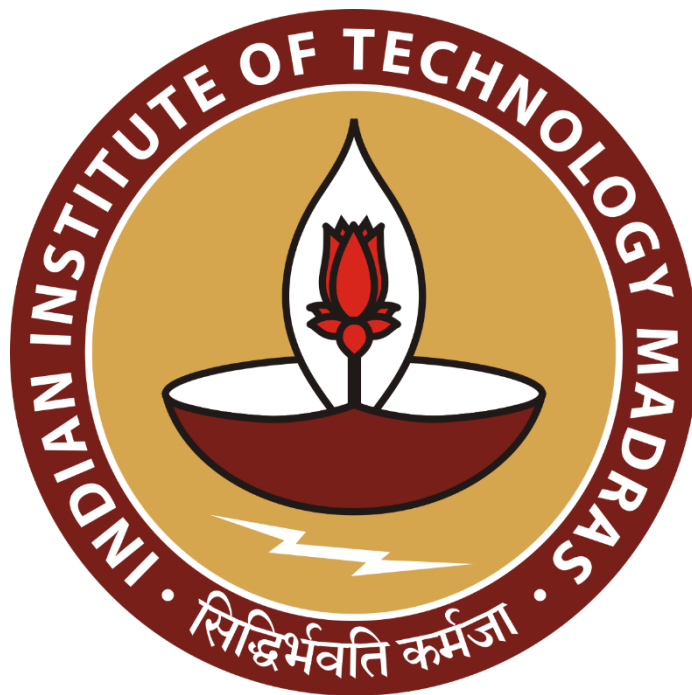**Modernizing Excellence: A Data-Driven Transformation for Sri Murugan Traders**

A Final submission for the BDM capstone Project

Submitted by

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Contents

1 Executive Summary:

"**SRI MURUGAN TRADERS**" has been an integral part of the Sriperumbudur community for over three and a half decades. Despite their long-standing presence, they have maintained their supplier details and rice variety data in physical books. While they can provide cost and selling price details for recent periods, they lack comprehensive records of rice prices. Furthermore, their ordering practices tend to be reactive, triggered only when the rice quantity reaches critically low levels.

With their business expansion and increasing competition, it has become imperative for 'SRI MURUGAN TRADERS' to conduct a thorough analysis of their operations. Unfortunately, the absence of proper data records hinders their ability to perform an in-depth business analysis.

I conducted a Google Form survey to collect information about quality problems and types of impurities in each rice brand. The final report I submitted includes crucial information related to potential solutions for all the problem statements. Additionally, it provides insights into the analytical process, results, and findings, offering a comprehensive view of the current state of the business.In the ongoing journey of 'SRI MURUGAN TRADERS,' several challenges have surfaced, demanding strategic interventions for sustainable growth. The primary issues identified are "Inconsistent Product Quality," "Tax Compliance," and "Supplier Price Fluctuation." Recognizing the critical nature of these challenges, I undertook a comprehensive analysis and proposed targeted solutions to navigate these complexities successfully.

Addressing the issue of inconsistent product quality, I advocated for a proactive approach wherein the owners prioritize the resolution of quality problems based on a predefined order. This strategic framework enables effective negotiations with suppliers, facilitating a systematic improvement in product quality. To mitigate tax compliance concerns, I suggested a collaborative effort with both suppliers and government authorities to find a balanced resolution that aligns with regulations while preserving the profitability of the business. Additionally, for managing supplier price fluctuations, a data-driven approach was employed. By standardizing the price differences and profits, 'SRI MURUGAN TRADERS' can identify brands less affected by price increases, ensuring informed decision-making in pricing strategies.

Beyond these immediate challenges, I leveraged machine learning algorithms to empower 'SRI MURUGAN TRADERS' with predictive capabilities. Three algorithms were developed to predict profits, ratings, and the number of rice bags that can be purchased based on the features of impurities and quality issues in each rice brand. While acknowledging the challenges posed by limited samples, these models offer valuable insights and pave the way for enhanced decision-making when provided with larger datasets.

Furthermore, to support the transition towards data-driven operations, I recommend implementing a comprehensive digital record-keeping system. This will not only streamline data accessibility but also provide a foundation for future analyses and strategic

decision-making. Additionally, ongoing employee training programs on data management practices can ensure the sustained effectiveness of these systems.

As part of the strategic roadmap, exploring partnerships with industry experts and agricultural research institutions can offer valuable insights into sustainable farming practices and quality improvement measures. This collaborative approach enhances the business's adaptability to emerging trends and positions 'SRI MURUGAN TRADERS' as a leader in quality-conscious sourcing.

In the realm of marketing and customer engagement, leveraging digital platforms for online promotions and customer feedback mechanisms can amplify the brand's visibility and strengthen its connection with consumers. This proactive engagement strategy aligns with evolving consumer preferences and contributes to a positive brand image.

This multifaceted approach aims to guide 'SRI MURUGAN TRADERS' toward a brighter and more prosperous future. The proposed solutions are crafted with a vision of sustainable growth, operational excellence, and resilience in the face of dynamic market conditions. By embracing these recommendations, 'SRI MURUGAN TRADERS' is poised for transformative enhancements, ensuring a competitive edge and fostering a thriving business landscape.

2   Detailed Explanation Of Analysis Process:

Initially, a comprehensive compilation of problem statements was undertaken, revealing challenges encompassing inconsistent product quality, tax compliance issues, and supplier price fluctuations. A notable gap in maintaining proper data records necessitated manual data collection. To streamline the data-gathering process, a Google form was deployed, focusing on crucial features such as supplier details, brand specifics, rice varieties, bag quantities, prices, selling durations, 5-star ratings, yearly profits, and various pricing phases spanning from the first half of 2021 to the second half of 2023. Additionally, qualitative aspects like quality problems and impurity types within each brand were elicited.

This raw data was meticulously entered into an Excel spreadsheet, initiating a preliminary preprocessing phase to rectify missing values, address typing errors, and organize the data for subsequent analyses. Following this, inquiries were directed towards the sources of rice purchasing. The owner's responses encompassed ordinary customers, heightened sales during festivals, transactions with schools, colleges, companies, and participation in temple festivals.

For a more nuanced exploration of quality-related issues, the features pertaining to quality problems and types of impurities were isolated into a distinct Excel file. Utilizing one-hot encoding, a correlation table was then generated for these features, facilitating a focused examination of their relationships. Insights derived from the correlation diagram revealed intriguing patterns, notably the high correlation between profits and 3-star ratings, with a counterintuitive negative correlation between profits and 5-star ratings. Further nuances were uncovered, such as the specific negative impact of texture, aroma, grain separation, and color

on 3-star rating brands. In the case of 2-star rating brands, a broader spectrum of quality problems, including grain separation, stickiness, grain integrity, uniformity, color, residue, and grain size, exerted influence.

The subsequent computational phase involved the derivation of annual profits for each brand, employing a formula factoring in selling price, consuming price, bag quantities, and selling duration. This comprehensive profit analysis was further refined by calculating the profit per 1 kg bag for every rice brand, providing a more granular perspective.

In collaboration with respected elders and leveraging online resources, I meticulously identified a range of quality issues associated with rice brands. These encompass texture, aroma, flavor, grain separation, grain integrity, stickiness, uniformity, adsorption, cooking time, color, residues/impurities, and grain size and shape. Additionally, I compiled a comprehensive list of impurity problems, including stones, husks and bran, insects and their fragments, foreign grains, mold and fungus, moisture and clumps, and extraneous materials.

To streamline the data collection process and gain insights into the unique challenges faced by each rice brand, I synthesized these quality and impurity issues into a structured Google Form. Subsequently, I shared this form with the owner, urging them to meticulously fill in the details for each rice brand based on the corresponding quality and impurity problems observed. This strategic approach ensures a systematic and detailed examination of the intricacies associated with each brand's rice quality, setting the stage for a nuanced analysis and targeted improvements.

Upon receipt of the completed forms, the amalgamated data will not only facilitate an in-depth evaluation but also empower data-driven decision-making. This collaborative initiative reflects a commitment to elevating the quality standards of 'SRI MURUGAN TRADERS,' positioning the business for enhanced customer satisfaction and competitiveness in the dynamic rice market.

To culminate the analytical journey, column charts were generated, illustrating the summation and averages of profits vs ratings. Collaborative analysis with the project owner allowed for the extraction of valuable insights and trends, facilitating informed decision-making in addressing the identified challenges.I acknowledge the challenges posed by a 5 to 6% loss in storage management attributed to the rainy season and rodent-related issues. While these factors can indeed pose significant hurdles for data-driven solutions, it's crucial to explore alternative strategies to mitigate losses. Implementing robust physical storage measures, such as elevated platforms or moisture-resistant containers, can safeguard rice stocks from the adverse effects of the rainy season. Concurrently, adopting effective rodent control methods, such as strategically placed traps or utilizing rodent-repelling substances, can help curb losses caused by rat-related damages. Combining these physical interventions with proactive monitoring and timely maintenance can contribute to minimizing storage losses, even in the absence of comprehensive data utilization.

Moreover, despite the challenges posed by the weather and rodents, exploring hybrid solutions that incorporate both physical measures and data-driven insights could offer a

comprehensive approach. Leveraging weather forecasts and data analytics tools, even intermittently, during non-rainy periods, can provide valuable information for optimizing storage conditions and reducing losses. This adaptive strategy allows for a balanced approach, combining practical interventions with occasional data-driven insights to address the storage management challenges effectively.

supplier id	supplier name	supplier place	Brand name	rice variety	quantity of rice bag	consuming price for given kg	selling price for given kg	no.of bags purchased at a time	selling duration in weeks	5 star ratings
1	sri varalakshmi agro tech industries	Andhra Pradesh	Muthayam	Steam Rice	26	1400	1470	100	8	2
	phase 1(2021-first half)	phase2 (2021-second half)	phase 3(2022-first half)	phase4 (2022 second half)	phase 5 (2023-first half)	phase 6(2023-second half)				
	1250	1300	1350	1400	1450	1450				

The computed annual profit for each brand using the formula:

" [(selling price - consuming price) * no. of bags purchased * (36 weeks / selling duration in weeks)] "

BRAND NAME	texture	aroma	flavor	Grain separation	stickiness	grain integrity	uniformity	absorption	cooking time	color	residue / Impurities	grain shape and size
Muthayam	1	0	0	0	0	0	0	0	1	0	0	0

BRAND NAME	stones	husk and bran	insects and its fragments	dirt and dust	foreign grains	mold and fungi	chemical residues	moisture and clumps	broken and fragmented grains	odor and off flavors	extraneous materials
Muthayam	0	1	0	0	0	0	0	0	0	0	0

Concluding the solution for the inconsistent product quality issue, it is recommended that owners prioritize addressing problems in the given order upon receiving new inventory. By adhering to a predefined preference order, owners can negotiate with suppliers to reduce

prices according to the severity of each problem. This proactive approach ensures a systematic and targeted resolution strategy.

Subsequently, attention was directed toward addressing the "supplier price fluctuation" problem. Initially, the difference between the selling prices in Phase 6 (2023-second half) and Phase 1 (2021-first half) was examined. Despite encountering challenges in obtaining data related to selling price, quantity of bags purchased, and selling duration for each phase, an attempt was made to understand how this price difference impacts profit growth. The solution involved standardizing the price difference and profit using the min-max scaler formula, resulting in features ranging between 0 and 1. Visualizing these standardized features through a line chart revealed the influence of price differences on profit. Further analysis involved dividing the standardized profit by the standardized price difference. Brands with scores above 2 were identified as less affected by price rises, those with scores between 1 and 2 were moderately affected, and those with scores below 1 were deemed more susceptible to price increases.

For the tax regulation issue, it was observed that 9 out of 21 brands produced bags weighing 25 kgs or less, leading to higher tax payments due to government regulations favoring 26 kgs and above bags. However, eliminating these brands was not feasible due to their significant contribution to the overall profit (nearly 20%). A proposed solution involved engaging both suppliers and government authorities to find a resolution.

To consolidate the solutions for the three identified problems, the next step involved developing machine learning algorithms. The first algorithm aimed to predict 5-star ratings based on impurities and quality issues. The second algorithm predicted the estimated quantity of bags to be purchased by considering 5-star ratings, impurities, and quality issues. The third algorithm forecasted profits by correlating 5-star ratings, impurities, and quality issues. Despite encountering challenges with low sample sizes, the models exhibited suboptimal accuracy scores and RMSE values. Nevertheless, these models can provide valuable insights when applied to larger datasets. The predictions, although rough, offer a qualitative understanding of the anticipated outcomes.

Various well-known non-overfitting classification and regression models were tested for prediction accuracy, and detailed results, including accuracy and RMSE scores, are presented in the subsequent results and findings section.Additionally, to enhance the robustness of the machine learning models, considering feature engineering techniques such as creating interaction terms or polynomial features could be explored. This can potentially capture non-linear relationships and intricate patterns within the data, thereby improving the models' predictive performance.In the context of addressing tax regulation issues, establishing partnerships with industry associations or advocacy groups can amplify the collective voice when engaging with government authorities. Collaborative efforts with other stakeholders can strengthen the case for reconsidering weight specifications for rice bags, showcasing industry-wide support for a regulatory adjustment that aligns with business interests

The whole data can be viewed by using the following link:

X project_phase2.xlsx

3   Results And Findings:

3.1 SUM OF PROFITS FOR EACH RATINGS
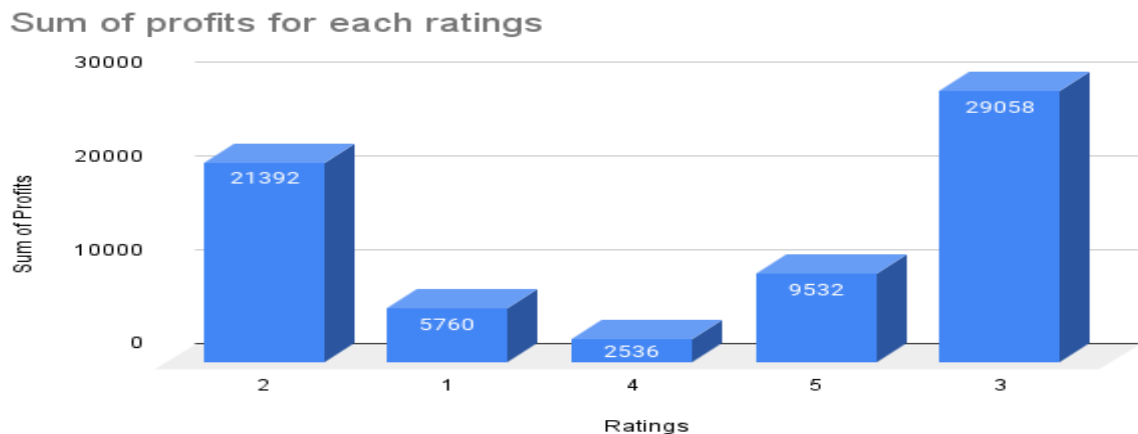
From the **"Total Profits for Each Rating"** plot, it is evident that brands with **"3 Star" and "2 Star"** quality rice have higher profit margins when compared to **"1 Star," "4 Star," and "5 Star"** quality rice brands. This phenomenon can be attributed to several factors**:**

3.1.1: Price Sensitivity: Customers often exhibit price sensitivity, prioritizing affordability over perceived quality**.**

3.1.2: Taste Preference: Some customers have distinct preferences for the taste and texture of 3 Star and 2 Star quality rice, making these brands more appealing.

3.1.3: Brand Loyalty: Many customers have developed strong brand loyalty to specific 3 Star and 2 Star rice brands. This loyalty can be challenging to break, even in the presence of higher-rated options.

3.1.4: Consumer Reviews: Positive reviews and recommendations from other customers can significantly influence purchasing decisions, favoring brands with favorable reviews.

3.1.5: Bulk Purchases: Certain customer segments, particularly those in the foodservice or catering industry, prioritize cost savings achieved through bulk purchases.

3.1.6: Cultural Preferences: Regional or cultural preferences might play a role in the popularity of 3 Star and 2 Star quality rice. Certain cuisines or cooking traditions may favor the characteristics of these rice varieties, contributing to their higher demand.

3.1.7: Marketing Strategies: Effective marketing campaigns and strategies employed by 3 Star and 2 Star rice brands could be influencing consumer perceptions. Clever advertising, promotions, and packaging may contribute to a positive image that resonates with the target audience.

3.1.8: Accessibility: The ease of availability of 3 Star and 2 Star quality rice in various retail outlets, both physical and online, can impact consumer choices. If these brands are more widely distributed or accessible, it could contribute to their higher sales.

3.1.9: Economic Factors: Economic conditions and income levels of the target market may affect purchasing decisions. If the majority of consumers are price-conscious due to economic factors, they may be more inclined to choose affordable options, even if they are of slightly lower quality.

3.1.10: Product Consistency: Consistency in quality and performance of 3 Star and 2 Star rice brands over time may build trust among consumers. If customers have had positive experiences with these brands in the past, they are likely to continue choosing them.

3.2 COUNT OF RICE BRANDS FOR EACH RATINGS:


Count of brands for each ratings
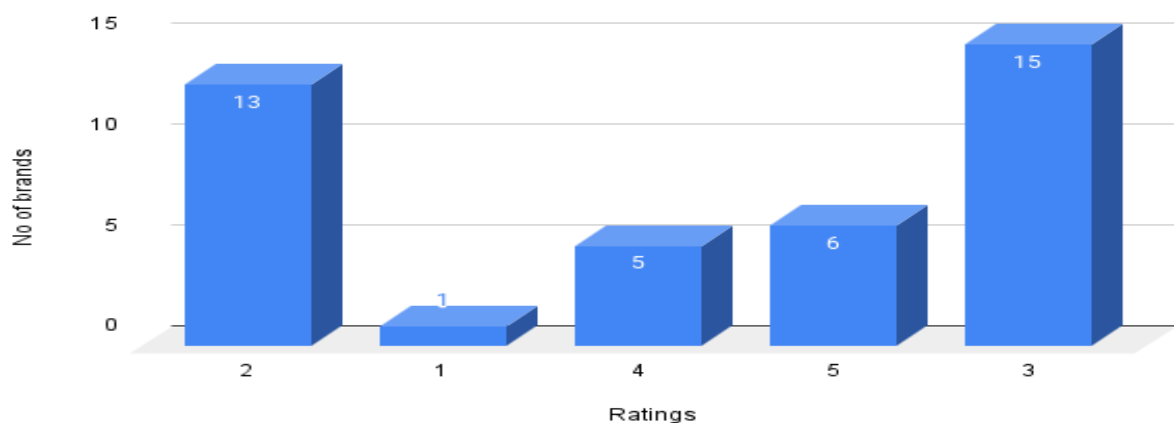
From the "Count of Rice Brands for Each Ratings" plot, it is apparent that the influx of rice brands is significantly higher for 5-star and 2-star quality, followed by 4-star quality, 3-star quality, and finally, 1-star quality. This distribution highlights a notable trend in the industry.Several factors may contribute to this observed pattern:

3.2.1: Market Perception: The higher representation of 5-star and 2-star quality brands may reflect a prevalent market perception that leans toward either premium quality or more budget-friendly options. Consumers might be drawn to extremes in quality based on their specific preferences or needs.

3.2.2: Competitive Landscape: It could be indicative of intense competition and innovation at the higher and lower ends of the quality spectrum. Brands may be strategically focusing on these categories to differentiate themselves and capture distinct market segments.

3.3 AVERAGE PROFITS FOR EACH RATINGS:

Avg profits for each ratings
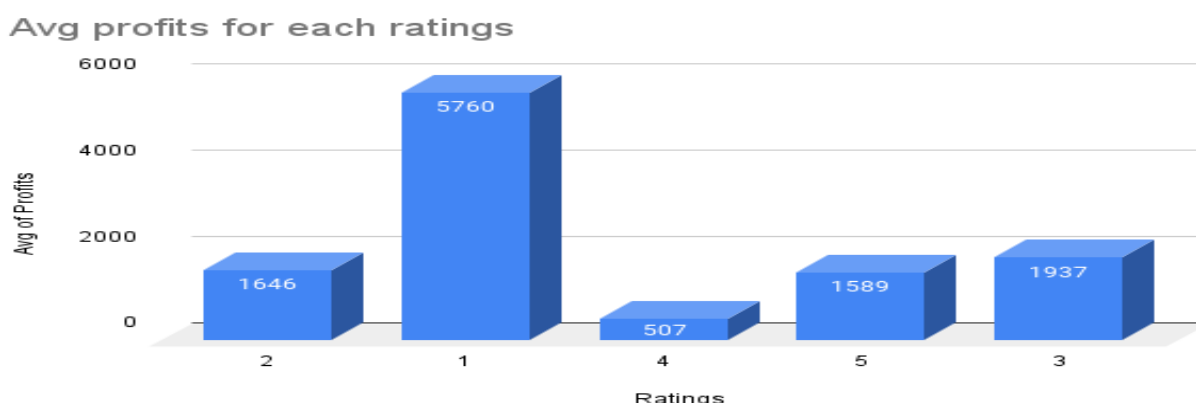
From the "**Avg Profits for Each Rating"** plot, it is evident that brands "**1 Star"** quality rice have high average profit margins compared to all other quality rice brands. This is due to bulk purchases for canteens, festivals, marriages, schools, companies, and colleges and its brand value also higher.

3.4 Mitigating Tax Burden: Advocating for Reduced Weights in 25 kg Rice Bags through Supplier Collaboration and Government Petitions:

Nearly 9 out of the 21 rice brands currently offer rice bags weighing 25 kgs or less, resulting in a slightly higher tax burden for the owner compared to the tax paid for rice bags weighing 26 kgs and above. Despite these brands contributing nearly 20% of the overall profit, eliminating them is not a viable option. To address this issue comprehensively, a multifaceted strategy can be employed.

Firstly, engaging in regular consultations and meetings with suppliers is crucial. By fostering open communication, owners can discuss the economic implications of the current weight specifications and explore potential adjustments. Collaborative efforts with suppliers may involve negotiating better pricing structures or finding innovative solutions that align with both the tax regulations and the profitability of the business.

Moreover, initiating a dialogue with government authorities is a proactive step. Submitting petitions to the relevant government agencies can serve as a powerful advocacy tool. The petitions should highlight the economic impact of the current weight specifications on businesses, emphasizing the potential benefits of reducing the weight threshold for rice bags. Presenting well-researched data and case studies can strengthen the argument, showcasing the positive outcomes for both business owners and consumers.

Furthermore, forming alliances with other stakeholders in the industry, such as industry associations, can amplify the collective voice advocating for change. A united front can

enhance the persuasiveness of the argument and demonstrate widespread support for revisiting the weight specifications.

In addition to supplier collaboration and government petitions, exploring alternative packaging solutions is another avenue. Investigating packaging materials that allow for cost-effective weight reductions without compromising the integrity of the product can be part of a comprehensive strategy.

By taking a holistic approach that combines supplier engagement, government advocacy, industry collaboration, and innovative packaging solutions, owners can position themselves as proactive advocates for positive change. This not only addresses the immediate tax burden issue but also contributes to the long-term sustainability and competitiveness of the rice industry.

3.5 FINDING CORRELATION BETWEEN FEATURES TO SOLVE INCONSISTENT PRODUCT QUALITY ISSUE:

	TEXTURE	AROMA	FLAVOUR	GRAIN SEPARATION	STICKINESS	GRAIN INTEGRITY	UNIFORMITY	ABSORRPTION	COOKING TIME	COLOUR	RESIDUE/IMPURITIES	GRAIN SIZE/SHAPE	Profit per kg	5 STAR RATINGS	ONLY 3 STAR	Only 2 STAR	Only 4 STAR	Only 5 STAR
TEXTURE	1	-0.23	-0.18	-0.18	-0.12	-0.086	-0.086		0.074	-0.23	-0.086	-0.2	0.016	-0.25	-0.046	0.27	-0.023	-0.23
AROMA	-0.23	1	-0.14	-0.14	-0.096	-0.067	-0.067		-0.12	-0.18	-0.067	-0.16	-0.064	0.0064	-0.036	0.0075	0.26	-0.18
FLAVOUR	-0.18	-0.14	1	-0.11	-0.076	-0.053	-0.053		-0.095	-0.14	-0.053	-0.13	-0.13	-0.27	-0.086	0.3	-0.13	-0.14
GRAIN SEPARATION	-0.18	-0.14	-0.11	1	-0.076	-0.053	-0.053		-0.095	0.093	-0.053	-0.13	-0.12	-0.027	-0.26	-0.053	0.13	0.093
STICKINESS	-0.12	-0.096	-0.076	-0.076	1	-0.037	-0.037		-0.065	-0.096	-0.037	-0.087	0.14	0.19	0.059	-0.16	-0.087	0.22
GRAIN INTEGRITY	-0.086	-0.067	-0.053	-0.053	-0.037	1	-0.026		-0.046	-0.067	-0.026	-0.061	-0.097	0.25	-0.12	-0.11	-0.061	0.38
UNIFORMITY	-0.086	-0.067	-0.053	-0.053	-0.037	-0.026	1		-0.046	0.38	-0.026	-0.061	0.16	0.022	0.21	-0.11	-0.061	-0.067
ABSORRPTION																		
COOKING TIME	0.074	-0.12	-0.095	-0.095	-0.065	-0.046	-0.046		1	-0.12	-0.046	-0.11	-0.074	0.052	-0.025	0.0051	-0.11	0.15
COLOUR	-0.23	-0.18	-0.14	0.093	-0.096	-0.067	0.38		-0.12	1	-0.067	-0.16	0.27	0.0032	-0.036	-0.14	0.053	0.02
RESIDUE/IMPURITIES	-0.086	-0.067	-0.053	-0.053	-0.037	-0.026	-0.026		-0.046	-0.067	1	-0.061	-0.17	0.022	0.21	-0.11	-0.061	-0.067
GRAIN SIZE/SHAPE	-0.2	-0.16	-0.13	-0.13	-0.087	-0.061	-0.061		-0.11	-0.16	-0.061	1	0.13	0.062	0.18	-0.1	-0.14	0.053
Profit per kg	0.016	-0.064	-0.13	-0.12	0.14	-0.097	0.16		-0.074	0.27	-0.17	0.13	1	-0.19	0.28	-0.06	-0.38	-0.07
5 STAR RATINGS	-0.25	0.0064	-0.27	-0.027	0.19	0.25	0.022		0.052	0.0032	0.022	0.062	-0.19	1	0.11	-0.79	0.4	0.65
ONLY 3 STAR	-0.046	-0.036	-0.086	-0.26	0.059	-0.12	0.21		-0.025	-0.036	0.21	0.18	0.28	0.11	1	-0.54	-0.29	-0.33
Only 2 STAR	0.27	0.0075	0.3	-0.053	-0.16	-0.11	-0.11		0.0051	-0.14	-0.11	-0.1	-0.06	-0.79	-0.54	1	-0.26	-0.29
Only 4 STAR	-0.023	0.26	-0.13	0.13	-0.087	-0.061	-0.061		-0.11	0.053	-0.061	-0.14	-0.38	0.4	-0.29	-0.26	1	-0.16
Only 5 STAR	-0.23	-0.18	-0.14	0.093	0.22	0.38	-0.067		0.15	0.02	-0.067	0.053	-0.07	0.65	-0.33	-0.29	-0.16	1

1. Profits and 3-star rating rice brands are highly correlated, but not with others. Profits and 5-star ratings are negatively correlated, which can be attributed to the reasons presented in the first plot.

2. For 3-star rating rice brands, texture, aroma, grain separation, and color are negatively correlated. This suggests that these quality problems are affecting the 3-star rating brands, while the impact of other quality problems is less pronounced.

3. In the case of 2-star rating rice brands, grain separation, stickiness, grain integrity, uniformity, color, residue/impurities, and grain size are influencing the brand, unlike other quality problems.

4. For 4-star rating rice brands, texture, aroma, flavor, uniformity, and residue have an impact, while other quality problems have less effect.

Negative correlated order of '3 STAR RATING BRAND' VS 'QUALITY PROBLEMS'

Grain Separation > Grain Integrity > Flavor > Texture > Color and Aroma > Cooking Time

Negative correlated order of '2 STAR RATING BRAND' VS 'QUALITY PROBLEMS'

Stickiness > Color > Grain Integrity > Uniformity > Residues > Grain Size and Shape > Grain Separation

Negative correlated order of '4 STAR RATING BRAND' VS 'QUALITY PROBLEMS'

Grain Shape and Size > Flavor > Cooking Time > Stickiness > Grain Integrity, Uniformity and Residues > Texture

**Negative correlated order of '5 STAR RATING BRAND' VS 'QUALITY PROBLEMS'**

Texture > Aroma > Flavor > Uniformity and Residues

5. As revealed by the first plot, 3-star and 2-star brands are highly profitable. Therefore, it is advisable to prioritize addressing the mentioned quality problems in the specified order to maintain and increase profitability.

6. However, for 4-star and 5-star brands, instead of returning products to the sellers in case of problems, a more beneficial approach might be to negotiate with the sellers for price adjustments, considering the preference order of problems. This can result in mutual profit gains.

Additionally, implementing targeted marketing and educational campaigns can play a crucial role in managing customer expectations and perceptions, especially for 3-star and 2-star brands. Educating consumers about the nuanced quality improvements being undertaken can positively influence their purchasing decisions and foster brand loyalty.Continuous monitoring of market trends and consumer feedback is paramount for all rating categories. This adaptive strategy ensures that brands remain responsive to evolving consumer preferences and can proactively address emerging quality concerns. Regular feedback loops can be established to gauge customer satisfaction and make informed adjustments to product offerings and quality standards.

3.6 Analyzing Price Dynamics: Contrasting Second Half of 2023 with First Half of 2021 and Examining the Relationship Between Standardized Price Differences and Standardized Profit Curves.
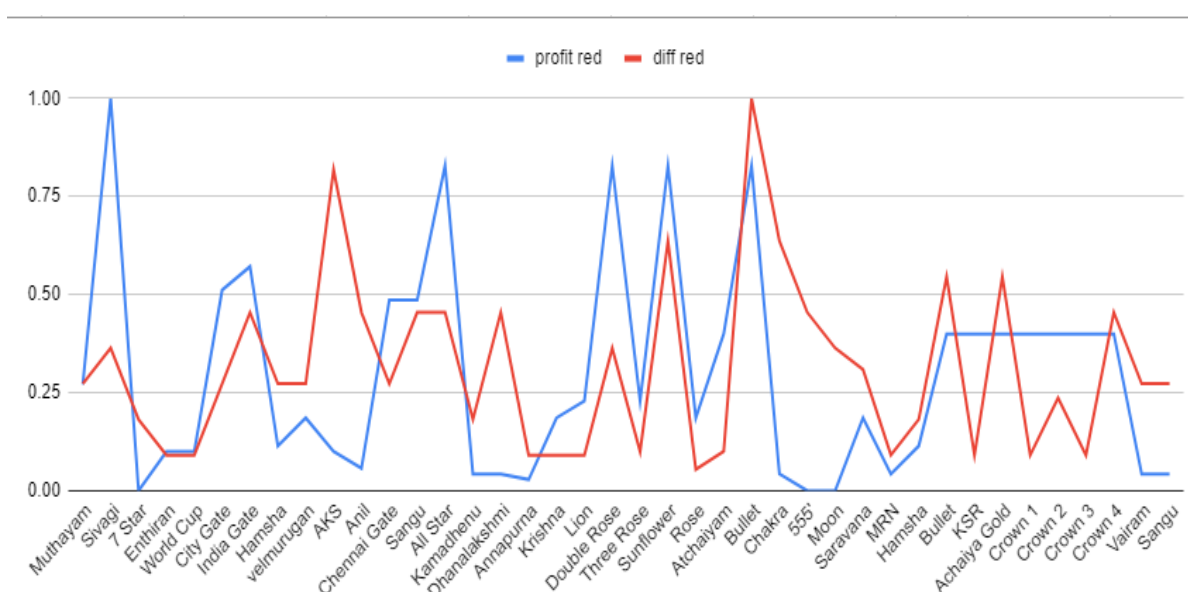
After analyzing the graph and performing calculations in Excel, I divided the standardized price differences by the standardized profit curves. Notably, values above or close to 1 suggest that brands can withstand increased prices in the short term but might encounter challenges thereafter. When values reach or exceed 2, it indicates the potential for sustained price increases with a slight margin. Conversely, values below 1 raise concerns, particularly for brands with an already low profit ratio. Further price increases in such cases could lead to a significant devaluation of the brand. Therefore, it is crucial for these brands to reevaluate their pricing strategy, as persistent hikes may erode their brand value.

At present, approximately 20 out of the 42 rice brands are positioned at this critical threshold point. If these brands proceed with additional price increases, it could have adverse effects in the upcoming future.The 20 rice brands are **7 star, Hamsha, Velmurugan, AKS, Anil, Kamadhenu, Dhanalakshmi, Annapurna, Bullet, Chakra, 555, Moon, Saravana, MRN, Hamsha, Bullet, Achaiya Gold, Crown 4, Sangu, Vairam.**

Moreover, a careful examination of the 20 brands positioned at the critical threshold point reveals that diverse factors contribute to their vulnerability, including market competition, production costs, and consumer expectations. A detailed analysis of these factors is essential for devising a strategic and sustainable pricing strategy that aligns with the market dynamics.

The data can be viewed by using the following link:

https://docs.google.com/spreadsheets/d/1UjXPNev7lDF5p5vDJhyVPfO1GpV-zTzvbF3C KptwswU/edit?usp=sharing

3.7 <u>**Utilizing Machine Learning to Assign 5-Star Ratings Based on Impurity Analysis for Each Rice Brand:**</u>

This model falls under the category of supervised classification models. In this dataset, there are a total of 5 labels representing the 5-star ratings. I experimented with several well-known classification-based machine learning models, including hypertuned logistic regression, hypertuned support vector classifier, hypertuned Multinomial Naive Bayes classifier, and hypertuned k-nearest neighbor classifier. Upon running the data through these models, I observed the highest accuracy score for the support vector classifier (SVC). However, due to the limited number of data samples, the overall accuracy score was relatively low. Nonetheless, in comparison to the other models, SVC demonstrated the best accuracy score for the validation set.This ML model enables us to predict 5-star ratings with ease by analyzing the differences in impurities associated with upcoming new rice brands.This capability will assist the owner in effortlessly predicting the ratings of new rice brands without relying on information from other individuals.

Test accuracy for SVM: 0.375

Test accuracy for Logistic Regression: 0.125

Test accuracy for MultinomialNB: 0.125

Test accuracy for KNN Classifier: 0.125.

The data and the models can be viewed by using the following links:

https://colab.research.google.com/drive/1zEM023o0ZzoEgHRp1iQez1LaME2I7YBw?usp=sharing

https://docs.google.com/spreadsheets/d/1Qv5tDQ4dwyaQGlf2ihuS7KbUcBiD6rjcmd_qx7RVQQQ/edit?usp=sharing

3.8 <u>**Leveraging Impurity Analysis and 5-Star Ratings Prediction for Determining Optimal Purchase Quantities of Rice Bags through ML:**</u>

This model is categorized as a supervised regression model, and my exploration involved testing various well-known machine learning models for regression. These models included hypertuned linear regression, hypertuned support vector regressor, hypertuned Lasso, hypertuned Polynomial regression, hypertuned Elastic Net, and hypertuned Ridge. Upon analyzing the data with these models, I identified the lowest root mean square error (RMSE) with the Lasso regression. However, due to the limited dataset, the overall RMSE remained relatively high. Nevertheless, when compared to the alternative models, Lasso exhibited the lowest RMSE for the validation set. Utilizing impurity analysis and 5-star ratings, this ML model facilitates the prediction of optimal purchase quantities for rice bags. This predictive capability empowers owners to effortlessly determine the ideal purchase quantities for new rice brands, independent of external information.

```
RMSE for Linear Regression: 113.23068605472382

RMSE for SVR: 60.110334740869575

RMSE for Lasso: 53.84344619363156

RMSE for Ridge: 55.71418590516533

RMSE for Polynomial Regression: 122.18701103547653

RMSE for ElasticNet: 58.79734965316052
```

The data and the models can be viewed by using the following links:

https://docs.google.com/spreadsheets/d/17SCFolrNHFlwOhsEtGevLfKJNm2WebUGZXbPMzjf90A/edit?usp=sharing

https://colab.research.google.com/drive/1ZC-FtPm8e48zW515TnwPRFijufCNO9Qn?usp=sharing

3.9 Forecasting Profits: Unveiling Insights into New and Established Rice Brands Using Impurity Analysis and 5-Star Ratings with Machine Learning Algorithms.

Categorized as a supervised regression model, this study involved experimenting with various well-known machine learning models, including hypertuned linear regression, hypertuned support vector regressor, hypertuned Lasso, hypertuned Polynomial regression, hypertuned Elastic Net, and hypertuned Ridge. Upon subjecting the data to these models, the Ridge regression revealed a notably low root mean square error (RMSE). However, due to the limited dataset, the overall RMSE remained relatively high. Nevertheless, when compared to alternative models, Ridge exhibited the lowest RMSE for the validation set. Leveraging impurity analysis and 5-star ratings, this ML model facilitates the prediction of forecasting profits for both new and established rice brands. Such predictive capability empowers owners to effortlessly anticipate the profitability of rice brands without relying on external information.

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RMSE for Linear Regression: 0.49771449

RMSE for SVR: 0.2812380073828464

RMSE for Lasso: 0.280993111848404

RMSE for Ridge: 0.2789877459910832

RMSE for Polynomial Regression: 0.6455411295208906

RMSE for ElasticNet: 0.2809931118484046
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The data and the models can be viewed by using the following links:

By employing the three ML models mentioned above, we can establish correlations among their results, allowing us to draw rough conclusions regarding 5-star ratings, the optimal number of bags for purchase, and approximate profit estimations for both new and existing rice brands based on changes in the qualities of rice brands.

4 INTERPRETATION OF RESULTS AND RECOMMENDATION:

4.1 Due to time constraints, a limited number of samples for quality problems and impurities were collected for each rice brand. To enhance the accuracy of the ML models predicting 5-star ratings, the number of bags that can be purchased at a time, and profits for specific rice brands, it is recommended that the owner actively collects more samples from customers for training purposes.

4.2 Upon acquiring a more extensive dataset, the next step involves plotting a correlation table or heatmap to discern the interrelationships among various impurities and quality issues. This exploration will provide valuable insights into how these factors correlate with each other, as well as their correlation with 5-star ratings and profits.

4.3 Establishing a preference order based on the correlation results is crucial. By arranging impurities and quality issues in a hierarchy from highly negatively correlated to highly positively correlated, the owner can strategically approach suppliers. Utilizing this preference order, negotiations can be tailored to address specific impurity concerns, potentially leading to a reduction in consuming prices.

4.4 Following the successful reduction of prices for problematic rice brands, a proactive step would be to provide consumers with modified cooking instructions. This approach aims to empower consumers to overcome any issues encountered while boiling and cooking the rice, thereby enhancing overall satisfaction with the product.

4.5 To address tax regulation issues, a collaborative effort can be initiated with both suppliers and government authorities. The suggestion is to encourage suppliers to provide rice bags larger than 26 kgs, while the government imposes taxes exclusively on bags smaller than 25 kgs. This strategic alignment ensures compliance with tax regulations while optimizing the profitability of the business.

4.6 To tackle supplier price fluctuation problems, historical price details and profit data should be gathered. Through the creation of plots depicting the relationship between price and profit over different periods, the owner can visually analyze trends. By correlating the

results, the business can identify supplier practices that lead to price increases and strategize accordingly.

4.7 In order to mitigate the challenges outlined in the problem statements, it is recommended to diversify the supplier base by establishing a broad range of suppliers. A larger pool of suppliers provides several strategic advantages, including increased negotiation leverage, access to a variety of rice sources, and a more resilient supply chain. This diversification minimizes the impact of inconsistent product quality, tax compliance issues, and supplier price fluctuations by offering flexibility in sourcing and negotiating favorable terms with multiple suppliers. It also enhances the business's ability to adapt to market dynamics and changes in supplier conditions, ensuring a more robust and stable operational framework.

4.8 In tandem with supplier negotiations, exploring partnerships with research institutions or agricultural experts can offer an additional layer of expertise. Collaborating with experts in the field can provide valuable insights into sustainable farming practices, crop quality improvement, and potential innovations in rice cultivation. This strategic collaboration not only addresses current quality concerns but also positions the business at the forefront of industry advancements.

4.9 Building on the idea of consumer empowerment, the implementation of a comprehensive customer feedback system can serve as a continuous improvement mechanism. By encouraging customers to share their experiences and preferences, 'SRI MURUGAN TRADERS' can gather real-time data to adapt quickly to changing consumer needs, ensuring product offerings remain aligned with market demands.

4.10 To reinforce the brand's commitment to quality, considering third-party certifications or quality assurance programs can add credibility. Achieving certifications from recognized bodies in the food industry can instill confidence in consumers, emphasizing the brand's dedication to delivering high-quality rice products.

4.12 Exploring sustainable and eco-friendly packaging options aligns with evolving consumer expectations for environmentally responsible practices. Transitioning to eco-conscious packaging not only appeals to environmentally conscious consumers but also positions the brand as socially responsible, contributing to positive brand perception.

4.13 Investing in technology solutions, such as blockchain, for supply chain transparency can further enhance trust and traceability. Implementing blockchain technology allows customers to track the journey of the rice from the farm to their table, ensuring transparency in sourcing and reinforcing the brand's commitment to quality and authenticity.

4.14 Consideration should be given to social media and digital marketing strategies to create brand awareness and engage with consumers directly. Establishing an online presence can facilitate direct communication with customers, enabling the brand to address concerns, share updates, and build a loyal online community.

4.15 Continuous employee training and development programs ensure that the team remains well-versed in industry trends, customer expectations, and technological advancements. A knowledgeable and skilled workforce is essential for the successful implementation of new strategies and the effective management of evolving challenges in the rice industry.

In summary, leveraging a more extensive dataset, interpreting correlations, and implementing strategic recommendations will empower 'SRI MURUGAN TRADERS' to address quality issues, tax compliance challenges, and supplier price fluctuations effectively. These actions are geared towards optimizing operational processes, enhancing customer satisfaction, and ensuring long-term business success.

Declaration Statement

I am working on a Project titled "BDM CAPSTONE PROJECT". I extend my appreciation to 'SRI MURUGAN TRADERS', for providing the necessary resources that enabled me to conduct my project.I hereby assert that the data presented and assessed in this project report is genuine and precise to the utmost extent of my knowledge and capabilities. The data has been gathered from primary sources and carefully analyzed to assure its reliability.Additionally, I affirm that all procedures employed for the purpose of data collection and analysis have been duly explained in this report. The outcomes and inferences derived from the data are an accurate depiction of the findings acquired through thorough analytical procedures.I am dedicated to adhering to the principles of academic honesty and integrity, and I am receptive to any additional examination or validation of the data contained in this project report.I understand that the execution of this project is intended for individual completion and is not to be undertaken collectively. I thus affirm that I am not engaged in any form of collaboration with other individuals, and that all the work undertaken has been solely conducted by me. In the event that plagiarism is detected in the report at any stage of the project's completion, I am fully aware and prepared to accept disciplinary measures imposed by the relevant authority.I understand that all recommendations made in this project report are within the context of the academic project taken up towards course fulfillment in the BS Degree Program offered by IIT Madras. The institution does not endorse any of the claims or comments.

Signature of Candidate:

Name: SIDDESH N B

Date: 04/10/2023