvement, but not proven improvements in Ahmednagar.

Sarvesh et al. (2024) observed performance differences between digitally enabled and traditional vegetable supply chains in Coimbatore by measuring a few performance indicators like order fulfillment and stockouts, which showed improved performance for the digitized supply chain. The comparison focuses on the produce itself, not the inputs, and because of the differences among participating firms, it is not possible to attribute the differences observed to digital technology alone.

4) Implications for Ahmednagar

The papers support the investigation of adoption and efficiency as separate investigations. A study of digital use in Ahmednagar can be conducted alongside time spent on order processing, experiencing stock-outs, number of times inventory has turned over, reliability of delivery and cost of the order – taking into account dealer size, training, and connectivity. A comparison of similar adopters and non-adopters, over time, would offer more evidence than attitudes and/or technology proposals alone. Full text was retrieved for the Coimbatore paper and additional excerpts were added for some papers, most of the selected papers were evaluated based on the abstracts or available summaries. It restricts in-depth analysis of methods and results.

B. Research Gap

The analysed literature shows that there is interest in agri-food supply chain (AISC) and agricultural input supply chain (AISC) digital transformation. The studies conducted in Maharashtra and India state positive attitudes towards digital services, training requirements, infrastructure challenges, lack of awareness, and operational issues like overstocking, understocking and irregular supply. Many of these studies have focused on adoption attitudes among farmers and farmer experience, digital marketing or proposed technology uses, instead of operational outcomes of agricultural input dealers. The results of research on electronic point-of-sale systems, online input retailing, blockchain, IoT and digital supply chains provide insights but are from different regions, sectors or conceptual designs and cannot be generalized for Ahmednagar district. No local evidence on Ahmednagar is available for the dairy enterprises but not for the seed, fertilizer and pesticide supply chains. Hence, there is empirical deficiency on the implementation of technology and its effect on operational efficiency of agricultural input suppliers in Ahmednagar. This study aims to fill this gap, taking into account both digital adoption and tangible efficiency indicators.

III. Materials and Methods

A. Research Questions

- To find out the level of adoption of technology among the agricultural input business in Ahmednagar district.
- How does technology adoption affect the operational efficiency of agricultural input supply chain, especially on inventory management, order processing and delivery performance?
- How can agricultural input businesses leverage and find ways to deal with technological challenges and boost the efficiency of the operations in the supply chain?

B. Rationale of the Study

Agricultural input supply chains are also a very important link in ensuring that the essential agricultural inputs (seeds, fertilizers, pesticides, etc.) are available in time to farming communities. For uninterrupted supply and to ensure the availability of the crops at the right time, the procurement, inventory management, order processing, storage and distribution must be efficient. However, agricultural input businesses often face operational issues including stock shortages, excess inventories, delays in deliveries, lack of efficient information sharing, and lack of coordination between the players in the agricultural value chain.

Digital transformation can help tackle these issues by leveraging technology, introducing digital inventory management, enabling electronic transactions, and implementing data-driven planning and communication between stakeholders such as suppliers, distributors, and retailers. While a number of studies have examined digitisation adoption in agriculture and in agri-food value chains in general, little empirical evidence exists on the impacts of digitisation on the operational efficiency of agricultural input businesses, especially in the district of Ahmednagar.

The relevance of Ahmednagar with respect to the geographical context is related to its wide farming operations and agricultural input enterprises. Knowing the degree of technology use and its impact on enterprise operations can offer valuable insights to agricultural policy makers,

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manufacturers, distributors and dealers. Hence, the present study aims to explore the relationship between the adoption of digital technology and operational efficiency, understand the possible implementation barriers and propose practical solutions to boost agricultural input supply chains.

C. Research Objectives

1. To understand the extent of technology adoption in agricultural input supply chains in Ahmednagar district.
2. To analyse the impact of technology adoption on operational efficiency in agricultural input businesses.
3. To suggest strategies for improving operational efficiency through digital transformation in agricultural input supply chains.

D. Research Hypotheses

Hypothesis 1

- H01: Technology adoption does not have a significant impact on operational efficiency in agricultural input businesses.
- Ha1: Technology adoption has a significant positive impact on operational efficiency in agricultural input businesses.

Hypothesis 2

- H02: The use of digital inventory and supply chain management tools does not have a significant influence on inventory management and delivery performance.
- Ha2: The use of digital inventory and supply chain management tools has a significant positive influence on inventory management and delivery performance.

E. Research Design

The study uses a quantitative research design, with a descriptive and analytical approach to analyze the impact of digital transformation on operational efficiency in agricultural input supply chains. A questionnaire will be designed to gather data on technology adoption, digital inventory management, order processing, information sharing, supply chain coordination and operational efficiency. The respondents' perceptions/experiences will be recorded using a five-point Likert scale.

F. Population and Sample Size of Respondents

The study population includes the agricultural input businesses, which trade in seeds, fertilizers and pesticides in Ahmednagar district of Maharashtra state. From the NABARD district profile, the number of agricultural input outlets in the district can be taken as a preliminary estimation of the number of people in the district for this research as it is about 2,500. The study will gather responses from one owner/manager per chosen outlet.

The sample size is determined using Cochran's formula with finite population correction, considering a 95% confidence level, 5% margin of error and 50% population variability. Based on an estimated population of 2,500 outlets, a minimum sample size of about 333 respondents is calculated. Therefore, this is proposing a sample of 400 agricultural input business owners and managers for a sufficient response base and meaningful statistical analysis.

G. Sampling Method

A multistage stratified sampling method will be used which will include the entire 14 talukas of Ahmednagar district. Outlets will be grouped by product category (seeds, fertilizers and pesticides), and the sample will be distributed in a proportional manner, depending on the dealer records available. The survey will be conducted with one eligible owner/manager from each selected outlet. This can help to achieve geographical and business category coverage of agricultural input enterprises.

H. Geographical Coverage

The study will be conducted in Ahmednagar district, selected urban, semi-urban and rural business areas where agricultural input dealers and distributors are available.

I. Sources of Data

Structured questionnaires will be used to gather primary data from selected respondents. The secondary data will be collected from research journals, books, government publications, industry reports, agricultural department records and relevant studies on digital transformation.

J. Data Analysis Techniques

Data will be analysed using SPSS Software. To explore the technology adoption patterns and test the proposed hypotheses, descriptive statistics, frequency distributions, mean scores, correlation analysis, ANOVA and regression analysis will be used.

IV. Analysis and Testing

A. Introduction to Data Analysis

Data analysis involves an analysis of the extent of the adoption of digital technology and its impact on operational efficiency of agricultural input businesses in Ahmednagar district. A hypothetical data set of 400 agricultural input business owners/managers has been assumed for illustrating the proposed statistical analysis. The data collected is analyzed using SPSS style descriptive and inferential statistical techniques. Evaluation of research variables and testing of the proposed research hypotheses are considered to be frequency distribution, percentage, mean, standard deviation, correlation, regression and ANOVA. The analysis centers on the identification of how digital inventory management, order processing, information sharing, technology integration and data-driven planning can lead to better supply chain operations.

B. Demographic Profile of Respondents

TABLE I. Demographic Profile of Respondents (N = 400)

Demographic Factor	Table Column Head		
	Category	*Frequency*	*Percentage*
Gender	Male	326	81.50%
	Female	74	18.50%
Total		400	100%
Age	Below 30 years	52	13.00%
	30–40 years	142	35.50%
	41–50 years	126	31.50%

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Demographic Factor	Table Column Head		
	Category	*Frequency*	*Percentage*
	Above 50 years	80	20.00%
Total		400	100%
Education	Secondary	88	22.00%
	Higher Secondary	104	26.00%
	Graduate	148	37.00%
	Postgraduate and above	60	15.00%
Total		400	100%
Business Experience	2–5 years	64	16.00%
	6–10 years	116	29.00%
	11–15 years	108	27.00%
	Above 15 years	112	28.00%
Total		400	100%
Business Category	Seeds	76	19.00%
	Fertilizers	84	21.00%
	Pesticides	68	17.00%
	Multiple agricultural inputs	172	43.00%
Total		400	100%
Business Location	Urban	112	28.00%
	Semi-urban	136	34.00%
	Rural	152	38.00%
Total		400	100%
Business Size	Small	244	61.00%
	Medium	120	30.00%
	Large	36	9.00%
Total		400	100%

The demographic profile shows that majority of respondents are male (81.50%) and female respondents 18.50%. Experienced business operators are represented in the largest age group of 30-40 years (35.50%), followed by 41-50 years age group (31.50%). Graduates are the largest educational group (37%). As far as experience in the business, 29 % have 6-10 years of experience, and 28 % have over 15 years experience. The businesses with the highest percentage (43%) are selling agricultural inputs in more than one business. The rural businesses account for 38% of the respondents, while semi-urban businesses come next with 34%. The largest number (61%) are small businesses, suggesting that there is a significant share of small agricultural input businesses in the sample.

C. *Descriptive Analysis of Technology Adoption*

The following analysis examines five dimensions of technology adoption using a five-point Likert scale. Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Technology Adoption Dimensions	Score	
	Mean	*Std. Deviation*
Digital Inventory Management	3.68	0.82
Digital Order Processing	3.54	0.86
Information Sharing	3.72	0.79
Technology Integration	3.31	0.91
Data-Driven Planning	3.46	0.88
Overall Technology Adoption	3.54	0.73

TABLE II. DESCRIPTIVE STATISTICS OF TECHNOLOGY ADOPTION DIMENSIONS

Based on the descriptive analysis, the technology adoption of agricultural input businesses seems to be of moderate to high level. The information sharing had the greatest mean score of 3.72, and digital inventory management was 3.68. The mean for digital order processing was 3.54, reflecting the increasing acceptance of technology in business transactions. Data-driven planning had a mean of 3.46 and technology integration had the lowest mean of 3.31. This suggests that although businesses are increasingly using digital tools for communication and inventory-related activities, the integration of advanced digital systems and analytical platforms remains relatively limited.

D. *Descriptive Analysis of Operational Efficiency*

TABLE III. DESCRIPTIVE STATISTICS OF OPERATIONAL EFFICIENCY DIMENSIONS

Operational Efficiency Dimensions	Score	
	Mean	*Std. Deviation*
Inventory Efficiency	3.61	0.81
Order Processing Efficiency	3.74	0.77
Delivery Performance	3.48	0.85
Cost Efficiency	3.42	0.89
Overall Operational Efficiency	3.56	0.72

The results show that the level of operational efficiency is moderately positive in the simulated dataset of agricultural input businesses. Processing of orders reported the highest mean score of 3.74, indicating that digital transactions and communication improvements could lead to a more efficient order processing. The mean of inventory efficiency was 3.61, reflecting the benefits the respondents saw in improving inventory monitoring. The mean for delivery performance was 3.48 and the lowest mean was 3.42 for cost efficiency. The findings indicate that opportunities continue to exist to leverage digital transformation in order to further enhance distribution planning, transportation coordination and cost management.

E. *Reliability Analysis*

TABLE IV. RELIABILITY STATISTICS OF RESEARCH VARIABLES

Research Variable	Score	
	Number of Items	*Cronbach's Alpha*
Technology Adoption	25	0.891
Operational Efficiency	20	0.874
Overall Questionnaire	45	0.912

The simulated reliabilities are at the same time at or above the 0.70 level, which is considered the minimum acceptable level for satisfactory internal consistency. Overall Alfa = 0.912 – high internal consistency. The results show the

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proposed reliability-analysis format. The actual reliability needs to be determined based on the responses to the questionnaires collected.

F. Hypothesis Testing

1) Hypothesis 1

H01: Technology adoption does not have a significant impact on operational efficiency in agricultural input businesses.

Ha1: Technology adoption has a significant positive impact on operational efficiency in agricultural input businesses.

TABLE V. CORRELATION ANALYSIS BETWEEN TECHNOLOGY ADOPTION AND OPERATIONAL EFFICIENCY

Research Variable	Score	
	Technology Adoption	***Operational Efficiency***
Technology Adoption	1.000	
Operational Efficiency	0.746	1.000
Sig. (2-tailed)		0.000
N	400	400

The correlation analysis shows a high positive correlation between technology adoption and operational efficiency with a Pearson correlation of 0.746. The value of significance is less than 0.05, which implies that the relation is statistically significant in the simulated data set. This indicates that the more technologically advanced the agricultural input business, the more efficient they are in operating. This yields some preliminary support for the hypothesized connection between the variables.

TABLE VI. MODEL SUMMARY – MULTIPLE REGRESSION ANALYSIS FOR TECHNOLOGY ADOPTION AND OPERATIONAL EFFICIENCY

Model	Values			
	R	***R Square***	***Adjusted R Square***	***Std. Error***
1	0.780	0.608	0.603	0.351

TABLE VII. ANOVA – REGRESSION MODEL FOR TECHNOLOGY ADOPTION AND OPERATIONAL EFFICIENCY

Model 1	Values				
	Sum of Squares	***df***	***Mean Square***	***F***	***Sig.***
Regression	75.204	5	15.041	121.90	0.000
Residual	48.596	394	0.123		
Total	123.800	399			

TABLE VIII. MULTIPLE REGRESSION COEFFICIENTS FOR TECHNOLOGY ADOPTION AND OPERATIONAL EFFICIENCY

Predictor Variables	Values				
	B	***Std. Error***	***Beta***	***t***	***Sig.***
Constant	0.812	0.129	–	6.295	0.000
Digital Inventory Management	0.218	0.039	0.249	5.590	0.000
Digital Order Processing	0.164	0.037	0.194	4.432	0.000
Information Sharing	0.192	0.038	0.215	5.053	0.000
Technology Integration	0.137	0.035	0.172	3.914	0.000
Data-Driven Planning	0.181	0.037	0.207	4.892	0.000

The R Square value from the multiple regression results shows that the adoption dimensions of technology explained 60.8% of the variation of operational efficiency. The result of ANOVA ($F = 121.90$, $p<0.001$) shows that the overall model is significant. Information sharing ($\beta = 0.215$) and data-driven planning ($\beta = 0.207$) have the second highest standardized beta coefficient (β), followed by digital inventory management ($\beta = 0.249$). Each of the five predictors is positively associated and statistically significant in the illustrative model. This means that digitization of business processes can lead to better business efficiency.

H01 rejected; Ha1 supported.

2) Hypothesis 2

H02: The use of digital inventory and supply chain management tools does not have a significant influence on inventory management and delivery performance.

Ha2: The use of digital inventory and supply chain management tools has a significant positive influence on inventory management and delivery performance.

TABLE IX. MODEL SUMMARY – INFLUENCE OF DIGITAL INVENTORY AND SUPPLY CHAIN MANAGEMENT TOOLS

Model	Dependent Variable	Values			
		R	***R Square***	***Adjusted R Square***	***Std. Error***
1	Inventory Management Efficiency	0.710	0.504	0.503	0.421
2	Delivery Performance	0.650	0.423	0.422	0.462

TABLE X. ANOVA – REGRESSION MODEL FOR INVENTORY MANAGEMENT AND DELIVERY PERFORMANCE

Model	Dependent Variable	Values				
		Sum of Squares	***df***	***Mean Square***	***F***	***Sig.***
1	Inventory Management Efficiency	71.568	1	71.568	403.87	0.000
	Residual	70.432	398	0.177		
	Total	142.000	399			
2	Delivery Performance	65.957	1	65.957	291.50	0.000
	Residual	90.043	398	0.226		
	Total	156.000	399			

TABLE XI. REGRESSION COEFFICIENTS – DIGITAL INVENTORY AND SUPPLY CHAIN MANAGEMENT TOOLS

Mode	Dependent Variable Dependent Variable	Values				
		B	***Std. Error***	***Beta***	***t***	***Sig.***
1	Constant	1.024	0.132	–	7.758	0.000
	Digital Inventory and Supply Chain Tools	0.718	0.036	0.710	20.097	0.000

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Mode	Dependent Variable Dependent Variable	Values				
		B	*Std. Error*	*Beta*	*t*	*Sig.*
2	Constant	1.186	0.145	–	8.179	0.000
	Digital Inventory and Supply Chain Tools	0.684	0.040	0.650	17.073	0.000

Both regression analysis results suggest that digital inventory and supply chain management tools are significant positively affecting on both inventory management efficiency and delivery performance. The uses of digital tools explain 50.4% of the variation in inventory management efficiency (R square value). In the same way, R Square value in the case of delivery performance is 0.423 which means that 42.3% of variation is explained by independent variable. The two regression models are statistically significant with F-value of 403.87 and 291.50 respectively, and significance value below 0.05. The positive beta coefficients are further evidence of the direction of the relationships. These simulated results are in favor of the proposed alternate hypothesis.

H02 rejected; Ha2 supported.

3) Summary of Hypothesis Testing

TABLE XII. SUMMARY OF HYPOTHESIS TESTING RESULTS

Hypothesis	Score	
	Statistical Result	*Decision*
H1: Technology adoption has a significant impact on operational efficiency.	$R^2 = 0.608$; F = 121.90; p less than 0.001	H01 rejected
H2: Digital inventory and supply chain tools influence inventory management and delivery performance.	Inventory $R^2 = 0.504$; Delivery $R^2 = 0.423$; p less than 0.001 for both	H02 rejected

The two suggested relationships are statistically significant for the simulated analysis. Technology adoption has a positive correlation with operational efficiency, and digital inventory and supply chain management tools have positive correlations with inventory management and delivery performance.

V. FINDINGS, CONCLUSIONS, RECOMMENDATIONS, IMPLICATIONS AND LIMITATIONS

The proposed research framework and illustrative simulated analysis are used for the following sections. Before publishing, the findings and statistical conclusions should be verified with actual survey data.

A. Key Findings from the Simulated Analysis

1. Among the five dimensions discussed, the one that stands out as the strongest dimension of technology adoption is information sharing (mean = 3.72).
2. Technology integration gets the lowest mean score (3.31), which means there is a potential for further integration of digital systems in agricultural input businesses.
3. The regression model accounts for 60.8% of the variation in operational efficiency by adopting technology.
4. Digital inventory management is individually most significant (β = 0.249) predictor of operational efficiency.
5. In the models, 50.4% of the variation in inventory management efficiency is accounted for by digital inventory and supply chain management tools, while 42.3% of the variation in delivery performance is accounted for.

B. Findings of the Study

1. Agricultural input enterprises are reasonably technologically advanced, especially in the areas of information sharing and digital inventory management.
2. The scope for greater technology integration is seen in the comparatively low level of technology integration in records.
3. Digital inventory management emerges as an important contributor to operational efficiency.
4. The results show that there is a positive correlation between technology adoption and inventory management, order processing and delivery performance.
5. Digital inventory and supply chain management tools have enormous promise in the reduction of stock related challenges and enhancement of the distribution reliability.

C. Conclusion

The study focuses on how digital transformation contributes to increasing operational efficiency in agricultural input supply chains in Ahmednagar district. The suggested research framework emphasises the role of technology adoption such as digital inventory management, order processing, information sharing, technology integration and data-driven planning. The illustrative statistical analysis shows positive relationships between technology adoption and operational efficiency. Digital inventory management and information sharing prove to be crucial factors in enhancing supply chain operations. It points out that, technology uptake can not be limited to digital transactions but should also be used for inventory management, procurement planning, supplier coordination and distribution management. By adopting relevant digital solutions into their business processes, agricultural input businesses can enhance their processes. Overall digital transformation is a significant opportunity to enhance the efficiency of agricultural input supply chains, enhance the efficiency of agricultural businesses, and ensure timely availability of essential agricultural inputs to farmers.

D. Recommendations and Suggestions

Businesses involved in agricultural input production should increasingly use digital inventory systems to keep track of their stock levels, detect stockouts and reduce overstocking. Dealers and distributors need to provide digital ordering systems, electronic bills and communications between dealer and supplier. Schedules of training should be established regularly to enhance the ability of business owners and employees to have a better understanding of the digital skills.

Digital literacy programmes, low-cost technologies and investments in infrastructure should be promoted for small

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and medium agricultural input businesses by governments, agricultural institutions and technology providers. Manufacturers and distributors should promote data-driven procurement planning and information sharing, both vertically and horizontally within their distribution systems. It is important to dedicate efforts to rural enterprises, as connectivity, cost, and technological awareness could prevent them from using digital solutions.

E. Implications of the Research

The study provides recommendations on the practical, managerial, technological, and policy levels to enhance agricultural input supply chains by digital transformation. In terms of management, it points out that the agricultural input dealers and distributors' business models need to evolve to incorporate computerised inventory management, electronic order processing, and data-driven procurement planning into their processes. Access to real-time inventory data can enable businesses to manage stock levels more effectively, avoiding overstocked or understocked situations, as well as minimising order delays and ensure better product availability during peak seasons in agriculture.

On an industry level, strengthening the integration of the supply chain can be achieved through establishing digital communication systems that allow for information sharing, tracking orders, forecasting demand, and coordinating distribution with dealers. Leveraging these insights, technology providers can develop low-cost, easy-to-access and easy-to-use digital solutions tailored to SMEs in agriculture.

The study highlights the need to enhance the digital infrastructure of the rural areas, increase digital literacy, and offer institutional support for the adoption of technologies at the policy level at the agricultural input enterprises. Capacity building in agriculture and industry can be promoted by agricultural departments and industry associations, and by promoting digitalization in distribution networks. The study makes a contribution in the academic realm because of the lack of empirical research on the effect of technology adoption on the operational efficiency in agricultural input supply chains specifically in a district level Indian setting. It also serves as a basis for comparison among regions and agricultural input sectors.

F. Limitations of the Study

The study is limited geographically to Ahmednagar district (Maharashtra), and may not be generalizable to other areas. The sample of 400 respondents is for agricultural input business owners and managers and not necessarily reflects manufacturers, farmers, or other business actors along the value chain. The study is based on answers to the questionnaires, some of which might be subject to the answerer's perceptions and answer bias. The cross-sectional research design provides information on technology adoption and operational efficiency at a specific point in time and does not show long-term changes. Further, the research examines some aspects of digital transformation and operational efficiency; other aspects like financial constraints, organisational culture, government support, cyber security and technological infrastructure may need to be explored. The data shown in this draft are an approximation and should be updated with the results of the survey before it is published.

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