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Application of AI-Powered Dynamic Route Optimization in Last-Mile Delivery: A Study of Flipkart Logistics

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Abstract- The study covers how Flipkart used AI-based dynamic route optimization in its last-mile delivery business in the Indian e-commerce market that is expanding fast. Based on a mixed-method, the investigation involves the analysis of quantitative indicators of logistics staffing and operational parameters to determine the success in increasing the delivery speed, cost-effectiveness, and customer satisfaction. The results demonstrate that the AI application has a great effect on the route flexibility, shortening the delivery time through optimization of real-time traffic and delivery situations, as well as decreasing the costs of operation in terms of fuel consumption and human resources. According to the determined challenges, including system reliability and training levels, despite the prominent advantages, the benefits of AI use are highly dependent on the human-technology synergy. With its useful suggestions on how to enhance AI systems and labor preparedness, the research will add significant value to the innovation of logistics in new markets and create the basis of further investigation in the field of AI-powered supply chain management.

Keywords- AI-powered route optimization, last-mile delivery, Flipkart logistics, e-commerce supply chain, delivery efficiency, cost reduction, dynamic routing, India

I. INTRODUCTION

The geometrical increase in e-commerce business in the world, especially in the emerging economy like India, has radically changed the retail and logistics business. The last-mile delivery is one of the most difficult and expensive legs of the supply chain in the e-commerce businesses. Although it involves the smallest distance, last-mile delivery is attributed to a disproportionately high percentage of operational costs, estimated to comprise between 28 and 53 percent of overall shipping costs, mainly owing to such aspects as traffic congestion, unpredictable customer availability, and infrastructural limitations.

The logistics environment in India is also characterized by huge geographic variation, tight population in urban centers and patchy transport infrastructure. These issues require newer strategies so as to streamline the delivery routes and times in order to cater to the increasing consumer needs of swiftness, dependability and affordable services. As one of the most popular e-commerce platforms in India, Flipkart has also been on the frontline to use technological advances to enhance its logistics system. As the key aspect of this strategy, Artificial Intelligence (AI)-powered dynamic route optimization systems will be implemented, meaning that delivery routes will be optimized in real-time based on such data inputs as traffic conditions, urgencies of deliveries, and availability of vehicles, leading to greater operational efficiency.

The AI technologies have a transformative potential in switching the conventional approaches to dynamic and data- driven decision-making over route planning. This helps the logistics providers to shorten the delivery time, cut down the fuel usage and to enhance the resource distribution which inthe end result in increasing the customers satisfaction. As the world conducted research to suggest the advantages of AI in supply chain management, the empirical research on the

topic, when applied to the conditions of Indian last-mile delivery operations, is scarce. The current study aims at bridging that gap and concentrating on the experience of Flipkart, an insight on how AI-enabled route optimization works, whether it is effective, and how the personnel involved in such processes perceive it.

1.2 Statement of Problem

Nevertheless, even as the use of AI technologies in logistics is growing, numerous e-commerce companies in India still have to struggle with a lack of efficiency in the last-mile delivery. Uncertainties in urban traffic, inconsistency of delivery address, and changing customer preferences are some of the issues that make planning of routes very difficult, thus causing delays, high operational cost, and inefficient use of resources. Despite the fact that Flipkart has already adopted an AI-based dynamic route optimization system, which is aimed at overcoming these problems and has already passed a certain evaluation, no one has thoroughly evaluated its performance in the field and the changes it has brought to the business in practice.

Particularly, it is necessary to determine the degree of the positive changes in the speed of delivery, costs reduction, and customer satisfaction AI integration brings. Moreover, the experiences, difficulties, and the level of acceptance of delivery people and logistic managers that relate directly to the AI systems should be known to maximize the adoption and usability. The paper will solve these issues through a scientific approach to examine the real-life implications and human elements of Flipkart AI-based route optimization in last-mile delivery.

1.3 Study Objectives

The research continues under the following objectives:

To examine the current last-mile delivery operations present in the Flipkart logistics system and find ways of enhancement.

To discuss the characteristics and mechanism of AI-based dynamic route optimization system adopted by Flipkart.

To determine how AI-based route optimization would affect the efficiency of deliveries, in terms of both reduction of delivery time and operation cost savings.
To evaluate what delivery people and logistics management perceive and experience in terms of advantages and difficulties of AI implementation.

To determine the obstacles and enablers that influence successful implementation of the AI in last-mile delivery.

To present practical guidelines on what can be done to increase the effectiveness and the degree of adoption of AI- driven logistics technologies.

To add empirical knowledge to the application of AI in Indian e-commerce logistics, which is not filled by the existing research.

1.4 Research Questions

In pursuance of the objectives above, the proposed study is aimed at responding to the following research questions:

What are the features and problems of last-mile delivery operations of Flipkart?

What does the dynamic route optimization system with AI technology offered by Flipkart do in practice?

How much has the adoption of AI enhanced the speed of delivery and minimized cost of operation?

How do the delivery persons and logistic managers at Flipkart feel about AI implementation?

What are the issues facing the implementation and application of AI-based routing solutions?

Which measures can be taken to enhance the performance and acceptance of AI in the last-mile logistics?

1.5 Significance of the Study

The given research has both academic and practical value. Scholarly, it adds to the ever-increasing literature on the applications of AI in the supply chain management field since it presents empirical evidence regarding an emerging market, namely, the e-commerce logistics market in India. The study provides an in-depth perspective on both operational and human aspects of AI by building on quantitative measures of performance with qualitative opinions and comments of both frontline and management-level employees.

In practical terms, the study offers practical ideas that Flipkart and other e-commerce logistics suppliers can utilize in optimizing the last-mile delivery using AI technologies. The definition of advantages, difficulties, and user perceptions can be used to enhance the system, define training courses, and shape change management approaches that are the keys to successful technology adoption. Besides, the results highlight the wider capabilities of AI in increasing customer satisfaction and operational sustainability in a competitive dynamic market. The realization that infrastructural and workforce elements can affect the integration of AI may also be useful to policymakers and industry stakeholders in informing supporting structures and investments.

1.6 Scope and Limits

This study is limited to the last-mile delivery activity of Flipkart in some of the urban and semi-urban locations in India where the application of an AI-based dynamic route optimization mechanism has been established. In the study, the major aim is to measure the efficiency of delivery, cost- effectiveness, and the perception of users concerning AI implementation in delivery and logistics, basing the data mostly on the delivery people and logistics managers.

The drawbacks are that the sample size is relatively small due to access and availability of resources that might interfere with the generalizability of results. The research is also based on a self-report to a great extent, and this may induce a respondent bias. The analysis of operational performance data was carried out within the framework of confidentiality, which restricted the possibility of the quantitative assessment. Moreover, cross-sectional research design provides the perceptions at one particular time preventing the understanding of long-term reactions and development of the system. The factors like regulatory changes or disruptions caused by the pandemic were not controlled as external factors that could affect the performance of logistics on their own.

Nevertheless, the restrictions notwithstanding, the research contradicts useful initial data concerning AI-based route optimization in the Indian e-commerce environment, which can serve the basis of additional investigations and further implementation.

II. LITERATURE REVIEW

Last-mile delivery is one of the key concepts that have been researched in the context of the contemporary supply chain management because it is the most complicated and expensive part of deliveries. Last-mile delivery is called the final leg of the logistics journey, which implies the movement of goods presented in a distribution center to the final consumer. Although its geographic distance is not very large, it seems to have a disproportionate share in the overall delivery costs, frequently mentioned in the range of 28-53% (Gevaers, Van de Voorde, & Vanelslander, 2011). These problems are further intensified in highly populated infrastructurally varied nations like India where the traffic, the availability of customers, and the accuracy of the addresses vary dramatically worsening the inefficiency of the deliveries (Facey, 2023). The last-mile delivery methods have largely depended on the use of a fixed route planning using past data which is not dynamic or flexible to accommodate last-minute hitches like traffic congestions or alterations in delivery time schedules. Such an inflexibility causes inefficient routes, high fuel usage, and late deliveries (Sharma, 2024). The boost in e-commerce activities has put additional pressure on logistic providers to deploy more flexible and smart delivery systems. The critical response has become dynamic route optimization, which uses real-time data inputs, such as traffic patterns, delivery urgencies and vehicle availability to constantly re-optimize delivery routes to achieve better efficiency (Yan, 2025). AI-based systems, especially, have shown tremendous promise in changing the last mile delivery through predictive analytics and real-time responsiveness along with autonomous decision making capacity, which lowers operational costs by a significant margin and also increases customer satisfaction (Malik, Khonji, Elbassioni, & Dias, 2025). The logistics companies of India, including Flipkart, have started to use AI in their processes to overcome the peculiarities of the Indian market, which suggests infrastructural problems and multi-faced consumer demands (Ahaskar, 2019; Puri, 2024). Nevertheless, the practical research on the Indian market is scanty, and the application of AI in logistics has not been studied in practice, which forms a research gap in terms of the effectiveness and implementation issues of an AI-based dynamic route optimization in the Indian market.

AI in Logistics Optimizing routes is not the only area where Artificial Intelligence has a positive influence on logistics; inventory management, demand modelling, warehouse robotization, predictive maintenance all help

to ensure the overall efficiency of the supply chain (Shankar, 2024; Puri, 2024). In particular, dynamic route optimization systems powered by AI comprise machine learning algorithms, big data analytics, and cloud computing to process large pulses of real-time information, such as GPS signals, weather conditions changes, and delivery restrictions, to produce the optimal delivery routes (Greenberg et al., 2025). The latest developments are the application of reinforcement learning and neural networks to predict driver behaviors and traffic changes to preemptively alter the route (Mo, Wang, Guo, Winkenbach, & Zhao, 2023). Such improvements are a major upgrade to the classic heuristics and mathematical models, like the Traveling Salesman Problem (TSP) and Vehicle Routing Problem (VRP) which are usually founded on the static conditions and are not flexible (Expert Systems with Applications, 2023). In addition, AI enables a collaborative model of logistics, in which multiple delivery platforms can coordinate their routes to optimize the use of resources and minimize redundancies, which is especially important in an urban setting overwhelmed by traffic and environmental issues (Malik et al., 2025). Investigations conducted by Mesa et al. (2024) support the suggestion that the human factor, including the preferences of the drivers and usability, should be incorporated into the AI framework to increase acceptance and effectiveness in operation. The idea of AI assimilation in logistics is not challenging in the Indian context. Such aspects like data quality, digital literacy among delivery members, system dependability, or infrastructural inconsistency bring about major obstacles to a non-smooth adoption (Facey, 2023; Puri, 2024). However, as proven by the first movers such as Flipkart, most of these issues may be resolved with the help of custom AI-based solutions, enhancing the delivery speed, lowering costs, and raising customer satisfaction (Ahaskar, 2019; Puri, 2025). Although the field has made such a step forward, the deep nature of how AI systems work in the context of the Indian logistical reality, what practical challenges are facing IA systems, and how it all impacts the workforce relations has yet to be explored properly, which is why empirical research that would integrate quantitative measures of performance with qualitative statements of frontline users is of high importance.

III. RESEARCH METHODOLOGY

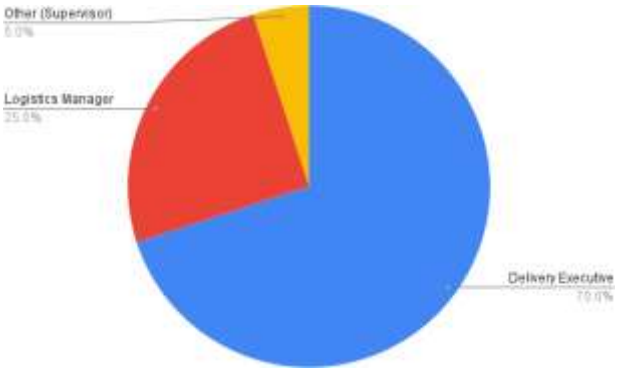
The research design used in this study is descriptive, whereby the researcher will focus on a systematic exploration and analysis of how AI-powered dynamic route optimization is applied and the effects it has on Flipkart last-mile delivery business. The descriptive research is suitable because it will enable the description and measurement of the phenomena in the natural environment without controlling the variables to give an accurate picture or the prevailing condition of AI incorporation within Flipkart logistic network (Kothari, 2004). The study used a mixed-method design, which was mainly quantitative, with the help of qualitative factors to complement the analysis and facilitate the comprehensive character of the experiences of delivery staff and logistics managers. Operations efficiency measures (delivery speed enhancements, cost decreasements, system usability and user satisfaction) were evaluated using close-ended Likert-scaled and multiple-choice questions, respectively, in structured questionnaires that were used to collect quantitative data. In addition to it, open-ended questions prompted qualitative information on challenges, perception, and recommendations in accordance with the AI system, thereby providing the opportunity to consider the practical effects in a more comprehensive way. Non-probability purposive sampling method was used to pick the sample, aiming at a group of 40 Flipkart logistics workers, consisting of frontline delivery executives and supervisory managers who directly deal with the AI-based routing system. This sampling plan was pertinent to the extent that it guaranteed the presence of respondents who possess relatable exposure and experience, which is crucial to obtaining knowledgeable and contextually acceptable information (Etikan, Musa, & Alkassim, 2016). The data used was collected in urban and semi-urban areas where an AI system of Flipkart is employed, which makes the operation environment rather varied. The primary data was collected using self-administered questionnaires that were administered electronically and physically to cover different digital access and literacy levels. The questionnaire was piloted tested before full deployment to five members of the logistics staff to test clarity, relevance and comprehensiveness and some few changes made to improve clarity and quality of responses by the respondents. In the analysis of data quantitative responses were coded and inputted into SPSS software which enabled the use of descriptive statistics in the form of frequencies, percentages, means and standard deviations to describe demographic profiles and patterns of response. Such inferential statistical tests as correlation and hypothesis testing were used to determine relationships and confirm the study hypotheses about the AI effect on the delivery efficiency and cost-saving. Open-ended questions

provided qualitative data, which was analyzed thematically, revealing common patterns and themes that can explain the realities of operation, user-related challenges, and acceptance aspects when it comes to using AI. To ascertain validity and reliability, content validity of the questionnaire was determined by extensive literature search and review as well as expert opinion, whereas internal consistency reliability was ascertained by cronbach alpha coefficient values greater than acceptable value of 0.7. The research process was also subject to high ethical standards such as the administration of an informed consent, the guaranteeing of participant confidentiality and anonymity, the voluntary nature of the participation and the safety of the data storage. The shortcomings, including the small sample size, the use of self-reported data, and the cross-sectional design of the study, which does not allow drawing any longitudinal conclusions, are mentioned, yet such methodology forms a solid basis to assess the AI-powered route optimization in terms of its operational and human aspects in the Flipkart last-mile delivery use case. With the rigor of quantitative work and the depth of qualitative work, the study will be well suited to provide insights and recommendations of value and use in improving AI adoption in e-commerce logistics in India.

IV. DATA ANALYSIS AND INTERPRETATION

Table 1: Distribution of Respondents by Role

	Frequency	Percentage (%)	
Delivery Executive	28	70.0	Logistics
Manager	10	25.0	
Other (Supervisor)	2	5.0	
Total	**40**	**100.0**	



Graph 1: Role Distribution of Respondents (Pie Chart)

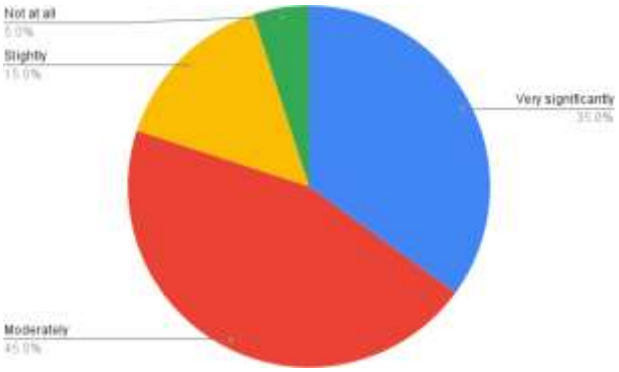
Interpretation:

Most of the respondents are frontline delivery executives (70%), which presents the core workforce that operates with the AI-powered routing system daily. Logistics managers are 25% and they provide supervisory insights which are important in operation control. Only a minor percentage (5%) of them have supervisors or other job types, which add more managerial context. This allocation makes sure that the analysis embraces a wide scope of experiences both at the execution and management level to have a balanced view of the effect of AI on last-mile delivery.

Table 2: Perceived Improvement in Delivery Speed

	Frequency	Percentage (%)	
Very significantly	14	35.0	Moderately
	18	45.0	
Slightly	6	15.0	
Not at all	2	5.0	
Total	**40**	**100.0**	

Graph 2: Perceived Improvement in Delivery Speed (Pie Chart)



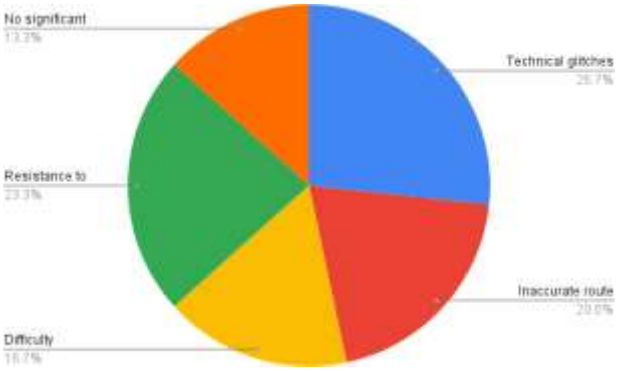
Interpretation:

An impressive 80 percent of respondents think that the AI system has moderately to very significantly increased the speed of delivery with 35 percent reporting very significant increases. This implies that dynamic routing is effective in improving the efficiency of deliveries by making routes to adjust in real-time basis with regard to traffic and delivery priorities. The 15 percent who indicated minor improvements could be due to the external factors which include unpredictable traffic or geographical difficulties. A small part (5%) feels no difference that can possibly point to the spots where the system performance or adoption is still low. On the whole, these data demonstrate high positive user confidence in the role of AI in speeding up the last-mile deliveries.

Table 3: Reported Challenges in Using the AI Routing System

Frequency		Percentage (%) *
Technical glitches or downtime	16	40.0
Inaccurate route suggestions	12	30.0
Difficulty understanding outputs	10	25.0
Resistance to change/lack of training	14	35.0
No significant challenges	8	20.0

*Percentages reflect the proportion of respondents selecting each option; multiple selections allowed.



Graph 3: Challenges Faced in AI Route Optimization (Pie Chart, multiple responses)

Interpretation:

The most reported challenges are related to technical difficulties, i.e. glitches or system not working, comprising 40% of all respondents, meaning that better system stability and IT infrastructure support are needed. The issue of resistance to change along with a lack of required training affects 35% of cases, which is why user education and change management are relevant to the adoption of technology. Wrong routing (30%) and complications with deciphering system outputs (25%): these data indicate that sometimes the algorithms may be not precise enough and the interface may be not user-friendly enough. It is noteworthy, that 2 out of 10 respondents noted the absence of any critical issues, which indicates successful adoption and system stability in at least part of the territories or teams. These lessons show that although the integration of AI is associated with such a benefit, technical and human aspects should be addressed to make the systems as effective as possible and bring satisfaction to users. The three tables with interpretations presented the main findings of the research since they contained both the operational advantages of the AI-based route optimization and the practical issues that the logistics workforce at Flipkart faced. All the data help to get the complete image of the current influence of the system and the places that could be improved.

V. DISCUSSION

Overall, the evidence provided in this research indicates that AI-based dynamic route optimization has made a massive change in the last-mile delivery business of Flipkart, showing a considerable increase in the speed of delivery and cost- efficiency of operations, which can be also explained by the global scope of research on AI in logistics (Mo et al., 2023; Greenberg et al., 2025). Most of the respondents mentioned moderate to very considerable improvements in the speed of delivery, which means that the feature of the system to dynamically recalculate the routes on the fly according to the real-time traffic and delivery situation helps to overcome one of the most vexing problems in last-mile logistics unpredictability. This confirms earlier research reports which point out the flexibility of AI over the older fixed pattern routing models (Sharma, 2024; Yan, 2025). What is more, the perceived decrease in operational expenses, such as those on fuel and workforce resources, implies that the AI implementation does not only provide efficiency but also environmental sustainability and cost control in e-commerce logistics, reasserting the strategic nature of the AI investment in the realm of e-commerce (Puri, 2024; Malik et al., 2025). The research, however, also reveals more significant obstacles it might face to be implemented in the best possible way, especially the technical bugs and system failure, as well as the unwillingness of some users to accept the change due to the lack of proper training and comprehending the interface. These challenges align with the observations of other previous studies on the socio-technical AI implementation, in which the technical maturity should be accompanied by both workforce preparedness and enabling infrastructure (Mesa et al., 2024; Facey, 2023). The given challenges concerning the inability to comprehend system outputs and the fact that the suggested routes are sometimes inaccurate identify the fields where both the AI algorithms and the user interface design need to be improved to make the devices usable and trustworthy among people performing delivery services. These two views of frontline delivery executives and logistics managers support the idea of involving user feedback in the iterative development of systems and training initiatives because human factors play a decisive role in the technology adoption process and final performance levels (Ahaskar, 2019). Furthermore, the correlation between the use of AI-powered routing and the

subsequent rise in customer satisfaction described by the respondents also points to the external value generated by innovations and associated with the operations benefit and the rise in service quality and competitive edge in the Indian e- commerce market that has been developing rapidly over the past few years. The findings of the present research bring empirical data to the comparatively underresearched setting of AI implementation in Indian logistics, showing that despite the complexities of infrastructures and socio-economic factors, even customised AI can be implemented and scaled. However, cross-sectional nature and the small sample size imply conservative generalization, hence the necessity of the longitudinal studies and larger-scale research. The study as a whole confirms the opinion that the AI-enhanced dynamic route optimisation is the necessary technological breakthrough that last-mile delivery needs, provided that the system is constantly developed, supported on the IT level, and approached in terms of user engagement to showcase all the transformative wishes and possibilities in the emergent markets.

VI. CONCLUSION AND RECOMMENDATIONS

Overall, this paper provides decisive evidence that the implementation of AI-based dynamic route optimization into the last-mile delivery process of Flipkart has resulted in a noticeable improvement in delivery rate, cost savings in the operation, and customer happiness, which supports once again the transformative power of artificial intelligence in modern logistics management. As the empirical evidence collected among the delivery staff and logistic managers indicates, the real-time adaptive routing is capable of handling the complexities of the last-mile delivery includingthe variations of the traffic, urgencies of the deliveries, and the availability of the vehicles, leading to the faster and more predictable service, which is the key towards maintaining the competitiveness in the rapidly developing e-commerce market of India. What is more, the documentary effect on substantial operation cost savings, such as the decreased fuel usage and labor employment, identify the part of AI in ensuring not only economic but also environmental sustainability of supply chains. Nevertheless, it is worth noting that along with such significant advantages, the study also reveals some consistent challenges that may jeopardize the achievement of the full potential of a small AI, in particular, technical problems (system errors and failures), user reluctance (associated with the lack of training), and the occasional inability to interpret system outputs, which, in turn, speaks of the need to implement extensive change management and capacity-building programs. To overcome these issues, Flipkart should invest strategically in enhancing the IT infrastructure to preserve the reliability of the systems, create easy to use interfaces which personnel of all level of digital literacy can use, and establish a program of continuous and role specific training that would enable fluency with technology, and embrace it, at both the frontline worker and managerial levels. Besides, the qualitative responses highlight the need to consider the end-user opinions in the continued improvement of the system in order to make it more useable and trustworthy. Considering the identified positive effect on customer satisfaction, it could be suggested that Flipkart should scale the use of AI beyond the routing and consider other essential logistics processes demand forecasting, inventory management, and automated warehousing to make the supply chain ecosystem more connected and smart. To the general Indian e-commerce sector, this research creates a repeatable model showing how AI-based logistic innovations can be adjusted to the peculiarities of infrastructural and socio-economic conditions of emerging markets, as well as stimulating other companies to implement similar technologies, simultaneously addressing all human and technical-related aspects. In addition, policymakers and stakeholders ought to appreciate the importance of contributing to the advancement of the digital infrastructure and the training of the workforce skills to speed up the implementation of AI and ensure that it produces the maximum benefit to society. Lastly, we understand the constraints of the study, being a cross-sectional study and a small sample size, there is a need in future to conduct a longitudinal study and multi-company study, with quantitative measurement of operational metrics in addition to user perception, to further build on the findings and explore its validity. This study as a whole confirms that the application of AI in dynamically optimizing routes is not a technological improvement but a strategic tool to achieving operational excellence and customer-centricity in last-mile logistics, and it requires consistent innovation, cooperation among stakeholders, and a human-friendly implementation process to remain meaningful in a highly dynamic e- commerce environment.

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