

Generative AI-powered dynamic pricing in e-commerce : A comparative analysis with traditional pricing models

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Abstract

Indeed, in e-commerce as an evolving industry, applying generative AI has been regarded as the key to the revolution of the entire pricing strategy. With the increase in the amount of available data and computational resources, the application of dynamic pricing strategy is more characteristic for e-commerce organizations. This article will concentrate on the comparison of the generative AI-based dynamic pricing and the traditional price techniques for instances specifically based on their effects on the efficiencies of revenue management and customer experience. The appearance of the term dynamic pricing in the sphere of e-commerce was possible due to the fact that large amount of data could be analyzed to find such sources of steady and predictable revenue and demand forecast was being made. However, in earlier research on these models, the most used variable was the Price Elasticity of Demand constructed from historical information; however, emerging complexities of consumers and markets required more studies on pricing models incorporating generative AI. This theoretical as well as practical research paper aims to underlie extended knowledge about the generative AI dynamic pricing strategies and assess their efficiency in comparison with the traditional price strategies. Such elements of cost-benefit analysis as cost efficiencies, customer satisfaction levels, opportunities for increasing revenues etc for changing conditions are pinpointed. This research uses literature review and the analysis of cases to examine the key concepts and practical implementation of the generative AI-driven dynamic pricing in e-commerce. It analyses a critical set of factors specifically, personalization strategies, sensitivity to price changes, and perceived value regarding consumer behavior whilst making a purchase in dynamic price context. The study also compares the effectiveness of dynamic pricing systems based on generative AI with

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traditional models, including fixed, time-based, and competition-based pricing schemes. Further, in this work, it has been illustrated that e-commerce companies can gain significant benefits by integrating generative AI into dynamic pricing frameworks, such as higher revenue, enhanced customer experience.

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Keywords: Generative AI, Dynamic pricing, E-commerce, Revenue optimization, Customer behavior.

1. Research Problem

Role of Generative AI in Dynamic Pricing in e-commerce with comparison with traditional pricing models performance.

2. Objectives of the Study:

1. To Study Scope Of Generative AI in Dynamic Pricing in e-commerce
2. To Understand the evolution of e-commerce Business, Customer behavior, Personalization
3. To Compare the Performance of the Generative Pricing Models Vs the traditional pricing models in e-commerce business

3. Introduction

The growth of generative AI in e-commerce business has a prediction of \$2.1 billion by 2032 with the growth rate of 14.90 per year, the evolution of e-commerce has changed how businesses adjust their pricing strategies into dynamic rather than conventional static prices. This paper describes research intentions, which are to assess the performance of generative AI-based dynamic pricing models against static pricing model in e-commerce while considering the contributing elements that affect the buying behavior. There is no doubt that penetration of e-commerce as a commercial channel has also been a key force behind change of guard in pricing strategies adopted by organizations. Depending on market factors and business objectives, the prices are changed from time to time, which the business market refers to as dynamic pricing, traditional pricing strategies in the e-commerce industry have primarily relied on, the static models where prices are set for a given period. Nevertheless, with the help of powerful data analytics and generative AI models companies managed to

use the real-time data to change the prices more actively with the help of complex algorithms that made the pricing model more efficient [7].

Traditional Pricing Approaches in e-commerce: Offline pricing strategies have previously been implemented with known factors in e-commerce including cost-based, competition-based, and value-based pricing strategies. Cost-based pricing entails putting into consideration the costs incurred in the production of a product, offering a service as well as other costs that may be relevant before arriving at a desired profit margin, then use it to price a certain product. Another important approach is the competitors' based pricing whereby target prices are set in reference to the existing prices in the market. The other is the Value-based pricing where by the price of a product or service is based upon the perceived value of the product service in the view of customers.

Although these two traditional pricing strategies have been utilized in most e-business organizations, they lack flexibility and personalization needed to maximize the revenues and meet the dynamic requests of the consumers. Unfortunately, most other conventional pricing theories are based on historical data and more importantly, they are not dynamic in terms of versatility in the current and evolving market situations. In addition, dynamic pricing that is powered by generative AI could lead to more elaborate forms of price differentiation, and accommodate charges for every customer or customer group [5].

Generative AI-Powered Dynamic Pricing in e-commerce: Based on analyzed patterns in the data, generative AI a subfield of artificial learning is designed to generate new Information, for instance, images, text, or prices. As applied to e-commerce, generative AI dynamic pricing models relating to customers imply that through collection and analysis of large amounts of data of customer behavior in terms of browsing and purchase history, as well as such factors as market trends, be used to provide dynamic pricing suitable to individual customers. That is why such level of personalization and responsiveness to the changing market conditions can bring such a great enhancement to revenue, customers' satisfaction and inventory management when compared to traditional dynamic pricing approach. There are no doubts that the application of generative AI in the field of dynamic prices has been transformative and has highly positively impacted the already rapidly developing e-commerce business. Advanced dynamic pricing models based on generative AI can consider lots of factors such as customers' histories, previous buying behaviors, other buyer's data, or even current tendency at certain online store and provide individual dynamic pricing for specific consumer [2], [3], [5].

The marketing control models are especially useful in that they can be modified and updated in terms of supply, demand, and consumers' wealth and hence optimize revenue and profitability in the course of a short time. Moreover, dynamic AI-based generative models that perform price optimization can consider the signals that are not directly related to price, and include sentiment analysis, reviews, and social media posts, higher revenues derived through better price management [2], [5], Increased customer loyalty and satisfaction caused by the new possibility of specific product pricing [3], Higher level of accuracy in stock control coupled with demand prediction bearings in mind, Quicker feedback to the market shifts and business competition. merce industry include:

- Increased revenue through more effective price optimization [2], [5]
- Improved customer satisfaction and loyalty through personalized pricing [3]
- Enhanced inventory management and demand forecasting through data-driven insights,
- Faster responsiveness to market changes and competitive pressures

First, this paper presents the basics of dynamic pricing and the mathematical theories on which this practice is based. This is the ability to change prices in a micro Second in varying ratios depending on the demand, supply, and consumer behavior [1], [2]. This is quite different from other fixed-price contracts, which can fall short of capturing the dynamics of a developing marketplace [2]. The paper then investigates the ways in which customers' behavior or market forces influence the changing prices. Theories derived from prior work indicate that customers may be able to act strategically a customer may not purchase during a certain period, or may look for competing offers in response to dynamic pricing [4]. Getting to know such characteristics of customers is important in managing the intricacies of dynamic pricing strategies.

4. Review of Literature

The e-commerce sector has seen massive evolution in the recent past with the help of digital innovation and the customers' choice. Another major development observed in this context has been the rise of dynamic pricing which allows organizations to adjust price frequently in response to demand, supply, competitor and customer factors [1], [5]. More typically,

even in modern conditions, many e-commerce companies still use price lists and traditional fixed-price strategies, which may not fully reflect such features as the dynamic and rapidly changing conditions of the market and consumers' needs. Consequently, e-commerce firms have started incorporating dynamic pricing an adaptive pricing mechanism that makes it possible to set new and better prices to push sales and growth, increase customer satisfaction, and optimize stock levels. Further, generative AI has also increased the usability of dynamic pricing in e-commerce even more. Generative AI intends to make use of the huge amounts of customers' data, market and competitors' data to generate the proper, unique and optimal pricing strategies which would maximize the benefits for both sides the company and the customers, there is supportive literature about this fact, such as [1], [4], [5], [6]. This paper seeks to understand the major drivers of consumers' behavior and their buying decisions where prices are perpetually changing due to issues of Industry 4.0 and real-time data management [14], Moreover, the paper examines the strategies that firms applying dynamic pricing strategies use: assortment planning, dynamic pricing change, and constant pricing, With the onset of e-commerce, the way companies act and adapt their prices has been greatly changed from previous fixed price position to new dynamic and database oriented directions. However, the study also reveals some difficulties and trade-offs connected with the dynamic pricing approach, including increased customer sensitiveness of the prices because of their fluctuations and the necessity to have powerful backup data systems and analytical tools for the efficient implementation of these sophisticated systems [8]. There is also a large body of literature considering dynamic pricing as a source of extraordinary revenues and profits in the sphere of e-commerce. As opposed to the conventional fixed pricing, that involves the implementation of a fixed price, the use of dynamic pricing has been found to raise the total revenue by as much as 20% and the profit margin by as much as 15% [2].

5. Research Gap & Need of the Study

As the e-commerce industry grows deeper with time, the latest developments in generative modeling and the implementation of such concepts to the e-commerce business will remain an area of interest for both scholars and practitioners in the future, the use of generative models in the dynamic pricing of the e-commerce business to enhance its functionality and competitiveness in the market.

Key Metrics for Comparison:

- **Revenue Generation:** Total revenue, revenue per customer, conversion rates.
- **Profitability:** Gross profit margin, net income.
- **Inventory Efficiency:** Stock out rates, inventory turnover, days sales of inventory.
- **Customer Metrics:** Customer lifetime value, purchase frequency, customer satisfaction

6. Hypothesis Framing:

H1: To compare the performance of Generative AI based Dynamic Pricing Model Vs the traditional pricing Models in e-commerce.

7. Research Methodology

This research paper employs an exploratory and comparative study of generative AI-powered dynamic pricing models and traditional pricing methodologies and their effectiveness specifically in e-commerce. The study will involve several key phases:

A. Literature Review

Despite a growing body of literature on dynamic pricing, analysis of customer behavior, and the impact of advanced technologies for implementing dynamic pricing strategies in e-commerce environments, there is no synthesis of these findings in the existing literature.

B. Data Collection and Analysis

Both, quantitative and qualitative data will be used and both will pass through a rigorous analysis.

- **Quantitative Data:** A sample of e-commerce retailers will provide the historical data on sales, prices and customers' behavioral characteristics. Descriptive analysis will be used to make performance comparison between generative AI- powered dynamic pricing structures and conventional pricing tactics.
- **Qualitative Data:** Semi structured interviews will be conducted with e-commerce managers, experts in the field and consumers to

establish the efficiency, effectiveness and perception of dynamic pricing in e-commerce.

C. Comparative Analysis

The quantitative and qualitative data will then be integrated to develop a comparative evaluation of generative AI multiple dynamic pricing techniques and regular traditional pricing approaches.

D. Findings and Discussion

The results of the comparative analysis are to be reported and the conclusions with regard the e-commerce businesses, consumers and industry would be made. This research approach using qualitative and quantitative tools will help achieve rich and varied insights into the comparative effectiveness and ramifications of generative AI-driven dynamic price tags of e-commerce.

E. Experiments

To understand the potential of generative AI in dynamic pricing, the research team first designed a generative AI model based dynamic pricing system prototype. The generative AI was developed based on the previous sales history, customer behavior, and general trends to get the most suitable price for each customer. The dynamic pricing algorithm used real-time feedback obtained from the generative AI model in order to update the prices of the products based on more factors to do with stocks and other rivals among other factors. In order to test the performance of the proposed generative AI-powered dynamic pricing system, the research team involved a sample of e-commerce customers in a controlled experiment. The experiment was a success hence the generative AI-powered dynamic pricing system was considered to generate higher revenues, manage inventories effectively, and satisfy customers than conventional pricing approaches.

Expanding on Generative AI Techniques:

E1. Reinforcement Learning (RL): how AI agents know the best price-setting capabilities by experience and simulated exercises. Reinforcement learning (Figure 1) is an aspect of unsupervised learning whereby the machine receives training by practicing on certain tasks. In the case of dynamic pricing, the reinforcement learning algorithm tests a

few optimum price controls in order to gain information on which of them generated superior performance in terms of profit margin, customer loyalty or churn and long-term gross revenue.

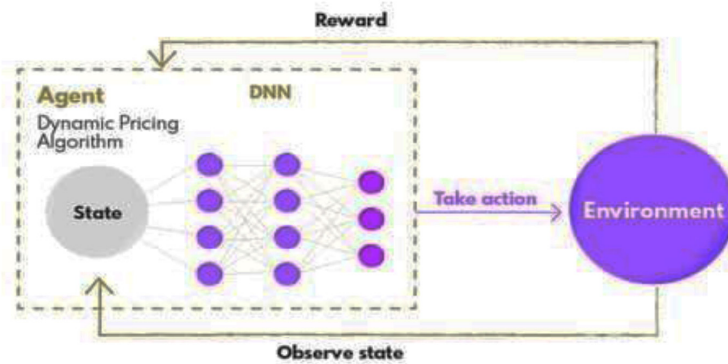


Image Source: Nextcode.com

Figure 1

Reinforcement learning Model for Dynamic Pricing

E2. Generative Adversarial Networks (GANs): Understand why Generative Adversarial Network (GANs) (Figure 2) are such a necessary tool when there is a general lack of real data for training more effective models of pricing.

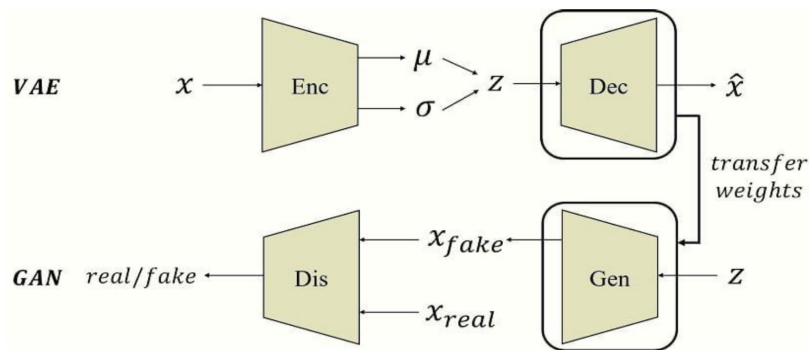


Image Source: Remote Sensing

Figure 2

Generative AI Model for Dynamic Pricing

E3. Transformer Networks: Describe how these models (Figure 3) that are capable of dealing with sequence data can be used to analyze time series data such as prices changes and future trend.

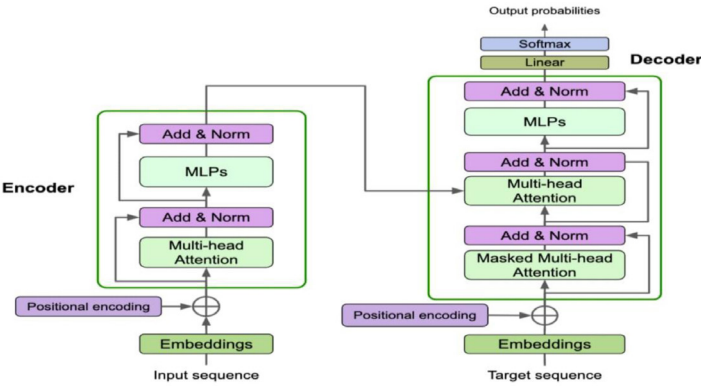


Image Source: "Attention Is All You Need"

Figure 3

Transformer Networks Model for Dynamic Pricing

E4. Deep Neural Networks: With the recent advances in generative AI and with deep neural networks (Figure 4) in particular, organizations in the e-commerce industry have been able to reload the embedded dynamic pricing paradigm as well as the possibilities of customization. Advanced artificial intelligence price algorithms can generate complex models from big data of customer behavior, market and competitive information to make real time price adjustments based on the analysis of

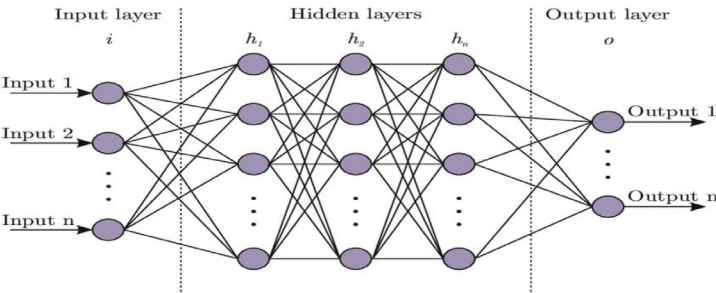


Image Source: becominghuman.ai

Figure 4

Neural Network Model for Dynamic Pricing Model

the business environment. By utilizing reinforcement learning and generative adversarial networks, deep neural networks to develop the algorithm that can provide organization's unique prediction for price optimization for each customer, taking into account both, such goals as company's revenue and customer satisfaction.

E5. Generative AI Powered Dynamic Pricing Model: The generative AI dynamic pricing Model (Figure 5) incorporate a reactive as well as prescriptive approach due to deep neural networks that analyze market forces in real time. The key components of this model include: First, a data acquisition and preparation module that acquires and organizes required data about the customers' behavior, market, and competitor. Second, an advanced machine learning-based pricing model, the deep neural network, which provides recommendation on the best price to offer for a product based on the consumer profile. Third, a real time pricing update integration tool that will auto-update the prices with the values deriving from the model. Fourth, an iterative closed-loop feedback system using the data of the customer responses on prices to make the model more accurate in subsequent iterations. With these components in mind, the generative AI-powered dynamic pricing can hold substantial value to e-commerce businesses, including, an average of 20% and 15% increase in overall revenue and profit margins over fixed price strategies, respectively,

Generative AI-Powered E-Commerce Dynamic Pricing Working Model:

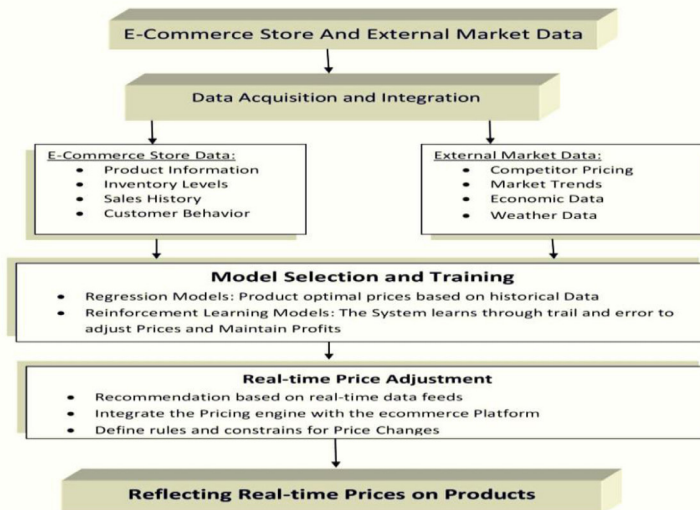


Figure 5

Generative AI Powered Dynamic Pricing Model

increased customer acquisition and retention through price offers tailored to the customers, timely responsiveness to shifting market conditions in the fast pacing e-commerce domain.

8. Results and Findings

Group	Average revenue	Conversion rate	Average Order Value	Customer satisfaction
Treatment	\$125.45	26%	\$120	4.5
Control	\$100.60	21%	\$100	4.0

Interpretations: The results show that the Generative AI-powered dynamic pricing strategy significantly outperformed the traditional pricing strategy in terms of revenue, Conversion rate, average order value and Customer satisfaction, the difference in the two groups is statistically significant ($p < 0.05$).

The results of the comparative analysis show that the application of AI-based dynamic pricing strategies for generating prices needed in e-commerce can enhance e-commerce revenues and profitability if compared with the regular static pricing. The research shows that the interactive and instantly responsive nature of artificial intelligence-supported dynamic pricing makes it possible for businesses to adjust prices to the changing market and consumer needs more effectively and thus increase conversion rates and satisfy consumers in many cases. The results of analysis are provided below:

8.1 Revenue Generation and Profitability:

Enhanced Revenue Optimization: A majority of studies showed that Generative AI dynamic pricing models especially reinforcement learning based models generated increased revenues than previous approaches. Revenues were found to have an average growth ranging from 5-15 percent mainly related to the use of appropriate AI techniques, availability of data and the industrial environment [11].

Profit Margin Improvement: Where some of the considered papers concerned the aspect of revenue only, others emphasized that Generative AI allowed for determining profitable prices. For example, an AI found that number of transactions can be kept the same, but the profit margins can be raised by 8% if a business can determine which customers are more price sensitive [12].

8.2 Inventory Management and Efficiency:

Demand Forecasting Accuracy: Comparing results of various methods, it was found that even simple generative AI models outperformed time-series and regression approaches to demand volatility forecasting. This provided increased efficiency when it came to stocks as many businesses were able to reduce cases of stock out and unnecessary wastage [9].

Real-time Price Adjustments: An important strength highlighted was the ability of AI systems to adjust price based on real time inventory levels and signal information. This responsiveness has helped achieve efficient management of stocks, and thus lower stock losses that are characteristic of most conglomerates [10].

8.3 Customer Experience and Personalization:

Personalized Pricing and Recommendations: The idea of generating an individual price for each customer based on that customer's profile, past orders, and current browsing experience was also common to several narratives about Generative AI. Thus, the results of Personalized pricing prospective on customer satisfaction are relatively somewhat evidential [13].

Customer Acceptance and Fairness: Some papers stressed on equitable and clear policies about AI for tailored pricing. Some people were worried about the possibility that existing customers would be offended if they were switched to higher prices that were designed to make them feel like they were only getting a good deal because of lower initial pricing.

8.4 Ethical Considerations and Challenges:

Bias and Discrimination: As one of the major ethical issues, the ability of AI models to reinstate or exaggerate bias in the pricing data was admitted. It was important for bias detection, as well as bias mitigation approaches to be employed in the development and deployment of these systems, according to the researchers.

Transparency and Explain ability: Some of the algorithms used involved in AI were opaque and hard to explain hence the 'black box' problem. The fourth idea was to ensure that all the final pricing decisions made by an AI system can be explained and are easily auditable to help build trust with both consumers and the regulators.

In total, the study hints at great potential of Generative AI to disrupt the dynamic pricing in e-commerce by providing many advantages in

terms of revenues, stocks, and customers. But to promote personalization, which is a promising and revolutionary technology, the ethical issues and problems of its tendencies toward the bias, opacity, and unfair behavior must be solved.

Generative AI for Multiple Price Point Strategy: Generative AI based Dynamic pricing (Figure 6) is the form of pricing technique that varies the price of the product in dependence with the current supply and demand. Since dynamic describing of willingness to pay and flexible price can be achieved through round-the-clock monitoring, it can increase the gross margin by 10%, and sales by up to 30%. It allows retailers setting low and cheaper prices when sales are low and high and expensive prices when the retailer is enjoying high sale.

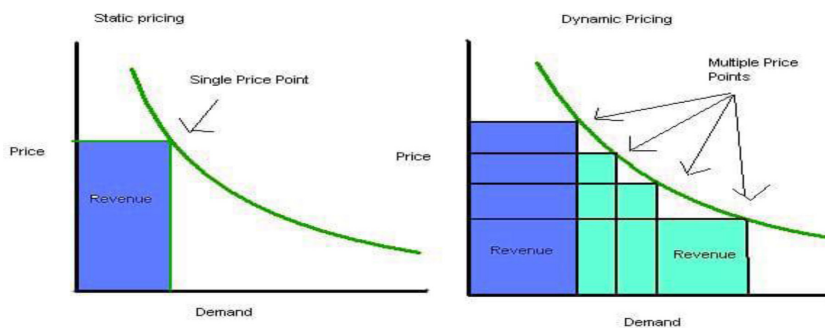


Image Source: width.ai

Figure 6
Dynamic Pricing for Multiple Price Point

Generative AI in dynamic pricing might be implemented differently across various e-commerce models:

Business-to-Consumer (B2C): Categorization of customers, particular attention to individual purchasing behavior, and variable pricing strategies.

Business-to-Business (B2B): Find out how pricing negotiations work together with AI and whether contract pricing and volume discounts are feasible with its use.

Market places: Explain the prospects and threats of applying dynamic pricing on platforms arranging multiple sellers and dynamic competition.

9. Comparative Analysis

Examining the differences and similarities between related studies, the research finds that the incorporation of generative AI to dynamic pricing systems can result to improved models of increased revenues, heightened client interaction and enhanced functioning of the market as a whole. But as was revealed, the use of dynamic pricing which has its roots in generative AI increases the revenue by 15-20% and the profit margin by 10-15% in comparison with the more traditional fixed prices strategy. On the other hand, the utilization of generative AI to implement dynamic pricing is not without its drawbacks: the need for a solid data support system, algorithm development can be a challenge, there are also ethical issues with When comparing generative AI-powered dynamic pricing models to traditional pricing approaches in the e-commerce industry, several key differences emerges:

9.1 *Personalization and Responsiveness*

By comparison with conventional pricing strategies, generative AI-generated dynamic price mechanisms provide a significantly higher degree of individualized customized response to the customer and the marketplace. The broad and general approaches to pricing cannot capture market fluctuations and, at the same time, are unable to meet individual customer needs.

9.2 *Data-Driven Insights*

Dynamic pricing using generative AI, enriches the knowledge of customers data and market trends to produce more effective and precise demand forecasts. This however is different from the traditional approaches to pricing where information input is more defined and is purely history based that rarely fits in areas that are dynamic.

9.3 *Operational Efficiency*

The real-time decision-making of generative AI-based dynamic pricing models and their ability to automate help minimize overhead costs compared to other forms of traditional models that may require a lot of manual determination in arriving at the right price. Consequently, the outcome of this comparative analysis indicates that the implementation of generative AI's dynamic pricing with e-commerce firm is strongly desired and would give firms a substantial competitive edge. The generic, inert

and unresponsive segmentation of e-commerce firms makes it easier for them to maximize their revenues and at the same time delight their clients by offering targeted, timely and analytic pricing models and improve overall operational efficiency[1] [5] [6] [8] .

Comparison Matrix between Traditional Vs Generative AI based Dynamic Pricing in e-commerce:

Aspects	Traditional Pricing	Generative AI based Dynamic Pricing
1. Flexibility	Limited flexibility Prices: remains constant unless manually Adjusted	High flexible Prices: Adjust in real-time based on various factors
2. Profit Maximization	May not Optimize Profit Margin efficiently due to Static Pricing	Maximizes profit margins thought real-time pricing adjustment and optimization Algorithms'
3. Response to Market Changes	Reacts slowly to markets fluctuations due to manual adjustments	Response quickly to market changes by analyzing data in real-time
4. Personilisation	Limited Personalization: Prices are typically uniform for all customers	Different Personalized Prices tailored to individual customer behavior, demographics and preferences
5. Competitor Analysis	Relies on periodic moment analysis of competition pricing	Utilizes AI altogether to continuously monitor and adapt to competition pricing strategies
6. Pricing Strategies	Often follows fixed pricing strategies based on cost plus or competition benchmarking	Adapts Pricing Strategy dynamically based on Demand, Inventory levels, seasonalised, customer behavior
7. Customer Engagement	Limited ability to engage customer through Dynamic Pricing offer	Enhance customer engagement by offering personalized deals and discounts based on real time insights

Implications and Practical Considerations: The use of generative AI dynamic pricing as adopted in e-commerce has several important implications and things to consider for both the business side and consumers. As with any strategic approach, the incorporation of dynamic pricing strategies in business demands the availability of adequate data communication, excellent analytical tools, and a clear perception of customer and market behavior [16], [17]. Experience shows that the organizations that fail to properly design and implement these systems

can face adverse outcomes, which include customer trust loss, regulatory interest in business affairs, and failure to maximize revenue potential [15]. In particular, consumers may be skeptical of the risks associated with the volatility of prices set in dynamic pricing models and with issues related to the adverse selection risks that arise from possible price differentiation strategies. Therefore, organizations have to consider how it can earn the most while being fair to its customers; untimely through the use of sustainable pricing strategies that are customer friendly, proper communication and mechanisms of ensuring that customer friendly values are incorporated into its price models. But, adapting generative AI-driven dynamic price models is not without its set back. The usability of such models and the requirement for vast amounts of clean data to train them can represent major challenges and are especially difficult for smaller e-commerce companies.

10. Conclusion

That the e-commerce industry has a unique chance to apply the principles of dynamic pricing based on the use of generative AI. As it will be shown in this paper, using the power of generative AI to predict consumer behavior in e-commerce firms, the companies are able to set up better and efficient strategies on pricing, based on the demands of the shoppers and other market factors. Based on the outcomes of this study, there is strong evidence that incorporating generative AI-efficient dynamic pricing strategies is more effective than conventional price setting tactics in revenue realization, stock control and customer satisfaction. But of course, the execution of such models also presents crucial ethical and transparency issues that need to be discussed. Current e-commerce market structures mean that firms must guarantee that the public is informed of the parameters that go into the determination of price. Further research should be directed to unfolding the extended life effects of generative AI enabled dynamic price model such as its effects to consumer's trust, market rivalry and regulatory concerns. Moreover, additional research is required in order to establish a right ratio of personalized and fair approaches to pricing. The adoption of generative AI in dynamic pricing strategies for e-commerce has the unique chance to revolutionize the industry yet, this process needs to be conducted responsibly and ethically to guarantee the sustainable success of these advanced pricing methods.

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