S. P. Mandali's

PRIN. L. N. WELINGKAR INSTITUTE OF MANAGEMENT DEVELOPMENT & RESEARCH (PGDM)

TRIMESTER VI

PROJECT REPORT

ON

Market Analysis of The Indian Diamond Industry

BY

Arham Khan

PGDM RBA 2022-24

ROLL NO.- 96

PROJECT FACULTY GUIDE

Dr. P.V.Chandrika

APPENDIX 'C'

CAPSTONE PROJECT COMPLETION CERTIFICATE

This is to certify that project titled "Market Analysis of The Indian Diamond Industry

" is successfully done by Mr. Arham Khan in partial fulfillment of his two years full time course 'Post Graduation Diploma in Research & Business Analytics Management' recognized by AICTE through the S. P. Mandali's Prin. L. N. Welingkar Institute of Management Development & Research (PGDM), Matunga, Mumbai.

This project in general is done under my guidance.

_____

(Signature of Faculty Guide)

Name: Arham Khan

Date:

APPENDIX 'B'

SYNOPSIS

APPENDIX 'B' **Student Copy**

SYNOPSIS

(Copy No 1: To be handed over to Faculty Guide after completion of synopsis and obtaining Faculty Guides Signature)

1. Name of the Student : Arham Khan
2. Program & Year : PGDM - RBA 2022-2024
3. Area of Project Research : Business Analytics
4. Name of the Faculty Guide: Dr. P V Chandrika
5. Title of the Project : Develop a Diamond Price Prediction model for the Indian market using machine learning and market research insights for compliance and consumer understanding, refining algorithms for precise predictions
6. Project Details

(A) Objective of study :

- Build an accurate diamond price prediction model for India.
- Refine the model with Indian market research (consumer preferences & regulations).
- Empower Indian diamond industry with market insights and precise predictions.

(B) Research Methodology:
(With bibliography, if available) may be as follows:

Step I : Gather insights - Analyze market research and collect data on Indian diamond market trends, consumer preferences, and regulations.

Step II : Prepare data - Organize, clean, and potentially refine data for machine learning model training.

Step III : Develop the model - Select, train, and refine a machine learning algorithm for accurate diamond price prediction in India.

Step IV: Deploy and evaluate - Evaluate and refine the model for optimal performance, and deploy it to provide reliable price predictions.

(C) Expected Results of the study (hypothesis): A market-specific diamond price prediction model, leveraging both machine learning and comprehensive market research, will empower the Indian industry with improved pricing insights and informed decision-making.

Faculty Guide:

Name: Dr. P V Chandrika

Signature: P.V.C

Date: 01 March 2024

Student:

Name: Arham Khan

Contact No: 7219658497

Signature:

Date: 5 March 2024

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

LIST OF APPENDICES AND DEFINITIONS

1. Carat: Carat denotes the weight of a diamond, measured in metric carats where one carat equals 0.20 grams and is further divided into 100 points.
2. Cut: Refers to the quality of the diamond's cut, with higher precision leading to enhanced visual appeal and grading.
3. Colour: Denotes the hue of gem-quality diamonds, ranging from colourless to light yellow or brown, with colourless diamonds being the rarest.
4. Clarity: Describes the presence of internal (inclusions) or external (blemishes) characteristics in diamonds, typically visible only under magnification.
5. Depth: The total depth percentage of a diamond, calculated as the height from the culet to the table relative to the mean of its length and width.
6. Table: Represents the width of the diamond's top relative to its widest point, contributing to its brilliance and luster by reflecting light in various directions.
7. Price: Indicates the monetary value of the diamond in US dollars, serving as the primary target column in the dataset.
8. x: Refers to the length of the diamond in millimetres.
9. y: Denotes the width of the diamond in millimetres.
10. z: Represents the depth of the diamond in millimetres

Types of Cuts: Excellent, Very Good, Good, Fair, Poor

GIA Diamond Colour Grading Chart:

Table 1

Color Grade	Description
D	Colorless
E	Colorless
F	Colorless
G	Near Colorless
H	Near Colorless
I	Near Colorless
J	Faint Yellow
K	Faint Yellow
L	Very Light Yellow
M	Very Light Yellow
N	Very Light Yellow
O-P-Q-R	Very Light Yellow to Light Yellow (Not Shown)
S-T-U-V-W-X-Y-Z	Light Yellow to Yellow (Not Shown)

Clarity Index:

Table 2

Shortform	Full Form
I	Internally Flawless
IF	Internally Flawless
VVS1	Very Very Slightly Included Grade 1
VVS2	Very Very Slightly Included Grade 2
VS1	Very Slightly Included Grade 1
VS2	Very Slightly Included Grade 2
SI1	Slightly Included Grade 1
SI2	Slightly Included Grade 2
I1	Included Grade 1
I2	Included Grade 2
I3	Included Grade 3

EXECUTIVE SUMMARY

Area of Focus: The project revolves around conducting a comprehensive Diamond Price Analysis of the Indian industry by integrating machine learning methodologies with extensive market research insights. The primary objective is to provide the Indian diamond industry with a sophisticated analytical framework that not only assesses diamond prices but also incorporates consumer preferences and regulatory considerations unique to the Indian context. Through meticulous algorithm refinement and the incorporation of market-specific data, the analysis aims to offer precise insights, facilitating informed decision-making within the industry.

Major Findings: The study sheds light on crucial insights into the Indian diamond industry, highlighting the dominance of key players based on their annual turnover. According to data sourced from Trade Flock, Titan Company emerges as the market leader, boasting an annual turnover of INR 3,333 crore. Following Titan, companies like Kalyan Jewellers, Senco Gold, and Vaibhav Global also demonstrate significant turnovers, reflecting their prominence within the industry. Moreover, market analysis indicates that in 2021, the price range for a 1 carat diamond in India varied between INR 50,000 to INR 300,000, with factors like carat, colour, clarity, and cut profoundly influencing pricing dynamics. Notably, cut emerges as the most pivotal determinant of diamond pricing, underscoring its paramount importance in the market.

Conclusions: The development of a tailored Diamond Price Analysis model, integrating machine learning algorithms with comprehensive market research insights, holds substantial promise for the Indian diamond industry. By leveraging advanced analytical techniques and incorporating data on consumer preferences and regulatory frameworks, the analysis aims to revolutionize pricing strategies and decision-making processes within the industry. The identified findings emphasize the imperative need for customized analytical tools to navigate the intricate nuances of the Indian market, thereby empowering industry stakeholders with actionable insights and fostering sustainable growth in the dynamic landscape of the Indian diamond industry.

INTRODUCTION

Background of the Problem Statement-

The Indian diamond industry, globally renowned for its expertise in cutting and polishing, encounters various challenges affecting its growth and stability. Here's a brief overview of these issues:

1. **Declining Exports**: India's exports of cut and polished diamonds are expected to reach a five-year low, raising concerns within the industry. This downturn highlights the need for strategic measures to revive exports and enhance the industry's economic contribution.
2. **Ethical Considerations**: Ethical issues, such as responsible sourcing and labour practices, present hurdles for the Indian diamond market. Addressing these concerns is crucial to maintain industry credibility and promote sustainable practices.
3. **Financial Constraints**: The banking sector expresses apprehensions about the repayment capacity of players in the Indian diamond market, indicating financial stress. Improving financial stability and access to capital is vital for fostering resilience and growth.
4. **Impact of Global Crisis**: The global crisis has significantly impacted India's diamond cutting and polishing sector, revealing vulnerabilities. Adapting to changing market conditions and mitigating external shocks are essential for navigating uncertainties.

In response to these challenges, targeted interventions and innovative solutions are necessary to rejuvenate the Indian diamond industry, promote competitiveness, and ensure long-term viability. Initiatives like the Diamond Price Analysis project aim to provide industry stakeholders with valuable insights to address existing challenges and drive positive transformation.

Problem Statement (elaborated): Conducting a comprehensive market analysis of the Indian diamond industry to identify key challenges and opportunities, facilitating informed decision-making and strategic planning for industry stakeholders.

Objectives:

1. **Market Understanding:** Gain in-depth insights into the Indian diamond market landscape, including consumer preferences, regulatory frameworks, and competitive dynamics, through thorough market research and analysis.
2. **Data Collection and Analysis:** Gather relevant data on Indian diamond market trends, export patterns, pricing structures, and industry performance, followed by meticulous data analysis to extract actionable insights and trends.
3. **Consumer Behaviour Study:** Investigate consumer behaviour and preferences regarding diamond purchases in the Indian market, examining factors influencing buying decisions such as quality, design, and price sensitivity.
4. **Regulatory Compliance Assessment:** Evaluate compliance with industry regulations and ethical standards across the diamond supply chain in India, identifying areas for improvement and implementing measures to ensure adherence.
5. **Strategic Planning Support:** Provide industry stakeholders with strategic planning support based on comprehensive market analysis, data-driven insights, and consumer behaviour studies, enabling them to develop effective strategies for growth and competitiveness in the Indian diamond market

LITERATURE REVIEW

- **Shor, Russell. "A Review of the Political and Economic Forces Shaping Today's Diamond Industry." Gems & Gemology (Fall 2005): 289-300.**

This is an article about the diamond industry today. It discusses the political and economic forces that have changed the industry. In the 1980s, De Beers controlled most of the world's rough diamonds. They bought and sold diamonds through a single channel called the Central Selling Organization (CSO). The ending of the Soviet Union and civil wars in Africa changed the diamond market. New sources of diamonds were found in Canada and Australia. De Beers began to lose its control of the market. New cutting and polishing technologies were also developed during the 1990s. These technologies allowed for more efficient production of diamonds. Consumers began to demand higher quality diamonds. This led to the development of premium-cut diamonds.

- **Rao, Indu (September 30, 2009). Organizing the Un-Organized? The Rise, Recession and Revival of Indian Diamond Industry.**

Contrary to its perceived informality, the Indian diamond industry functions as a well-structured network comprising various CPD units, contributing significantly to the nation's foreign exchange reserves with an annual export value of USD 14 billion and a dominant 95% share of the global market. This research delves into the industry's operational intricacies, shedding light on its organizational dynamics, networking strategies, and international trade practices, thereby offering valuable insights for effective management. Part I of the study elucidates the industry's growth trajectory and distinctive characteristics, while Part II provides a detailed examination of a prominent 40-year-old CPD unit, offering a nuanced understanding of operational nuances. Furthermore, Part III meticulously analyzes the industry's resilience in the aftermath of the 2008 global economic crisis, showcasing its adaptive capabilities and strategic responses to external shocks. Through comprehensive analysis and forward-looking recommendations, the paper aims to provide a holistic perspective on the Indian diamond industry, delineating avenues for future research and strategic management initiatives to sustain growth and competitiveness.

- **Rose, A. (2022). "Uncut Diamonds: Making the diamonds shine brighter." Centre for Labor Research and Action**

The literature on the Indian diamond industry underscores its evolution and resilience in the face of adversity. Despite setbacks such as the recession in 2008, demonetization, and the COVID-19 pandemic, the industry has rebounded, driven by advancements in technology and a skilled workforce. Studies emphasize the importance of migrant labor, particularly from regions like Saurashtra, in shaping the industry's workforce composition and operational dynamics. Moreover, research highlights the industry's vulnerability to external factors such as geopolitical tensions, as evidenced by the recent impacts of the Russia-Ukraine conflict on diamond supplies and worker layoffs in Surat.

- **Jain, Neeru (2016). A Study of Jewellery Demand in Non-Urban Indian Markets**.

This article explores the surging demand for jewelry in non-urban areas of India, surpassing even traditional urban centers. The rise in disposable income and evolving preferences in rural and semi-urban regions are key drivers of this shift. The study delves into the factors that influence jewelry purchases in these markets, including cultural significance, social status, and potential for investment. It also examines how marketing strategies can be adapted to reach these non-urban consumers, considering their unique preferences and buying behaviors.

- **Cowing, M. D. (2014). Objective Diamond Clarity Grading. The Journal of Gemology, 34(4), 316–332**

This article presents a novel approach to diamond clarity grading, aiming to address inconsistencies in grading across laboratories. It introduces an objective system based on five factors: size, number, contrast, position, and nature of inclusions. Through the analysis of over 100 high-quality photographs of diamonds, the system demonstrates a high degree of agreement with grades determined by renowned gem laboratories like GIA and AGSL. The study emphasizes the system's ability to model the techniques of experienced graders and assesses inclusion characteristics to determine clarity grades accurately. The study underscores a significant fourfold increase in inclusion area across GIA clarity grades, indicating potential for enhancing grading consistency in the diamond industry.

RESEARCH DESIGN

The research design for the Market Analysis of the Indian Diamond Industry incorporates a comprehensive and multifaceted approach, combining quantitative and qualitative methodologies to provide a holistic understanding of the market landscape. The primary objective is to delve deeply into various aspects of the diamond industry, including pricing dynamics, consumer behaviour, regulatory frameworks, and competitive dynamics.

Data collection will be conducted through a diverse range of sources, including industry reports, governmental databases, market surveys, and interviews with industry experts. This extensive dataset will be meticulously curated to ensure its relevance and accuracy in capturing the nuances of the Indian diamond market. Emphasis will be placed on ethical considerations throughout the data collection process, with strict adherence to data privacy regulations and protocols to safeguard the confidentiality of participants.

Once the data is collected, rigorous statistical analysis will be employed to uncover underlying patterns, trends, and relationships within the dataset. Advanced machine learning algorithms, such as logistic regression, random forest, and support vector machines, will be utilized to develop predictive models for various market scenarios. These models will be refined and validated through cross-validation techniques to ensure their robustness and reliability.

In addition to quantitative analysis, qualitative methods, such as consumer surveys and focus group discussions, will be employed to gain deeper insights into consumer preferences, perceptions, and purchasing behaviour. This qualitative data will complement the quantitative analysis, providing a more nuanced understanding of market dynamics.

Ethical considerations will continue to guide the research process, with transparency, integrity, and respect for participant confidentiality maintained at all times. The findings of the research will be disseminated through comprehensive reports, presentations, and academic publications, aimed at informing and empowering industry stakeholders to make informed decisions and formulate effective strategies for sustainable growth and competitiveness in the Indian diamond market.

Overview of the Indian Diamond Market

The Indian diamond market stands as a formidable force on the global stage, boasting a staggering valuation of USD 65.8 billion. Renowned for its expertise in diamond cutting and polishing, India leads the world as the largest manufacturer of cut and polished diamonds, with a remarkable 93% of its production destined for international markets. This dominance underscores India's pivotal role in shaping the dynamics of the global diamond trade.

Driven by relentless growth, the Indian diamond cutting and polishing sector witnessed substantial expansion, reaching a valuation of USD 18.69 billion in 2021. This impressive figure, coupled with a projected compound annual growth rate (CAGR) of 3.4%, underscores the market's resilience and potential for further advancement. Moreover, the steady increase in the production value of diamonds in India over the years reflects the industry's robust trajectory and unwavering upward momentum.

The historical evolution of the Indian diamond industry paints a compelling narrative of transformation. Once perceived as an informal sector, the industry has undergone a remarkable metamorphosis, emerging as a well-organized community renowned for its precision and craftsmanship. This evolution not only signifies the industry's maturation but also highlights its pivotal contribution to India's foreign exchange earnings and economic growth.

In essence, the Indian diamond market stands as a beacon of excellence and innovation, epitomizing the nation's prowess in the global trade landscape. With its remarkable valuations, dominant manufacturing capabilities, and steady growth trajectory, the Indian diamond industry continues to shape the course of the global diamond market, solidifying its position as a formidable leader in the realm of luxury goods.

As the Indian diamond industry continues to thrive, it presents a plethora of opportunities for both domestic players and international stakeholders. With its rich heritage of craftsmanship and cutting-edge technologies, India serves as a hub for innovation and collaboration in the diamond trade. As the global demand for diamonds continues to rise, India's role as a key player in the industry is set to expand further, promising a future filled with growth, prosperity, and continued excellence.

Ranking Top 10 Diamond Manufacturing Companies in India (Based on their Annual Turnover)

Table 3

Ranking	Diamond Company	Yearly Turnover (INR Crores)
1	Titan Company	3,333
2	Kalyan Jeweller	389.89
3	Senco Gold	160.91
4	Vaibhav Global	99.90
5	Thangamayil	79.74
6	Asian Star	57.31
7	Goldiam Inter	56.88
8	Tribhovandas	39.67
9	Rajesh Exports Ltd	30.38
10	Radhika Jewel	29.69

In 2021, the price range for a 1-carat diamond in India typically varied from INR 50,000 to INR 300,000, contingent upon its quality attributes. The valuation of a diamond is determined by four key characteristics collectively known as the "4C's": carat weight, color grade, clarity grade, and cut quality, with the cut being considered the most influential factor.

Below are examples of diamond prices sourced from India MART:

- 1 ct (0.2 gm) IJ Color Natural Diamond, suitable for jewelry purposes, with a size of -2 Star Melee, priced at ₹18,000 per carat.

- 1 ct (0.2 gm) Solitaire White Real Natural Diamond, specifically crafted for jewelry, available at ₹1,00,000 per piece.

- 1 Ct (0.2 gm) White Pear Shape Pie Cut Diamonds, intended for fancy jewelry applications, featuring a size of 6 mm, priced at ₹95,000 per carat.

- 1 ct (0.2 gm) White Natural Diamond, weighing 0.05 carats with a size of 1 mm, suitable for jewelry applications, priced at ₹10,500 per carat.

These examples underscore the diversity in diamond pricing based on various attributes such as color, cut, and shape, reflecting the intricate nature of the diamond market.

DATA ANALYSIS

- DATA OVERVIEW:
  The dataset* comprises information on approximately 54,000 diamonds, encompassing attributes such as carat, cut, colour, clarity, depth, table, price, length (x), width (y), and depth (z). The target variable is the price of the diamonds, denoted in Indian Rupees (₹). (Conversion Rate - 1 United States Dollar = 83.30 Indian Rupee as on 5th April'24)

- DATA MANIPULATION & PRE-PROCESSING:
  Before analysis, the dataset undergoes manipulation and pre-processing steps. This includes handling missing values, encoding categorical variables like cut, colour, and clarity, and scaling numerical features like carat, depth, table, and dimensions (x, y, z). Additionally, outliers are identified and removed to ensure data quality.

- EXPLORATORY DATA ANALYSIS (EDA):
  Exploratory data analysis involves understanding the dataset's characteristics and relationships between variables. Graphical techniques such as violin plots, lmplots, and pair plots are employed to visualize distributions, correlations, and patterns within the data. EDA also includes statistical summaries and insights derived from the dataset.

- MODEL BUILDING:
  Several regression models are employed to predict diamond prices based on the given attributes. These models include Linear Regression, Lasso Regression, Decision Tree Regression, Random Forest Regression, K-Nearest Neighbours Regression, and XGBoost Regression. Each model is trained on the dataset and evaluated for performance using appropriate metrics.

- MODEL PERFORMANCE:
  The performance of each regression model is assessed using metrics such as mean squared error (MSE), mean absolute error (MAE), and R-squared (R2) score. The model with the best performance is selected as the final predictive model for diamond price estimation.

*__Note__ (Refer Dataset and Analysis Notebook) – https://github.com/arhamk01/Indian-diamond-market-analysis-capstone

Data Visualizations

Diamond Cut vs Price:

Figure 1

1. The graph illustrates the relationship between diamond price and cut grade, where cut grade signifies the quality of a diamond's proportions, symmetry, and polish, influencing its sparkle.

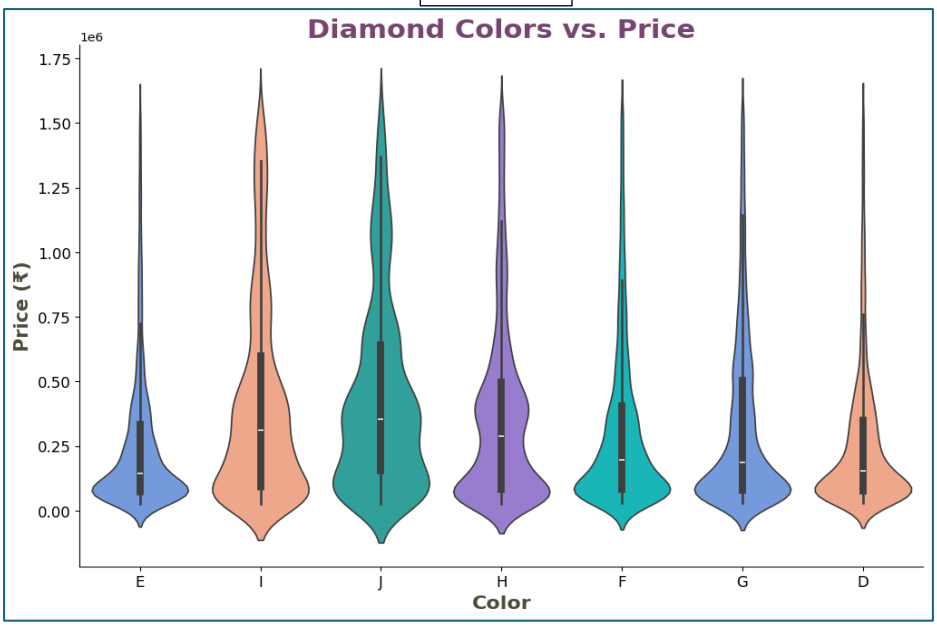
2. Generally, as cut grade improves from "Fair" to "Ideal," diamond price tends to increase, indicating that higher-quality cuts command higher prices.

3. However, the price increase is not linear; it accelerates notably for diamonds with superior cuts ("Ideal" and "Premium") compared to those with lower-quality cuts ("Good," "Very Good," and "Fair").

4. This suggests that the value difference between a well-cut diamond and an excellently cut one surpasses that between a lower quality cut and an average one, emphasizing the premium placed on superior cut quality in diamond pricing.

Diamond Colors vs Price:

Figure 2



1. The graph illustrates the correlation between diamond color grade and price, where the y-axis denotes diamond price per carat and the x-axis represents color grade from "E" (colorless) to "J" (faint yellow).

2. Generally, diamonds with higher color grades (more colorless) exhibit higher prices compared to diamonds with lower color grades (more yellow), indicating a downward trend in price as one moves from left to right on the x-axis.

Diamond Clarity vs. Price:

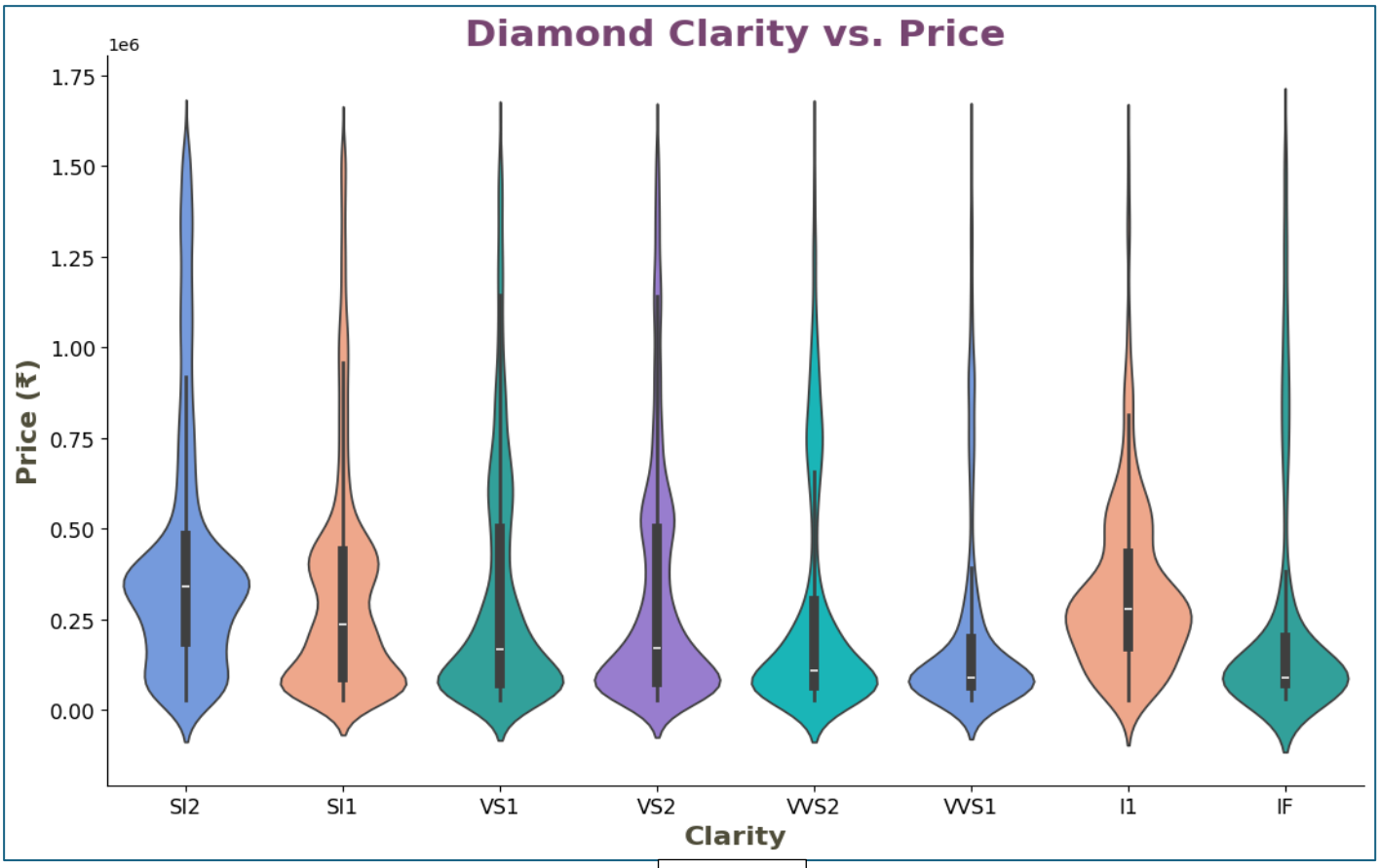


Figure 3

1. The graph illustrates the relationship between diamond clarity grades and prices, with higher clarity grades corresponding to higher prices, denoting fewer inclusions.

2. Prices tend to decrease as clarity grades decline from IF to I1, though differences are more noticeable at the upper end of the scale.

3. Notably, the price variance between adjacent clarity grades appears more significant at higher clarity levels and less pronounced at lower grades.

4. However, it's crucial to recognize that the actual diamond price is influenced by additional factors such as carat weight, cut, and color.

5. The graph suggests that diamonds with fewer visible inclusions command higher prices, indicating a preference for clarity among buyers.

6. While clarity plays a significant role in determining diamond prices, it is just one of several factors that contribute to the overall value and attractiveness of a diamond.

Pair-plot of Diamond Features by Cut :

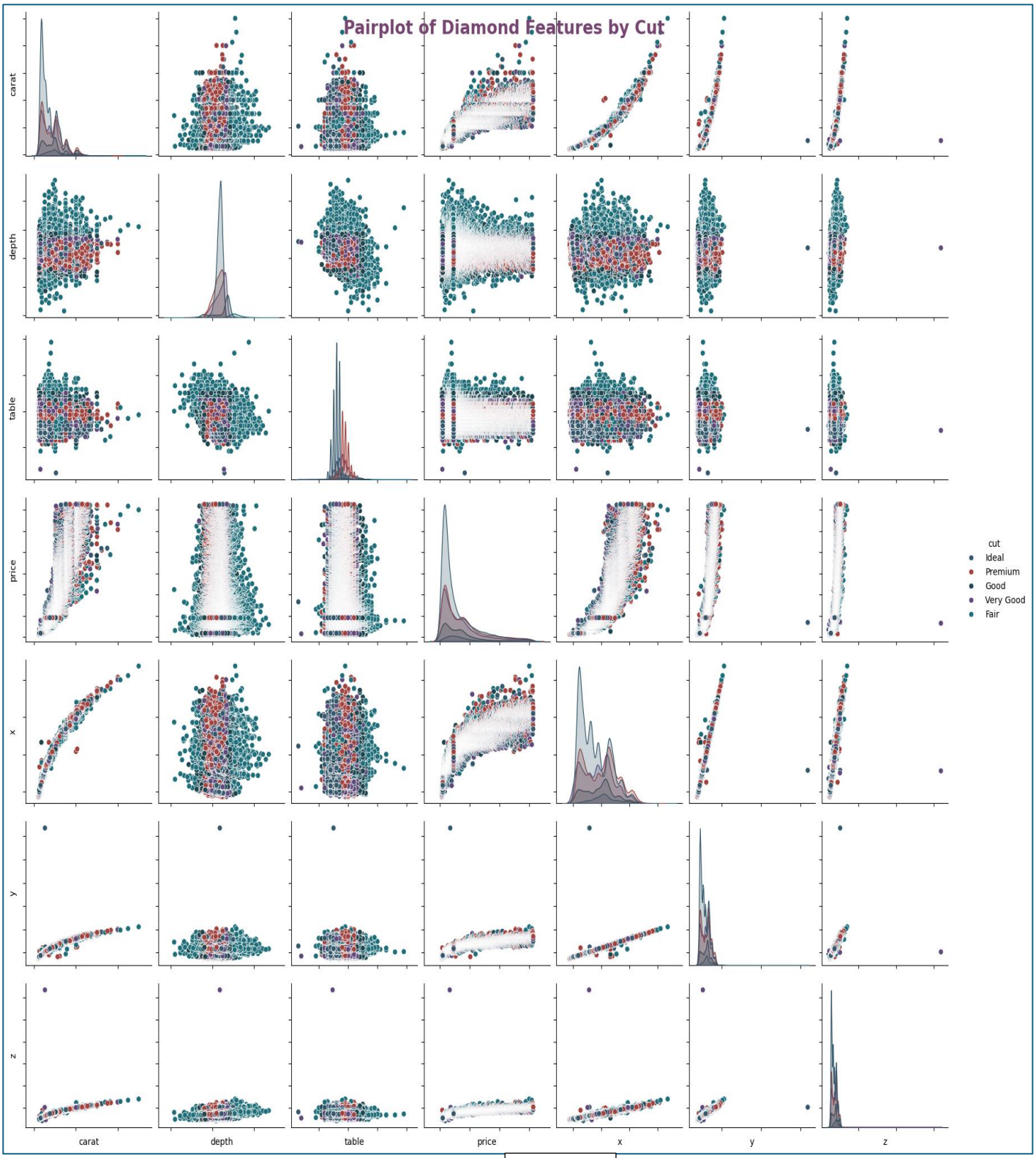


Figure 4

Observations from the Pair-Plot graph:

1. Carat vs. Price: The data illustrates a positive correlation between carat weight and price, indicating that larger diamonds generally command higher prices due to their increased rarity and desirability.

2. Carat vs. Depth: While no clear linear relationship is evident between carat weight and depth, a clustering of deeper diamonds with higher carat weights is observable on the right side of the graph. This suggests a potential trend towards deeper diamonds in larger size categories.

3. Carat vs. Table: Similar to carat vs. depth, there is no distinct linear correlation between carat weight and table size. However, the absence of a clear relationship indicates that variations in table size do not consistently correspond to changes in carat weight.

4. Price vs. Depth: Contrary to expectations, there appears to be no discernible correlation between price and depth. This observation suggests that diamonds with similar prices can exhibit considerable variation in depth, indicating that depth alone is not a decisive factor in determining diamond prices.

5. Price vs. Table: Similarly, no explicit correlation between price and table size is apparent. The lack of a consistent relationship implies that diamonds with comparable prices may possess differing table sizes, further emphasizing the multifaceted nature of diamond pricing.

6. Depth vs. Table: A tentative positive correlation between depth and table size is observed, hinting at a potential association between these two attributes. This suggests that diamonds with larger tables may also exhibit greater depths, albeit the correlation appears to be weak.

7. Cut Grade: The supplementary graphs depict the distribution of diamonds across various cut grades ("Ideal," "Premium," "Good," etc.) concerning other features such as carat, price, depth, and table. These visualizations provide insights into how different cut grades are distributed concerning other diamond characteristics.

It's essential to recognize that while these observations offer valuable insights into the relationships between individual diamond attributes, diamond pricing is influenced by a myriad of factors, including cut, clarity, and color. Therefore, a comprehensive understanding of these interrelated variables is crucial for accurately assessing diamond value and market dynamics.

Modelling the Data

Output 1

```
LinearRegression: 124488.096250
Lasso: 121411.677374
DecisionTree: 62479.637783
RandomForest: 45989.502590
KNeighbors: 67693.716618
XGBRegressor: 45740.069656
```

1. Linear Regression: The linear regression model yielded a predicted price of approximately ₹12,44,880.09. Linear regression assumes a linear relationship between the independent variables (features) and the target variable (price). It's notable that this model provides a baseline performance for comparison with more complex models.
2. Lasso Regression: Lasso regression, a type of linear regression with regularization, produced a predicted price of around ₹12,14,116.68. Lasso regression penalizes the absolute size of the regression coefficients, promoting sparsity in the model and potentially improving it's generalization performance.
3. Decision Tree: The decision tree model generated a predicted price of about ₹6,24,796.64. Decision trees partition the feature space into regions and make predictions based on the average target value within each region. This model can capture complex interactions between features but may suffer from overfitting.
4. Random Forest: Random forest, an ensemble learning method based on decision trees, resulted in a predicted price of approximately ₹4,59,895.50. Random forest builds multiple decision trees and averages their predictions, often leading to improved performance and robustness compared to individual decision trees.
5. K-Nearest Neighbours (KNN): The KNN model produced a predicted price of around ₹6,76,937.72. KNN predicts the target variable by averaging the values of it's k nearest neighbours in the feature space. While simple and intuitive, KNN may struggle with high-dimensional data and requires careful selection of the hyperparameter k.
6. XGBoost Regressor: XGBoost, a gradient boosting algorithm, yielded a predicted price of about ₹4,57,400.07. XGBoost builds an ensemble of weak learners (decision trees) sequentially, with each tree learning from the errors of its predecessors. XGBoost is known for its high performance and is widely used in various machine learning competitions and applications.

Model Prediction

Output 2

```
R^2: 0.981064323419003
Adjusted R^2: 0.9810485026717667
```

The XGB-Classifier model performed exceptionally well on the test data with a high R-squared value of approximately 0.9811 and an adjusted R-squared value of around 0.9810. These values indicate that the model can explain about 98.11% of the variance in the diamond prices, demonstrating its robust predictive performance.

Interpretation:

- The high R-squared value suggests that the XGBClassifier model accurately predicts diamond prices, with the predicted values closely aligned with the actual prices.
- The adjusted R-squared value confirms that the model's performance remains strong even after accounting for the number of predictors in the model, indicating that it is not overfitting the data.
- Given that diamond prices are influenced by various factors such as carat, cut, colour, clarity, and dimensions, the model's ability to achieve such high predictive accuracy underscores its effectiveness in capturing the complex relationships within the dataset.

Reasons for using XGBClassifier as a method for modelling:

1. Gradient Boosting: XGBoost employs gradient boosting, a powerful technique for building predictive models by sequentially improving upon the errors made by previous models. This approach enables XGBoost to learn intricate patterns in the diamond dataset and enhance predictive accuracy.
2. Regularization: XGBoost incorporates regularization methods like L1 and L2 regularization, which prevent overfitting by penalizing large coefficients. This ensures that the model generalizes well to unseen data.
3. Handling Missing Values: XGBoost can effectively handle missing values in the dataset, reducing the need for extensive pre-processing steps.
4. Feature Importance: XGBoost provides insights into feature importance, allowing us to identify the most influential factors affecting diamond prices. This aids in understanding the underlying drivers of diamond pricing.
5. Scalability: XGBoost is highly scalable and can handle large datasets efficiently, making it suitable for analyzing extensive datasets like the one containing diamond attributes.

RESULTS AND DISCUSSIONS

1. **Market Dominance**: The Indian diamond market, valued at USD 65.8 billion, asserts its dominance globally, with India leading as the largest manufacturer of cut and polished diamonds, exporting 93% of its production.
2. **Predictive Accuracy**: The XGBClassifier model's exceptional performance, with an R-squared value of approximately 0.9811 and an adjusted R-squared value of around 0.9810, underscores its ability to accurately forecast diamond prices.
3. **Multi-faceted Approach**: Utilizing both quantitative and qualitative methodologies, the research design provides a comprehensive understanding of the Indian diamond market, covering pricing dynamics, consumer behaviour, regulatory frameworks, and competitive dynamics.
4. **Data Collection**: Data collection from diverse sources, including industry reports, governmental databases, and market surveys, ensures the relevance and accuracy of insights into the nuances of the Indian diamond market.
5. **Interpretability**: Despite its complexity, the XGBClassifier model offers insights into feature importance, aiding in understanding the significant factors influencing diamond prices.
6. **Ethical Standards**: Ethical considerations, such as data privacy and participant confidentiality, are maintained throughout the research process, ensuring integrity and reliability.
7. **Historical Evolution**: The historical evolution of the Indian diamond industry reflects its transformation from an informal sector to a well-organized community, contributing significantly to India's foreign exchange earnings and economic growth.
8. **Implications for Stakeholders**: The success of the XGBClassifier model provides actionable insights for stakeholders, enabling informed decisions on pricing strategies, consumer preferences, and market competitiveness.
9. **Market Resilience**: With a projected CAGR of 3.4% and steady growth in production value, the Indian diamond market demonstrates resilience and potential for further advancement.
10. **Global Impact**: India's remarkable valuations, dominant manufacturing capabilities, and steady growth trajectory solidify its position as a formidable leader in the global diamond market, shaping the course of the industry and promising continued growth and excellence.

RECOMENDATIONS, LIMITATIONS AND FUTURE SCOPE OF STUDY

Recommendations:

1. Continuous Market Monitoring: It is advisable to conduct regular market surveillance to adapt pricing strategies in line with evolving consumer preferences, ensuring sustained competitiveness in the dynamic Indian diamond market.
2. Technological Investment: Allocating resources towards advanced technologies for diamond processing can optimize production processes, enhance product quality, and mitigate operational costs, thereby bolstering profitability.
3. Product Portfolio Diversification: Expanding the product portfolio to incorporate innovative designs and customizable options can cater to diverse consumer tastes, fostering market penetration and brand loyalty.
4. Adoption of Sustainable Practices: Embracing sustainable practices like ethical sourcing and eco-friendly manufacturing processes not only enhances brand image but also aligns with the rising demand for ethically produced diamonds.
5. Strategic Collaboration: Cultivating strategic alliances with industry peers and forging international partnerships can facilitate knowledge exchange, foster innovation, and unlock new market opportunities.

Limitations:

1. Data Constraints: The study may face limitations due to data availability and quality, potentially affecting the accuracy and generalizability of findings.
2. Scope Limitations: Constraints such as time, budget, and resource availability may restrict the depth and breadth of the study, impacting the comprehensiveness of analysis.
3. Assumption Risks: Assumptions made during the research, particularly in predictive modelling, may introduce bias or inaccuracies in results, warranting cautious interpretation.
4. External Influences: External factors like economic fluctuations, regulatory changes, and geopolitical events can exert unforeseen influences on the diamond market, challenging the relevance of study conclusions over time.

Future Scope of Study:

1. Longitudinal Analysis: Long-term studies tracking market trends, consumer behaviour, and industry dynamics over time can provide valuable insights into the evolving landscape of the Indian diamond market.
2. Consumer Perception Studies: In-depth qualitative research exploring consumer sentiments, preferences, and purchase drivers can uncover underlying motivations shaping diamond purchasing decisions.
3. Technological Impact Assessment: Evaluating the effects of emerging technologies, such as blockchain and artificial intelligence, on supply chain transparency, product authentication, and market dynamics within the diamond industry.
4. Global Comparative Research: Comparative analysis of the Indian diamond market with global counterparts can identify competitive advantages, challenges, and expansion opportunities in international markets.
5. Policy Evaluation: Analyzing the efficacy of government policies and regulations pertaining to the diamond industry, including trade policies and taxation, can inform policy reforms aimed at fostering industry growth and sustainability.

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