Optimizing FMCG Spending: Commodities and Derivative Products Price Prediction

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informs ANALYTICS CONFERENCE

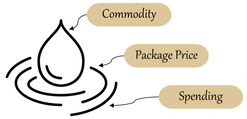
ABSTRACT

This research introduces a new insight on **spending forecast** by **integrating commodities forecast** to market price predictions of resin packaging products. It delves into the **seasonality** of commodities and their derivative products. Enhancing predictive pricing and spending ability for private FMCG companies for next 12 months by comparative analysis of statistical (ARIMA, VMD-ARIMA) and ML models (LSTM, GRU).

BUSINESS PROBLEM

FMCG company incurs substantial costs in packaging, predominantly composed of resin and paper, which is highly sensitive to the commodity price. The project aims to accurately predict the commodity prices seeking to forecast **package prices in the coming 12 months**, thereby facilitating spending projections for the company, and strengthen company's resilience over price fluctuation and lower the ripple effect on the spend.

With accurate prediction on commodity and package price, this study improve business performance :



Business Benefit

Cost Optimization: Proactively manage and optimize packaging costs.

Financial Planning: Provide accurate spending projections.

Risk Mitigation: Minimize the impact of commodity price fluctuations.

DATA & ANALTICS PROBLEM

This project work with two data set:

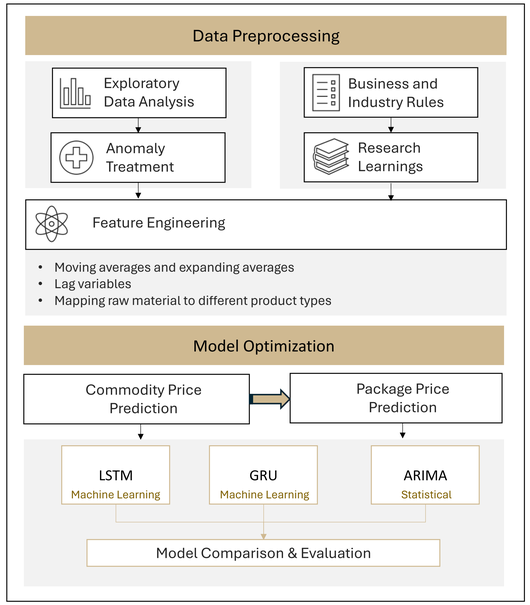
- **Commodity price**: public monthly price of several commodities for 11 years
- **Spend:** information of purchasing orders, includes package type, unit price, purchase date, etc., for 5 years from industry partners purchase record.

Different in Time
Commodity is monthly data and spend with multiple entries in daily.

Missing Data
Not all materials are purchased on daily basis.

- Is them time-series data?
- Does seasonality show in artificial commodity?
- What is the best fit model?
- How to connect commodity price to package price prediction?
- What is the relationship between commodity and package price?

METHODOLOGY

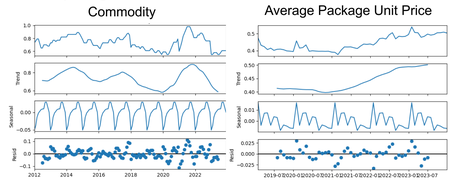


SEASONALITY

Kruskal-Wallis Test

Period (month)	3	6	12	18	24
Commodity	v	v	v	v	v
Pacakge Price	v	v	v	v	v

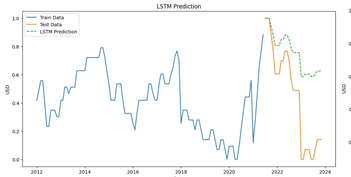
Decomposing

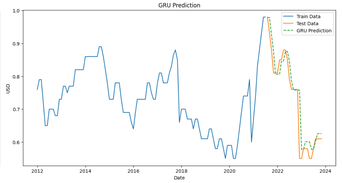


Krusakal-Wallis test show low p-value (.05) in period of 3, 6, 12, 18, and 24 months on commodity and package unit price indicating the existence of seasonality. Although different commodities and packages have different results, they show most **significant** in seasonality for **12- or 18-months**. Aligning with Krusakai-Wallis test result, both commodity and package price show seasonal in the decomposition.

STATISTICAL RESULT & INSIGHT

Commodity Price Prediction: LSTM and GRU have similar performances, and both approaches perform better than ARIMA and VMD-ARIMA. However, the improvement between ARIMA and VMD-ARIMA is clear.

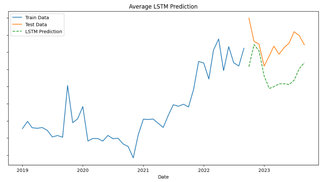


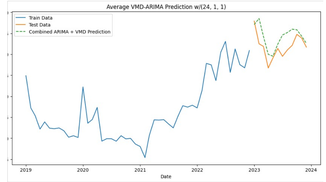


Model	ARIMA	VMD-ARIMA	LSTM	GRU
RMSE	0.123	0.062	0.050	0.048
MAPE	16.53%	7.77%	4.56%	4.19%

Package Price Prediction

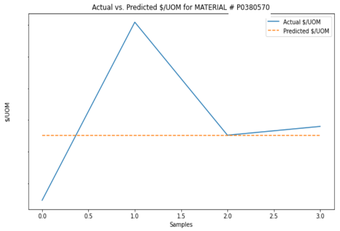
Material Group Level: Considering the data was trained with monthly average, with less data point both ML approach is not robust. As the fluctuation in package price is small, VMD-ARIMA has successfully capture the trend and seasonality

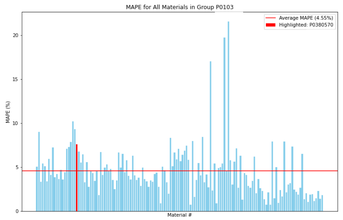




Model	ARIMA	VMD-ARIMA	LSTM	GRU
RMSE	0.018	0.015	0.038	0.062
MAPE	2.69%	2.43%	6.59%	11.87%

Material Level: Given the irregular monthly data points, an LSTM time series approach for package material forecasting at material level is unsuitable, leading to the consideration of a non-sequential predictive model as an alternative.





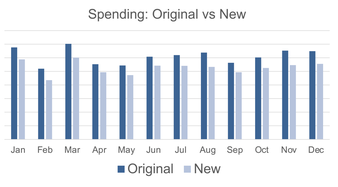
Material			
RMSE	0.0234	MAPE	7.6%

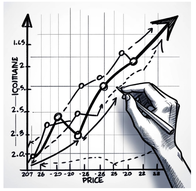
Material Group	
MAPE	4.55%

EXPECTED BUSINESS IMPACT

Using current model, following the predicted average price, company will save 10-16% per month or 13% per year by avoiding overprice package.

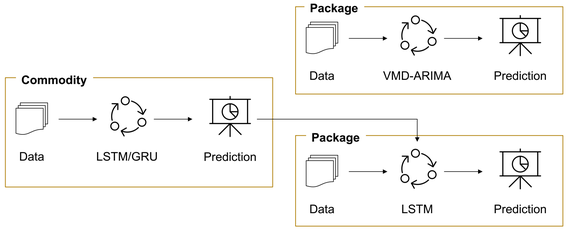
10 – 16% **save per month**
13% **save annually**





DEPLOYMENT & FUTURE

Model/ Category	ARIMA	VMD-ARIMA	LSTM	GRU
Commodity			v	v
Pacakge Price		v	v	



It is recommended to run the commodity prediction with LSTM or GRU and package price prediction with VMD-ARIMA or LSTM. However, the performance of LSTM and GRU package price model is limited to monthly prediction due to the data characteristic. The model could be more robust by gaining daily commodity price for the training of package price prediction model.

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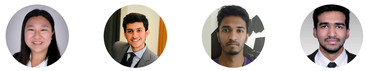
Student Team



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