

Impact of Artificial Intelligence on Supply Chain Visibility and Operational Efficiency in Indian Manufacturing Companies

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Abstract: Indian manufacturing is going through a big change because of new technology. Among all new tools, Artificial Intelligence (AI) is now one of the most used and most talked-about technologies in factories and supply chains. AI helps companies guess future demand correctly, watch goods moving in real time, stop machines from breaking down suddenly, cut down mistakes, and take faster decisions.

This paper looks at two important results of using AI - supply chain visibility (being able to see every part of the supply chain clearly and instantly) and operational efficiency (doing work faster, cheaper, and with fewer errors). Most past studies on this topic come from the USA, Europe, or China. There is very little research that uses fresh data collected directly from people working in Indian factories.

To fill this gap, this study collected data from 108 supply chain and manufacturing professionals across India using a questionnaire with 20 questions. The questions were rated on a 1 to 5 scale (1 = Strongly Disagree, 5 = Strongly Agree). The data was studied using simple tools in Microsoft Excel - percentages, averages (mean), standard deviation, and correlation.

The results show that AI is clearly helping Indian manufacturers. The average score for supply chain visibility was 4.10 out of 5, and for operational efficiency it was 4.07 out of 5 - both in the "High Agreement" range. About 70% of all answers about visibility, and 67% of all answers about efficiency, were positive (Agree or Strongly Agree). The correlation between AI use and supply chain visibility was 0.74, and between AI use and operational efficiency was 0.71 - both strong positive numbers. This means both research hypotheses were proven true.

Large companies benefit much more from AI than small companies. The automobile sector benefits the most, while the textile sector benefits the least. The paper ends with practical suggestions for companies, small businesses, government policymakers, and business schools.

Keywords: Artificial Intelligence, Supply Chain Visibility, Operational Efficiency, Indian Manufacturing, AI Adoption

I. INTRODUCTION

1.1 Background of Indian Manufacturing

India is one of the biggest manufacturing countries in the world. Its factories make cars, medicines, clothes, electronics, food products, and many other goods. Manufacturing gives jobs to crores of people and adds around 16-17% to India's total economy (GDP).

In 2014, the Government of India started the "Make in India" program. The goal was to turn India into a global manufacturing hub, attract more investment, and compete with countries like China and Germany.

India has both big companies (like Tata Motors, Sun Pharma, and Bajaj Auto) and a huge number of small and medium businesses (SMEs). These SMEs are the backbone of Indian manufacturing because they employ a large part of the workforce.



Even though manufacturing has grown a lot, Indian factories still face many problems - poor infrastructure, complicated logistics, late deliveries, high transport costs, and a shortage of skilled workers. One of the biggest headaches is managing the supply chain - the journey of raw materials coming into the factory, production happening inside, and finished goods going out to customers. When even one part of this chain breaks (a late supplier, a broken machine, sudden demand), the whole system gets disturbed, costing money and customer trust.

1.2 What is Artificial Intelligence in Supply Chain

Artificial Intelligence (AI) means computer programs that can do tasks that normally need human thinking - like recognizing patterns, predicting the future, making decisions, and learning from past data.

Some common AI tools used in supply chains are:

- **Demand Forecasting Software** - Looks at past sales and trends to predict how much product will be needed.
- **Predictive Maintenance Systems** - Watches machines and warns before they break down.
- **Real-Time Tracking Tools** - Shows where materials and shipments are at any moment.
- **Automated Inventory Management** - Automatically reorders stock when it runs low.
- **Supplier Risk Management** - Watches suppliers and warns about possible problems.
- **Warehouse Automation** - Uses robots and smart systems to move goods inside warehouses.

1.3 What is Supply Chain Visibility

Supply chain visibility means being able to see what is happening at every step of the supply chain, in real time. Think of the supply chain as a long chain of events - raw material comes from a supplier, goes to the factory, becomes a product, sits in a warehouse, then moves to a distributor, and finally reaches the customer.

If a company has good visibility, it knows exactly where every item is at any time, and can spot problems early. Without visibility, a company is "working blind" - it only finds out about a problem after the damage is already done.

AI helps a lot here because it can take data from many sources (GPS, sensors, supplier systems, orders) and show it all on one simple, clear, real-time screen. This was not possible before AI because humans cannot process so much data so fast.

1.4 What is Operational Efficiency

Operational efficiency means getting work done in the best way - using the least money, time, labor, and materials to get the best output. A factory with high efficiency has:

- Machines that rarely break down without warning
- Raw materials arriving on time, in the right amount
- Production running smoothly without stops
- Goods delivered to customers on time
- Very little wastage
- Few manual mistakes in ordering, billing, and stock management

AI improves efficiency by automating boring repeat tasks, predicting problems before they happen, analyzing data faster than humans, and reducing manual mistakes.

1.5 How AI, Visibility, and Efficiency are Connected

These three things are deeply linked. When AI improves visibility, it leads to better operational efficiency. For example, if AI shows a manager exactly how much raw material is in stock and when the next delivery is coming, the manager can plan production better. This means smoother production and on-time delivery - which is operational efficiency.



Similarly, when AI warns a maintenance team that a machine might break down in 48 hours, the team can fix it during planned downtime instead of facing a sudden, costly stoppage. This improves both efficiency and supply chain continuity.

So visibility and efficiency are not separate goals - they support each other. A company that can see clearly can act efficiently, and an efficient company can invest more in better AI tools.

1.6 Current Situation of AI in Indian Manufacturing

AI use in India is growing but not equal everywhere. Big companies in automobile, pharma, and electronics sectors - like Maruti Suzuki, Dr. Reddy's, and Tata Steel - have already started using AI in their supply chains.

But many small and medium manufacturers are still at an early stage. Some use basic tools like inventory software or GPS tracking, but have not moved to advanced tools like predictive analytics.

This uneven adoption is exactly why this research is needed - to understand where Indian manufacturers stand today, what tools they use, how much these tools actually help, and what problems they face.

1.7 Why This Study Matters

The COVID-19 pandemic (2020-2022) showed how fragile manufacturing supply chains can be. Companies with AI-powered systems handled the crisis better because they had real-time information and could react fast. Companies still using old manual methods struggled much more.

This proved that AI in supply chains is no longer just a "nice to have" - it is becoming a necessity for any company that wants to survive disruptions and stay competitive.

But Indian manufacturers - especially small and medium ones - cannot just copy what big global companies do. They have different problems, infrastructure, skills, and budgets. This is why India-specific research is so important.

1.8 Scope of the Study

This study covers Indian manufacturing companies from different sectors - automobile, pharmaceutical, textile, electronics, food and beverages, and others. It includes professionals working in supply chain, operations, procurement, and logistics, with at least one year of experience. The study covers the whole of India, not just one city or state.

The two main things studied are supply chain visibility and operational efficiency, and the main factor being checked is how much AI tools are being used.

II. REVIEW OF LITERATURE

This chapter looks at studies done by other researchers on AI in supply chains, mostly from 2022 to 2026, and points out the gaps that this study tries to fill.

AI Adoption - Global View Researchers found that companies in Asia (China, Japan, South Korea) that used AI in procurement and inventory cut their supply chain costs by about 20%. But this study did not cover India, and did not look at problems faced by developing countries like poor data systems and low digital skills.

Predictive Maintenance in Indian Auto Companies A study on Indian automobile factories found that AI connected with sensors could predict machine failures and let companies repair machines in advance, reducing unplanned stoppages. But this study only covered 8 large plants in Pune and Chennai, so it cannot be applied to other sectors or smaller companies.

Managing Disruptions with AI Another study found that companies with AI handled COVID-19 supply chain problems much faster - they could find new suppliers and change routes quickly. But this study only looked at disruption situations, not normal day-to-day operations.

Warehouse Automation A study on AI-powered warehouses found faster order processing, fewer mistakes, and better space use. But it only covered big companies that could afford automation, and did not connect warehouse improvements to overall supply chain visibility.



Supplier Management Using AI Research showed that AI tools that check supplier performance and risks helped companies pick better suppliers and avoid problems. But this was based only on interviews with 15 people, with no numbers to measure actual improvement.

Cost Reduction in Pharma A study in Indian pharma companies found AI reduced costs in procurement, production, and logistics by 12-22%. But it only covered pharma, and the cost data was self-reported by companies, which can be biased.

AI Dashboards and Faster Decisions Managers using AI dashboards made faster and better decisions than those using old spreadsheets. But the study did not check if faster decisions actually led to better real results.

Blockchain + AI Combining AI with blockchain improved transparency in food and consumer goods companies. But blockchain is still rare in India and mostly used by big companies.

Employee Resistance to AI Workers who felt their jobs were threatened by AI often resisted using it or gave wrong data, which reduced AI's effectiveness. This study was based on only 6 companies in Kerala and Karnataka and did not measure the impact in numbers.

AI in Textile Sector Large textile companies use AI for demand forecasting and quality checks, but thousands of small weaving and garment units don't know about AI or cannot afford it. This created a "digital divide" within the same sector.

AI and Demand Response AI tools that track sales and social media trends helped companies react faster to demand changes. But this was based on only 12 large companies and looked at only one outcome.

AI for Sustainability AI helped reduce fuel use, material waste, and electricity use in factories. But this study focused only on environmental benefits, not on overall business performance.

Data Quality Problems Many Indian companies have lots of data, but it is messy, incomplete, and stored differently across departments. When such bad data goes into AI, the results are unreliable, and managers stop trusting AI. This study said companies must fix their data first, before investing in AI.

Multi-Location Inventory AI helped large companies with factories in many states balance their stock better, avoiding situations where one place has too much stock and another has too little. But this was based only on 4 large companies.

AI Maturity Framework A study created a way to measure how advanced a company's AI use is, and found that more "mature" AI use leads to better supply chain results. But this was tested on only 30 medium-large companies.

AI in Auto Component Supply Chains AI improved supplier monitoring and quality checks in the auto components sector, reducing delays at assembly plants. But this was limited to one sector with very specific supply chain needs.

AI and Supply Chain Resilience Post-Pandemic Companies using AI for risk monitoring recovered faster from pandemic disruptions. But this study only looked at crisis situations, not regular daily operations.

AI Skills Gap Many supply chain workers in India don't have the skills to use AI tools properly, so even when companies buy AI systems, they are underused. This study focused on training needs, not on actual performance results.

AI in Food Traceability AI traceability systems helped food companies find and isolate bad batches quickly, improving food safety. But this only applies to food, not other sectors.

AI Integration with ERP Systems When AI was connected with ERP software (like SAP), data processing improved a lot, and departments worked together better. But many companies struggled to connect AI with old ERP versions.

AI and Competitive Advantage Companies that fully used AI in their supply chains performed better than competitors in delivery, cost, quality, and customer satisfaction, and won more export orders.

2.3 Research Gaps

From all these studies, the following gaps stand out:

1. Most studies look at either visibility OR efficiency separately - not both together using fresh data from India.
2. Most research focuses on large companies, ignoring small and medium businesses that form the majority of Indian manufacturing.



3. Most studies use old data, interviews with very few people, or focus on only one sector.
4. Most research is limited to Maharashtra, Gujarat, and Tamil Nadu - other states are not studied much.

This research tries to fill all these gaps by collecting fresh data from 108 people across India, from many sectors and company sizes, and measuring both visibility and efficiency together.

III. RESEARCH METHODOLOGY

3.1 Research Design

This study uses a Descriptive Research Design. This means the goal is to describe and measure what is currently happening - how AI is being used and what effect it is having - without changing or controlling anything. The study simply observes and reports real opinions of working professionals.

3.2 Research Approach

This study follows a Quantitative Approach. This means the answers are collected as numbers (using a rating scale) and studied using statistics like averages, percentages, and correlation. This approach gives clear, measurable, and unbiased results.

3.3 Research Objectives

- Objective 1: To find out which AI tools are used in Indian manufacturing companies and how they affect supply chain visibility and operational efficiency.
- Objective 2: To study the relationship between AI use and the level of supply chain visibility and operational efficiency.

3.4 Research Hypotheses

Set 1 - Supply Chain Visibility

- H_01 : AI tools do NOT have a significant impact on supply chain visibility.
- H_11 : AI tools DO have a significant impact on supply chain visibility.

Set 2 - Operational Efficiency

- H_02 : There is NO significant relationship between AI use and operational efficiency.
- H_12 : There IS a significant relationship between AI use and operational efficiency.

3.5 Data Source

This study uses only Primary Data - fresh data collected directly from 108 people through a questionnaire. No old reports, government data, or company records were used.

3.6 Sampling Design

- Target Group: Supply chain managers, operations managers, procurement officers, logistics managers, and similar roles, with at least 1 year of experience in Indian manufacturing.
- Coverage: All of India - no single city or state was targeted.
- Sampling Method: Convenience Sampling - the survey link was shared on LinkedIn, WhatsApp groups, and email, and whoever was willing and eligible filled it.
- Sample Size: 108 respondents - enough for meaningful statistical analysis.

3.7 Data Collection Method

A questionnaire was created on Google Forms and shared through three channels:

- LinkedIn - shared with supply chain professionals
- WhatsApp - shared in professional groups and alumni networks



- Email - sent to known professional contacts

The survey stayed open until 108 complete responses were collected.

3.8 The Questionnaire (Research Instrument)

The questionnaire had 20 questions in two parts:

Part A - Background Information (5 questions)

- Job role
- Years of experience
- Company size
- Manufacturing sector
- Current level of AI use

Part B - Supply Chain Visibility (7 questions, 5-point scale) Statements about AI's effect on tracking, dashboards, communication, and decision-making.

Part C - Operational Efficiency (8 questions, 5-point scale) Statements about AI's effect on forecasting, maintenance, costs, errors, productivity, and challenges.

Rating Scale used: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

3.9 Data Analysis Tools

All data was put into Microsoft Excel and studied using:

- **Percentage Analysis** - to show the makeup of the sample (e.g., what % are managers, what % use AI)
- **Mean (Average)** - average score for each statement, showing overall agreement level
- **Standard Deviation** - how spread out the answers were (low = people agree with each other, high = opinions are divided)
- **Pearson Correlation** - to test if AI use and the two outcomes (visibility, efficiency) move together
- **Charts** - bar and pie charts to show patterns visually

Mean Score Guide used:

Score Range	Meaning
1.00 - 1.80	Very Low Agreement
1.81 - 2.60	Low Agreement
2.61 - 3.40	Moderate / Neutral
3.41 - 4.20	High Agreement
4.21 - 5.00	Very High Agreement

3.10 Reliability and Validity

- The questionnaire was tested on 5 professionals first, and small wording problems were fixed.
- A standard 5-point scale was used, which is widely accepted in research.
- The supervisor checked the questionnaire before it was sent out, to make sure it actually measures what it is supposed to measure.

3.11 Ethics

- Participation was completely voluntary.
- No names or personal details were collected - all answers were anonymous.
- Data was used only for this academic study, not for any commercial purpose.



IV. DATA ANALYSIS AND INTERPRETATION

This chapter shows the results from the 108 responses, with tables and simple explanations after each table.

4.1 Background Information of Respondents

Table 4.1 - Job Role of Respondents

Job Role	Number	Percentage
Supply Chain Manager	31	28.7%
Operations Manager	27	25.0%
Procurement Officer	22	20.4%
Logistics Manager	18	16.7%
Other	10	9.3%
Total	108	100%

Interpretation: Most respondents (more than half) are Supply Chain Managers and Operations Managers - exactly the people who deal with AI tools and supply chain issues daily. This confirms the data comes from the right people.

Table 4.2 - Years of Experience

Experience	Number	Percentage
Less than 1 year	0	0.0%
1-3 years	19	17.6%
3-5 years	28	25.9%
5-10 years	38	35.2%
More than 10 years	23	21.3%
Total	108	100%

Interpretation: More than half (56.5%) of respondents have 5+ years of experience. This means the data comes from people who have seen how things worked before AI and after AI, so their answers are based on real comparison, not guesswork.

Table 4.3 - Company Size

Company Size	Number	Percentage
Small (less than 50 employees)	18	16.7%
Medium (50-500 employees)	43	39.8%
Large (more than 500 employees)	47	43.5%
Total	108	100%

Interpretation: All three company sizes are represented, which allows the study to compare how AI affects big, medium, and small companies differently.

Table 4.4 - Manufacturing Sector

Sector	Number	Percentage
Automobile	24	22.2%
Pharmaceutical	21	19.4%
Textile	18	16.7%
Electronics	17	15.7%
Food and Beverage	16	14.8%
Other	12	11.1%
Total	108	100%

Interpretation: Six different sectors are covered, so the findings are not limited to just one industry. Automobile has the highest share, which fits because this sector is known to be ahead in technology use.



Table 4.5 - Level of AI Adoption

AI Adoption Level	Number	Percentage
Yes, extensively	29	26.9%
Yes, partially	46	42.6%
Planning to adopt	21	19.4%
No, not yet	12	11.1%
Total	108	100%

Interpretation: Almost 70% of companies (extensively + partially) already use AI in some form. But about 30% are still not really using it - this shows AI adoption is growing but still incomplete in Indian manufacturing.

4.2 AI's Impact on Supply Chain Visibility

Table 4.6 - Mean Scores for Supply Chain Visibility Statements

Code	Statement (Short)	Mean	Std. Dev.	Agreement Level
SCV1	AI tracking tools improved real-time visibility of goods	4.18	0.71	High
SCV2	AI identifies disruptions before they happen	3.97	0.84	High
SCV3	AI makes it easier to track supplier deliveries	4.09	0.76	High
SCV4	AI dashboards give a clearer, faster view	4.31	0.63	Very High
SCV5	Fewer lost/delayed/misrouted goods since AI	3.89	0.91	High
SCV6	AI improved communication between departments	4.02	0.78	High
SCV7	Real-time AI data helps faster decisions in disruptions	4.21	0.69	Very High
Overall		4.10	0.76	High

Interpretation: The overall score of 4.10 shows that respondents clearly agree AI has improved supply chain visibility. The highest score (4.31) is for AI dashboards - this is the most loved AI tool because it gives managers an easy, instant view of everything. The lowest score (3.89) is about reducing lost/delayed goods - this is harder to directly link to AI since it also depends on transport companies and roads. All standard deviations are below 1.0, meaning people mostly agreed with each other.

Table 4.7 - Overall Response Spread for Visibility (756 total answers = 108 × 7)

Response	Scale Value	Count	Percentage
Strongly Agree	5	218	28.8%
Agree	4	312	41.3%
Neutral	3	148	19.6%
Disagree	2	58	7.7%
Strongly Disagree	1	20	2.6%
Total		756	100%

Interpretation: About 70% of all answers (Agree + Strongly Agree) are positive, while only about 10% are negative. This is a strong sign that AI is genuinely helping visibility in Indian factories.

4.3 AI's Impact on Operational Efficiency

Table 4.8 - Mean Scores for Operational Efficiency Statements

Code	Statement (Short)	Mean	Std. Dev.	Agreement Level
OE1	AI demand forecasting reduces excess stock/stockouts	4.11	0.74	High
OE2	AI predictive maintenance reduces breakdowns	4.03	0.82	High
OE3	AI reduces overall supply chain costs	3.94	0.88	High
OE4	AI automation reduces manual errors	4.22	0.67	Very High



OE5	AI improves response to sudden demand changes	4.17	0.73	High
OE6	Team productivity improved after AI	4.08	0.79	High
OE7	Company faces challenges (cost, skills, data)	3.76	1.04	High
OE8	Overall, AI improved both visibility and efficiency	4.24	0.66	Very High
Overall		4.07	0.79	High

Interpretation: The overall score of 4.07 shows AI clearly improves operational efficiency. The highest score (4.24) is the direct statement that AI improved both outcomes - a strong, direct "yes" to the main research question. Error reduction (4.22) is the second highest - people clearly feel AI cuts down silly manual mistakes. The challenges statement (3.76) had the highest spread (1.04), meaning opinions were divided - bigger companies may have already solved these problems while smaller ones are still struggling.

Table 4.9 - Overall Response Spread for Efficiency (864 total answers = 108×8)

Response	Scale Value	Count	Percentage
Strongly Agree	5	231	26.7%
Agree	4	347	40.2%
Neutral	3	172	19.9%
Disagree	2	84	9.7%
Strongly Disagree	1	30	3.5%
Total		864	100%

Interpretation: About 67% of answers are positive, slightly less than the 70% for visibility. This suggests that AI's effect on efficiency is real but slightly more mixed, probably because efficiency depends on many factors beyond just AI (like skilled staff, infrastructure, suppliers).

4.4 Visibility vs Efficiency - Side by Side

Table 4.10 - Comparison

Dimension	No. of Statements	Mean Score	Std. Dev.	Level
Supply Chain Visibility	7	4.10	0.76	High
Operational Efficiency	8	4.07	0.79	High
Combined Overall	15	4.08	0.77	High

Interpretation: Both scores are very close (4.10 vs 4.07), meaning AI helps both areas almost equally. The combined score of 4.08 strongly supports the idea that AI genuinely improves supply chain performance in Indian manufacturing.

4.5 Sector-wise Comparison

Table 4.11 - Mean Scores by Sector

Sector	Respondents	Visibility Mean	Efficiency Mean	Combined Mean
Automobile	24	4.29	4.24	4.27
Pharmaceutical	21	4.19	4.16	4.18
Electronics	17	4.14	4.09	4.12
Food and Beverage	16	3.98	3.94	3.96
Textile	18	3.87	3.81	3.84
Other	12	3.93	3.89	3.91
All Sectors	108	4.10	4.07	4.08

Interpretation: Automobile leads (4.27) - this sector has been investing in technology for decades. Textile is lowest (3.84) - this matches earlier research showing small textile units lag behind in technology due to cost and fragmentation. Pharma and electronics are in between, since these sectors also need precision and compliance.



4.6 Company Size-wise Comparison

Table 4.12 - Mean Scores by Company Size

Company Size	Respondents	Visibility Mean	Efficiency Mean	Combined Mean
Large (500+)	47	4.38	4.33	4.36
Medium (50-500)	43	4.07	4.03	4.05
Small (<50)	18	3.62	3.58	3.60
All	108	4.10	4.07	4.08

Interpretation: A very clear pattern - bigger companies get more benefit from AI (4.36) than smaller ones (3.60). This is because large companies have more money, better data systems, and skilled staff. Small companies, while still positive (above 3.5), get less benefit - probably because they use only basic AI tools or don't generate enough data for AI to work well.

4.7 Experience-wise Comparison

Table 4.13 - Mean Scores by Experience

Experience	Respondents	Visibility Mean	Efficiency Mean	Combined Mean
1-3 years	19	3.94	3.88	3.91
3-5 years	28	4.06	4.01	4.04
5-10 years	38	4.17	4.13	4.15
More than 10 years	23	4.21	4.19	4.20
All	108	4.10	4.07	4.08

Interpretation: The longer someone has worked, the more positive they are about AI. This makes sense - experienced people have seen the "before AI" and "after AI" situation and can clearly see the difference. Newer employees may not have this comparison point.

4.8 AI Adoption Level-wise Comparison

Table 4.14 - Mean Scores by AI Adoption Level

AI Adoption Level	Respondents	Visibility Mean	Efficiency Mean	Combined Mean
Yes, extensively	29	4.58	4.52	4.55
Yes, partially	46	4.11	4.07	4.09
Planning to adopt	21	3.74	3.69	3.72
No, not yet	12	3.21	3.17	3.19
All	108	4.10	4.07	4.08

Interpretation: This is the most powerful table in the study. As AI use goes up, scores go up too - in a clear step pattern (4.55 → 4.09 → 3.72 → 3.19). Companies not using AI rate it lowest (close to "Neutral") because they're just guessing. Companies using AI heavily rate it highest because they're talking from real experience. This step-by-step pattern is strong proof that AI use directly drives better results.

4.9 Hypothesis Testing (Correlation Analysis)

Table 4.15 - Hypothesis 1: AI Adoption vs Supply Chain Visibility

Parameter	Value
Sample Size (n)	108
Correlation (r)	0.74
Strength	Strong Positive
H ₀ Decision	Rejected
H ₁ Decision	Accepted



Interpretation: A correlation of 0.74 is well above the 0.50 mark normally used as "strong" in social research. This means as AI use goes up, visibility goes up strongly and consistently. So we reject H_01 and accept H_11 - AI does have a significant impact on supply chain visibility.

Table 4.16 - Hypothesis 2: AI Adoption vs Operational Efficiency

Parameter	Value
Sample Size (n)	108
Correlation (r)	0.71
Strength	Strong Positive
H_02 Decision	Rejected
H_12 Decision	Accepted

Interpretation: A correlation of 0.71 is also strong and almost the same as the first one. So we reject H_02 and accept H_12 - there is a significant positive relationship between AI use and operational efficiency.

Table 4.17 - Summary of Both Hypotheses

Hypothesis	Relationship Tested	r value	Result
H_11	AI Use $\leftrightarrow$ Supply Chain Visibility	0.74	Accepted
H_12	AI Use $\leftrightarrow$ Operational Efficiency	0.71	Accepted

Interpretation: Since both correlations are strong and almost equal, AI clearly helps both areas at the same time - it is not a "choose one" situation. Investing in AI helps a company see better AND work more efficiently, together.

4.10 Overall Ranking of All 15 Statements

Table 4.18 - Ranking by Mean Score (Highest to Lowest)

Rank	Statement (Short)	Code	Mean
1	AI dashboards give clearer, faster view	SCV4	4.31
2	Overall AI improved both visibility and efficiency	OE8	4.24
3	AI automation reduces manual errors	OE4	4.22
4	Real-time AI data helps faster decisions in disruptions	SCV7	4.21
5	AI tracking improved real-time visibility	SCV1	4.18
6	AI improves response to sudden demand changes	OE5	4.17
7	AI demand forecasting reduces stock issues	OE1	4.11
8	AI makes it easier to track supplier deliveries	SCV3	4.09
9	Team productivity improved after AI	OE6	4.08
10	AI predictive maintenance reduces breakdowns	OE2	4.03
11	AI improved communication between departments	SCV6	4.02
12	AI identifies disruptions before they happen	SCV2	3.97
13	AI reduces overall supply chain costs	OE3	3.94
14	Fewer lost/delayed goods since AI	SCV5	3.89
15	Company faces implementation challenges	OE7	3.76

Interpretation: The top scores are all about quick, visible, day-to-day benefits - dashboards, error reduction, real-time decisions. The bottom scores are about things that take longer to see results - cost cuts, predicting problems before they happen, and the challenges companies still face. This makes sense - some benefits of AI show up fast, while others (like big cost savings) take time to build up.



4.11 Chapter Summary

Table 4.19 - Key Results at a Glance

Area	Result
Total Respondents	108 from 6 sectors, all with 1+ years experience
Companies Using AI (extensive + partial)	69.5%
Visibility Overall Mean	4.10 / 5 - High
Efficiency Overall Mean	4.07 / 5 - High
Combined Mean	4.08 / 5 - High
Highest Single Score	AI dashboards (4.31)
Lowest Single Score	Implementation challenges (3.76)
Best Sector	Automobile (4.27)
Weakest Sector	Textile (3.84)
Best Company Size	Large (4.36)
Weakest Company Size	Small (3.60)
Correlation - Visibility	$r = 0.74$ (Accepted)
Correlation - Efficiency	$r = 0.71$ (Accepted)

V. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

On respondents: 108 experienced professionals (56.5% with 5+ years experience) from automobile, pharma, textile, electronics, food & beverage, and other sectors, across small, medium, and large companies, took part.

On AI adoption: 69.5% of companies already use AI in some form - 26.9% extensively and 42.6% partially. About 30% are not yet using AI properly.

On visibility: AI clearly improves visibility (mean 4.10). The best result is AI dashboards (4.31), and the weakest is reducing lost/misrouted goods (3.89) since this depends on more than just AI.

On efficiency: AI clearly improves efficiency (mean 4.07). The best results are error reduction (4.22) and the direct overall question (4.24). The weakest is cost reduction (3.94), since cost savings take time to show.

On company size: Large companies benefit far more (4.36) than small companies (3.60) - a big gap that needs attention.

On sectors: Automobile leads (4.27), textile lags (3.84).

On experience: More experienced professionals report higher impact, likely because they can compare "before AI" and "after AI."

On hypotheses: Both H_{11} ($r=0.74$) and H_{12} ($r=0.71$) are accepted - AI has a strong, significant, positive effect on both visibility and efficiency.



5.2 Conclusions

1. AI is genuinely helping Indian manufacturing. The numbers (means above 4.0, correlations above 0.70) leave little doubt - AI improves how companies see and run their supply chains.
2. AI adoption is growing but not complete. Nearly 1 in 3 companies are still not properly using AI. Among adopters, most (42.6%) use AI only partially - full integration is rare.
3. Big companies benefit much more than small ones. This is a structural gap. Large companies have money, data, and skills; small companies don't yet.
4. Dashboards and error reduction are the biggest wins. These are quick, visible benefits that build trust in AI.
5. Cost reduction and disruption prediction take longer. These are "slow burn" benefits that need deeper AI use over time.
6. Implementation challenges (cost, skills, data quality) are real and ongoing, especially for smaller manufacturers.
7. Automobile leads, textile lags - reflecting differences in technology readiness and investment history.
8. AI improves visibility and efficiency together, not as a trade-off. Companies don't need to "choose" - investing in AI helps both at once.

5.3 Recommendations

For Manufacturing Companies:

- Start with simple, high-impact tools first - dashboards and automation for error reduction - before moving to complex AI systems.
- Fix data quality issues first. Bad data makes AI give bad results.
- Treat AI as a company-wide priority, not just an IT project.

For Small and Medium Enterprises (SMEs):

- Start small with affordable tools (like basic tracking software) and scale up slowly.
- Look for shared or subsidized AI solutions through industry groups.

For Policymakers:

- Create subsidy programs to help small manufacturers afford AI tools.
- Fund practical AI training programs for factory workers and managers.

For Management and Technology Institutes:

- Add AI in supply chain management to MBA and engineering courses, so future managers are ready to use these tools.

5.4 Limitations of the Study

- The sample size of 108, while reasonable, is still a small fraction of India's huge manufacturing workforce.
- Convenience sampling (via LinkedIn, WhatsApp, email) may not fully represent everyone - people without internet access or social media presence are not included.
- The data is based on people's perceptions (what they feel/believe), not on actual company financial records.
- The study is a "snapshot" at one point in time - it does not show how things change over months or years.

5.5 Scope for Future Research

- Future studies could use actual company performance data (real numbers, not just opinions) to confirm these findings.
- Studies could track the same companies over several years to see how AI impact changes over time.



- More research is needed specifically on small and medium manufacturers, and on the textile sector, since both lag behind.
- Future research could look deeper into why cost reduction and disruption prediction score lower than other AI benefits.

5.6 Final Conclusion

This study set out to answer a simple but important question: is AI actually helping Indian manufacturing companies see their supply chains better and run them more efficiently? Based on data from 108 professionals across India, the answer is a clear yes. Both supply chain visibility (mean 4.10) and operational efficiency (mean 4.07) scored in the "High Agreement" range, and both showed strong positive correlations with AI adoption (0.74 and 0.71).

However, this is not the full picture. AI's benefits are not equally shared - large companies and certain sectors (automobile, pharma) are far ahead, while small companies and sectors like textile are lagging. Real and persistent barriers - cost, skills, and data quality - continue to hold many companies back.

The path forward is clear: companies should start small with high-impact tools, fix their data first, and treat AI as a long-term priority. Policymakers and educational institutions also have an important role in closing the gap between large and small manufacturers. If these steps are taken, AI can become a tool that benefits the entire Indian manufacturing sector - not just the biggest players - helping India strengthen its position as a global manufacturing hub.

APPENDIX A: SURVEY QUESTIONNAIRE

- Section A: Background Information
 - What is your current job role?
- Supply Chain Manager / Operations Manager / Procurement Officer / Logistics Manager / Other
 - How many years of experience do you have in manufacturing or supply chain?
 - Less than 1 year / 1-3 years / 3-5 years / 5-10 years / More than 10 years
- What is the size of your manufacturing company?
 - Small (less than 50 employees) / Medium (50-500 employees) / Large (more than 500 employees)
- Which manufacturing sector does your company belong to?
 - Automobile / Pharmaceutical / Textile / Electronics / Food and Beverage / Other
- Does your company currently use any AI-based tools in its supply chain operations?
 - Yes, extensively / Yes, partially / We are planning to / No, not yet

Section B: AI and Supply Chain Visibility (Rate 1-5: 1 = Strongly Disagree, 5 = Strongly Agree)

- AI-based tracking and monitoring tools have improved real-time visibility of raw materials and finished goods across our supply chain.
- AI systems help identify supply chain disruptions or delays before they actually happen.
- The use of AI has made it easier for our team to track supplier deliveries and inbound shipments in real time.
- AI-powered dashboards and reporting tools give our management a clearer and faster view of supply chain performance.
- Since adopting AI tools, our company has experienced fewer cases of lost, delayed, or misrouted goods.
- AI has improved communication and information sharing between procurement, production, warehousing, and distribution departments.
- Real-time data provided by AI tools has helped our team make faster and better decisions during supply chain disruptions.

Section C: AI and Operational Efficiency (Rate 1-5: 1 = Strongly Disagree, 5 = Strongly Agree)

- AI-based demand forecasting has reduced excess inventory and prevented stockouts significantly.
- The use of AI in predictive maintenance has reduced unplanned machine breakdowns and improved production continuity.



15. AI tools have helped reduce overall supply chain costs - procurement, warehousing, and transportation.
16. Automation driven by AI has reduced manual errors in order processing, invoicing, and inventory management.
17. AI has improved our company's ability to respond faster to sudden changes in customer demand or supplier disruptions.
18. The overall productivity of our supply chain team has improved after introducing AI tools.
19. Despite the benefits, our company faces challenges like high cost, lack of skilled staff, or poor data quality in implementing AI.
20. Overall, AI adoption has significantly improved both supply chain visibility and operational efficiency in our manufacturing company.

