**Effect of AI on data collection used to determine prices**

1. Introduction
2. Literature Review

2.1. Artificial intelligence

2.1.1. AI Benefits

Artificial intelligence has enabled a massive advancement in commercial practices. As we move towards the holistic algorithmic enterprise, AI is progressively addressing the administrative, dispositive, and planning processes in management, sales, and marketing. A few advantages of AI include responding to and resolving customer enquiries, automating monotonous job tasks, attracting talent, and enhancing advertising and other marketing functions (Gentsch et al., 2018).

Also according to Bhalerao et al (2022), AI is beneficial in market research as it affects, 1. Decision Making: Effective decision-making is crucial for managers. While companies gather vast amounts of data through digital tools, they often lack the means to analyze it. Customized AI solutions help companies process this data, leading to improved business decisions. 2. Customer Engagement: AI-driven chat systems enhance how companies interact with customers. These technologies allow businesses to understand customer needs, analyze buying behavior, and provide tailored rewards. This results in quicker responses to inquiries, increased customer satisfaction, and higher revenue. 3. Human Resources: Managing talent acquisition, development, and retention can be challenging for companies. Customized AI solutions automate various HR tasks, such as candidate searches and training management, while reducing human errors like biases. This significantly boosts the efficiency and effectiveness of HR functions. 4. Inventory Management: Managing inventory is complex for small retail businesses. AI solutions enhance the tracking and management of inventory, aiding in procurement, material handling, warehousing, and overall productivity. This leads to better stock maintenance and efficiency. 5. Cyber Security: Cybersecurity is a major concern for both individuals and organizations, affecting operations and brand reputation. Companies are increasingly using AI technologies to safeguard data. AI and machine learning help detect unusual behavior and identify security threats, enabling companies to manage cyber risks more effectively.

AI advancements are crucial for improving technology performance and driving industry transformation. AI has the potential to significantly impact businesses and the economy by offering many new opportunities. AI offers numerous commercial benefits, including identifying patterns in large datasets, accelerating visualisation and analytics, improving product design, and providing detailed insights. These benefits are intended to enhance service quality, raise profits, expand businesses, and improve efficiency and costs (Soni et al., 2020).

2.1.2. AI Tools

Several artificial intelligence tools are essential for improving data collecting and analysis in the ever-changing field of market research. Businesses may watch inventory and consumer behaviour in real time by utilising RFID (Radio Frequency Identification) technology, which offers insightful data on purchase habits. Chatbots allow businesses to communicate directly with customers, rapidly obtaining their preferences and feedback. Natural Language Processing (NLP) enables businesses to analyse text data from surveys and social media, efficiently extracting feelings and patterns. Image Recognition technology helps analyse visual content, including ads and packaging, to analyse consumer responses. Machine Learning Algorithms improve predictive analytics by finding trends in massive datasets, enabling more informed decision-making. Data Mining Tools use AI to manage customer relationships more effectively by customising marketing plans based on individual consumer behaviour. CRM Systems use data mining tools to find hidden patterns and correlations in massive volumes of data, giving actionable insights. Social Listening Tools automate data gathering and reporting activities to speed up research operations, while Virtual Assistants monitor online conversations to assess public mood and brand perception. When combined, these AI technologies greatly increase the efficacy and efficiency of market research projects. (Gupta & Kumar, 2020).

2.2. Dynamic Pricing

Dynamic pricing is a strategic revenue management strategy that allows firms to maximise profit by constantly altering prices in response to swings in demand. Dynamic pricing replaces the "gut feeling" approach to pricing with analytical, fact-based decision-making. It entails varying the price charged for a product or service over time, among consumers, or between products/services. Originally established for airlines, it has since expanded to car rentals and hotels, which now rely heavily on it. These sectors share a number of characteristics that make them ideal application areas for dynamic pricing: perishability, fixed capacity, demand volatility, customer advance booking, wide swings in supply and demand balance, market micro segmentation, lower cost competition, and high fixed costs relative to variable costs (Gibbs et al., 2018).

The adoption of dynamic pricing is an expensive proposition in terms of both technical and human resources. Companies invest millions of dollars developing systems that can collect data, assess findings, and provide real-time pricing recommendations. Although the analytic engines used for dynamic pricing strive to update pricing in real time, they frequently require human intervention to approve recommendations. As a result, dynamic pricing is typically implemented by properly qualified individuals. Interestingly, the employment and training of specifically skilled revenue managers has been regarded as one of the hotel industry's most pressing concerns today (Bodea and Ferguson, 2014).

2.2.1. Dynamic Pricing Strategies

A dynamic pricing strategy adjusts prices based on demand and other factors that influence customer behaviour. These other factors, for example could be the weather or the day of the week. Price adjustments might occur on a weekly, daily, or real-time basis. Personalised pricing allows for price variations based on consumer preferences. Dynamic pricing aims to maximise profits while minimising price inefficiencies (Markula, 2023).

According to Popescu & Wu (2007), there are many pricing strategies such as,

1. Gain-Loss Asymmetries: they are behavioural theories that suggest that consumers may react differently to discounts versus surcharges. Surcharges loom larger than discounts of the same magnitude (loss aversion).
2. Shifting Reference Price: Limited work has been done to characterize dynamics of the reference effect when the status quo varies. A distinctive feature of our work is to incorporate such effects in the most general manner. For example, many people would be happy to spend half an hour on the Internet for a 50 Euro discount on a 100 Euro airplane ticket, but not on a 2,000 Euro one. In both cases, however, costs (30 minutes) and benefits (50 Euro) are identical, so from a purely rational viewpoint the trade-off is the same. This example indicates that consumers are less responsive to a given price change when the status quo price is higher

2.3. AI in dynamic pricing

Implementing AI-assisted dynamic pricing solutions can revolutionise commercial pricing decisions. AI-assisted dynamic pricing improves pricing accuracy by segmenting clients into groups and providing personalised prices. AI algorithms can analyse massive datasets, including client preferences, purchasing history, and market trends, in real-time. Moving on to customer-centric personalisation. Integrating AI into dynamic pricing techniques enables a more personalised and customer-centric approach. Targeted coupons have been shown in studies to increase profits significantly. For efficiency and automation, AI-assisted dynamic pricing involves frequent price adjustments. Accurate pricing adjustments can be made in real-time using available data. Real-time market response provides short-term benefits. Physical restrictions in classic dynamic pricing might slow down price adjustments. Finally, we explore the competitive advantages of AI-assisted dynamic pricing. AI-powered dynamic pricing provides a significant competitive advantage to businesses. AI-assisted pricing selections that align with optimal pricing can significantly boost a company's profit. Analysing client preferences, purchase history, and market trends can provide a significant competitive edge. Companies that have successfully used AI-assisted dynamic pricing can gain a significant advantage over firms that do not use AI (Markula, 2023).

2.3.1 AI techniques for dynamic pricing

AI techniques for dynamic pricing include machine learning, neural networks, reinforcement learning, and Bayesian methods. These techniques enable firms to create dynamic pricing plans that adjust to changing market conditions, rather than static models (Putha, 2023).

According to Gupta (2024), machine learning is a branch of AI that trains algorithms to identify patterns in data and make predictions. Dynamic pricing involves training ML models on previous sales data to forecast appropriate prices for various products and consumer segments. Reinforcement Learning (RL) is a strong AI technique that teaches an agent to make decisions by interacting with its environment and receiving feedback in the form of rewards. Dynamic pricing allows agents to alter prices based on market conditions, maximising long-term earnings. Neural networks are machine learning models based on the structure of the human brain. Neural networks process incoming data and generate anticipated prices. Bayesian approaches use probabilistic frameworks to model uncertainty in pricing decisions. These methods apply Bayes' theorem to update the probability of a hypothesis based on fresh data.

2.3.2. Prediction Models  
Machine learning algorithms provide significant benefits for dynamic pricing. Unlike classic econometric models, machine learning does not require data to have a normal distribution, making it more adaptable to real-world datasets. Modern processing capacity allows for the rapid completion of iterative processes such as stochastic gradient descent and grid search, lowering time and cost restrictions. Furthermore, machine learning algorithms excel at discovering complicated, nonlinear correlations between variables, resulting in high prediction accuracy while minimising estimation error (Sarkar et al., 2023).

According to Ho et al.(2021) there are many models for prediction some of them are: The Support Vector Machine (SVM) is a supervised learning technique used for classification and regression tasks. It works by determining which hyperplane best splits data points into various categories. When linear separability is insufficient, SVM uses a nonlinear transformation to translate data into a higher-dimensional space, allowing it to better spot patterns. SVM use maximal margin hyperplanes to reduce classification errors and accommodate additional data points. This method's regression variation, Support Vector Regression (SVR), works especially well for continuous and categorical predictions. SVM has been used in a variety of applications, including handwriting recognition, text classification, and property price prediction, demonstrating its versatility and accuracy. Its capacity to model nonlinear interactions makes it well-suited for complicated forecasting jobs.

Random Forest is an ensemble learning strategy that combines numerous decision trees to improve prediction accuracy. It chooses a random selection of features to split at each node and uses bootstrap sampling to train each tree on various subsets of the data. Random Forest minimises overfitting and lowers variance by averaging predictions across several trees. This model works quite well for situations involving both regression and classification. Because Random Forest is resistant against complicated and noisy datasets, it regularly outperform linear models in property price estimation. It is the perfect option for dynamic pricing because of its capacity to manage a huge number of parameters and capture complex interactions between them.

Gradient Boosting Models (GBMs) are complex machine learning approaches that iteratively enhance model performance by correcting faults from prior iterations. These models integrate numerous weak learners, usually decision trees, to create a powerful prediction model. GBMs are well-known for their excellent accuracy in regression and classification tasks, and they are frequently used in competitive machine learning applications. They have demonstrated efficacy in predicting housing values and assisting with property purchase decisions. GBMs' iterative nature enables them to handle hard datasets with complicated variable interactions, making them an effective tool for dynamic pricing scenarios.

Linear models like Linear Regression, Ridge Regression, and LASSO are fundamental techniques for predictive modelling. Linear regression requires a direct, suitable relationship between input features and target variables. Ridge Regression goes beyond this by including normalisation to prevent overfitting, especially when dealing with multicollinearity in the data. LASSO improves on this strategy by doing feature selection, making it suitable for datasets with numerous irrelevant or redundant variables. While simpler than ensemble methods, linear models are nonetheless valuable for making quick, interpretable predictions and serving as benchmarks for evaluating more complicated algorithms.

Boosting algorithms are ensemble approaches that increase prediction accuracy by combining numerous weak models into a powerful learner. These algorithms work iteratively, focussing on fixing earlier faults. AdaBoost, a well-known boosting method, performs well for classification tasks, although other algorithms, such as RIPPER, thrive in specific situations. Boosting techniques are extremely effective in handling complicated datasets and have been effectively used in property prediction applications. Their ability to reduce errors through iterative refinement makes them an excellent complement to dynamic pricing schemes.

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Chapter 4 Research gap

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