Development of the Adaptive Forecasting Model for Retail Commodities by Using Leading Indicator: Retailing Rule Based Forecasting Model (RRBF)

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Abstract- **Presently, the sales promotion- short term activities which provide material inducements to consumers and trade have been used commonly in most retail business. The accuracy of forecasting for the promotional items becomes a challenging issue for most retail managers because there are the direct impacts on the inventory and customer service level. Due to the frequent changes of both promotional items and promotional mechanism, traditional forecasting models could not be applied effectively for sales forecast because they are generally based on time series techniques. In this paper, we fulfill this gap by applying the data mining concept to develop the forecast model that utilizes various pieces of data to forecast the future sales using the rule-based techniques. By applying this new model with the case study for retail stores, we found that using RRBF forecast error had been improved.**

Index Terms- **Promotional Forecasting, Demand Planning, Inventory Management, Rule Based Forecasting.**

I. INTRODUCTION

Due to the growth of retail industry in Thailand for the last two decades, the competitions in this industry become increasingly intense. Each retail stores need to create more promotional events in order to increase sales by attracting more customers to the stores. Sales increases from the promotional events are one of the key management successes, however, this always create the issues of inventory management. The retail companies spend a large amount of money to invest in marketing & promotion campaign. According to the research by Anderson Consulting estimate that 15% of promoted volume is lost due to the out of stock (OOS) when out of stock occurs, 20% of customers report leaving the stores without purchasing any merchandises [1] [2]. If retailers overestimate demand, they are left with excess inventory—which means lower overall profitability for these items.

Therefore, it is very critical for the retailers to make an accurate plan for inventory of the upcoming sales events. Accurate demand forecasts are essential for any retailer. With demand forecasts made available to retailers' purchasing and replenishment functions, appropriate inventory levels can be maintained for every item on promotion, leading increasing in overall sales. However, the traditional forecasting models employed by marketing scholars are not always applicable to forecast the demand during the promotion period since the promotion events create unsystematic deviation in the demand pattern. In addition, for the items that are new to the promotion, the retailers will have no historical data to support their forecasting demand. This makes the demand of the promotion item particularly difficult to forecast. One of the largest retailers in Thailand reports that the errors from their promotional items forecast could vary from 8 to 450% depending on the promotion events.

In this paper, we introduce the forecasting techniques that developed in order to exploit the historical demand data from the past promotion events. The goal of our development effort is to use the information as a strategic asset in promotional planning process. By identifying some leading indicators, the demand growth during the upcoming promotion period can be estimated based on the pre-established rules.

II. LITERATURE REVIEW

The forecasting method has been studied for many decades for example combining forecast [3], [4], [5]. Combining individual forecasts produce consistent gains in forecasting accuracy [5]. Also Forecast accuracy can be substantially improved through the combination of multiple individual forecasts [4].

Forecasting, Planning and Strategies for the 21st Century are also studied by emphasizing in every industry, for

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example in retail forecasting [1], the tailor forecasting [6], Fiction forecasting [7], Business forecasting methods [8], Economist planning [9]. For Economist forecast emphasizes on Cost-effective short-term planning and planning process.

Chaos Forecasting [10], [11], [12] is one of the method which covers the concepts of prediction, incremental changes and forecasting, complexity growth, disorder, edge transformation, non-causal mechanisms, initial conditions, butterfly effect, dissipation, bifurcations, new order development, focused coherence, evolutionary changes, and strange attractors. Chaos forecasting methods are in a state of rapid evolution. Most Chaos studies, S-growth curve, are performed after a niche is filled and beginning of the growth curve also has characteristics of Chaos [12]. Forecasting future business sales include spreadsheet forecasting, group meeting, trend analysis, informed forecasting, involved forecaster, single plan forecaster, outside opinions forecaster, multiple scenarios forecaster, and cause and effect forecasters were studied [13] and [14] stated that Judgmental forecasting as an important component for business forecasting. Including a quantitative component reduces forecasting accuracy.

Others methods and applications include forecasting and promotion planning in TV advertising [15], promotion activities on brand sales [16], high-tech products [17], brand sales patterns are cause by various marketing activities[18], using the assortment forecasting method to enable sales force involvement in forecasting [19].

III. GENERAL RETAIL FORECASTING PROCESS IN THAILAND

In this session explain forecasting process used by retail stores in Thailand to provide the initial understanding on the current forecasting system. To forecast the normal items, retailer normally takes the historical sales data from the previous week to estimate the future based line sales. Then this estimates sales numbered are adjusted again based on the aspect such as seasonality, product life cycle and promotional plan from the marketing deferment before reaching the final forecasting results. For the seasonal items, the seasonal indexes have been used to incorporate the seasonal influences into the final forecast values. For the promotion items, the effects of the promotion events were incorporated into the final forecast values based the historical sales of the same or similar items during the recent promotion period. This process provides accurate results for the items which demands are stable. However, for the promotional or newly introduced items, the forecast errors are quite significant because of several factors that might impact the actual sales of these items haven't been considered or incorporate into the current promotion item.

A. Impacts of the Promotional Events.

During the promotion period, consumer's buying behaviours are partially influenced by the incentives offered through each promotion events and consumers make their final purchasing decisions based on their perceived values of these promotion events. In marketing theory, a promotional mix consists of four main aspects, Personal Selling, Advertising, Promotions Incentives and Publicity. Among these, Promotion incentives and Advertising in Thailand retail stores business, Personal selling such as sales presentations or sample are used normally for the new products in order to create the sales and the degree of publicity are also related to the advertising and the promotion events. Promotion events are popular in terms of mechanics, communication channels, length of promotion periods and degree of publicity. Therefore, each promotion event could impact consumer decision to increase their purchase differently.

Various promotions mechanics have been created by retailers to stimulate the consumer's demands. Each of these mechanics creates different impacts on consumer decision to increase their purchase in different percentage. In addition to the promotion mechanic, there will be different percentage of promotion results by using different type of medias.

B. Promotion Mechanics.

Promotion schemes in Thailand have been categorized into three mechanics which are Buy 1 get 1 free, Buy 2 for less and Mark down.

Buy 1 get 1 Free (BOGO), the retailers attempt to create the exciting promotion mechanics and to draw customers to stores and those will gain more sales through other SKUs.

Buy 2 for Less, the retailers attempt to gain more baskets through the promotion mechanics. Retailers offer discount when customers purchase combo items, In other word, the customers will receive more discounts on their purchase regardless of the purchase quantity.

Mark Down, the retailers attempt to gain more price image through promotion mechanics and try to keep loyalty of customers through price discount.

Because these three promotional mechanics have their own characteristics and provide customers with different levels of value perceptions, therefore, they should take into account then estimate the demand during the promotion period.

C. Promotion Media.

In Thailand, both off-line and on-line medias have been commonly used for promoting the store items which are Television, Newspaper, Brochure and Company website. The promotion medias also play significant roles and effects on the promotion demands in terms of medias type and the duration of the promotion. All mentioned medias are employed to inform the customer about the promotion events differently,

Brochure is specifically used to promote the assortment items with longer period. The cost is reasonable.

Newspaper, unlike Brochure, total sales in promotion items show growth steadily, Promotion cost is high but acceptable. The main reasons for using Newspaper are, reach the prospected customers, flexibility, and results proven.

Television, retailers attempt to promote selected SKUs with high discount promotion mechanics with shorter period. However, promotion cost is quite high comparing to other medias.

D. Degree of Publicity.

For any promotion events, their degrees of publicity are determined from the combination of medias, promotion duration, and display locations. The effects of promotion duration are reflected through the type of media used because,

in general, the duration of the promotion events offered through television, newspaper, brochure and company website are different. For the display locations, most retailers set specific locations for displaying the promotion items based on the items categories and the type of medias. Generally, most items advertised through television and newspaper will be placed at the best location in stores. The decision to apply and implement any specific type of promotion mechanics are made by the retailer head quarters.

To gain more insights on the effects of different promotion mechanics and medias on the item demand, we conducted an initial analysis to compare the item demand during the normal and the promotion periods. In our studies, the historical data from past 52 weeks consisting of 466 promotion events for 198 items were investigated. To increase the validity of our analysis, we intend not to use the historical sales data but the historical demands data that were calculated by combining the selling quantities of each item with the shortage quantities in the same period.

Figure 1, 2, and 3, illustrate the demand growth of retail products by using newspaper, whereas Figure 4, 5, and 6 represent brochures, as a promotion media. For the item on different categories, it is clearly seen from these figures that the promotion event influence their demand growth differently. In addition, as shown Figure 1, 2, and 3, when comparing the demand growth created from three promotion mechanics through the newspaper media, Buy 1 Get 1 Free creates the largest growth on sale quantities while Buy 2 for less creates the smallest ones. These effects are also presented in Figure 4, 5, and 6, when Brochures are used as a promotion media. This is because the unique characteristics of each promotion mechanics provide customers with different level of value perceptions. However, the growth on item demands seems to be more evident if the promotion events are communicated through above-the-line medias, for example newspaper. It is apparent in Figure 4, 5, and 6, that newspaper is highly effective in drawing customers to purchase the promotion items.

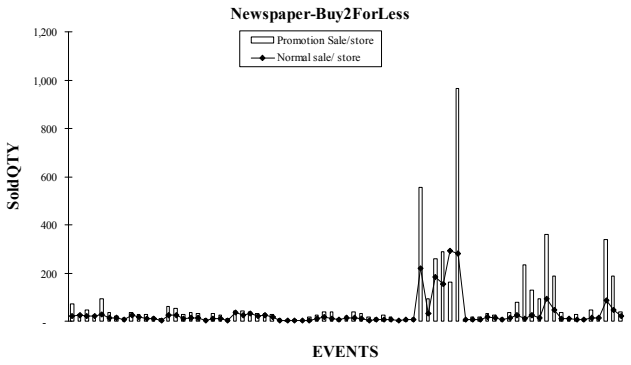

Figure1: Comparison Between Promotion sales, Buy 2 For Less, Advertised in Newspaper, with Normal Sales.

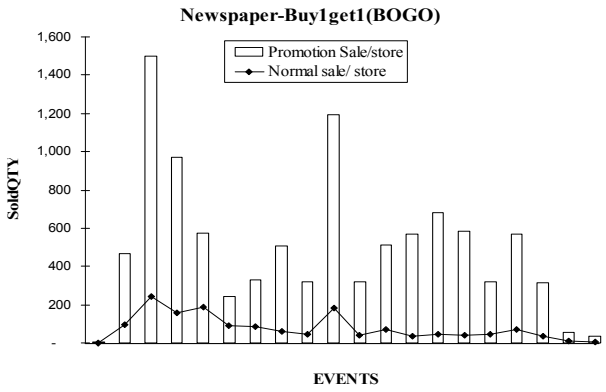

Figure2: Comparison Between Promotion sales, Buy 1 Get 1 Free, Advertised in Newspaper, with Normal Sales.

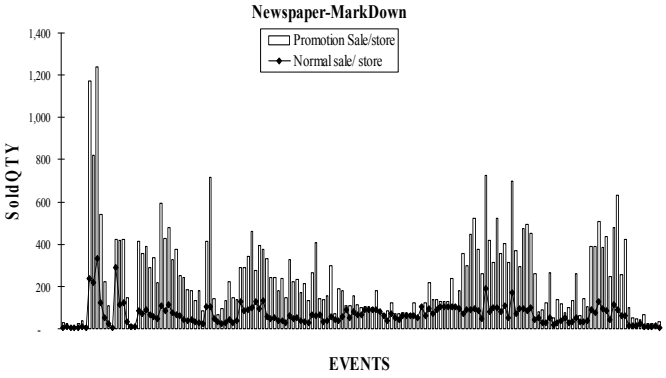

Figure3: Comparison Between Promotion sales, Mark Down , Advertised in Newspaper, with Normal Sales.

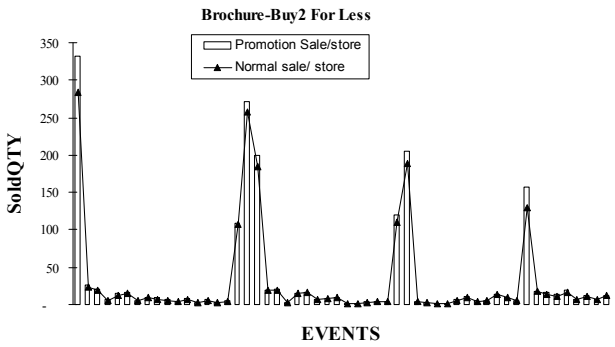

Figure4: Comparison Between Promotion sales, Buy 2 For Less, Advertised in Brochure, with Normal Sales.

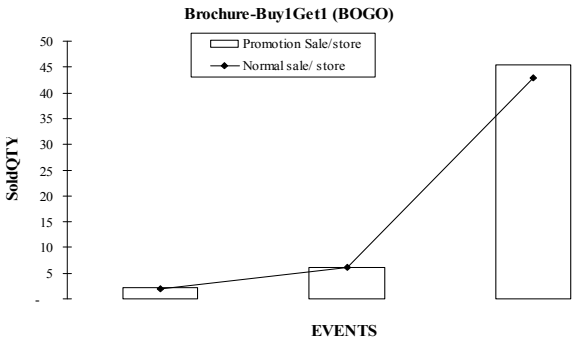

Figure5: Comparison Between Promotion Sales, Buy 1 Get 1 Free, Advertised in Brochure, with Normal Sales.

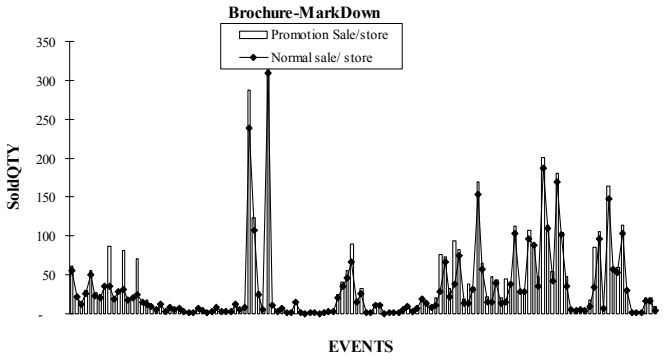

Figure 6: Comparison Between Promotion sales, Mark Down, Advertised in Brochure with Normal Sales.

Based on our initial analysis, the demand growth is highly influenced by the item categories, the type of promotion medias, and the type of promotion mechanics used during the promotion periods. Therefore, they should be taken into account and used as leading indicators when estimating the sales for the upcoming promotion period.

IV. RULE BASED FORECASTING MODEL (RRBF)

To exploit our leading indicators to estimate the sales growth for the upcoming promotion events, we introduce the logical rule that can be used to identify the dynamic pattern of each promotion event. This rule was developed based on the logical relationships between the leading indicators and the sales growth that have been examined from the historical sales data during the past promotion period. All relevant data used in our analysis was taken data from the retailer's "Data Bank" which keeps all promotion related data.

From our initial analysis, historical sales data obtained from the past promotion event should be a strong indicator of what sales to expect if the same item is put into the same promotion event again. However, for some items that have not been in such promotion event before, historical sales data from the items in the same sub-category can also be used to indicate the initial growth of sales as we noticed the similar effects from the items in the same sub-category. Therefore, it is necessary to incorporate these logical relationships into the retail stores forecast system to be used for estimating the sales during the promotion periods. Figure 7 and 8 illustrate the applications of our logical rule.

Basically, if the item plans for upcoming promotions have been put under the same promotion events, historical sales data during the promotion period should be a strong indicator of what sales to expect. However, if the item planned for upcoming promotion is the new product or has never been put on the same promotion event, consider the historical sales data from the same sub-category.

To estimate the demands (sales) during the upcoming promotion events, we classify the considerations into three cases. The reason is for obtaining the forecast demand during the promotion periods.

Case 1: With historical results and have been using medias:

1. When the products have been launched through the same medias or promotion mechanics, the normal forecast demand would be used directly to represent the forecast demand during the promotion period.
2. When the products have been launched through the same promotion mechanics but different medias, the normal forecast demand would be adjusted by media coefficient.
3. When the products have been launched through the same media but different promotion mechanic, the normal forecast demand is adjusted by promotion co-efficiency.
4. When the products have been launched through different type of medias and different promotion mechanics, the normal forecast demand is adjusted by promotion co-efficiency and media co-efficiency.

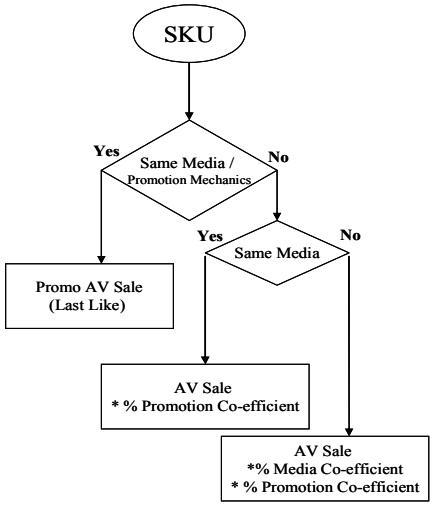

Figure7: Flow Chart to Illustrate the Application of Logical Rule at SKU Level.

Case 2: With historical results and have not been using medias: When products have never been launched through any promotion event, the normal forecast demand would be adjusted promotion co-efficiency and media co-efficiency.

Case 3: Without historical results: When new products are planed to promote, the normal forecast demand will be taken from average sales of Sub-Category. Average sales of Sub-Category will also be adjusted by promotion co-efficiency and medias co-efficiency.

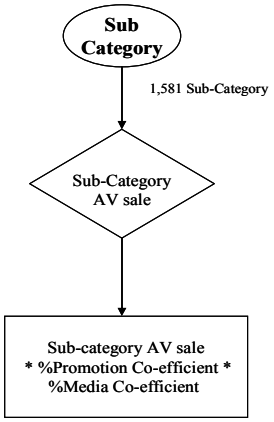

Figure8: Flow Chart to Illustrate the Application of Logical Rule at SKU Level.

V. Overall Forecasting Framework Development

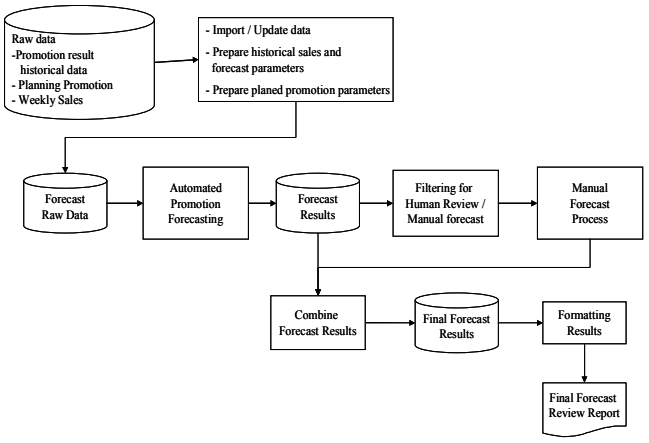

Figure 9: Overall Forecasting Methodology

To apply our rule to make a sales forecast, it can be integrated into the current forecasting system by developing algorithm in computer programming language, allowing it to be processed automatically. As illustrated in figure 7, However, in reality, this automated system may not be able to notice some obvious signs of forecasting errors and human judgement is still necessary. Therefore, to increase the forecast accuracy, the human review system procedures should be integrated into the current forecasting system.

In this study, we identified some criteria for justifying the validity of the forecast results obtained from automated system. In general, these criteria are the unusual incidence that can be used to signal the needs for human revision identified based on information obtained from in dept interview with the planning managers from three largest retailers in Thailand. We will regard these criteria as a flag.

Table 1 displays some relevant Human Review Flags. For example "Too Few" and "Missing > 25%" means that the human review is required if the promotion items have sales data less than 15 weeks or if more than 25% of data has no sales information. even though have promotion in the past, or next coming event have gap of last sales date more than 50 days due to the sales trend of those SKUs may change or the results have quantities that excess 3 times of last same promotion mechanics and medias.

The implementation of "Filtering Flag" provided a starting point for systematically utilize the human knowledge. Figure 9 illustrates the overall forecasting framework that we suggest for any retail business.

Table1: Filtering Flag.

Flag	Meaning
Too few	Sale historical data < 15 weeks (about 4 months)
Missing > 25%	> 25% of rows are missing or has zero sales
Gap	Forecast start date - Latest sale date >= 50 days
Diff > 3X	Forecast' s result >3 x avg.sales of similar promotion (similar in price,media)

VI. RESULT

To confirm the practicality of our retail rule based forecasting model (RRBF model), we apply it with the actual data from prior promotion events that has been shown in section III of this paper (contains data from 52 weeks, 466 events, 198 items). Five pieces of information are necessary for our analysis and need to be drawn from database. These consists of the average normal sales of the items, matching media, matching promotion mechanics, forecasts for sales during the promotion period, and actual sales during the promotion period. The first three pieces of data are required for calculating the coefficients of media and coefficient of promotion mechanic to be used for forecasting sales. Forecasts and actual sales during the prior are compared to see the errors causing from the used of current forecasting method. These errors will be set for benchmarking the results from our rule-based forecast.

Table2: Co- efficiency Results from Promotion Historical Data.

Coefficiency	Buy2 for less	BOGO	MarkDown
Newspaper	1.5	5.5	2.6
Brochure	1.01	1.05	1.02

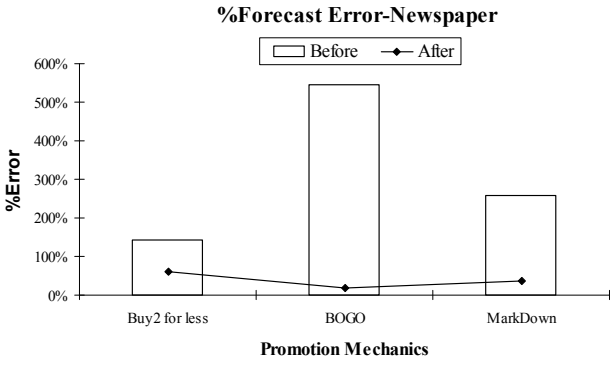

Figure10: Comparison Forecast Error after Using RRBF, Buy 1 Get 1, Free, Buy2 for Less, Markdown which Advertised in Newspaper.

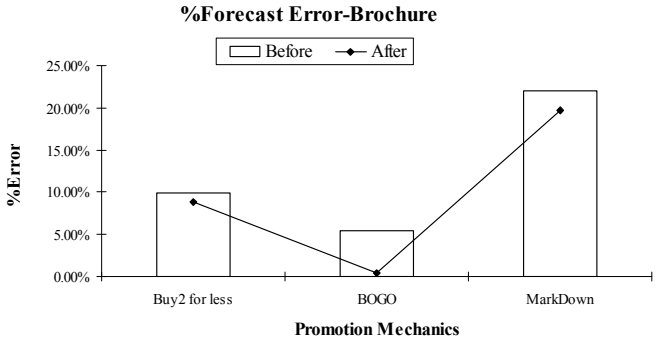

Figure11: Comparison Forecast Error after Using RRBF, Buy 1 Get 1 Free, Buy2 for Less, Markdown, which Advertised in Brochure.

Figure 10 and 11 illustrate the forecast errors after applying our RRBF Model comparing to those obtained from the current methods used by the retailers. The results illustrate the dramatic reduction on forecast errors by using adaptive forecasting techniques as follow:

1. Forecast error for SKUs advertised in Newspaper with Buy2 for less promotion mechanics have been reduced from 141% to 61%.
2. Forecast error for SKUs advertised in Newspaper with Buy1 get 1 free promotion mechanics have been reduced from 547% to 18%.
3. Forecast error for SKUs advertised in Newspaper with Mark Down promotion mechanics have been reduced from 257% to 37%.
4. Forecast error for SKUs advertised in Brochure with Buy2 for less promotion mechanics have been reduced from 9.90% to 8.81%.
5. Forecast error for SKUs advertised in Brochure with Buy1 get 1 free promotion mechanics have been reduced from 5.5% to 0.48%.
6. Forecast error for SKUs advertised in Brochure with Mark Down promotion mechanics have been reduced from 22.03% to 19.64%.

VII. CONCLUSION

We have provided a tool, The Retailing Rule Based Forecasting Model (RRBF) to help retailers improving their forecasting system. Due to the uniqueness environment of the retail business whose item demands are highly fluctuated and items availability is very critical, demand forecasting becomes increasingly complicated especially during the special events. Many retailers attempt to increase their forecast accuracy in order to improve their customer satisfaction, reduce wastes, and increase overall profitability. Therefore, it is very critical for the retailers to make an accurate plan for inventory of the upcoming sales events. There is, however, an overall lack of understanding as to how this might be achieved and what tools can be used in practice The Retailing Rule Based Forecasting Model (RRBF) proposed in this paper, though it still needs to be fully developed and validated, constitutes an important effort to utilize the available information as a strategic asset in promotion planning process. For practitioners in retail business, they would get better performance of promotion, gain visibility into actual product demand across multiple sales channels, promotional events, and media types.

To extend the applicability of our tool, additional analysis on other factors that might influence the demand during the promotion events need to be conducted. These factors include the duration of the promotion period, the level of promotion incentive, variation of prices (VOP), and the location of product display.

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