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Systematic Literature Review on "Exploring the Various Forecasting Techniques".

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Abstract: This paper provides an in-depth analysis of the various forecasting techniques utilized in the Fast-Moving Consumer Goods (FMCG) industry. The study begins with an introduction to the FMCG industry and its importance in the global market. The paper then highlights the significance of accurate demand forecasting and how it can impact supply chain management and overall business performance.

The paper discusses four forecasting techniques used in the FMCG industry: Qualitative Forecasting, Time Series Forecasting, Causal Methods, and Forecast Aggregation. The Qualitative Forecasting method is based on expert opinions and judgments, while Time Series Forecasting is based on historical data patterns. Causal methods use variables such as price, promotions, and economic indicators to forecast demand, and Forecast Aggregation combines multiple forecasting methods to achieve more accurate predictions.

The paper delves into each technique and describing its methodology in the FMCG industry. Additionally, the paper provides guidance on when to use which technique based on the type of data available and the forecasting horizon.

Overall, the paper emphasizes the importance of selecting the appropriate forecasting technique in the FMCG industry to achieve accurate predictions and enhance business performance.

Index Terms: **FMCG industry, forecasting techniques, qualitative forecasting, time series forecasting, causal methods, forecast aggregation, supply chain management, demand forecasting.**

1. Introduction

For ages, people have been trying to predict or understand the future. Humans may not have been able to predict the future but through forecasting, one can come close to estimating the future in certain aspects like sales and weather. Forecasting is a way to predict what will happen in the future based on past data.

Forecasting is one technique that helps a business stay ahead of the competition by predicting future sales and preventing an organization from losing any business anywhere. Forecasting helps a business predict sales of a product based on historical trends that are mapped based on the available data.

Making predictions based on historical and current facts is the process of forecasting. The most popular method for doing this is trend analysis. To estimate a variable of interest at a specific future time would be a simple example. A comparable but broader phrase is prediction. Both phrases can be used to refer to more formal statistical methods or less formal assessing procedures that employ time series, cross-sectional, or longitudinal data. The terms "prediction" and "forecasting" are used for more general estimations, such as the frequency of floods over a long period, while "forecast" and "forecasting" are occasionally reserved in the context of hydrology for predictions of values at specific future intervals.

Since risk and uncertainty are at the core of forecasting and prediction, it is generally accepted as best practice to convey the degree of uncertainty surrounding a particular projection. The data must be current in any case for the forecast to be as accurate as feasible. Sometimes the data that is utilised to anticipate the important variable is forecasted on its own.

This paper discusses the various forecasting techniques that are used in various industries while emphasising the techniques used in the FMCG industry.

Forecasts are crucial for many of the choices we make, such as when to get up in the morning to avoid being late for work or which television brand offers the best value for money. To avoid customer service concerns and high inventory costs, supermarkets need projections to support their strategic development, make tactical decisions, and manage their demand and supply planning procedures. [1] [2]

2. Fast Moving Consumer Goods

Fast Moving Consumer Goods (FMCG) are defined as "inexpensive products that people usually buy on a regular basis, such as supermarket foods or toiletries. FMCG is an abbreviation for 'fast-moving consumer goods'" by Collins Dictionary [3]. These are goods that are inexpensively sold rapidly. They often have a limited shelf life, are routinely replaced, and are used daily. Food and drink, toiletries, personal care items, and home cleaning supplies are a few examples of FMCG products. According to a report published by the India Brand Equity Federation (IBEF), the fourth-largest sector of the Indian economy is the FMCG Industry [4].

The FMCG is divided mainly into 6 sectors:

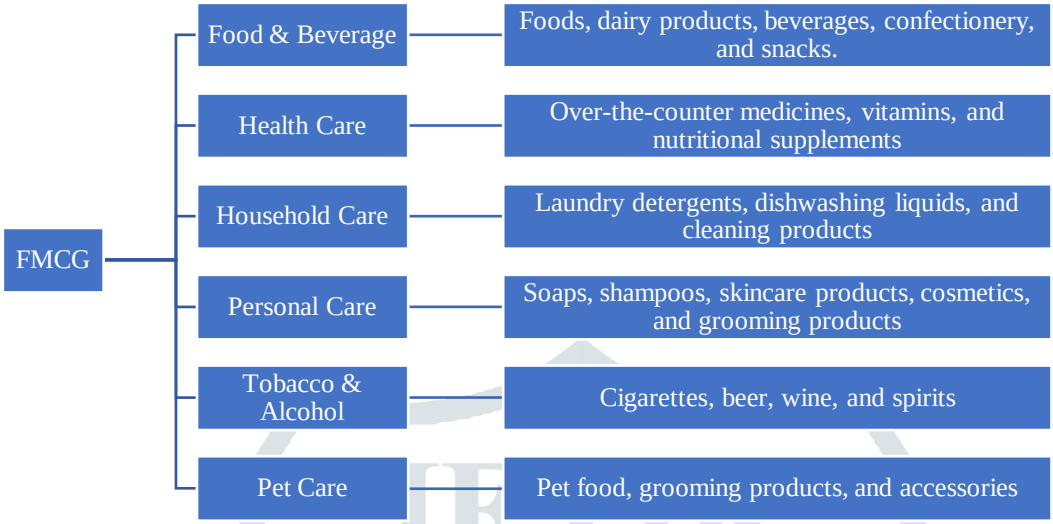

Fig.1 – FMCG Sectors

3. Forecasting

A Forecast is any future prediction made based on the available data.

Literature and various articles define Forecasting in various ways, some of the definitions of forecasting include:

- Merriam Webster's Dictionary defines forecasting as an activity "to calculate or predict (some future event or condition) usually as a result of study and analysis of available pertinent data". [5]
- Investopedia defines "Forecasting as a technique that uses historical data as inputs to make informed estimates that are predictive in determining the direction of future trends." [6]
- The Cambridge Dictionary defines a Forecast as "a statement of what is judged likely to happen in the future, based on information you have now." [7]
- According to the Corporate Finance Institute, "Forecasting refers to the practice of predicting what will happen in the future by taking into consideration events in the past and present." [8]
- According to Herbig et al., 1993 [9], "Forecasting is estimating some future event or condition which is outside of an organisation's control and provides a basis for managerial planning."
- According to Tonbul, 2019 [10], " forecasting is a set of efforts to predict what will happen in the future under certain assumptions."
- American Marketing Association defines sales forecasting as "An estimate of sales in dollars or physical units for a specified future period under a proposed marketing plan or program and under an assumed set of economic and other forces outside the unit for which the forecast is made." [11]

3.1. Industries that use Forecast

In the highly competitive business environment today, companies want to stay on top, one way of doing so is by predicting the future or simply put a Forecast. The various industries that make use of Forecasts include:

- **Tourism** – As brought out by Khadivi and Ramakrishnan (2016) [12] forecasting tourism demand is crucial in a variety of contexts, including business planning and evaluating the economic activity in a region, as it is one of the most lucrative businesses in the world.
- **Electricity/Water/Energy/Utility** – In research from Bianco et al., 2009 [13], the authors bring out the importance of forecasting electricity demand in Italy using various models. According to Billings and Jones, 2011 [14] forecasting water needs helps officials determine various factors like capacity needs, water use restrictions, the capacity of water treatment plants and the supply systems, revenue changes, and the policies of water use needed to be implemented.
- **Sales/Manufacturing** – In sales and manufacturing forecasting helps in production planning, distribution planning, raw material and packaging material planning, and replenishment scheduling which ultimately helps an organisation stay ahead of its competition. [15]
- **Demographic study** – As brought out in the article "Understanding and Using Population Projections," n.d. [16], the use of Population forecasting is done by government agencies to identify future needs for services such as food, water, and energy as

well as to predict future demographics. Population predictions can assist policymakers to create policies that can be modified for different projection scenarios and alert them to important trends that may have an impact on economic development.

- **Business/Financial/Securities Market** – according to Mallikarjuna and Rao, 2019 [17], one of the best methods for risk management, portfolio diversification, and creating reliable projections for investment decision-making is to forecast stock market returns. Thus, Successful stock trend forecasting can lower the chance of loss while increasing profit.
- **Climate** – perhaps one of the oldest fields to forecast, weather forecasts are used to plan one's day. In the article "Reasons for a weather forecast" Haby [18] highlights some of the other reasons to use weather forecasting, planning power consumption, planning the nature of activities, planning for irrigation, and planning events.
- **Health sector** - Soyiri and Reidpath, 2013 [19] highlighted the advantages of using forecasting in the health sector like foreseeing future health-related events or circumstances, such as the demand for medical services and healthcare requirements. By providing health service providers with the necessary information in advance they may take the necessary precautions to reduce risks and manage demand, it facilitates preventive medicine and healthcare intervention techniques.

Even though all these industries use forecasting, the techniques, and styles to forecast used in each of the fields differ. The various forecasting techniques will be discussed further while more emphasis will be given to the FMCG industry.

3.2. Forecasting Techniques

Forecasting Techniques can be divided into mainly of 5 types

a. Qualitative Forecasting
b. Time Series Forecasting
c. Causal Methods
d. Forecast Aggregation

3.2.1. Qualitative Forecasting

Qualitative forecasting techniques are judgement-based techniques that make use of opinions and views of industry experts that understand the systems and are aware of changes happening outside that affect the industry. [20] [21] [22] [23]

a. Delphi Method

The Delphi method was developed as a survey method of research to capture and structure group opinions and discussions. The method is named after the Greek deity Apollo Pythios, who was famed for his prodigious foresight while serving as the master of Delphi. An early study made an effort to foresee the outcomes and likely policy ramifications of a catastrophic nuclear attack on America. [24] [25] [26] [27]

The Delphi method is a framework for forecasting based on the findings of numerous rounds of questionnaires distributed to a panel of experts. Each expert is given a summary of the results from the previous round of surveys after each round, allowing them to modify their responses in light of the consensus. The advantages of expert analysis and aspects of the wisdom of crowds are combined in this technique [28]. The Delphi technique stands out from other group decision-making processes thanks to four characteristics. They are anonymity, regulated feedback iterations, statistical group responses, and professional input.

Anonymity - Guaranteed anonymity has the benefit of encouraging opinions that are genuine and unaffected by peer pressure or other extraneous influences. However, it can also imply that it results in a lack of accountability. anonymity may encourage hasty decisions since the respondent feels confident that he won't be held accountable by the other participants for what he stated. The instantaneous unconsidered response may be less likely to occur in the majority of Delphi investigations because participants are chosen based on their expertise and willingness to participate. [24]

Regulated feedback iterations - In Delphi research, regulated feedback iterations are typically accomplished by using a series of questionnaires. The respondents are asked for information and/or their opinions. Then, to keep all study participants updated on the state of the overall group view, this is incorporated into following questionnaires. Additionally, it means they have the chance to add more commentary and, if they so choose, to change a prior opinion. The Delphi technique tries to facilitate a group opinion or judgement that may be said to be representative through this fundamentally democratic procedure. [24]

Statistical group responses – for the individuals to judge their own predictions, a statistic like the mean, median forecast value or the variances of the opinions or values provided by them is also shown for the panellists to consider. Additional information may be provided which justifies outliers of the opinions while maintaining anonymity. [29]

Professional input – the respondents that are selected, are usually experts or informed individuals of their fields or the particular issue at hand. Thus, the majority of Delphi studies use a panellist selection method that prioritises the contribution from a recognised expert or knowledgeable person. [24] [30]

Thus, through the Delphi method of forecasting one can gain a greater consensus among panellists by not just taking their opinion once and leave them but also give them a chance to reconsider their opinions by providing iterative feedback to them.

b. Market Research

A common qualitative forecasting technique used in a business is market research. Through questionnaires and customer surveys, it predicts future demand. This method is used by businesses to learn important consumer insights, such as when launching a new product.

It differs from the Delphi technique in that it considers the opinions of the general population as well as specialists to gain insights. In response to changing market challenges, market research approaches likewise adapt [21]. Market research and marketing can be crucial to predicting. Its contributions to sales drivers and forecasts of which items will be purchased separately or in combination are among marketing's responsibilities. Market segments and anticipated promotional increases might also be revealed by marketing analytics. For new or reintroduced items, market research can reveal how preference shares vary in a market simulator, assisting the forecaster in incorporating competition information. Each of these events is explained in depth in this article. [31]

Market research may be used to forecast the sales for a new product or a re-introduced product. Through market research, the company can understand the reasons behind low sales of a product, the new target market and how a new product is forecast.

c. Panel Consensus

Panel consensus is a qualitative forecasting method that gathers all of an organization's internal specialists for a free-wheeling discussion on a good or service. The meeting will terminate when an agreement is established, and anyone may participate. Ex post facto validation of the forecast's accuracy using actual sales data. Other names for it include expert aggregation, ensemble averaging, model averaging, forecasting averaging, and forecasting averaging. Because only professionals from within the company are involved, this strategy varies from Delphi or market research. [21]

d. Visionary Forecasting

Visionary forecasting, as opposed to using group think, typically relies on the unique viewpoint or judgement of a knowledgeable and well-respected expert in the field. With this approach, the "visionary" frequently makes a list of potential future events based on the past. Therefore, it is somewhat non-scientific and based on personal speculation.
Forecasting that is visionary is distinguished by the "vision" of the expert being consulted. It incorporates opinions, subjective probability estimations, and intuitive judgement. Senior staff members of the organisation are urged to forecast new product development by keeping an eye on historical occurrences and trends. [21]

3.2.2. Time Series Forecasting

a. Naïve

The simplest of them, this forecasts the value for the following period using the most recent value recorded in the time series. This effectively suggests that none of the previous observations are taken into account. The "free-hand projection method" is another technique of this nature. Plotting the data series on graph paper and fitting a free-hand curve to it are included in this. The forecasts are derived by extending this curve into the future. Another simplistic approach is the "semi-average projection method." The time series is split into two halves in this instance, averages are computed for both, and a line is drawn to connect the two half averages. Forecasts are created and this line is projected into the future.[32]

Naïve method of forecast is usually used as a benchmark to judge the other methods of forecasting.

Seasonal Naïve is a Naïve forecasting method that takes into account the seasonality of consumption or sales. In seasonal Naïve the value considered is the value corresponding to the same date or day of a previous month or year depending on the timelines of the forecast. [33]

b. Simple Moving Average (SMA/MA)

A time series' present level is typically estimated using simple (equally weighted) moving averages, and this value is then forecasted for upcoming observations [34]. A forecasting technique known as the moving average uses the average of multiple recent sales data points to predict sales for the upcoming period. Seasonal patterns cannot be followed by this method; however, trend patterns can be followed with a slight time delay. To comprehend the overall patterns of the sales during the chosen period, moving average is one of the simplest forecasting techniques. It can be estimated for any period that works for the firm, but 3, 4, 6, or 12 months are typically taken into account.

A simple moving average can be calculated by using:

$$z_t = \frac{1}{n}\sum_{i=1}^{n} D_{t-i}$$

Where:

z_t = the Forecast for period t
D_{t-i} = the Actual sales/demand for the period t – i
n = the number of periods taken into consideration

In other words, by averaging the values of the time series over m periods, one can estimate the trend cycle at a given moment. Timely observations are likely to be close in value as well. As a result, the average removes some of the data's variability and leaves a smooth trend-cycle component. [35]

A moving average can be helpful in reducing random fluctuations from forecasts when demand for a product is neither increasing nor decreasing quickly and does not exhibit seasonal characteristics. [32]

c. Weighted Moving Average (WMA)

The weighted moving average method emphasises the most recent data by giving the most current data set a greater weight while averaging numerous recent data sets.

A Weighted Moving average can be written as

$$z_t = \sum_{i=1}^{n} W_i \, D_{t-i}$$

Where:

W_i = Weight assigned to any data point. The weights should all sum to one.

D_{t-i} = The actual sales/demand for the period t-i

z_t = the Forecast for period t

The simple -MA is a special case where all of the weights are equal to 1/m. [35]

The easiest ways to choose weights are through experience and trial and error. The most recent past is typically the best signal of what to anticipate in the future, thus it should be given more weight. For instance, a more accurate prediction of the upcoming month's revenue or plant capacity would be the previous month's performance. The ability to alter the effects of historical data gives the weighted moving average a significant advantage over the simple moving average. [32] [36]

d. Exponential Smoothing

Exponential smoothing gives the observed time series different weights. More weight is given to recent observations than to older ones. One or more smoothing parameters, which control how much weight is given to each observation, are used to achieve the unequal weighting. [37]

An exponentially weighted moving average is a means of smoothing random fluctuations that has the following desirable properties: (1) declining weight is put on older data, (2) it is extremely easy to compute, and (3) minimum data is required. A new value of the average is obtained merely by computing a weighted average of two variables, the value of the average from the last period and the current value of the variable. [38]

Formula:

$$F_{t+1} = \alpha D_t + (1 - \alpha) F_t,$$

Where:

F_t = forecast of expected sales during the t^{th} period

F_{t+1} = forecast of expected sales in the $(t+1)^{th}$ period

α = smoothing co-efficient, usually the value ranges from 0.1 to 1.0

D_t = Actual sales during the t^{th} period. [37] [39] [40]

This approach is appropriate for predicting data without a distinct trend or seasonal pattern.

3.2.3. Causal Method (Econometric)

a. Regression Analysis

Regression analysis refers to a method of mathematically sorting out which variables may have an impact. The importance of regression analysis for a small business is that it helps determine which factors matter most, which it can ignore, and how those factors interact with each other. The importance of regression analysis lies in the fact that it provides a powerful statistical method that allows a business to examine the relationship between two or more variables of interest. [41]

The benefits of regression analysis are manifold: The regression method of forecasting is used for, as the name implies, forecasting and finding the causal relationship between variables. An important related, almost identical, concept involves the advantages of linear regression, which is a procedure for modelling the value of one variable on the value(s) of one or more other variables.

The relation between two variables can be found by using the formula:

$$Y = mX + c$$

Where:

Y = the dependent variable

X = the independent variable

c = the point of interception

m = the slope of the line

This method helps one to establish what kind of relationship exists between two variables that are used in forecasting and to forecast. Understanding the importance of regression analysis, the advantages of linear regression, as well as the benefits of regression analysis and the regression method of forecasting can help a small business, and indeed any business, gain a far greater understanding of the variables (or factors) that can impact its success in the coming weeks, months and years into the future. [13] [42] [40]

b. Auto Regressive Integrated Moving Average (ARIMA)

Regression analysis using an ARIMA model evaluates the strength of one dependent variable in relation to other varying variables. Instead of using actual values, the model looks at variations between values in the series to forecast future securities or financial market movements. [43]

ARIMA (p, d, q) model is called differential autoregressive moving average model, where AR is autoregressive, p is the number of autoregressive terms; MA is the moving average, q is the number of moving average terms; I is a single integer, d is the number of difference times (order) to make time series become stable series. The specific modelling steps of ARIMA (p, d, q) model include stability test and processing, model recognition, model order determination and model test, etc. [44] [45]

$$\hat{y}_t = \mu + \phi_1 y_t - 1 + \cdots + \phi_p y_{t-p} - \theta_1 e_{t-1} - \cdots - \theta_q e_{t-q}$$

Following the Box and Jenkins convention, the moving average parameters (θ 's) are defined here with negative signs in the equation. They are defined differently by some authors and software (such as the R programming language). There is no ambiguity when real numbers are entered into the equation, but it's critical to understand which convention your software use when reading the results. There, the parameters are frequently identified by AR (1), AR (2), etc., as well as MA (1), MA (2), etc.

To model time series, we can work with the traditional statistical models including moving average, exponential smoothing, and ARIMA. These models are linear since the future values are cramped to be linear functions of past data Time series forecasting models are mostly used to predict demand. Under an autoregressive moving average hypothesis, Kurawarwala and Matsuo31 calculated the seasonal variation of demand by using historical data and validated the models by examining the forecast performance.

Miller and Williams mixed seasonal factors in their model to improve forecasting accuracy, the seasonal factors are calculated from multiplicative model. Hyndman widened Miller and Williams'32 work by applying different relationships between trend and seasonality under seasonal ARIMA hypothesis. The classical ARIMA approach becomes prohibitive, and in many cases, it is impossible to determine a model, when seasonal adjustment order is high or its diagnostics fail to indicate that time series is stationary after seasonal adjustment. In such cases, the static parameters of the classical ARIMA model are considered the principal constraint to forecasting high variable seasonal demand. Another constraint of the classical ARIMA approach is that it requires a large number of observations to determine the best fit model for a data series.

Literally, each observation consists of a random component (random shock, ε) and a linear combination of the previous observations. α1 in this equation is the self-regression coefficient. [46]

c. Life cycle modelling

Life cycle modelling is a supply chain forecasting method that analyses the growth and development of a new product. It requires data across different market groups such as creators, early and late adopters, and the early and late majority.

The data then determines the future performance and demand of a specific product across multiple markets, which helps brands determine how to distribute and market products, and how long the product will be in demand.

Hu et al., 2019 [47] bring out the difficulties faced in establishing forecasts for newly introduced products. Life cycle modelling helps in overcoming this by establishing, which phase of the product life cycle the product lies in and helps the forecasters to come up with accurate forecasts related to it.

d. Forecasting using Machine Learning (ML) and Neural Networks (NN)

Alroomi et al., 2022, [48] has shown strong empirical proof that machine learning approaches can outperform statistical methods has been presented by the M5 forecasting competition; in essence, sophisticated methods can be more accurate than simple ones. Zhang, 2003 [49] has shown that ANN appear to offer a viable alternative to more conventional linear approaches.

Although ML methods have demonstrated outstanding empirical performance, it is unclear why, when, and how these methods perform better than tried-and-true techniques like exponential smoothing. While the most recent competitions showed off the promise of ML techniques, they also amply illustrated that not all ML techniques can outperform statistical benchmark techniques [50]. The same ML algorithm may succeed in some solutions and fall short in others, greatly outperforming the statistical benchmarks in some cases. [51]

3.2.4. Forecast Aggregation

a. Bottom Up

Bottom-up forecasting is a method of estimating a company's future performance by starting with low-level company data and working "up" to revenue. This approach starts with detailed customer or product information and then broadens up to revenue. This guide will provide examples of how it works and explain why it's commonly used in financial modelling and valuation.

When each component has a unique pattern of variation, bottom-up forecasting is preferable than top-down forecasting. The idea behind bottom-up forecasting is to forecast each component separately, then sum the results to get the forecast for the entire group. [52]

In the M5 accuracy competition the top-scoring solutions used a global bottom-up methodology, which entails employing global forecasting techniques to get bottom-level forecasts in the hierarchy and then a bottom-up methodology to obtain coherent forecasts for aggregate levels. [53]

b. Top Down

Top-down forecasting is a method of estimating a company's future performance by starting with high-level market data and working "down" to revenue. This approach starts with the big picture and then narrows in on a specific company. This guide will provide examples of how it works and explain why it's commonly used in financial modeling and valuation.

The top-down approach is often used by established, mature companies that have decades of financial results, an international presence and several different lines of business segments (e.g., Amazon, Microsoft). For companies of such large magnitude and diverse revenue sources, breaking the business model into a granular product-level forecast could become too complicated and more importantly, the benefit of doing a detailed bottoms-up forecast would only be marginal.

The top-down approach is also often used for early-stage companies that lack any historical financial data in order to create a fundamentals-based forecast.

Rather than being meant to be a precise projection, the use-case of top-down forecasting is a "back-of-the-envelope" estimate in order to decide if an investment opportunity is worth diving into. Because of the absence of data to work with, a top-down approach is the only option in those scenarios, as a bottoms-up forecast for a seed-stage company would include too many discretionary assumptions that cannot be backed up by historical results.

While top-down forecasts are viewed as less credible than bottom-up forecasts, it is still useful for quickly validating the revenue potential of an early-stage company operating in markets that are not yet well-defined. [54]

4. Advantages of Forecasting

Forecasting can entail many advantages when performed correctly, some of them include:

- Gaining valuable insights – analysing past data can give great insights that may not be observed before. This can help in reducing the losses suffered.
- Preventing Bull Whip Effect – the bull whip effect is when even little changes in retail demand can lead to gradually bigger changes in wholesale, distributor, manufacturer, and raw material supplier demand. [55] [56]
- Encourages Collaboration – for some forecasting methods like visionary forecasts, many people need to come together to give their opinions and predictions, this helps in increasing collaboration among the various collaborators.
- Focuses on the potential for growth opportunities – the trends that are seen while coming up with forecasts can provide insights regarding a particular product to be emphasised on or capturing a growth opportunity.
- Guide for Scheduling – as forecasting is one of the first steps in the S&OP cycle, it can act as a guide to schedule all the other proceeding activities in the procurement cycle.

5. Conclusion

Different forecasting techniques are being used now to predict the various factors like sales, demographics, weather. The forecasting techniques highlighted in the paper can especially be applied to the FMCG sector to forecast the demand and sales so as to ensure robustness of the Supply chain and preventing ill effects like the Bull whip effect, inventory piling, and inevitably leading to losses suffered in business.

Further study needs to be conducted in the Indian FMCG sector that can establish the suitable techniques or hybrid models that can be used in the specific industry.

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