RESEARCH PAPER

Prioritizing Technology of Ai-Driven Enablers for Efficient Distribution of Finished Pharmaceutical Products in Indian Markets: An Ahp Approach

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ABSTRACT

Purpose: This paper aims to outline and describe the main AI-based enablers that can serve to optimize the distribution of finished pharmaceutical products in the Indian markets. It is aimed at identifying the technological, operational, and regulatory aspects that play the greatest role in enhancing the performance of distribution using artificial intelligence.

Design/Methodology/Approach: Fuzzy Analytic Hierarchy Process (Fuzzy AHP) - Multi-Criteria Decision-Making (MCDM) method was used to analyze and prioritize the key AI-based enablers that affect pharmaceutical distribution. Data were obtained by interviewing 15 professionals, such as pharmaceutical supply chain managers, logistics professionals, data scientists, and academic scholars in the field of healthcare operations and artificial intelligence. Expert judgments were reviewed based on pair-wise comparison and fuzzy logic principles to give relative weights and determine the rankings of enablers.

Findings: The review has identified Cold Chain Monitoring and Management, Quality Control Automation, and Predictive Demand Forecasting as the strongest enablers that lead to efficiency in the pharmaceutical distribution process. The importance of Counterfeit Detection and Prevention and Real-Time Supply Chain Visibility was moderate as they positively affected the enhancement of transparency and product authenticity. In the meantime, supportive roles were performed by Inventory Optimization, Intelligent Dispatch Planning, and Regulatory Compliance Automation that helped to increase coordination and manage regulatory alignment. The results show that AI-based temperature control, predictive analytics, and quality assurance mechanisms are the main factors supporting efficient distribution.

Implications: The findings would be useful to pharmaceutical companies, transportation partners, and policymakers intending to enhance distribution networks by using artificial intelligence. The paper highlights the need to invest in AI-assisted cold-chain infrastructure, automated quality checking, and services prediction to enhance service reliability.

Originality/Value: The study is also one of the first to use Fuzzy AHP to rank AI enablers in the business of Indian pharmaceutical distribution. It ushers in an expert-led, systematic method of decision making that takes a balance between theoretical knowledge and industry. The study qualifies as conceptually and empirically useful in that it seeks to depict important technological priorities that can serve as a guiding tool in undertaking strategic investment and policy efforts to create wise, resilient, and strong pharmaceutical distribution systems in India.

Keywords: Pharmaceutical Products, Artificial Intelligence, Fuzzy Analytic Hierarchy Process.

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1. Introduction:

The allocation of the finished medicines in the Indian pharmaceutical setting is among the complex and vital concerns, which are driven by the need to have an access to these medicines in time, maintain their integrity, and meet the regulatory and market demands. It is also believed that the Indian pharmaceutical industry is the pharmacy of the world, and its generics production occupies a large proportion, yet the distribution infrastructure in the country remains related to a considerable number of inefficiencies and risks (Sharma, 2025; Wong et al., 2023). The urgency of the research is justified by the ever-reemerging issues of failure of the stock-outs, cold-chain systems, delays in the last-mile delivery, and the absence of coherence of the inventory system - all these have a negative impact on the patient safety and the operating costs. To provide an example, the Indian supply chain study states that service quality in the industry is substandard compared to the global requirements and must adopt the advanced technology, including AI and ML (Sharma, 2025). The new technologies have presented interesting opportunities to transform the pharmaceutical logistics with the assistance of artificial intelligence (AI). According to the previous studies, AI-based predictive analytics, machine-learning-based inventory optimisation, real-time sensor data, and route-optimisation algorithms can critically enhance the resilience, responsiveness, and cost-effectiveness of supply-chain (Vora et al., 2023; Al-Hourani and Weraikat, 2025). However, much of the current literature is theoretical or model-driven, which may include minimal field research to concentrate on the Indian environment of distributor networks, regulatory disparities, cold-chain exposure, and rural outreach last-mile (Adekola and Dada, 2024; Saini et al., 2025). This gap creates the necessity to carry out a detailed, context-related study to analyze the facilitators, constraints and measurable outcomes of AI adoption in Indian pharmaceutical distribution. The process of manufacturing, warehousing, transportation, wholesaling, and retailing are interrelated processes that entail distribution of completed pharmaceutical products that need to be highly fidelity coordinated and traced (Wong et al., 2023). This is also complicated by India, where the geographic terrain is heterogeneous, storage facilities are heterogeneous, regulatory overlays (e.g. GDP/GMP compliance) and demand trends are evolving very fast (Sharma, 2025; Kumar, 2022). As a cross-cutting enabler, AI can be applied by predictive models of demand-forecasting to focus on minimising the inventory mismatch, real-time monitoring systems to reduce cold-chain violations, and route-optimisation models to reduce the lead-time to enhance the supply chain performance (Vora et al., 2023; Saini et al., 2025; Al-Hourani and Weraikat, 2025). Such interventions, however, depend on the level of maturity of the data, the existence of infrastructure to undertake their work, congruence with the regulatory framework, stakeholder training and governance model, which is not well analysed in the Indian distribution systems (Kumar, 2022; Adekola and Dada, 2024). The present research paper is based on this and examines AI-based facilitators to the successful distribution of the finished drug items in the Indian markets. It must discover the best enablers in the Indian distribution environment, explore obstacles to their application, and provide viable guidance to policy-makers, industry and logistics providers to create scalable context-sensitive AI solutions. In that way, the study will have a contribution to both theoretical and practical implications in terms of inculcating intelligence in the pharmaceutical distribution in the particular context of India and the operating and regulating system.

The current paper will discuss how the use of AI-based enablers can lead to the improved efficiency, transparency, and responsiveness of the distribution of finished pharmaceutical products in the Indian markets. It aims to give a theoretical and practical background of how artificial intelligence (AI) applications, can be implemented in pharmaceutical supply chains to enhance operational accuracy, regulatory compliance, and service quality. The research also advances a systematic analytic framework linking the level of technological adoption and the two outcomes of performance that can ascertain that the effects of AI enablers can be quantified, contrasted, and generalized to strategic options in the Indian pharmaceutical distribution system.

The research questions to be used in the study are as follows:

RQ1: Which are the most important enablers that affect the integration of artificial intelligence (AI) into the distribution of the finished pharmaceutical products in the Indian markets?

RQ2: How do these enablers, related to each other, enhance efficiency and transparency of pharmaceutical distributions systems?

The study is a valuable addition to the already increasing area of digital transformation in pharmaceutical logistics as it connects the theoretical framework of AI and efficiency of the supply chain to actual distribution patterns. It goes beyond previous descriptive research on digital logistics and utilizes the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP) to assess and rank AI-based enablers, including predictive demand forecasting, IoT-based monitoring, blockchain-enabled traceability, and AI-assisted decision support systems, in an organized manner. The Fuzzy-AHP method is an effective way of dealing with subjective decision making and uncertainty of various stakeholders and thus making the analysis stronger and the results more reliable. The originality of the present study is the integration of Fuzzy-AHP and the stakeholder-based assessment; it is necessary to define the most significant technological, infrastructural, and organizational aspects that help to incorporate AI in pharmaceutical distribution. The proposed decision-making model is a systematic basis to enhance data-based distribution management, which offers theoretical meaning as well as practical advice to policy-makers, logistics managers, and technology providers.

In the paper, there are five sections. The introductory section summarises the rationale, necessity, and aims of exploring AI-driven enablers in efficient pharmaceutical distribution in India, as well as the gaps in the research and contributions. The second section outlines the research methodology which focuses on the use of the Fuzzy-AHP technique to classify and rank AI enablers. The third part is the in-depth examination of the main reasons that can affect the adoption of AI in pharmaceutical supply chains. The fourth part provides the report and analysis of findings in the form of analytical tables and graphic models to understand them. Lastly, the implications, limitations and recommendations are discussed in the fifth section as a way of facilitating effective and responsible application of AI technologies in the pharmaceutical distribution systems in India.

2. Enablers for Efficient Distribution of Finished Pharmaceutical Products in Indian Markets

1. **Predictive Demand Forecasting**

Pharmaceutical supply chains have been transformed by AI-based predictive demand forecasting which employs machine learning to predict demand by utilizing historical data, seasonal variations and market forces. These predictive models assist companies to minimize stockouts and surplus inventory, enhance service reliability and responsiveness. Al-Hourani and Weraikat (2025) write that AI-based forecasting can contribute greatly to the supply chain resilience, and Vora et al. (2023) add that it is also potentially useful in facilitating the production and inventory optimization in pharmaceutical systems that are complicated. All these studies indicate that AI has increasingly become important in enhancing forecasting accuracy and efficiency of operations in healthcare logistics.

2. **Intelligent Dispatch Planning**

Smart dispatch planning is a system that combines AI-based algorithms in route optimization, scheduling, and resource allocation to reduce transportation delays and costs. Wong et al. (2023) prove that AI-based routing provides better models of accuracy and flexibility to delivery during changing logistics conditions. Likewise, Huanbutta (2024) highlights the importance of predictive route analytics to enhance last-mile distribution by minimizing the travel time and protecting the integrity of drugs. The literature supports the increased role of AI in dispatch optimization but requires increased empirical experiments in emerging markets like India where infrastructure limitations continue to prevent broad usage.

3. **Real Time supply chain visibility**

The real-time visibility in pharmaceutical supply chain helps firms to trace products back to the manufacture stage to dispensing to ensure that there is transparency and regulatory adherence. Research by Wong et al. (2023) and Kodumuru et al. (2025) indicates that the combination of AI and IoT sensors enhances logistics network traceability and decisions. These systems enable stakeholders to have real-time information on location, condition, and delivery status thus improving coordination and risk management. Although the world is advancing, the current topic of real-time AI-based visibility of the Indian pharmaceutical networks is a poorly researched area.

4. **Cold Chain Monitoring and Management**

Temperature preservation is crucial to vaccines and biologics, which, in turn, is the core purpose of AI regarding the real-time monitoring of the cold chain. Jackson (2025) discovered that AI/ML algorithms have the ability to forecast temperatures deviations and optimize cooling facilities to stop spoilage. In a similar manner, Vora et al. (2023) have observed that smart cold chain management guarantees the safety of products through the incorporation of sensor feedback and predictive analytics. These results highlight that AI-based cold chain systems have a potential to improve compliance and product quality, especially in the Indian complex climatic and infrastructural environments.

5. **Quality Control Automation**

Achieving quality control systems that depend on AI: through deep learning and image recognition, product defects are identified and the pharmaceutical quality standards are met. Vora et al. (2023) emphasize that the accuracy of automated inspection systems enhances the accuracy of manufacturing and packaging and decreases human error. Huanbutta (2024) also notes that AI improves monitoring of the processing processes and prevents regulatory violations and the uniformity of the products. Combined, these studies prove the importance of AI in enhancing the effectiveness of quality assurance, but the combination with distribution processes downstream remains unexplored.

6. **Inventory Optimization**

The AI-powered inventory optimization allows pharmaceutical organizations to match the stock quantities with the demand projections and decrease wastage and holding expenses. Inventory control is listed as one of the most established AI applications used in the pharmaceutical logistics sector by Al-Hourani and Weraikat (2025) with enhancement of the responsiveness of supply chains. Similar results were indicated by Ma (2022) who observed that digital transformation projects based on AI improve decision making and decrease the inefficiency in inventory planning. Nevertheless, the literature also mentions the barriers to the implementation in the developing markets which involve data fragmentation and system incompatibility.

7. **Regulatory Compliance Automation**

The pharmaceutical sector requires a very high degree of regulatory compliance, and AI is becoming more popular as a way to standardize these functions. He demonstrates that AI-based natural language processing can speed up the document review process and enhance compliance reporting accuracy (Patil, 2023). Serrano et al. (2024) also attest that AI-based analytics have the potential to assist in audit preparedness and regulatory control, minimizing the number of errors and manual work. However, the use of AI in compliance automation at distribution level operations, especially in India, is still scanty.

8. **Counterfeit Detection and Prevention**

AI counterfeit prevention is based on machine learning, image search, and traceability (blockchain-based) to verify pharmaceutical items. The authors showed that AI-based blockchain models enhance transparency and traceability, which is a sufficient response to prevent the circulation of counterfeits (Sylim et al., 2018). Another AI-powered drugs authentication framework that can help improve security of digital supply chains was suggested by Gomasta et al. (2023). These results highlight the transformative nature of AI in making sure that patients are safe and trustful of the system, as they will not receive falsified drugs.

3. Research Methodology

The introduction of Artificial Intelligence (AI) solutions into the pharmaceutical distribution model is a multidimensional system, and its introduction associates a large number of interrelated technological, operational, and regulatory variables. It is important to consider the relativity of the importance of these AI-based enablers in a manner that would facilitate the subjective judgments and interactions based on multi-criteria. To this end, the Fuzzy Analytic Hierarchy Process (Fuzzy AHP)- a hybrid Multi-Criteria Decision-Making (MCDM) methodology that incorporates the methodological hierarchy of the Analytic Hierarchy Process (AHP) with the uncertainties management of the fuzzy logic, have been used in the current study.

AHP is a method that allows the decision-maker to break down a problem into hierarchical levels of criteria and sub-criteria originally introduced by Thomas L. Saaty in 1977. This is enhanced by fuzzy extension of AHP, which will adapt the linguistic ambiguity and imprecision of expert judgment (Saaty and Hu, 1998). This has made it quite appropriate in assessing the AI enablers whose effects may differ at the infrastructural, compliance, technology preparedness and supply chain integration levels in the pharmaceutical industry of India.

AHP Action Process to determine the Relative Leadership of AI-Driven Enablers.

Step 1: Critical Enablers Identification.

The first thing that was done was to outline essential AI-based enablers of an efficient distribution of pharmaceutical products using a comprehensive review of peer-reviewed journals and validated research publications. Eight major enablers, which included predictive demand forecasting, smart dispatch planning, real-time supply chain visibility, cold chain monitoring, automation of quality control, inventory optimization, automation of regulatory compliance, and detecting counterfeits were identified. These factors were proven by consulting 15 domain experts who are pharmaceutical supply chain managers, logistics professionals, data scientists and academic researchers. The feedback provided by experts was necessary to make the enablers fit within the context of the Indian market environment, and to be empirically-supported.

Step 2: Pairwise Comparison upon Expert Verdicts.

To assess the relative importance of the identified enablers, the experts developed a pairwise comparison between them with the help of the 9-point scale by Saaty where 1 implied the equal importance of the enablers, and 9 extreme preferences of one enabler instead of another. Aggregated judgments were obtained, which formed a Reciprocal Comparison Matrix (RCM) in the consensus-based approach. In order to present the uncertainty and subjectivity of human estimation, Fuzzy AHP was used, and linguistic preferences were converted into triangular fuzzy numbers. It was a procedure that increased the accuracy of the weight derivation and a reduction in the cognitive bias when the expert opinion.

Table 1: Saaty Scale for Pairwise Comparison

Numerical Value	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Demonstrated importance
9	Absolute importance
2, 4, 6, 8	Intermediate values

Step 3: Finalization of Comparison Matrix

The results of the pairwise comparisons, the reciprocal matrix understood them such that diagonal rows and columns were equal to 1 (self-comparison) and the off-diagonal rows and columns were the corresponding values of the comparative importance. Indicatively, when the experts pegged predictive demand forecasting five times higher than real-time visibility, the reversed comparative had a 1/5 peg. This guaranteed mathematical consistency and logical consistency in relative assessment.

Step 4: Normalized Matrix

All the enablers were then scaled to the aggregated matrix to give similar scales. The amount found in each column was normalized to one, and normalized weights could be calculated to determine the relative weighing of each enabler driven by AI. With these normalized weights, the ranking of the enablers based on their contribution to improving efficiency and sustainability of pharmaceutical distribution networks were achieved.

Step 5: Calculation of Consistency Index.

Consistency Index (CI) and Consistency Ratio (CR) have been calculated to make sure that the comparisons of experts are logical. CR was contrasted to the Random Consistency Index (RI) in which, the value of CR of less than 0.10 represented an admissible consistency of expert ratings. Any figure higher than this range resulted in revisiting and narrowing of decisions. This move guaranteed the methodological strength and internal validity of the fuzzy AHP-based rankings.

Table No: 2 Random Consistency Index

n	1	2	3	4	5	6	7	8
RI	**0**	**0**	**0.58**	**0.90**	**1.12**	**1.24**	**1.32**	**1.41**

4. Data Collection

Table No: 3 Enablers for Efficient Distribution of Finished Pharmaceutical Products in Indian Markets

Enablers	PDF	IDP	RTSC	CCMM	QC	IO	RC	CDP
Predictive Demand Forecasting (PDF)	1							
Intelligent Dispatch Planning (IDP)	X	1						
Real-Time Supply Chain Visibility (RTSC)	X		1					
Cold Chain Monitoring and Management (CCMM)	X	X	X	1				
Quality Control Automation (QC)	X	X	X	X	1			
Inventory Optimization (IO)	X	X	X	X	X	1		
Regulatory Compliance Automation (RC)	X	X	X	X	X	X	1	
Counterfeit Detection and Prevention (CDP)	X	X	X	X	X	X	X	1

The research gathered information on 15 well-chosen professionals who constituted a cross cut across the stakeholders in the pharmaceutical distribution dynamic in India. The sample consisted of the supply chain managers of the large pharmaceutical manufacturing companies, the third-party logistics companies, the data analytics professionals, regulatory advisors, and the academicians in the field of healthcare operations and artificial intelligence.

These experts were sent questionnaires that were structured in a pairwise comparison with each other. The questionnaires were a rating on the relative importance of each identified AI-driven enabler. The Fuzzy AHP was used to consolidate responses and produce a resultant weighted ranking. The methodological rigor was stressed by the process of data collection, which focused on triangulation of expert opinions, the existence of the criteria which will undergo a validation process before the end of the cycle, and on the opinions aggregation based on consensus. This methodology offers a strong platform of the most important AI-driven enablers able to promote the efficiency, transparency, and reliability of pharmaceutical distribution within the Indian market due to its systematic and quantitative nature and an expert-based approach.

Table no: 4 Pairwise Comparison Matrix of Enablers for Efficient Distribution of Finished Pharmaceutical Products in Indian Markets

Enablers	PDF	IDP	RTSC	CCMM	QC	IO	RC	CDP
Predictive Demand Forecasting (PDF)	1	5	3	0.33	1	7	5	2
Intelligent Dispatch Planning (IDP)	0.2	1	0.33	0.14	0.2	0.33	3	0.2
Real-Time Supply Chain Visibility (RTSC)	0.33	3	1	0.2	0.2	1	5	0.33
Cold Chain Monitoring and Management (CCMM)	3	7	5	1	3	5	7	3
Quality Control Automation (QC)	1	5	5	0.33	1	5	5	3
Inventory Optimization (IO)	0.14	3	1	0.2	0.2	1	3	0.5
Regulatory Compliance Automation (RC)	0.2	0.33	0.2	0.14	0.2	0.33	1	0.33
Counterfeit Detection and Prevention (CDP)	0.5	5	3	0.33	0.33	2	3	1
TOTAL	6.37	29.33	18.53	2.67	6.13	21.66	32	10.36

Table 4 shows the pairwise comparison matrix, which was calculated on expert judgment using Saaty nine-point scale to answer the question of the importance of AI-driven enablers in the efficient distribution of pharmaceutical products. The relative significance of each enabler to the rest is represented by each element in the matrix. To illustrate, the value of Stormin (3) with respect to most of the other enablers (with most of them ranging between 1 and 5) is relatively low with very minimal argument because the experts found it to be the most important in preserving product integrity during storage and transportation. Also moderately high comparative scores were placed on Predictive Demand Forecasting (PDF) and Quality Control Automation (QC), which are essential in the availability and quality of the product. Regulatory Compliance Automation (RC) and Intelligent Dispatch Planning (IDP) are ranked comparatively lower, which suggests that, whereas they are supposed to play an important role in the reliability of the operation, they do not have a direct influence on the instant distribution efficiency. Connection between the two parties of the matrix prove consistency and rational consistency in the appraisal of the experts.

Table No: 5 Normalized matrix

Enablers	PDF	IDP	RTSC	CCMM	QC	IO	RC	CDP
Predictive Demand Forecasting (PDF)	0.1570	0.1705	0.1619	0.1236	0.1631	0.3232	0.1563	0.1931
Intelligent Dispatch Planning (IDP)	0.0314	0.0341	0.0178	0.0524	0.0326	0.0152	0.0938	0.0193
Real-Time Supply Chain Visibility (RTSC)	0.0518	0.1023	0.0540	0.0749	0.0326	0.0462	0.1563	0.0319
Cold Chain Monitoring and Management (CCMM)	0.4710	0.2387	0.2698	0.3745	0.4894	0.2308	0.2188	0.2896
Quality Control Automation (QC)	0.1570	0.1705	0.2698	0.1236	0.1631	0.2308	0.1563	0.2896
Inventory Optimization (IO)	0.0220	0.1023	0.0540	0.0749	0.0326	0.0462	0.0938	0.0483
Regulatory Compliance Automation (RC)	0.0314	0.0113	0.0108	0.0524	0.0326	0.0152	0.0313	0.0319
Counterfeit Detection and Prevention (CDP)	0.0785	0.1705	0.1619	0.1236	0.0538	0.0923	0.0938	0.0965
							CI	0.068
							RI	1.41
							CR	0.095

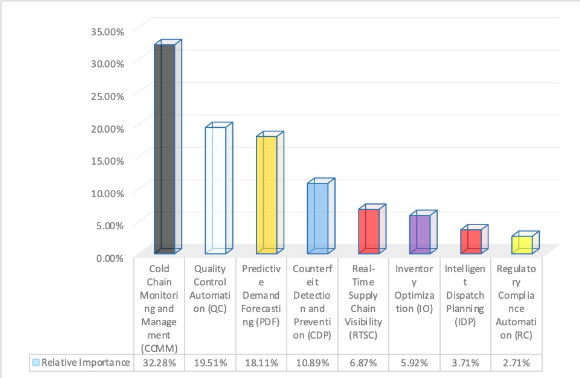
The normalized comparison matrix, which transforms all the comparison raw values into proportional weights to make comparisons consistent, is presented in Table 5 obtained on the basis of the pairwise judgments. Normalization will make sure that the sum of each column is equal to one and help to determine standardized relative importance scores of all enablers. It can be concluded that the Cold Chain Monitoring and Management (CCMM) has the highest normalized weight in most of the criteria, which confirms its hegemonic role in the Indian pharmaceutical supply chain setting. The values of Predictive Demand Forecasting (PDF) and Quality Control Automation (QC) are also highly normalized, which indicates their role in the reliability of the distribution and the safety of the products. On the other hand, the Intelligent Dispatch Planning (IDP) and Regulatory Compliance Automation (RC) exhibit lower normalized scores implying that they play a supportive and not a guiding role. The value of the consistency ratio (CR) that equals 0.095 is smaller than the acceptable value of 0.10 and this statement proves the reliability and consistency of the expert judgments against the validity of the AHP model.

Table No: 6 Relative and Cumulative Importance of Factors

Enablers for Efficient Distribution of Finished Pharmaceutical Products in Indian Markets	Relative Importance	Cumulative Importance
Cold Chain Monitoring and Management (CCMM)	32.28%	32.28%
Quality Control Automation (QC)	19.51%	51.79%
Predictive Demand Forecasting (PDF)	18.11%	69.90%
Counterfeit Detection and Prevention (CDP)	10.89%	80.79%
Real-Time Supply Chain Visibility (RTSC)	6.87%	87.66%
Inventory Optimization (IO)	5.92%	93.58%
Intelligent Dispatch Planning (IDP)	3.71%	97.29%
Regulatory Compliance Automation (RC)	2.71%	100.00%

Table 6 shows the relative and cumulative significance of every AI-enabled enabler, obtained by multiplying weights through normalization. Findings indicate that the strongest factor is the Cold Chain Monitoring and Management (32.28%), which shows the importance of AI-enabled monitoring systems to maintain the pharmaceutical products that are sensitive to temperature and the regulations of these products. Quality Control Automation (19.51%) and Predictive Demand Forecasting (18.11) come second, in that order as they play a crucial role in reducing wastage, ensuring quality of the product, and enhancing the accuracy of inventory. There are contributions of moderate strength by Counterfeit Detection and Prevention (10.89) and Real-Time Supply Chain Visibility (6.87) strategies, making supply chain transparency and authenticity stronger. In the meantime, the Inventory Optimization (5.92%), Intelligent Dispatch Planning (3.71%), and Regulatory Compliance Automation (2.71%) show relatively less impact, though they are the most necessary supportive factors. In general, the totals of the importance values, reaching the total of 100, show that the hierarchy of enablers is balanced, with the three leading ones contributing almost 70 per cent of the overall impact, which means that they play the key role in the optimization of the pharmaceutical distribution efficiency of AI-based mechanisms.

Figure No: 1 Relative Importance



5. Conclusion

The findings of this study concluded that AI driven technologies contribute a critical role in enhancing the efficiency, reliability, and transparency of pharmaceutical distribution in India and the enablers with the most significant impact include the Cold Chain Monitoring and Management, Quality Control Automation, and Predictive Demand Forecasting. All these factors lead to the fact that they nearly 70 percent of the overall influence, making them critical to product safety and supply sustainability. These results support previous academic literature that the introduction of AI promotes a well-informed decision-making process, real-time management, and mitigation of risks throughout the pharmaceutical logistics. In addition, the study builds upon existing literature by providing an organized prioritization of AI enablers with the help of Fuzzy AHP in line with determining how the use of expert-tested weighting can guide the industry in the selection of technology investments and creation of policies. Conclusively, the findings propose a targeted use of AI in key control aspects-forecasting, monitoring, and quality to deliver resilient and sustainable pharmaceutical supply chains in the Indian environment.

6. Discussion

According to the AHP analysis results, the most effective enablers to guarantee efficient distribution of the finished pharmaceutical products within Indian market are Cold Chain Monitoring and Management, Quality Control Automation, and Predictive Demand Forecasting. The results are in line with the main findings of previous studies that claim that AI-based cold-chain technologies are effective to provide a great deal of product integrity and compliance (Jackson, 2025; Vora et al., 2023). In the same way, the necessity to automate quality control is proved by the results of Huanbutta (2024) and Vora et al. (2023), who have shown that AI-powered inspection and process monitoring reduce the number of errors made by people and enhance adherence to regulations. Predictive demand forecasting has higher priority, which confirms the findings of Al-Hourani and Weraikat (2025), who concluded that forecasting accuracy is one of the significant determinants of the supply-chain resilience of pharmaceutical. Conversely, the negative places of regulatory compliance automation and intelligent dispatch planning sound like gaps in the work of Serrano et al. (2024) and Wong et al. (2023), where the lack of empirical adoption and infrastructural barriers inhibited its quantified influence. Overall, the discussion highlights the fact that, whereas each of the eight enablers has a beneficial influence on performance, predictive accuracy, temperature control, and quality assurance of products are the operations core of AI efficiency in the Indian pharmaceutical distribution.

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