INVESTIGATION OF CHALLENGES OF THE ACCURATE FORECASTING OF DEMAND OF ADULT DIAPERS IN SRI LANKA. : CASE STUDY OF A LEADING PHARMACEUTICAL COMPANY

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Master of Logistics & Supply Chain Management

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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Name of the supervisor: Prof. Amal S. Kumarage

…….. ……

Signature of the supervisor: Date:

DEDICATION

I dedicate this research to my beloved parents who encouraged me providing emotional and spiritual effort in this endeavor….

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ABSTRACT

In this competitive market environment proper product forecasting is a key element for the significant growth of the company. This case study focuses on factors effecting Adult Diaper sales in a reputed pharmaceutical company in Sri Lanka. To face high competition among competitors, organization need to come up with a strategy which can mitigate the above situation. The aim of this study was to explore existing demand factors effecting the diapers segment of the organization, in order to suggest feasible attributes that can be integrated into the enhancement of adult diapers forecast technique in the organization.

In a research the theoretical framework plays a greater role so as to conduct the research. In this study, it is straight forward to determine the factors affecting the accurate forecasting of demand of adult diapers. According to the study, dependent variable is demand of adult diapers whereas independent variables are factors affecting the accurate forecasting of demand of adult diapers.

To gather factors effecting adult diaper sales forecast, had to go through with a thorough literature survey. To further verify the factors found from the literature survey, pilot survey was conducted in open forum which participants for the survey representing different industries. With high rate of score for each factor, same pilot survey factors were taken into the primary survey. The primary survey was done within the organization (internally conducted survey) and gathering information with in the sample population is more accurate.

According to findings, seven factors identified as critical factors having an impact on the diapers forecast. Those factors are poor prediction reliability, unawareness of importance of forecasting, no one is accountable for demand forecast, poor communication among relevant parties when forecasting, planning done around the goals which do not become reality, sales figures did not reflecting the actual demand pattern, product planning issues. Factors were validated through the literature survey. Applicability to local context is validated from the pilot survey.

While using EViews 7, Six years sales data were evaluated. Based on observation all four segments of the adult diapers consist of ARIMA (0,1,1) data models. Further evaluation of the ARIMA model used and based on that for each unit forecasting model was developed. This will provide better solution to the stock out and over stock situation of the organization.

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LIST OF ABBREVIATIONS

Abbreviation	Description
DP	Direct Purchase
OLT	Order Lead Time
AR	Auto Regressive
MA	Moving Average
ACF	Autocorrelation Function
ADF	Augmented Dickey-Fuller
PACF	Partial Autocorrelation Function
ARMA	Autoregressive- Moving Average
ARIMA	Autoregressive Integrated Moving Average model

LIST OF APPENDICES

1. INTRODUCTION

The present case study focuses on factors effecting Adult Diapers sales in a reputed pharmaceutical company in Sri Lanka. There is a high market potential for the Adult diapers segment and to fulfill that several companies are trying to expand their market share. To face high competition organizations need to come up with competitive strategies with a valid forecasting technique.

1.1. Product description

An adult diaper is a disposable diaper consisting of an absorbent space between two nonwoven structures. This helps prevent leaks, maintains body fluid level and improves comfort. An adult diaper is different from the baby diaper. The diapers can be used for adults with various diseases, such as severe diarrhea, dementia and incontinence or impaired mobility. Adult diapers come in various forms, including those that resemble traditional infants pants and pads resembling sanitary napkins or known incontinence pads.

The adult diapers market is primarily driven by affordable prices, population aging, urbanization and increased awareness of the treatment of urinary incontinence treatment worldwide. The global growing diapers market is expected to grow rapidly due to an aging population, economic prosperity and health system improvements. But the price volatility and the social and economic constraints associated with the use of adult diapers are a major limitation that can limit the adult diaper market.

The adult diaper market is divided into types that include pad type diapers, panties, soft diapers and so on. Nappies with adult insoles accounted for the largest share of the global adult diaper market in 2015, which accounts for approx. 48.01% of the total market. The two types of adult diapers available on the market include disposable diapers and adult reusable diapers.

The Asia-Pacific is one of the largest regions for adult diapers and is expected to grow modestly in the coming years. Developing countries are expected to experience the

strongest growth due to changing lifestyles and population growth. Japan was one of the largest markets in the Asia Pacific region. China, followed by India, has the largest number of elderly people and is expected to grow the fastest in the coming years. It is proposed that new producers develop quality products at reasonable prices and thereby maintain their market share.

1.2. Introduction to global adult diapers industry

These producers range from large multinationals to small private companies competing in this sector. The top three producers account for about 58% of sales. In the region, North America is the largest market and leader in the adult diaper industry. Adult diaper intake rose from 12321 million units in 2012 to 18878 million units in 2016, with an average growth rate of over 11.26%. In 2016, China held 24.12% of the consumer market. Follow Japan, North America and Europe, each of which represents about 23.01%, 20.28% and 20.02% of the total industry. In other countries, consumption is lower. Kimberly Clark, SCA and Unicharm are the major producers in the sector and represent respectively 24.71%, 20.25% and 13.20% of the revenue market. The average price of adult diapers will continue to fall. The average price of the product has decreased in recent years due to technological developments and the average price will maintain this trend in the coming years due to nature of production technology and raw material costs. Global sales of adult diapers are expected of continue to grow at an annual rate of 6%. We tend to believe that this sector still has a promising future given the current demand for adult diapers. According to a new GIR study, the global adult diaper market is expected to increase by around 6.4% in the next five years by $ 1.545 million in 2023, compared to $ 10.700 million in 2017.

1.3. Introduction to the diapers industry in Sri Lanka

In the Sri Lankan context, few suppliers are well established in the industry. The Main diaper sales are captured from Colombo, Kandy, Gampaha, Kalutara, Kurunegala and Ratnapura Districts. The Adult diapers segment is not very new to the market but still some customers are not aware of it. Another direct impact factor is the income level of the customers. High sales come from the above mentioned districts because of high population and high income level of people distributed among those districts. The same as the global contest adult diapers can be used for various conditions, such as severe diarrhea, dementia, incontinence or mobility impairment. In the local market the adult diaper market is segmented from pants-type diapers, flat type diapers. No other types of adult diapers is found commonly in Sri Lanka.

Main few competitors are competing to a 2,520,573 target population. This market segment includes males and females. From this market few of them are likely to wear only for a shorter period as they are immovable. In addition another market segment includes those who are permanently disabled and paralyzed. Below mention statics show target market for adult diapers. This data are based on the department of census and statics.

Table 1.1-The elderly population above 60yrs

Age group	Total	Male	Women	Sector		
(yrs.)	Total	Male	Women	Urban	Rural	Estate
Total	2,520,573	1,115,651	1,404,922	473,991	1943372	103210
60-64	917,910	425,428	492,482	169,167	706,777	41,966
65-69	633,289	283,764	349,525	121,751	481,782	29,756
70-74	412,414	181,846	230,568	77,909	318,216	16,289
75-79	283,186	116,389	166,797	52,087	222,031	9,068
80-84	159,379	64,250	95,129	30,707	125,088	3,584
85 and over	114,395	43,974	70,421	22,370	89,478	2,547

Source : Census of Population and Housing 2012
Department of Census and Statistics

Table A3: Percentage distribution of population according to district by age and sex (Both sexes)

District	Total population	All Ages	Age Group (in years)																
			Under 01	01-04	05-09	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80 & Over
Both sexes	**20,271,464**	**100.0**	**1.7**	**6.9**	**8.6**	**8.0**	**8.1**	**7.5**	**7.6**	**8.0**	**6.9**	**6.8**	**6.3**	**6.0**	**5.2**	**4.5**	**3.1**	**2.0**	**1.4**	**1.3**
Colombo	2,310,136	100.0	1.4	5.8	7.4	6.9	7.6	8.0	8.1	8.4	7.4	7.1	6.5	6.4	5.3	4.9	3.5	2.2	1.5	1.5
Gampaha	2,294,806	100.0	1.5	6.1	7.6	7.3	7.7	7.7	8.1	8.8	7.5	7.2	6.5	5.9	5.3	4.6	3.3	2.1	1.4	1.5
Kalutara	1,217,566	100.0	1.6	6.6	8.6	7.6	7.3	7.0	7.1	8.2	7.4	7.3	6.2	5.7	5.2	4.7	3.6	2.4	1.8	1.6
Kany	1,370,247	100.0	1.7	6.9	8.8	8.2	8.1	7.0	6.7	7.4	6.5	6.6	6.7	6.2	5.6	4.9	3.4	2.3	1.5	1.4
Matale	482,406	100.0	1.9	7.5	8.9	8.3	7.6	6.7	7.3	7.8	7.0	6.8	6.5	6.3	5.6	4.6	2.8	1.9	1.3	1.2
Nuwara Eliya	706,726	100.0	2.1	7.7	10.1	9.3	7.3	6.4	7.7	7.9	6.2	6.5	6.1	6.1	5.1	4.5	3.2	1.9	1.1	0.8
Galle	1,059,069	100.0	1.6	6.5	8.4	7.9	8.2	7.2	7.0	7.5	6.6	6.9	6.1	6.1	5.4	4.7	3.7	2.5	1.9	2.0
Matara	809,617	100.0	1.6	6.9	8.6	8.2	8.3	7.1	6.9	7.2	6.3	6.4	6.3	6.1	5.3	4.7	3.5	2.4	1.9	2.2
Hambantota	596,788	100.0	1.9	7.3	9.0	7.7	8.0	7.4	7.6	8.2	6.8	6.5	6.2	6.2	5.6	4.2	2.6	1.7	1.5	1.7
Jaffna	583,613	100.0	1.6	5.7	8.5	9.3	9.4	8.8	7.6	7.3	6.1	5.5	5.4	5.6	5.2	5.2	3.8	2.3	1.5	1.3
Mannar	99,107	100.0	1.7	7.6	9.6	11.8	11.4	7.6	7.3	7.7	6.8	5.8	5.0	4.7	3.9	3.8	1.9	1.5	1.0	0.9
Vavuniya	171,390	100.0	1.8	7.5	8.9	8.7	10.6	8.6	8.1	8.5	6.5	6.1	5.6	5.4	4.5	3.8	2.2	1.5	0.9	0.8
Mullaitivu	90,842	100.0	2.4	9.2	9.4	9.0	9.3	8.0	8.8	9.0	6.8	5.3	5.0	4.6	4.2	4.3	2.2	1.2	0.5	0.6
Kilinochchi	112,980	100.0	1.9	9.5	11.1	10.1	9.6	7.7	8.1	8.4	6.7	5.0	4.9	4.1	3.7	4.3	2.4	1.2	0.8	0.5
Batticaloa	525,399	100.0	2.0	8.1	10.5	10.4	10.0	8.2	8.1	8.1	6.4	5.9	5.5	5.0	4.2	3.2	2.0	1.3	0.8	0.6
Ampara	648,343	100.0	1.9	8.3	10.0	9.3	9.6	7.9	8.1	7.9	6.5	6.6	6.2	5.5	4.3	3.2	2.1	1.3	0.8	0.5
Trincomalee	378,255	100.0	2.2	8.7	10.2	10.0	10.1	8.1	8.1	8.2	6.6	5.7	5.3	4.8	4.1	3.2	1.9	1.2	0.8	0.6
Kurunegala	1,610,955	100.0	1.7	7.0	8.3	7.5	7.5	6.5	7.1	7.8	7.1	7.1	6.7	6.6	5.8	5.1	3.1	2.2	1.6	1.5
Puttalam	760,078	100.0	2.0	7.4	9.2	8.7	8.7	7.5	8.5	8.3	6.9	6.2	6.2	5.6	4.9	4.2	2.4	1.5	1.0	0.9
Anuradhapura	856,399	100.0	2.1	8.1	9.3	8.1	8.2	7.3	7.6	9.1	7.5	6.8	6.5	5.9	4.8	3.7	2.1	1.4	0.9	0.8
Polonnaruwa	403,782	100.0	1.9	7.7	8.8	8.2	8.1	7.6	7.9	8.1	7.1	7.0	6.5	6.1	5.2	3.9	2.5	1.6	1.0	0.9
Badulla	815,253	100.0	1.7	6.9	9.2	8.6	8.0	8.6	7.1	7.5	6.7	6.8	6.7	5.9	4.8	4.1	3.1	2.0	1.3	0.9
Monaragala	448,210	100.0	2.1	7.7	8.8	7.8	8.8	7.9	8.9	8.1	6.8	6.8	6.5	6.0	4.6	3.6	2.2	1.4	1.1	0.9
Ratnapura	1,082,838	100.0	1.7	6.8	8.4	7.4	7.8	7.5	7.7	8.2	7.1	7.0	6.1	6.1	5.2	4.6	3.2	2.1	1.6	1.3
Kegalle	836,659	100.0	1.5	6.4	8.2	7.7	7.5	7.3	7.0	7.5	6.6	6.6	6.4	6.5	5.9	5.1	3.8	2.5	1.7	1.5

Census of population and housing of Sri Lanka, 2012 (Provisional data based on the 5 % sample)

Table 1.3- Mid-year population estimate 2018

In Thousands

Age Group	2016*			2017*			2018*		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Total	**21,203**	**10,265**	**10,938**	**21,444**	**10,382**	**11,062**	**21,670**	**10,492**	**11,178**
0-4	1,818	917	901	1,839	927	912	1,859	938	921
5-9	1,821	919	902	1,843	930	913	1,863	940	923
10-14	1,709	864	845	1,729	874	855	1,748	884	864
15-19	1,713	854	859	1,733	864	869	1,752	873	879
20-24	1,596	773	823	1,614	782	832	1,632	790	842
25-29	1,617	774	843	1,636	783	853	1,653	791	862
30-34	1,707	830	877	1,727	839	888	1,745	848	897
35-39	1,467	714	753	1,484	723	761	1,499	730	769
40-44	1,415	689	726	1,431	697	734	1,446	704	742
45-49	1,339	644	695	1,354	651	703	1,368	658	710
50-54	1,270	605	665	1,284	612	672	1,297	618	679
55-59	1,108	521	587	1,120	527	593	1,132	533	599
60-64	955	443	512	966	448	518	975	452	523
65-69	659	295	364	666	298	368	672	301	371
70-74	429	189	240	433	191	242	438	193	245
75-79	295	121	174	298	123	175	301	124	177
80+	285	113	172	287	113	174	290	115	175

Source: Registrar General's Department

1.4. Research problem statement and purpose of the research.

Managing optimum the stock situation is challenging to any company. This case study tries to address the same problem which Sri Lankan leading adult diaper market leader facing the situation of over stocking and stock out situation in the adult diaper segment leading to an adverse effect to the company. Excess stocks lead to increased unexpected

warehouse cost and it is an adverse effect to profitability of the company. Because of high usage of floor space in the warehouse for the diapers segment high extra warehouse charges are occurring every month. For the one CBM only 120 packs of large 10's, 150 packs of medium 10's, 210 of large 4's or 250 of medium 4's can be stacked. Due to the high market growth rate the number of order placements is done frequently without proper forecast, this causes adverse effects. In general direct sales are considered as primary sales to the organization and is the transaction between the organization and thedistributor. Distributors needs to maintain 80% of the stock and it's a right for the company to order fulfill up to that level. Over stocking in distributor point will solve to reduce overstocking in warehouses but it badly effects payment received from distributors. More credit days, stock damages, and short expiry without proper stock management within the distributor's premises creates an importance for managing diapers stocks, as well as the significance of implementing proper forecasting technique. While using accurate information a proper forecasting formula can be developed and based on that an optimum stock quantity can be maintained. Therefore, it was important to study about diapers stock management within the organization.

1.5. Research gap

In order to provide an accurate demand forecast for the adult diapers segment the organization needs to identify what the critical factors are that effect adult diaper forecast. In local and global contexts there is no research conducted based on factors effecting the diaper industry.

1.6. Objectives of the research

The aim of this study was to explore existing demand factors affecting the diaper segment of the organization, in order to suggest feasible attributes that can be integrated into the enhancement of adult diapers forecast technique in the organization. In order to achieve this aim, the following objectives were formulated.

1. Identifying the factors that affect the accurate demand forecasting of adult diapers in Sri Lanka

2. Analyzing the effect of identified factors for the accurate demand forecast.
3. Suggestions for reducing the forecasting error in demand in the adult diapers industry.

1.7. Research methodology

1.7.1. Literature survey and review

A comprehensive literature survey was carried out through journals, and research articles and publications to gather further information already gathered from government reports and factors affecting diapers forecast.

1.7.2. Case study

For this research the case study research approach was adopted and this facilitated in-depth investigation of the whole process of diapers forecasting, sales operation, order placement, supplier lead-time etc... With this study it abled to identify how management makes the policies and how they react to the market trends. This will lead to improve adult diaper forecast in the organization.

1.7.3. Data collection

With a thorough literature survey validated factors were found. To verify factors found from the literature survey, a pilot survey was carried out in open form which included numerous industries production to services. Further rated factors were carried out on the organization to see what are the critical factors that affect adult diapers demand forecast.

1.7.4. Scope and limitations of the study

This case study was based on reputed pharmaceutical company in Sri Lanka who import and distribute throughout the country. Diapers manufacturers were not considered in this study. Last six year's data were taken as not significant variation from market interferences and threats from new entrances. Market promotions are considered as constantly continued throughout the period and from that has no impact on the sales. Even though there are many ways to forecast Demand ARIMA forecasting technique used as

appropriate technique with observations. To analyze data Excel 2013 and EViews 7 was used.

Overview of the thesis

1.7.5. Introduction

An overview is given to the dissertation. It includes Product description, Introduction to the global adult diapers industry, Introduction to the diaper industry in Sri Lanka, Research gap, Objectives of the research, Scope and limitations of the study.

1.7.6. Literature review

This chapter explores theoretical status of the research on which factors are effecting adult diaper forecast. Factors such as poor prediction reliability, ignored the importance of forecasting, no one is accountable for demand forecast, poor communication among relevant parties, planning done around the goals which do not become reality, sales figures did not reflect the actual demand pattern and product planning issues affect proper sales forecast. The Literature did not directly address the adult diapers segment in the market but covers the whole industry.

1.7.7. Research methodology

This chapter will address the theoretical framework, Conceptual design, Secondary data collection, Pilot survey, the Primary survey data collection, population, and sample size, method of data analysis and possible errors of data collection.

1.7.8. Data Analysis

In this section discussed how to analyze pilot survey and primary data collected with Excel 2013. Furthermore how to analyze past year data through EViews 7 and measure reliability of the data to develop the ARIMA forecasting model.

1.7.9. Research findings

While observing data patterns validated data for EViews 7 ARIMA forecasting model for each diaper segment will be developed under this section.

1.7.10. Conclusion and Recommendation

This section comprises conclusions and recommendations of the research. Based on the empirical findings gathered analysis, a better forecast technique was developed to the organization. This will be a better opportunity to further researchers who are interested in forecast in pharma industry and they can explore in the future.

2. LITERATURE REVIEW

The Literature review will cover what other researchers have conducted on the subject. The subject chosen is the accurate forecasting of the adult diaper demand. This area was not previously covered by most of the researchers, especially as this cover the Sri Lankan context. Thus, the Literature Review will be conducted on the demand decisive of a general industry practice, rather than on adult diaper industry. So, most of the literature review will be adopted from other researchers who had conducted researches or published journals or books on the subject of demand forecasting.

Forecasting is a critical input for planning. Organizations forecast as it can plan & shape their future. In a survey conducted by Fransoo & Wouters in 2000, taking 175 companies as the respondents, 92 percent of the respondents indicated that the forecasting was important for their company's success. Most of the management of those companies were much depending on forecasting and they were also prepared and concerned on the continuous production to take place. Thus, forecasting was more important for their companies in long run as well as in short run.

Cachon & Lariviere in 2001 has seen the importance, which in his own words has explained "The dissemination of accurate information is critical for the supply chain to operate effectively. The supplier's limited capacity may lead to numerous lost sales, hurting both parties". That is, the forecasting or dissemination of accurate information in other words are important mostly in the supply chain, as the continuous supply of materials are important for the company's continuous operation.

Availability of materials for new product is guided by the short and long range forecasting of material. (Chambers & Mullick, 1987). Thus, any company should make sure to forecast the material usage according to the respective demand and supply situations. Further it was noted that forecasting is necessary to plan on organizations activities and it should be relevant to a particular management task, otherwise it will be of little value. (Bernard et al., 2010)

The importance of forecasting in business applications was not understood by most of the companies. Thus, they invest huge amounts of money on unnecessary software to plan their future, without having a more realistic method of forecasting.

In the same survey conducted by Fransoo & Wouters in 2000 on the subject of actual forecasting happening inside the companies, where they practically carry out the forecasting, it was found that 10 percent of all companies responded to the question as "wait and see, then react". Further 3 per cent stated "we don't forecast, we make it happen". The remainder were engaged in some form of forecasting. Forecasting provides a basis for managerial planning and it is a future event or condition which is outside an organization's control. (Capital & Management, 1997)

Fransoo & Wouters in 2000 emphasized that both under-forecasting and over-forecasting are bad. Many managers are down playing their importance by not doing good forecasting. One reason can be that when a forecast is correct nobody can hear them. But when a forecast is wrong only, then it comes to be further considered. (Bernard et al., 2010) basic issue in data quality is how accurately the nature and effect of a variable can be measured. Demand amplification has two types:

1. Delay of transferring demand information
2. Delay in transferring physical products through the supply chain (lead times)

Most of the companies operating in the manufacturing sector have allocated the forecasting and budgeting process to the finance department. This has enabled the organization to be financially viable, whereas the practicability emerges with the

forecasting. (Capital & Management, 1997) But the accountability of forecasting the future income and expenditure should not only lie in the hands of the accountant. Instead, all the employees at all levels should focus on a more involved budgeting method.

The accountability for the budgeting and forecasting the demand lies with the respective department heads, rather than with the finance departments. The top management should understand that budgeting is a more realistic process where real scenarios should be considered by the respective departments and the accountability of forecasting their incomes and expenses lies upon them. The finance department's responsibility is to collect all the data, at each department and to put them up in a single document to form a budget. (Capital & Management, 1997)

In conducting the budgeting, the companies mostly tend to just focus on the historical data. Most organizations prepare the incremental budgets, based on the previous year'dsfigures. (Chambers & Mullick, 1987) But sometimes these figures may contain false data. For an example, the sales figures may not actually reflect the actual sales, where due to the seasonal offers the company had for the customers, the sales may have increased. This necessarily does not mean that the actual sales have increased or the demand for the product has increased. In a study done by Harshan. K in 2014, on a sample taken from India, it was revealed that the garment sales had increased due to the offers, but the demand was the same as before.

The forecast figures will also deviate from the actuals due to errors in forecasting. (Chambers & Mullick, 1987) The errors will occur due to use of incorrect data, human calculation errors and forecast being wrong. However, the management should have backup plans in place in order to make the correct decisions at the correct time with all the forecasting being done for the betterment of the entity. The actual demand pattern should be identified in forecasting, using the actual scenarios, so that the company could correctly stock in and provide the supply in line with the demand forecast.

The traditional approaches to calculus focus on decision relevance and implementation. This is not the only way, but this is the one which works best most often. The more

unstable the demand accuracy of the forecasting is more critical and forecasting procedure is also more elaborating. (Bernard et al., 2010)

According to Chambers & Mullick (1987) there are three basic elements of a good forecast. The accuracy of the forecast itself, a measure of the accuracy of the forecast, and the implicit or explicit assumptions behind the forecast. The first two elements are inputs for the decision-making process, while the third provides the basis for tracking the forecast and identifying when turning points occur. The first is a scientific one that leads to a greater understanding of the phenomena. Here the goal is to build either normative or descriptive models which advance knowledge. The second is a pragmatic thrust concerned with the capability of management science to aid decision makers to take correct decisions at correct time.

Sperber, D., & Wilson, D (1986) has identified that the communication is one of the key success factors in any organization. According to their research, a good communication is a must for any organization to bloom out. Thus, the management of any organization should focus more on making an effective communication, when forecasting the budgets. Because even the smallest piece of information, which is handled by the lowest level employee will be decisive when analyzing the market factors of demand. By maintaining a good communication channel among the peers, the forecasting can be easily and correctly done.

The effects of communication matters to an organizational success in real time. Effective communication can lead the organization towards its success with the real demands and needs being communicated to the right place to produce right needs in right quantities. On the other hand, a bad communication is the only factor which takes all and reverses the efforts made by the management. The power of communication is such fact, that all the organizations should use communication methods from the beginning of production – forecasting of demand to the end, distributing the finished goods as per the demand. (Castells, M. 2013) Poor communication can make things worse by enabling the

customers to go for substitutes and rather impact on the organizational financial performance in a negative manner.

Planning is important in any occasion. Planning enables the organizations to focus on their vision and mission and make the paths on how they are going to achieve their targets. Thus, planning is critical in an organization where the achievement of the organizational goals will depend on them. A success plan can lead the organization towards its success as well as a bad plan will make the organization dead. (Healey, P. 1992). Also, it is important to understand the impact of a bad plan. The planning should be done targeting to achieve the organizational goal, rather than planning on achieving separate goals.

The planning process is itself a process of taking decisions considering the future, present and the past of the organization. The past of the organization will decide its present and its planning with present will decide the future of the organization. Thus, any organization should plan to achieve its goals in a given period of time, as a plan without a timeline will not be effective. The plan should be done focusing on the target, along with a timeline to get proper use of the plan. Thus, planning exactly to achieve the organizational targets are much important. (Stadtler, H., & Kilger, C. (2002).

When planning the organizational future, issues do occur due to various reasons. If the planning department is not communicated on the exact need of the product, the planning process may be fully in vain. Thus, it is always important to have a good communication with the planning department to reduce the number of issues arising in the planning systems. In a research conducted by Guide Jr. in 2000 using 60 organizations as the sample, it was identified that the 80% of the sample were having planning departments. But only 40% of the total population had much success in the planning process. The reason for the reset 60% to fail was identified as the poor inter communication among the departments. (Guide Jr, V. D. R. 2000). Thus, it is important to have an effective communication for the betterment of the organization, as well as to be realistic with the forecasting process.

The forecasting method used have a direct impact on the results, that using the most suitable forecasting systematic method is a must for the success of the output to be obtained. There are many forecasting methods available, out of which most of them will involve different calculation methods to arrive at a final decision. The company should choose which best suits them, their organization and use that for their analysis purposes. It will enable the company to get a more accurate result, which will best suit the organizational environment. (Holt, C. C. 2004)

Further Mann. D in 2003 has said that the forecasting methods should be continuously updated with the technological advancements and social changes which are happening every day everywhere. The forecasting methods should address the environment which it operates in effectively and use the environmental factors in forecasting too. By that way a more accurate forecast could be conducted where the organization will be the ultimate party to enjoy its plans being success but as planned.

In summarizing the literature review, it was seen that most of the time the matter was the method used, the assumptions used and the target for a better forecast of the demand. Thus going in line with them it can be concluded that those factors are the direct decisive factors of demand for a product.

3. RESEARCH METHODOLOGY

3.1. Introduction

This research study is based on the factors affecting accurate forecast for adult diapers sale of a reputed pharmaceutical company in Sri Lanka. The chapter explains mainly about the Theoretical framework of the research, research design, research method, methods of data analysis and evaluations and the summary of the chapter. As this study deliberates the factors that influence forecast of adult diaper sales and relevant factors, there is no systematic technique used for forecasting, ignorance of the importance of forecasting, Accountability for demand forecasting, sales figures did not reflect the actual demand pattern, poor communication among relevant parties when forecasting, planning being done around the goals which do not become reality ie Product planning issues. Identifying the critical factors will lead to improve the accuracy of demand forecasting of adult diapers.

3.2. Theoretical framework

In a research the theoretical framework plays a great role so as to conduct the research. In this study, it is straight forward to determine the factors affecting the accurate forecasting of demand of adult diapers. According to the study, the dependent variable is demand for adult diapers whereas independent variables are the factors affecting the accurate forecasting of demand for adult diapers. However, accurate forecasting for demand of adult diapers, has become a challenging task due to many reasons.

To gather the factors affecting the adult diaper sales forecast, had to go through with a thorough literature survey. To further verify the factors found from the literature survey, a pilot survey was conducted in open forum in which participants for the survey represented different industries. With high rate of score for each factor, the same pilot survey factors are taken into the primary survey. The primary survey was done within the organization (internally conducted survey) and gathering information within the sample population is more accurate. On the other hand, an internal pilot survey will consider the

respondents in the pilot as the first participants in the main survey. According to the pilot survey, the below mentioned factors were identified.

1. Poor prediction reliability.
2. Ignorance of the importance of forecasting.
3. No one is accountable for demand forecast.
4. Poor communication among relevant parties when forecasting.
5. Planning done around goals which do not become reality.
6. Sales figures did not reflect the actual demand pattern.
7. Product planning issues

3.3. Conceptual design view

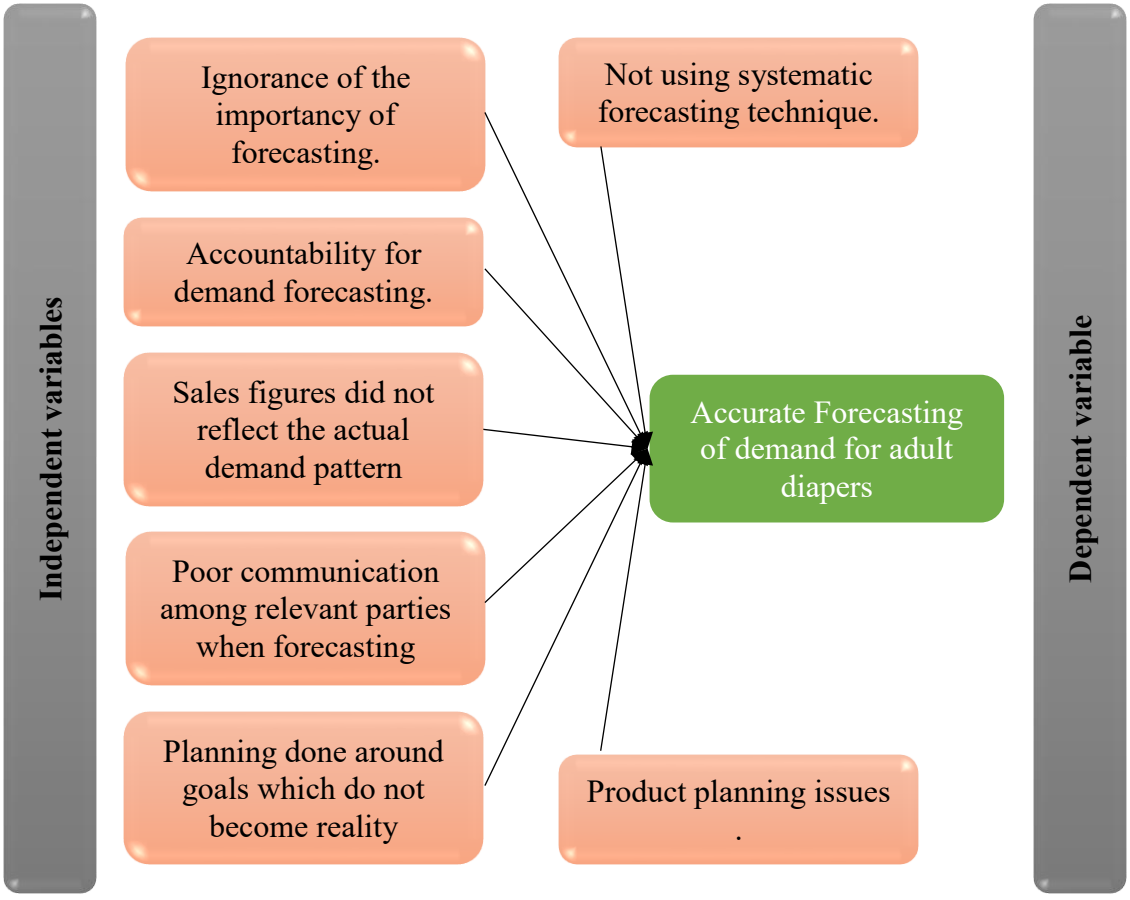


Figure 3-1-Conceptual design

In this dynamic business environment many organizations try to compete in the market with different marketing strategies. Selecting right data and analyzing it gives better solutions to different complications. Most of the successful companies study their past data and do a proper product and market forecast thus giving them competitive advantage. As per the records some organizations do not study past data. While using their personal judgements product forecasting will take place. This will give bad implication to staff of the organization and this can be an indirect cause to other factors as well.

Organizations need to identify forecasting as a consquence of competitive advantage among competitors. Support from top management will improve accuracy of the information provided by employees and the variance among actual and forecast will significantly reduce.

Preparation of forecast is not a solution for better forecast. There should be a person to evaluate it continuously and do the right adjustments. Accountability takes a prominent place in every activity, if not no one will do the right thing and information comes to management is incorrect. This will lead to making erroneous decisions by the top management.

Sales figures are being manipulated by Marketing Staff- In order to achieve the monthly Sales target, Marketing staff do manipulate the sales figures. This may lead to inaccurate sales forecasts, since sales forecasts are based on the previous sales figures. Because of that, there may be over or under stocks in the warehouse, which in return will increase cost to the company. If the available stock is not sufficient as per forecast, the company needs to import stock, incurring additional shipping costs. On the other hand, if the available stock is higher than the forecast it will lead to increased finance cost and also the holding cost.

Better communication is essential to make every successful activity. Work as a team will reduce the time to market the product. But if communication is given a prominent place, decisions which management make get delayed and at that time information will be outdated. At the same time reliability of the information become questionable. In modern

era, highly successful companies try to build better communication among decision makers and information providers through cross functional team creations, Team building programs etc. When do forecasting activities of the organization, communication among relevant parties is essential. Right information & right time make better decisions.

When planning is done around personal preference and it can be a cause to bring sales forecast to an adverse effect. Preferable way of forecasting to, collect the correct past data and do the forecasting based on that. As per the observation, adult diaper sales forecast done based on personal preference and which does not become reality.

In product planning correct supplier lead-time, managing logistics activities, correct order levels calculation etc. is very important because it directly effects product planning. Calculating correct supplier lead time-A Company has to order required products from foreign suppliers. Therefore, it is essential to know about the time it takes the stocks to arrive in Sri Lanka. Otherwise, even though demand is there, the supply of product may impact the markets which will lead to the existing customers to switch to substitute products. When dealing with suppliers, there are some conditions as to order minimum quantities, and committed quantities at pre agreed prices where a company has to face many difficulties when ordering the quantities. Not defining the target market properly- For an optimum placement of product, the target market should be clearly defined with exact age group, income level, geographical area, etc. it will lead to the company to achieve the best market available. Thus a company should properly target its products towards the market clearly identifying the critical factors in the target market.

There are some factors which organizations cannot control. Those factors are beyond the control of the organization and giving good attention to those factors will prevent unpredictable movements from the forecast. Below described factors are beyond the control of the organization and those factors are not taken into consideration in this study.

Unavailability of current competitor’s sales and volume statistics can be recognized as the other major issue. The competition in the pharmaceutical industry is very high due to profit margins being high. This has led to the market being an oligopoly. Thus, the

competitor actions are directly affecting us. So most of the sales, market, volume, details are not available publicly and even the available data cannot be accessed easily. Furthermore, available data are also not reliable to take as base factors to do the forecasting. And also sales promotional activities done by competitors may directly impact the company's sales figures.

In addition to that there are threats from the new entrants who low ball the market with inferior quality products which are bulk imported from China, and India. Due to this factor, company can't accurately forecast the demand for adult diapers. The elasticity of customer demand is very high. Therefore, customers move from one supplier to other suppliers by considering the prices and quality of the products offered by the competitors.

Challenges in distribution channels- One of the critical success factors in achieving the target is a proper distribution channel. The distribution channel plays a vital role in delivering the products to the final customers. The return which the distribution channels earn is the commission paid on their sales volumes. When one supplier pays a higher commission rate, the distributor will favor that supplier. Also, the distributor can get more than one suppliers' consignments. This will lead the higher commission paying supplier to success. Also distributor is the final chain before the customer gets the products. Therefore, the distributors act directly affects the supplier's demand where a good service provided will lead to better customer satisfaction.

3.3.1. Secondary data collection.

Based on the thorough literature survey, seven key elements were found as key factors which an organization can control and they highly effect the accuracy of the forecast. There are many challenges affecting accurate forecasting of demand on adult diapers but some factors are beyond the control of the organization, objective of the study being to identify the concercutive reasons , Analyzing the effect of identified factors for the accurate demand forecast and Suggestions for reducing the error in demand forecast in the adult diapers industry.

3.3.2. Pilot survey

Pilot study is a small-scale, preliminary study which aim to investigate whether crucial components of a main study will be feasible. With this researcher has confidence in the key steps which will take when conducting this type of study to avoid wasting time and resources.

Main purposes of the pilot study Is to identify the process, where the feasibility of the key steps in the main study is assessed, assessing problems with time and resources that may occur during the main study and how to manage the problems with gathering data and with the team involved in the study.

In this case study pilot survey organized in open forum which includes representatives from every industry. The basic idea is to identify key factors collected from the literature survey are practically applicable to the Sri Lankan industry perspective. The Questionnaire distributed to participants of the pilot survey which includes 2 sections. Section “A” is to identify industry and section “B” is to gather information on how each participant thinks of the factors related to each industry forecast. Each factor contains three questions to further elaborate the fact. From the pilot survey, low scored (highly effected factor(s)) will be selected to the primary questionnaire.

3.3.3. Primary survey data collection

Both primary and secondary methods of data collection will be used to collect data.

3.4. Primary data

There are different kinds of approaches available to collect primary data and among them, are the questionnaire and observations were used to collect the required data. Validated factors found from the literature survey and further designated from the pilot survey will be forwarded to the internal staff who directly intervene in the forecasting procedure of the company. Under these methods realistic data can be collected and evaluated.

3.5. Secondary data

Secondary data refers to the already available data. These will be collected from internal sales and marketing reports, related journal articles, researches and other e-resources, order placement reports, Good Received Reports, etc...

3.5.1. Population

This study is based on a particular company which is the market leader in the Sri Lankan diaper industry. From that Population are participants for the forecasting procedure in the organization. Total employee count of the organization would be 250 and nearly 40 employees will be directly participating in the forecasting procedure.

3.5.2. Sample size

According the study, total population and sample size would be all most the same. Participants in the forecasting would be nearly 40 employees and among them 34 samples had collected. Sample which included general staff, executives, middle managers, top managers. Senior managers included in questionnaire but all the senior managers are located in the factory and they are not directly involving in the forecasting process.

For sample each department was included except the Human resource, Production (because diapers are an imported product), maintenance and quality assured. Other departments such as Marketing, Finance, and Logistics, IT, Regulatory and others were included in the sample.

3.5.3. Method of Data analysis

Primary Survey and secondary survey analyses through excel because weightage of each factor is calculated. All the questions of primary questioner and pilot questioner will be ranked based on the Likert Scale. No other descriptive analysis uses this. Further analysis of past sales data EViews 7 had being used. From the results from EViews 7 equations for diapers segments were developed.

3.5.4. Possible errors in data collection process and how to overcome them

- Error of participant

When filling the distributed questionnaire, it is needed to be distributed among employees. Respondent of the questionnaire will be biased because of fear of top management. Therefore, when distributing the questionnaire, it is required to educate participants that there is no need to mention their names and all the information provided by participant will be highly confidential.

- Participant bias

Participants for the survey will sometimes have second-thoughts about what the researcher is after, or change their answers or behaviors in different ways, depending on the experiment it can have a huge impact on research findings. Respondents need to be given the free opportunity to give their free ideas. Once they are given the full freedom they will give their maximum support to conduct the research while providing their true views and also ensuring that the participants know that their data are truly confidential. With these actions, effects of social desirability bias can be mitigated.

- Viewer error.

When doing a research, normally a sample is selected, but the sample itself doesn't give a true and fair view of the actual scenario. Thus proper justification should be used to reduce the errors which could happen due to assumptions.

- Sampling error

Sampling error occurs when surveying only a sample of the survey target population. This amounts to the difference between the sampled respondents and the entire survey population. Sampling error is highly dependent on sample size, hence the common recommendation that larger sample sizes are almost always better. Of all the types of error, sampling is the most quantifiable method as it can be calculated mathematically. In this study sampling error will be minimized because of sample size is adequately equal to the research population.

3.6. Conclusion

In this chapter the research methodology has been described. Under this section, data collection methods, data analysis method, research population, sample method possible errors in the data collection process and methods used to overcome them were discussed in detailed.

4. ANALYSIS

4.1. Introduction

This case study is based on the adult diapers segment necessitates a proper planning issue. Basically there are four items in the adult diaper segment and they are Medium 10's, Large 10's, medium 4's and large 4's. In general, most of the time all four items are placed in one purchase order with different quantities. There is no proper way of analyzing future trends, as a result stock out situations and over stocks situations happen regularly.

4.2. Past data analysis

For analysis purpose, 6 years past data have being collected. The table given below shows that, i.e. how many orders are placed during the period. Due to rapid increase in sales, number of shipments increased gradually.

Table 4.1- Diapers orders during the period

Year	No of shipments	Growth rate
2013	9	
2014	7	-22%
2015	10	11%
2016	12	33%
2017	13	44%
2018	21	133%
2019	1	

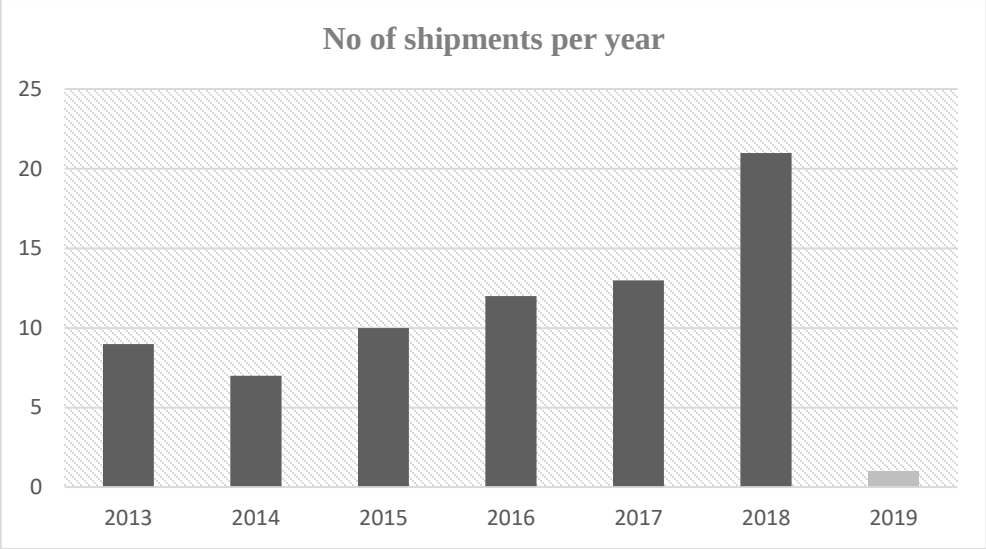


Figure 4-1- Diapers orders

When compared to 2013 no of shipments to 2014 has reduced by 22%. But 2014 to 2018 no of shipments increased by 11%, 33%, 44% and 133% respectively. But up to January only one order has being placed.

4.2.1. Order lead time analysis

Table 4.2-Order lead time analysis

Total lead time calculation	Days
Internal lead time	20
External lead time	21
Clearance days	3
Total lead time	44

When calculating order lead time, five sub categorized lead-times need to be identified.

- Order Lead Time - Time between customer order received to customer order delivered
- Order Handling Time - Time between customer orders received to sales order created.
- Manufacturing Lead Time - Time between creations of sales order to completion of production. (Ready for delivery).
- Production Lead Time - Time between start of physical production of first submodule to production completion (ready for delivery).
- Delivery Lead Time - Time between production completions to delivery of customer order.

There are four definitions for the concept of (OLT) though they look similar there are differences among the definitions around the concept of. Order lead time (OLT). That will help the industry to identify customer order behavior. The four definitions are:

- The Actual Order Lead Time (OLT Actual) The order lead-time, refers to the time taken between the receipt of the customer's order (Order Entry Date) and the dispatch of the goods.
- The Requested Order Lead Time (OLT Requested) is the time between the Order Entry Date and the delivery date requested by customer. ; This will help the company to understand the customers order behavior. The company will design profitable models to cater customer needs.
- The Quote Order Lead Time (OLT Quote) is the agreed time between the Order Entry Date and the supplier's committed delivery date of goods as given in a supply chain contract.
- The Confirmed Order Lead Time (OLT Confirmed) represents the time between the Order Entry Date and supplier confirmed delivery date of goods.

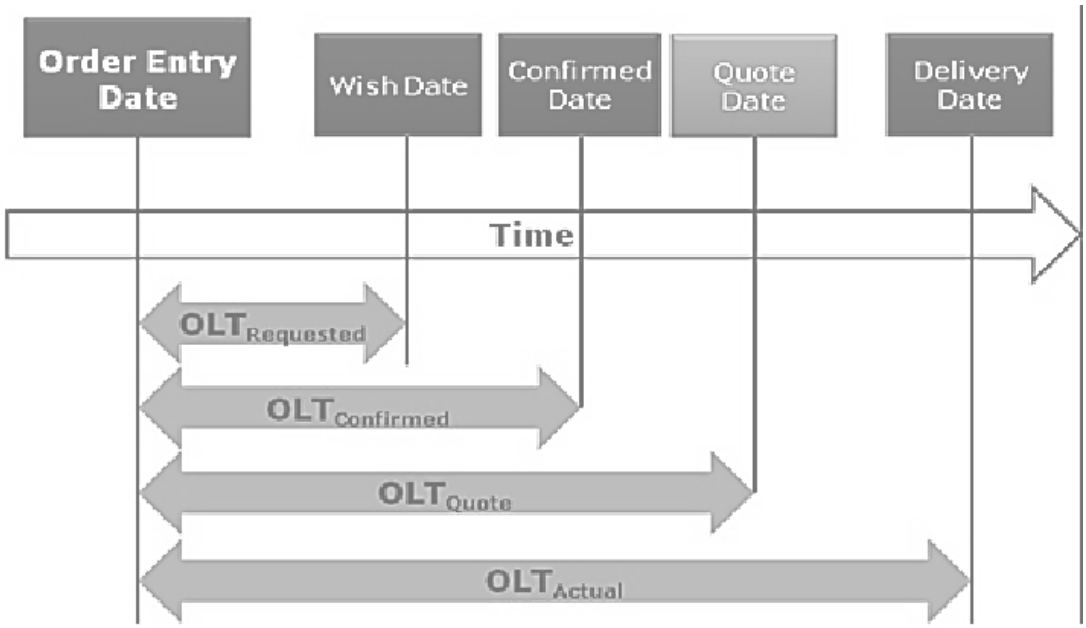


Figure 4-2-Order lead time calculation chart

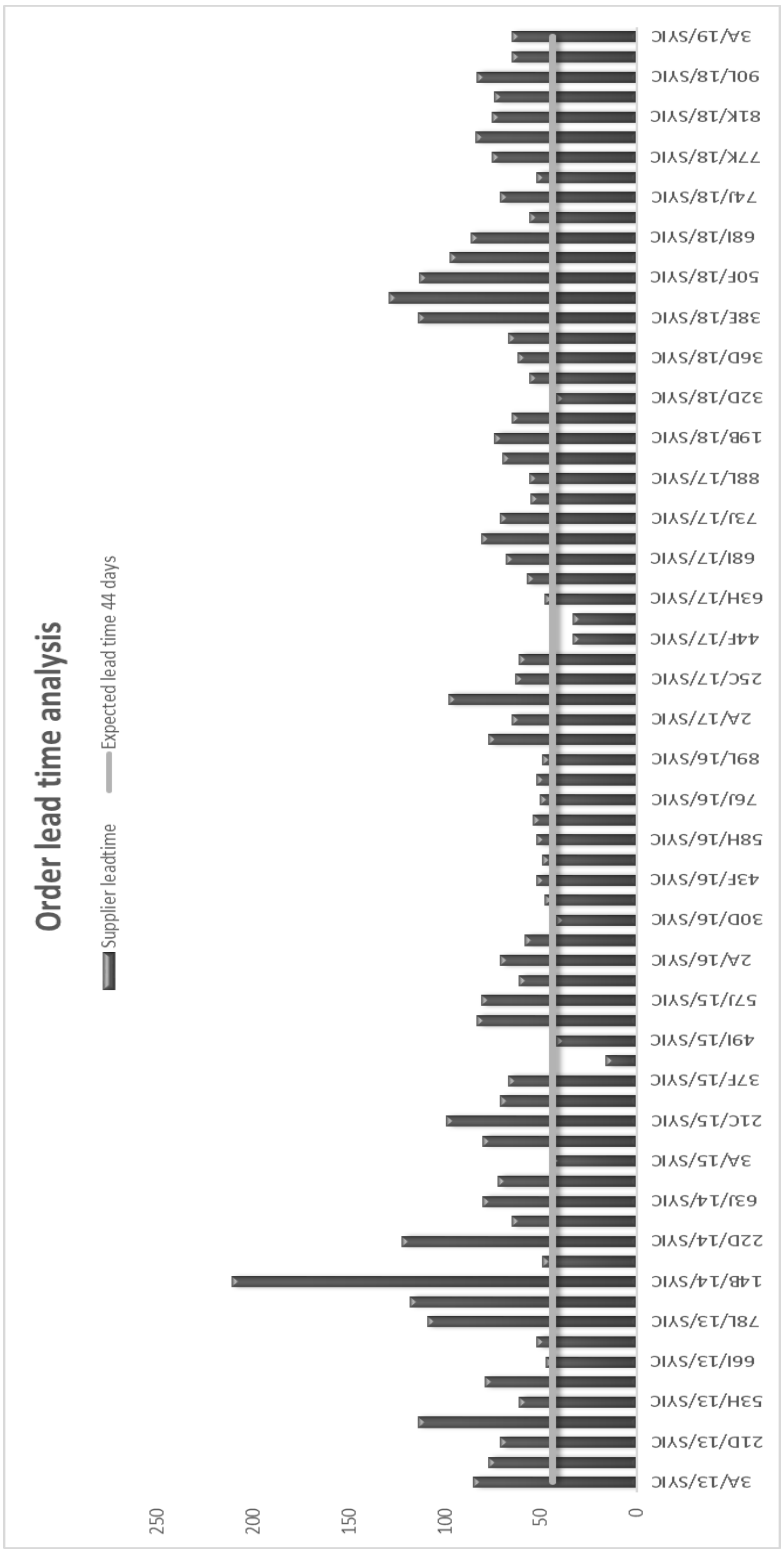


Figure 4-3-Order lead time analysis data chart

4.3. Actual sales vs Budgeted sales

Charts given below demonstrate actual diaper sales and forecasted diaper sales variation over a six year period. For analysis purpose 6 years past data have been analyzed and time period starts from year of 2013 to 2018.

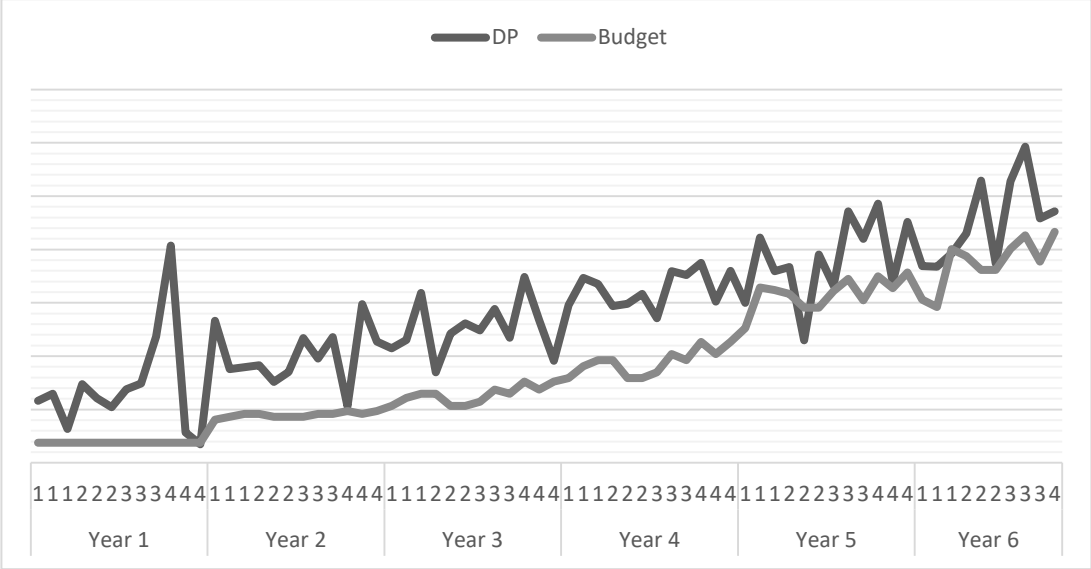


Figure 4-4-Actual sales Vs budgeted sale for Medium 10's

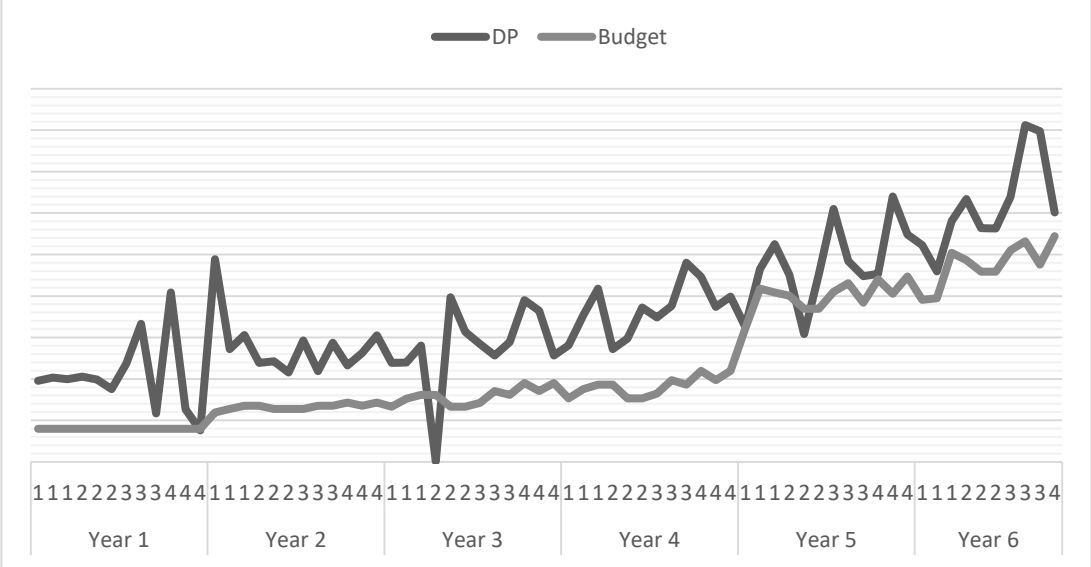


Figure 4-5-Actual sales Vs budgeted sales for Large 10's

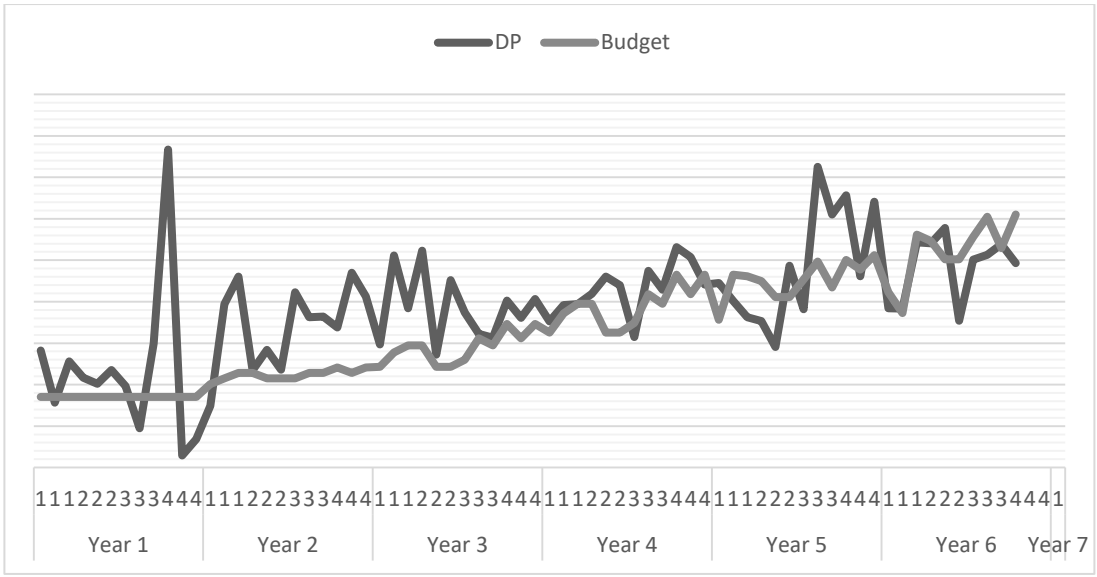


Figure 4-6-Actual sales Vs Budgeted sales for Medium 4's

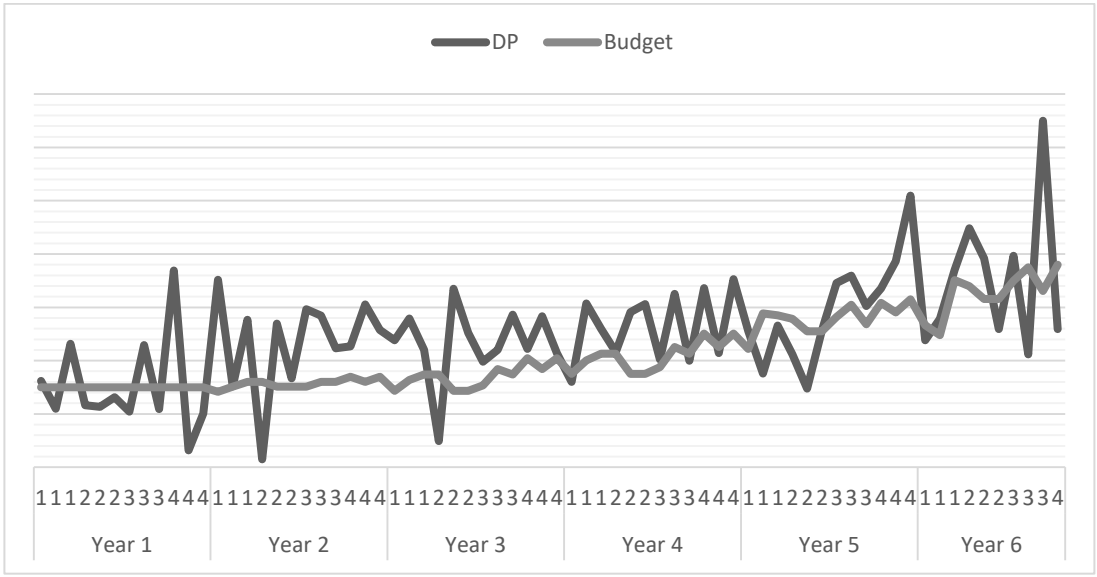


Figure 4-7-Actual sales Vs Budgeted sales for Large 4's

4.4. Pilot Survey

A major role in a research project is played by Pilot study and is conducted to identify potential problem areas and deficiencies in the research instruments and protocols prior to implementation during the full study. Pilot study was done to test research protocols, data collection instruments, sample recruitment strategies, and other research techniques in preparation for a larger study.

After the literature survey, seven factors were identified as critical factors affecting the diaper industry as well as other industries. To verify the seven factors a pilot was being conducted. In this case study, a pilot study was conducted in open forum consisting of different industry segments and also the production and service sector. A Pilot study was carried out in the period of 16th January to 20th January 2019. The pilot study questionnaire was distributed among participants physically and as a soft copy. In the pilot survey 17 participants enrolled and they belong to, hospitality, apparel , banking & financial, FMCG, aviation, tourism, freight forwarding, air express industry, retailing, Sri Lanka Air Force, warehousing, food & beverages, IT industry, retail industry and pharmaceuticals.

The pilot questionnaire consisted of two major parts. Section “A” includes information about organization and section “B” contains seven factors which need to be evaluated. Each factor contains three questions to get better feedback and results of the questionnaire was ranked according to ascending order. As for the results low scored factors are highly effecting to any industry. All collected sample data were entered into a excel worksheet and the factor scores were calculated.

Table 4.3-Results of pilot survey

#	Idntified factors	Relavent question	Individual score	Factor Score	Ranking
B	Using systematic forecasting technique	B1	74%	72%	11
		B2	78%		12
		B3	64%		4
C	Unawareness of importance of forecasting	C1	68%	79%	5
		C2	79%		13
		C3	91%		21
D	Accountability for demand forecasting	D1	81%	78%	16
		D2	73%		9
		D3	80%		15
E	Poor communication among relevant parties when forecast	E1	68%	76%	5
		E2	86%		19
		E3	73%		9
F	Planning done around the goals which do not become reality	F1	87%	80%	20
		F2	82%		18
		F3	69%		7
G	Sales figures did not reflect the actual demand pattern	G1	79%	77%	13
		G2	81%		16
		G3	72%		8
H	Product planning issues	H1	51%	51%	2
		H2	46%		1
		H3	56%		3
		Average	73%		

Results of the pilot survey clearly gave the indication that, all the factors are significant and directly affect accurate forecasting. Among that product planning issues play a significant role in forecasting. Because of significant variations of the pilot survey, all the factors are taken into consideration of the primary survey.

4.5. Primary survey

Based on the pilot survey, all the factors are taken into account and in the primary survey those factors are reflected as evaluated criteria. All the questionnaires were distributed among active participants in the forecasting procedure (Finance, Marketing, Logistics, and Regulatory etc.). Results of the primary questionnaire were evaluated based on positions held and department wise.

4.5.1. Selecting the sample

The judgmental sampling technique was used in this case study because the researcher knows who the parties are directly involving for the forecasting procedure.

4.5.2. Sample size

Before identifying sample size there is need to define the population accurately. Based on the central limit theorem minimum required sample size is 30. But sample size can determine based on below mentioned constraints (funding available, the time constraints etc.) Sample size depends on the below mentioned factors.

- The type of data analysis to be performed
- The intended accuracy of the estimates one aims to achieve
- The kind and number of comparisons that will be made
- The number of variables that have to be examined simultaneously
- How heterogeneous the sampled population is.

In this case study sample population and sample size were approximately the same. Thirty four interviewees participated in this study with different dimensions. Top to bottom who actively participate in forecasting will be interviewed and different departments correspondingly.

Below mentioned data tables shows how different categories of employees give weightage to each factor. Factors are:

- Q1 - Poor prediction reliability effect to demand forecast
- Q2 – Ignorance of importance of forecasting effecting demand forecast.
- Q3 – No one is accountable for demand forecast
- Q4 - Poor communication among relevant parties when forecast will affect the proper forecast.
- Q5 - Planning done around the goals which do not become reality.
- Q6 - Sales figures did not reflect the actual demand pattern.
- Q7 - Product planning issues affect proper sales forecast

Table 4.4-Position wise primary data analysis

Position wise	Q1	Q2	Q3	Q4	Q5	Q6	Q7
General staff	3.38	3.13	3.63	3.75	4.00	3.38	4.63
Executive	3.91	3.55	3.73	3.82	3.18	3.09	3.82
Middle manager	4.00	3.11	3.56	3.11	3.11	3.11	3.44
Senior manager	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Top manager	3.00	3.00	2.00	3.00	3.00	4.00	3.00
	14.28	12.78	12.91	13.68	13.29	13.58	14.89

Based on the employee categorywise result, general staff experiencing Product planning issues and planning done around the goals which do not become reality. As a result sales forecast and actual sales were different. Executives think that, poor prediction reliability, Poor communication among relevant parties when forecasting and Product planning issues will affects proper sales forecast. Middle managers ideology is poor prediction reliability effect to demand forecast. All senior managers are based at the factory and they are not actively participating in forecasting. Top management ideology is sales figures did not reflect the actual demand pattern and it will affect the sales forecast. Overall output of the result would be Poor prediction reliability affect demand forecast.

Table 4.5-Department wise primary data analysis

Department wise	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Marketing	3.87	3.27	3.73	3.47	3.87	3.33	4.20
Finance	3.50	3.63	3.38	3.13	2.38	2.38	3.25
Logistics	4.00	2.75	3.63	4.38	3.75	3.88	4.25
Human Resource	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IT	4.00	3.00	4.00	4.00	4.00	4.00	3.00
Other	3.00	3.00	2.00	3.00	3.00	4.00	3.00
	18.37	15.64	16.73	17.97	16.99	17.58	17.70

When it comes to departmentwise analysis, the marketing department tends to think that because of product planning issues, planning done around the goals which do not become reality have poor prediction reliability affects the demand forecast. When it is compared to finance department, Poor prediction reliability affect demand forecast and unawareness of importance of forecasting affecting demand forecast become critical factors. Logistics department also tends to think of poor prediction reliability, Poor communication among relevant parties when forecasting and product planning issues affect proper sales forecast. Human resource department does not actively participating in product forecasting. IT department thinks of, poor prediction reliability, no one is accountable for demand forecast, Poor communication among relevant parties, Planning done around the goals which do not become reality and Sales figures did not reflect the actual demand pattern which will affect demand forecasting. Other departments think poor communication among relevant parties when forecasting will affect proper forecasting. Overall result for departmentwise factor analysis is poor prediction reliability affects demand forecast.

Based on the results, one can arrive the decision of poor prediction reliability effect on the demand forecast. It clearly shows the facts that position and departmentwise totals 14.28 and 18.37 respectively. While studying past sales patterns developing a better forecasting modal will be a better solution for the current situation.

4.6. Why time series analysis is important

Time series analysis is based on statistical techniques which deal with data of time series and trend analysis. While monitoring individual processes or by tracing corporate business metrics, time series data can arise. When reviewing time series data, it's useful measuring the sequence of non-random orders. Like most other statistical methods, time series also is based on the assumption that successive values in the data file represent consecutive measurements taken at equally spaced time intervals.

The two main goals of time series analysis are:

- To identify the nature of occurrances presented in the sequence of observations
- To forecast variables of time series values.

To achieve both these goals, time series patterns need to be observed and identified. Trend and seasonality are the two basic classes of components of time series patterns. To identify trend component of time series, there is no automatically proven technique.

4.7. Theoretical background

4.7.1. Augmented Dickey Fuller, ADF, Test

In this case study, to identify stationary data of different time series, the Augmented Dickey-Fuller t-statistic Unit Root Tests was used were used. The Augmented Dickey-Fuller (ADF) test has been developed to test univariate time series for the presence of unit roots or non-stationarity.

The following test equation is used when the time series is flat and potentially slow-turning around zero. When the time series is flat it doesn't have a trend

$$\Delta Z_t = \theta Z_{t-1} + \alpha_1 \Delta z_{t-1} + \alpha_2 \Delta z_{t-2} + \cdots + \alpha_p \Delta z_{t-p} + a_t$$

The number of augmenting lags (p) is determined by minimizing the Schwartz Bayesian information criterion or minimizing the Akaike information criteria or lags are dropped until the last lag is statistically significant. EVIEWS allows all of these options for you to choose from. This test equation does not have a time trend. What is wanted to use for the test is the t-statistic associated with the ordinary least squares estimate of θ. , the Dickey-Fuller t-statistic does not follow a standard t-distribution as the sampling distribution of this test statistic is skewed to the left with a long, left-hand-tail. By using EVIEWS we can get a correct critical values for the test.

When the time series is flat and slow-turning around a non-zero value, the following test equation.is used

$$\Delta Z_t = a_0 + \theta Z_{t-1} + \alpha_1 \Delta z_{t-1} + \alpha_2 \Delta z_{t-2} + \cdots + \alpha_p \Delta z_{t-p} + a_t$$

This equation has an intercept term in it but no time trend. The number of augmenting lags (p) is determined by minimizing the Schwartz Bayesian information criteria F or minimizing the Akaike information criterion or lags are dropped until the last lag is

statistically significant. When using EViews, all these options are available to choose from.

When the time series has a trend in it (either up or down) and is potentially slow-turning around a trend line, we use the following test equation:

$$\Delta Z_t = a_0 + \theta Z_{t-1} + \gamma t + \alpha_1 \Delta z_{t-1} + \alpha_2 \Delta z_{t-2} + \cdots + \alpha_p \Delta z_{t-p} + a_t$$

Notice that this equation has an intercept term and a time trend. Again, the number of augmenting lags (p) is determined by minimizing the Schwartz Bayesian information criterion or minimizing the Akaike information criterion or lags are dropped until the last lag is statistically significant. While using EVIEWS all of these options can be tested. Then we use the t-statistic on the θ coefficient to test whether you need to difference the data to make it stationary or we need to put a time trend in our regression model to correct for the variables deterministic trend. Notice of the test is left-tailed.

4.7.2. Algorithm Breakdown: AR, MA and ARIMA models

A common approach to model time series is to regard the label at current time step X_t as a variable dependent on previous time stepsX_{t-k}. We thus analyze the time series on nothing more than the time series. ARIMA models are the most used models when using time series. In this post, we'll explore how these models are defined and we are going to develop such a model in Python with nothing else but the numerical package.

ARIMA models are a combination of two, (or three if taken differencing as a model) processes that are able to generate series data. ARIMA models are based on an Auto Regressive (AR) process and Moving Average process (MA). Both AR and MA processes are stochastic processes. Stochastic means that the values come from a random probability distribution, which can be analyzed statistically but may not be predicted precisely. In other words, both processes have some uncertainty.

Theoretically of ACF and PACF of the First-order Moving Average Model or MA (1)

$$X_t = \mu + \epsilon_t + \sum_{i=1}^{q} \theta_i \epsilon_{t-i}$$

Where θ are the parameters of the process and q is the order of the process. With order we mean how many times steps q we should include in the weighted average.

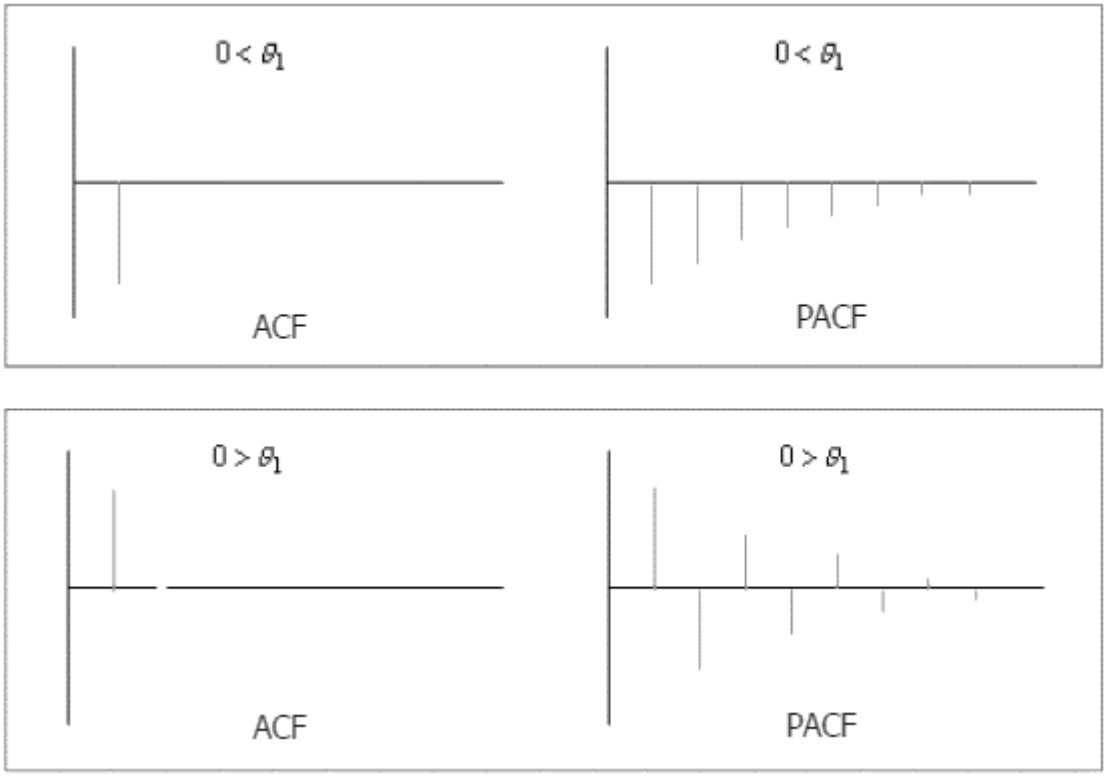


Figure 4-8-First-order Moving Average Model

An MA process can have both positive and negative values for θ. In the plots above it can be seen that when the order of MA(q) increases, the values are longer correlated with previous values. Actually, because the process is a weighted average of the ϵ values until lag q, the correlation drops after this lag. Based on this property we can learn about order of an MA(q) process. This is good because it is very hard to infer the order by looking at the plots directly.

4.7.3. Autocorrelation

When a value X_t is correlated with a previous valueX_{t-k}, this is called autocorrelation. The autocorrelation function is defined as:

$$ACF(X_t, X_{t-k}) = \frac{E[(X_t - \mu_t)(X_{t-k} - \mu_{t-k})]}{\sigma_t \sigma_{t-k}}$$

Numerically we can approximate it by determining the correlation between different arrays, namely X_t and arrayX_{t-k}. By doing so, we do need to truncate both arrays by k elements in order to maintain an equal length.

Theoretically of ACF and PACF of the Second-order Moving Average Model or MA (2)

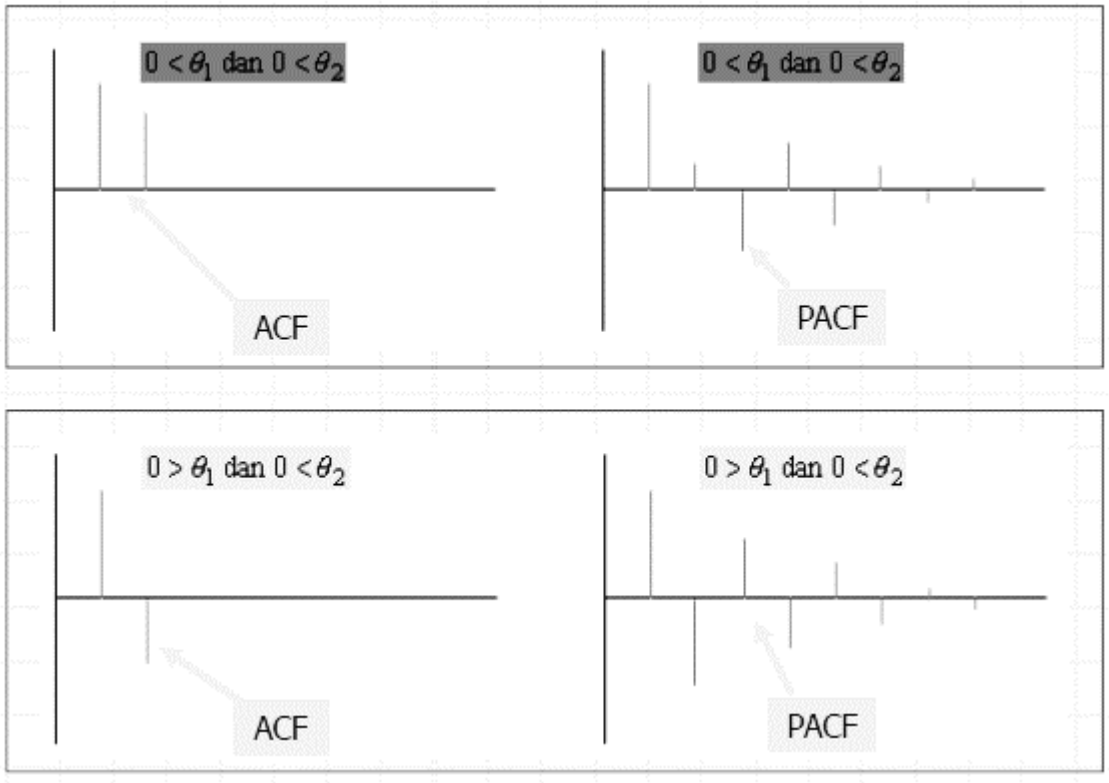


Figure 4-9-Second-order Moving Average Model

Now we are going to simulate another series called the Auto Regressive (AR) process we're inferring the order of the process visually. Simulation is done with Partial Autocorrelation Functions (PACF).

An AR(p) process is defined as:

$$X_t = c + \epsilon_t \sum_{i=1}^{p} \emptyset_i X_{t-i}$$

Now $\emptyset$ are the parameters of the process and p is the order of the process. Where MA(q) is a weighted average over the error terms, AR(p) is a weighted average over the previous values of the series X_{t-p}.

Theoretically ACF and PACF of the First-order Autoregressive Model or AR (1) are shown in the model below.

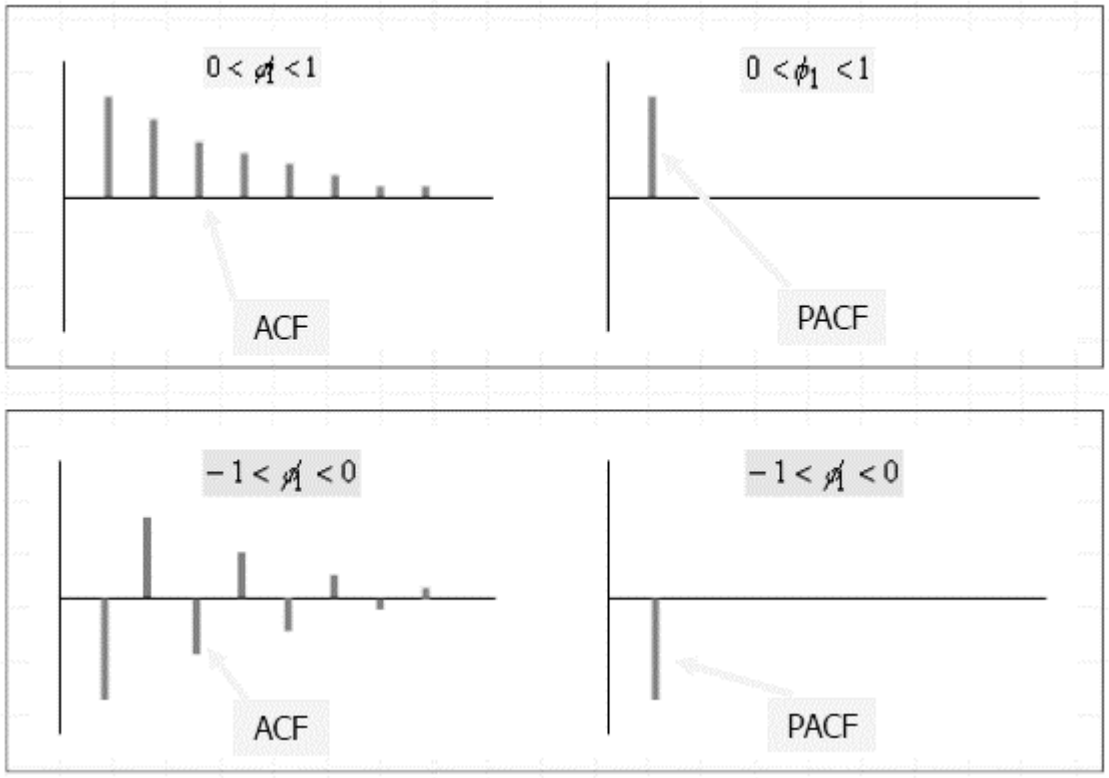


Figure 4-10-First-order Autoregressive Model

Theoretically ACF and PACF of the Second-order Autoregressive Model or AR (2)

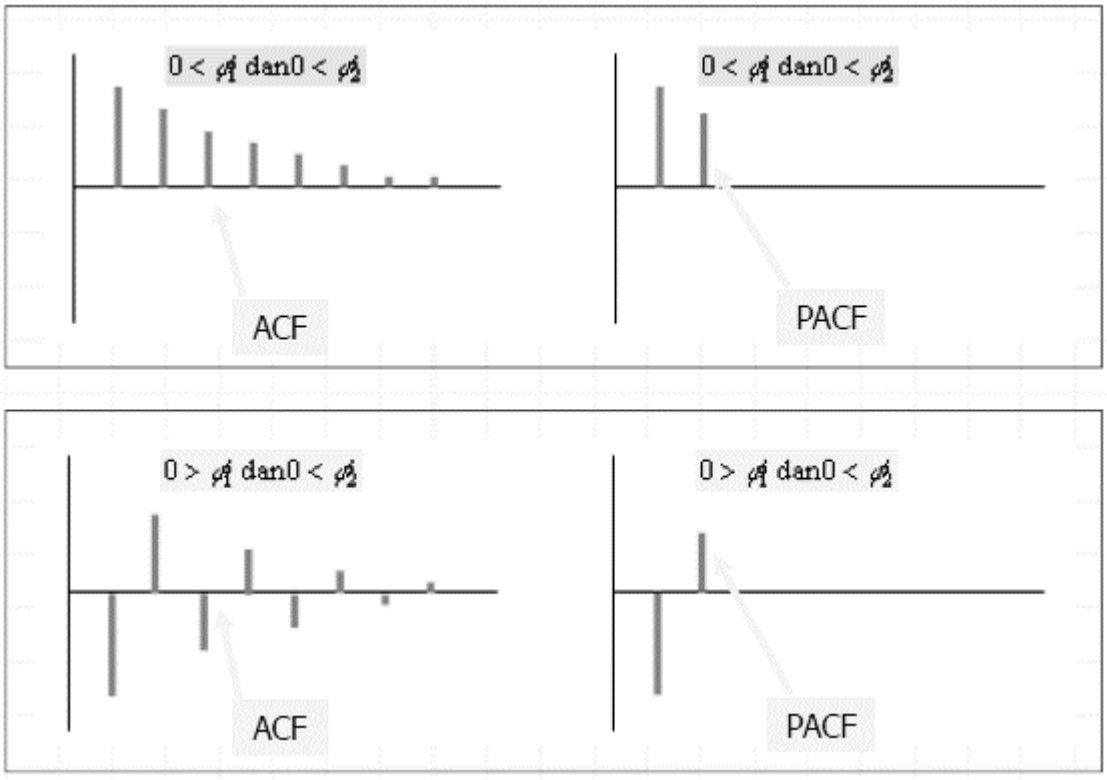


Figure 4-11-Second-order Autoregressive Model

By analyzing these plots, we can identify these AR processes and to which type of AR type for this data set belongs.

4.7.4. Partial Autocorrelation

The partial autocorrelation function shows the autocorrelation of value X_t and X_{t-k} after the correlation between X_t with the intermediate values $X_{t-1} \cdots X_{t-k+1}$ explained. The partial autocorrelation calculation steps

$$PACF(X_t, X_{t-k}) = corr((X_t - \hat{X}_t), (X_{t-k} - \hat{X}_{t-k}))$$

4.8. ARIMA model

An ARMA model requires the data to be stationery, which an ARIMA model is not. A stationery series has a constant mean and a constant variance over time. For the white

noise, AR and MA processes data to be stationery, but for a lot of real-world data this does not. ARIMA models can work with data that aren't stationary,

ARIMA model has hyper parameters p, q and, d which are,

- p is the order of the AR model
- q is the order of the MA model
- d is the differencing orders (how often we difference the data)

ARIMA combination is defined as

$$Y_t = \mu + \emptyset_1 Y_{t-1} + \cdots + \emptyset_p Y_{t-p} + \theta_1 \varepsilon_t + \theta_2 \varepsilon_{t-1} + \cdots + \theta_{q+1} \varepsilon_{t-q}$$

Theoretically ACF and PACF of the Mixed Autoregressive- Moving Average Model or ARMA are shown in the model below.

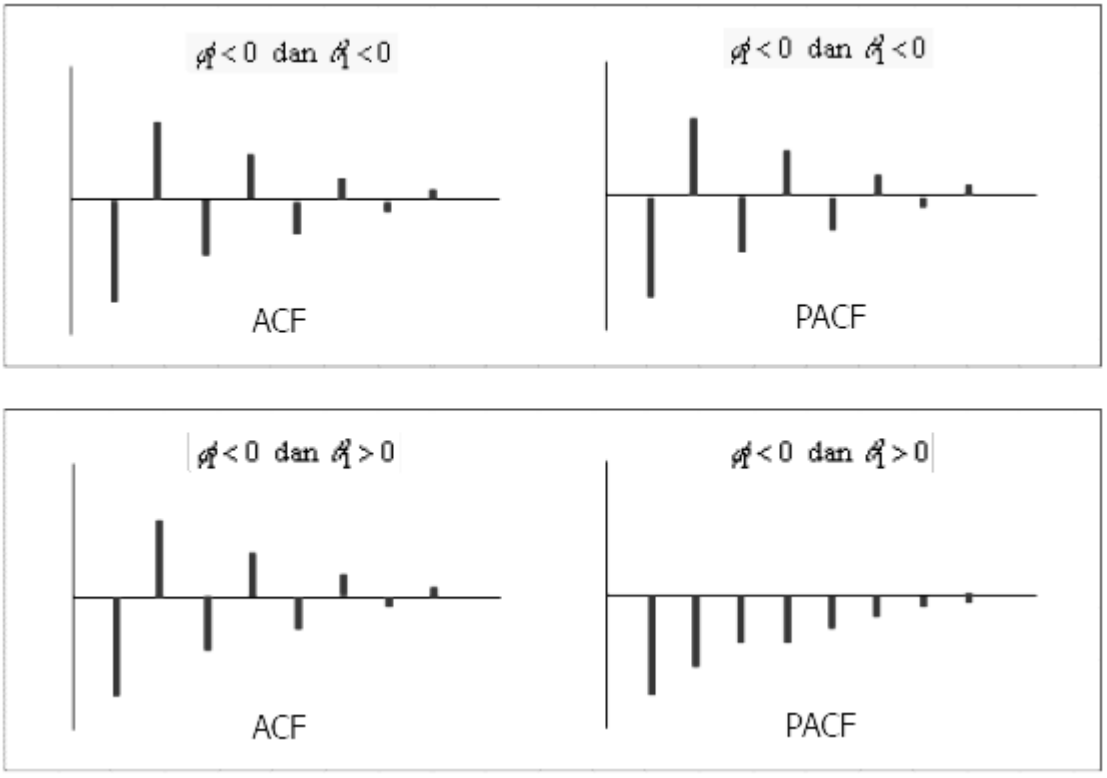


Figure 4-12-ARMA model

4.8.1. R-squared

R-squared (R^2) is a statistical measure.In a regression Model how much variation of a dependent variable is explained by the independent variable is calculated by R-squared. Whereas correlation explains the strength of the relationship between an independent and dependent variable, R-squared explains to what extent the variance of one variable explains the variance of the second variable. So, if the R^2 model is 0.50, then approximately half of the observed variation can be explained by the model's inputs. For the forecasting purposes, R^2 of more than 0.50 is acceptable.

- 0% indicates that the model explains none of the variability of the response data around its mean.
- 100% in dicates that the model explains all the variability of the response data around its mean.

The formula for R-Squared is,

$$R^2 = \frac{N\sum xy - \sum x \sum y}{\sqrt{[N\sum x^2 - (\sum X)^2][N\sum y^2 - (\sum y)^2]}}$$

4.8.2. F-statistic

The F-statistic refers a ratio of two variances. Variances measure how far the data are scattered from the mean. Larger values means greater dispersion. It is commonly used when comparing a set of data that have been fitted to a statistical model, in order to identify the model that best fits the population from which the data were sampled.

$$f = [{s_1}^2/{\sigma_1}^2]/[{s_2}^2/{\sigma_2}^2]$$

Where $\sigma_1$is the standard deviation of population 1, $s_1$is the standard deviation of the sample drawn from population 1, $\sigma_2$is the standard deviation of population 2, and s_1 is the standard deviation of the sample drawn from population 2.

4.8.3. Durbin Watson

The Durbin Watson Test is a measure of autocorrelation (also called serial correlation) in residuals from regression analysis. Autocorrelation is the similarity of a time series over successive time intervals. It can lead to underestimates the standard error and can cause us to think predictors are significant when they are not. The Durbin Watson test looks for a specific type of serial correlation, the AR (1) process.

$$DW = \frac{\sum_{t=2}^{T}(e_t - e_{t-1})^2}{\sum_{t=1}^{T} e_t^2}$$

A rule of thumb is that test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside of this range could be a cause for concern. Suggests that values under 1 or more than 3 are a definite cause for concern.

For the forecasting, each adult diaper segment is analyze through EViews 7.

4.9. Adult Diapers Medium 10's

Table 4.6-Adult Diapers Medium 10's data validation

Null Hypothesis: DP has a unit root

Exogenous: Constant

Lag Length: 5 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.127457	0.9414
Test critical values:	1% level	-3.536587	
	5% level	-2.907660	
	10% level	-2.591396	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DP)

Method: Least Squares

Date: 04/05/19 Time: 15:12

Sample (adjusted): 2013M10 2019M01

Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DP(-1)	-0.012375	0.097092	-0.127457	0.8990
D(DP(-1))	-0.928444	0.155157	-5.983904	0.0000
D(DP(-2))	-0.902798	0.188526	-4.788731	0.0000
D(DP(-3))	-0.736347	0.193760	-3.800307	0.0004
D(DP(-4))	-0.437088	0.176848	-2.471551	0.0165
D(DP(-5))	-0.318400	0.133305	-2.388511	0.0203
C	296.6274	287.9024	1.030306	0.3072

R-squared	0.513032	Mean dependent var	57.40625
Adjusted R-squared	0.461773	S.D. dependent var	984.1502
S.E. of regression	722.0117	Akaike info criterion	16.10488
Sum squared resid	29714154	Schwarz criterion	16.34101
Log likelihood	-508.3561	Hannan-Quinn criter.	16.19790
F-statistic	10.00848	Durbin-Watson stat	2.058299
Prob(F-statistic)	0.000000		

Probability of data validation according to Dickey-Fuller test is 0.9414 which is very high level and it clearly indicates reliability of the data set is at a prominent level. R-squared value is 0.513032 which acceptable level is more than 0.50 and it's also at acceptable level. According to F-statistic, probability is low enough to reject the null hypothesis.

Durbin-Watson stat indicated the value of 2.058299 and it's also between the range of 1.5 to 2.5. According to this data is validated and can derive a formula for Adult Diapers Medium 10's.

Time series model

Original set of sales data consist of a non-stationary data set which cannot forecast directly. To make this data set into stationary, 1st difference was used.

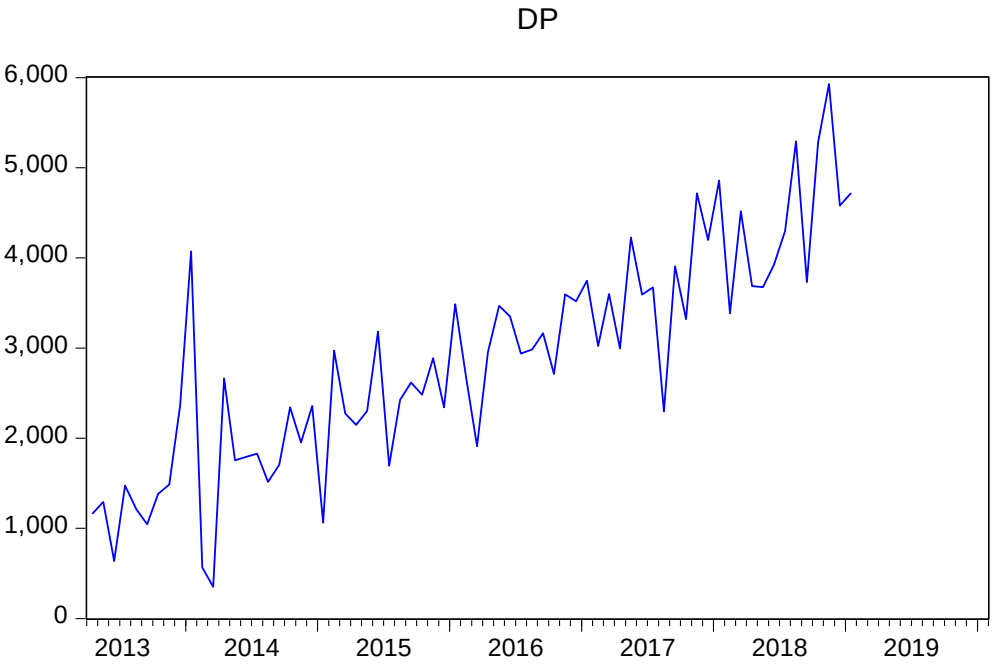
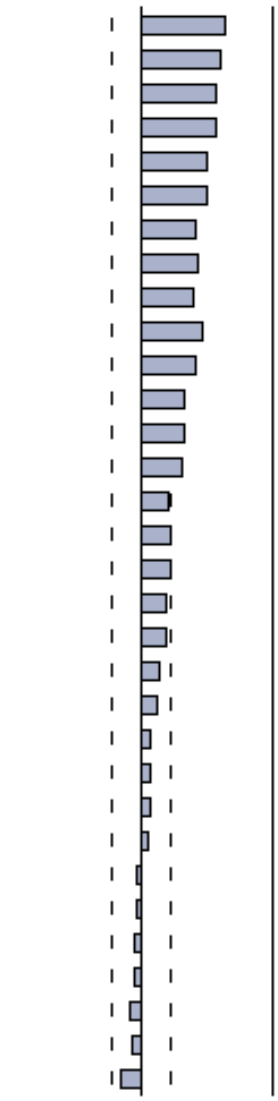


Figure 4-13-Non-stationary data set of adult diapers medium 10's

Date: 04/05/19 Time: 15:19
Sample: 2013M04 2020M01
Included observations: 70



	AC	PAC	Q-Stat	Prob
1	0.670	0.670	32.807	0.000
2	0.639	0.344	63.042	0.000
3	0.596	0.174	89.744	0.000
4	0.586	0.154	115.98	0.000
5	0.521	0.004	136.99	0.000
6	0.518	0.074	158.14	0.000
7	0.442	-0.068	173.74	0.000
8	0.456	0.069	190.62	0.000
9	0.414	0.004	204.82	0.000
10	0.482	0.194	224.34	0.000
11	0.436	0.023	240.55	0.000
12	0.338	-0.205	250.46	0.000
13	0.343	0.006	260.86	0.000
14	0.318	-0.050	269.94	0.000
15	0.218	-0.167	274.30	0.000
16	0.230	0.023	279.22	0.000
17	0.235	0.113	284.47	0.000
18	0.192	-0.015	288.03	0.000
19	0.191	0.023	291.65	0.000
20	0.135	-0.126	293.50	0.000
21	0.120	-0.085	294.99	0.000
22	0.075	-0.049	295.58	0.000
23	0.067	0.014	296.05	0.000
24	0.071	0.064	296.60	0.000
25	0.048	0.087	296.86	0.000
26	-0.033	-0.099	296.98	0.000
27	-0.025	-0.131	297.06	0.000
28	-0.056	-0.066	297.44	0.000
29	-0.050	0.013	297.75	0.000
30	-0.082	-0.018	298.60	0.000
31	-0.072	0.125	299.27	0.000
32	-0.161	-0.099	302.70	0.000

Figure 4-14- Correlogram Chart for adult diapers medium 10's data

1st difference use to convert data set into stationary data set.

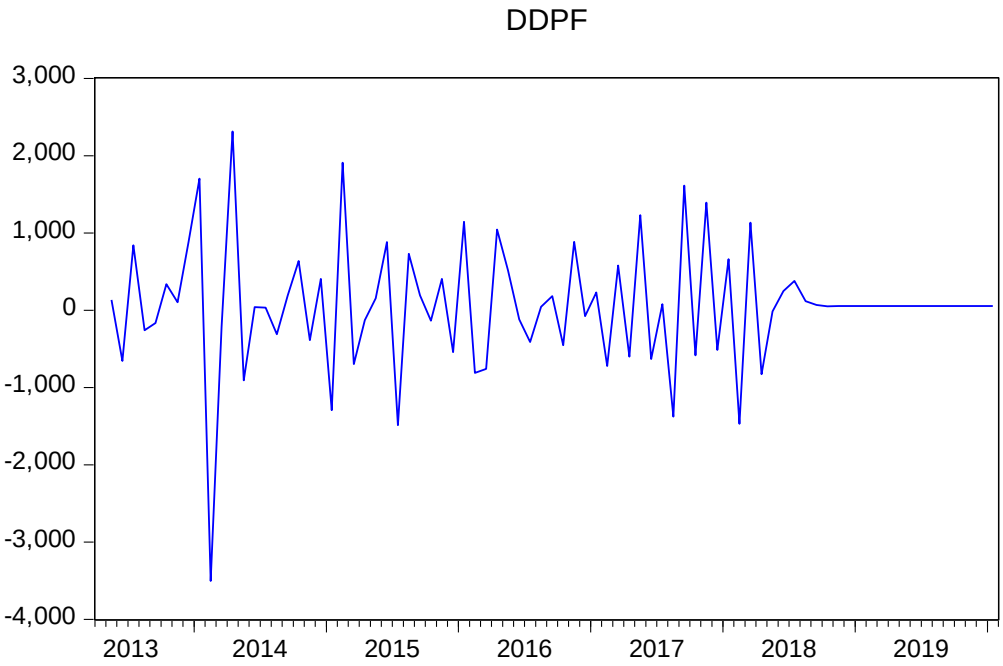
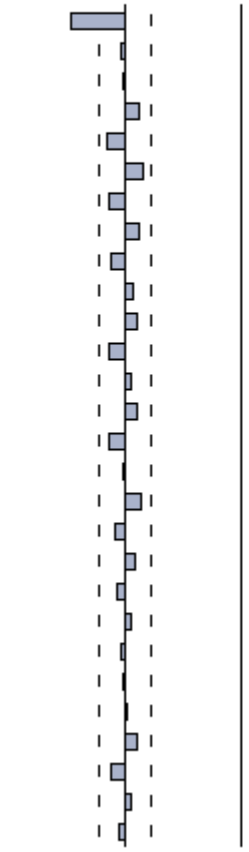


Figure 4-15-1st difference data set of adult diapers medium 10's

Date: 04/27/19 Time: 13:16
Sample: 2013M04 2020M01
Included observations: 69



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.495	-0.495	17.629	0.000
		2	-0.043	-0.381	17.766	0.000
		3	-0.017	-0.364	17.787	0.000
		4	0.130	-0.162	19.065	0.001
		5	-0.161	-0.294	21.042	0.001
		6	0.160	-0.100	23.043	0.001
		7	-0.140	-0.217	24.596	0.001
		8	0.123	-0.083	25.809	0.001
		9	-0.136	-0.212	27.316	0.001
		10	0.066	-0.272	27.679	0.002
		11	0.111	-0.019	28.722	0.003
		12	-0.156	-0.198	30.805	0.002
		13	0.044	-0.108	30.972	0.003
		14	0.107	0.047	31.990	0.004
		15	-0.146	-0.030	33.924	0.003
		16	-0.018	-0.115	33.954	0.006
		17	0.133	-0.055	35.631	0.005
		18	-0.098	-0.119	36.546	0.006
		19	0.083	-0.006	37.219	0.007
		20	-0.078	-0.023	37.828	0.009
		21	0.048	0.018	38.066	0.013
		22	-0.029	0.001	38.151	0.018
		23	-0.024	-0.081	38.214	0.024
		24	0.018	-0.130	38.250	0.033
		25	0.105	-0.049	39.484	0.033
		26	-0.127	0.023	41.326	0.029
		27	0.048	0.049	41.599	0.036
		28	-0.058	-0.069	41.995	0.043

Figure 4-16-1st Difference correlogram Chart for medium 10's data

With the observation of autocorrelation and partial correlation graph, this can be identified as ARIMA (0,1,1) model time series.

While using EViews 7, equation for adult diapers medium 10's has been developed.

Table 4.7-Estimated equation for medium 10's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 13:09

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 15 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	52.52656	3.864730	13.59126	0.0000
MA(1)	-0.999983	0.000138	-7249.360	0.0000

R-squared	0.561827	Mean dependent var	51.56522
Adjusted R-squared	0.555287	S.D. dependent var	957.1299
S.E. of regression	638.2791	Akaike info criterion	15.78399
Sum squared resid	27295811	Schwarz criterion	15.84874
Log likelihood	-542.5475	Hannan-Quinn criter.	15.80968
F-statistic	85.90774	Durbin-Watson stat	2.282009
Prob(F-statistic)	0.000000		

Inverted MA Roots	1.00

Probability of constant variable is in an acceptable level and R-squared value is also at acceptable level and it's around 0.561827. F-statistic is also at acceptable level and Durbin-Watson stat between the ranges of 1.5 to 2.5. Based on these figures this will be better formulated to follow adult diapers medium 10's. Based on the correlogram it can

develop a few other formulae but practically this formula is suitable compared to others. Akaike info criterion value also is lower compared to other developed formulae.

4.10. Adult Diapers Large 10's

Table 4.8-Adult Diapers Large 10's data validation

Null Hypothesis: DP has a unit root

Exogenous: Constant

Lag Length: 4 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.559150	0.9993
Test critical values:	1% level	-3.534868	
	5% level	-2.906923	
	10% level	-2.591006	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DP)

Method: Least Squares

Date: 04/05/19 Time: 15:49

Sample (adjusted): 2013M09 2019M01

Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DP(-1)	0.146611	0.094033	1.559150	0.1243
D(DP(-1))	-1.130627	0.156784	-7.211362	0.0000
D(DP(-2))	-1.151899	0.175847	-6.550589	0.0000

D(DP(-3))	-0.832918	0.165985	-5.018030	0.0000
D(DP(-4))	-0.497035	0.126292	-3.935593	0.0002
C	-92.42401	171.1404	-0.540048	0.5912

R-squared	0.563489	Mean dependent var	31.03077
Adjusted R-squared	0.526497	S.D. dependent var	644.3353
S.E. of regression	443.3771	Akaike info criterion	15.11448
Sum squared resid	11598412	Schwarz criterion	15.31520
Log likelihood	-485.2207	Hannan-Quinn criter.	15.19368
F-statistic	15.23257	Durbin-Watson stat	2.171921
Prob(F-statistic)	0.000000		

Probability of data validation according to Dickey-Fuller test is 0.9993 which is a very high level and it's clearly indicates reliability of the data set is at a prominent level. R-squared value is 0.563489 which is an acceptable level is more than 0.50 and it's also at acceptable level. According to F-statistic, probability is low enough to reject the null hypothesis. Durbin-Watson stat indicated the value of 2.171921 and it's also between the range of 1.5 to 2.5. This data is validated and can derive a formula to Adult Diapers Large 10's.

Time series model

According to the pattern of the data it can be identified as non-stationary.

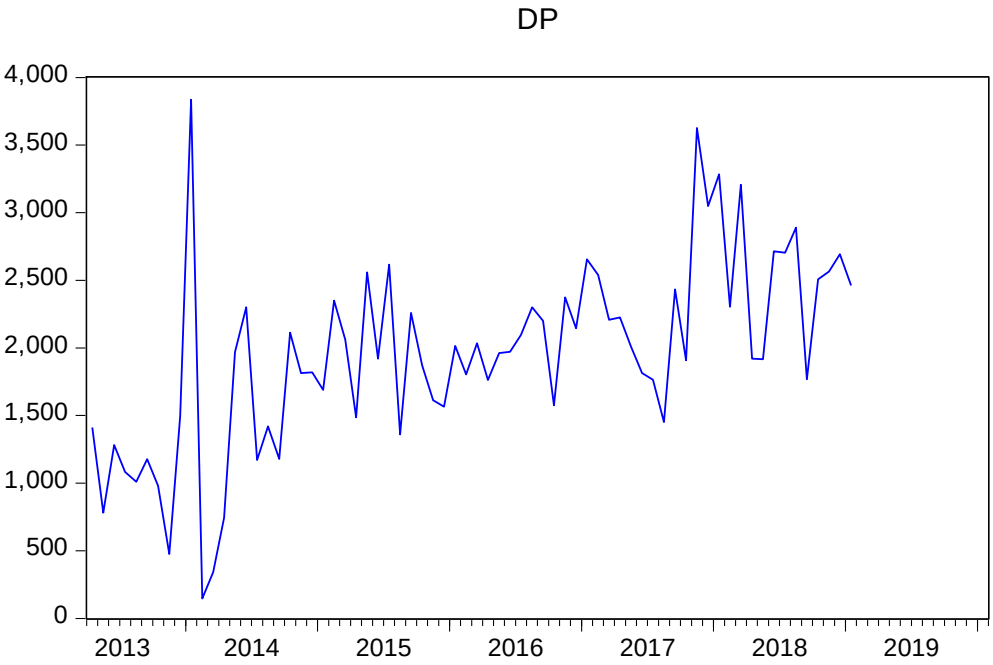
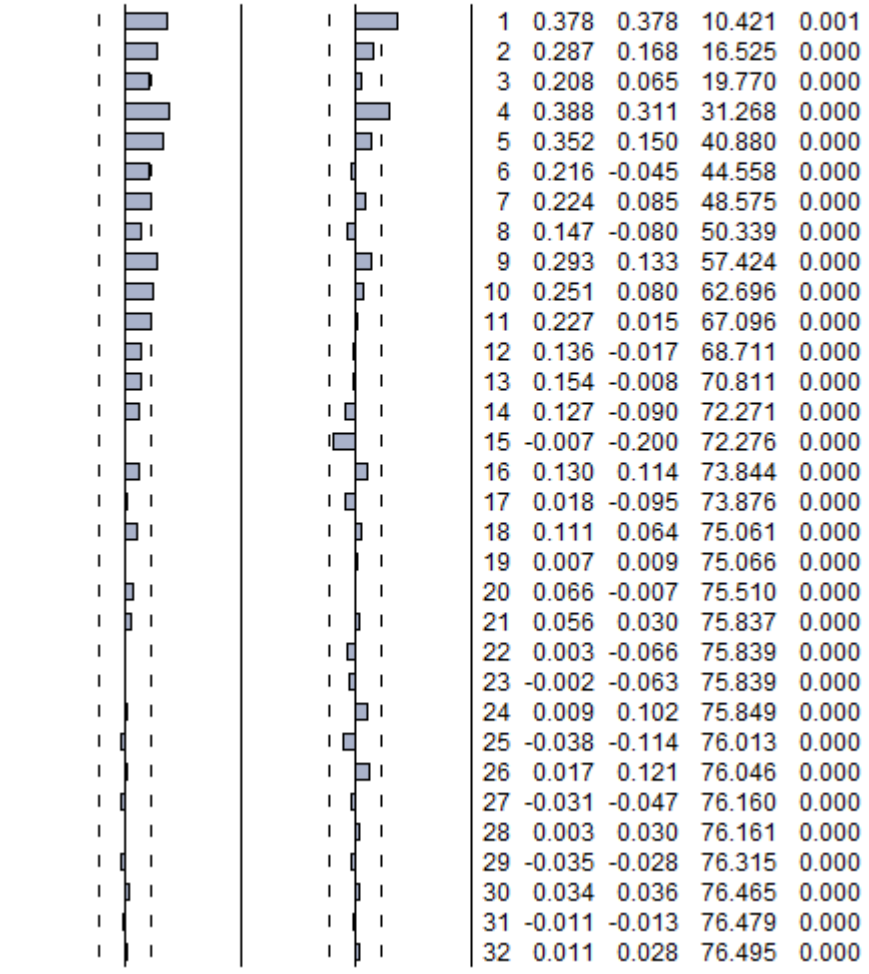


Figure 4-17-Non-stationary data set of adult diapers large 10's

Date: 04/28/19 Time: 11:12
Sample: 2013M04 2020M01
Included observations: 70



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.378	0.378	10.421	0.001
		2	0.287	0.168	16.525	0.000
		3	0.208	0.065	19.770	0.000
		4	0.388	0.311	31.268	0.000
		5	0.352	0.150	40.880	0.000
		6	0.216	-0.045	44.558	0.000
		7	0.224	0.085	48.575	0.000
		8	0.147	-0.080	50.339	0.000
		9	0.293	0.133	57.424	0.000
		10	0.251	0.080	62.696	0.000
		11	0.227	0.015	67.096	0.000
		12	0.136	-0.017	68.711	0.000
		13	0.154	-0.008	70.811	0.000
		14	0.127	-0.090	72.271	0.000
		15	-0.007	-0.200	72.276	0.000
		16	0.130	0.114	73.844	0.000
		17	0.018	-0.095	73.876	0.000
		18	0.111	0.064	75.061	0.000
		19	0.007	0.009	75.066	0.000
		20	0.066	-0.007	75.510	0.000
		21	0.056	0.030	75.837	0.000
		22	0.003	-0.066	75.839	0.000
		23	-0.002	-0.063	75.839	0.000
		24	0.009	0.102	75.849	0.000
		25	-0.038	-0.114	76.013	0.000
		26	0.017	0.121	76.046	0.000
		27	-0.031	-0.047	76.160	0.000
		28	0.003	0.030	76.161	0.000
		29	-0.035	-0.028	76.315	0.000
		30	0.034	0.036	76.465	0.000
		31	-0.011	-0.013	76.479	0.000
		32	0.011	0.028	76.495	0.000

Figure 4-18-Correlogram Chart for adult diapers large 10's data

To make this data set into stationary, 1st difference was used. With the observation of autocorrelation and partial correlation graph, this can identified as ARIMA (0,1,1) model

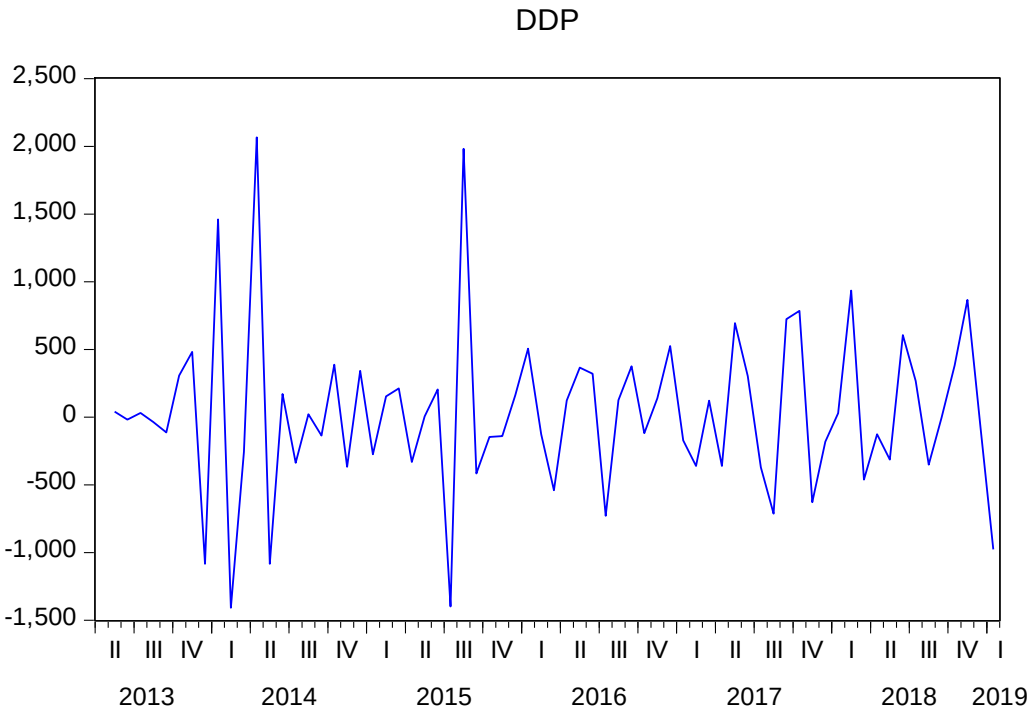
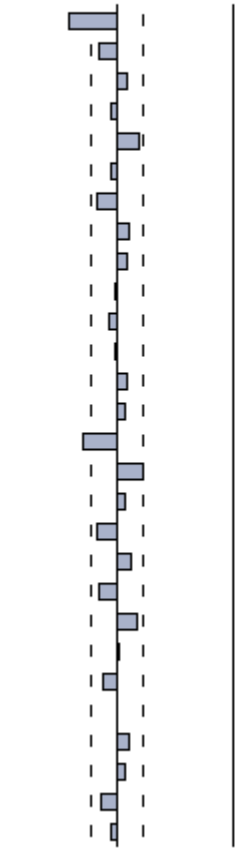


Figure 4-19-1st difference data set of adult diapers large 10's

Date: 04/28/19 Time: 09:52
Sample: 2013M04 2019M01
Included observations: 69



		AC	PAC	Q-Stat	Prob
1		-0.437	-0.437	13.780	0.000
2		-0.160	-0.435	15.657	0.000
3		0.084	-0.314	16.185	0.001
4		-0.053	-0.384	16.394	0.003
5		0.191	-0.094	19.175	0.002
6		-0.059	0.020	19.445	0.003
7		-0.187	-0.132	22.198	0.002
8		0.100	-0.146	22.998	0.003
9		0.089	-0.050	23.650	0.005
10		-0.018	0.005	23.679	0.009
11		-0.080	-0.053	24.224	0.012
12		-0.013	-0.048	24.239	0.019
13		0.091	0.036	24.961	0.023
14		0.081	0.203	25.551	0.030
15		-0.309	-0.216	34.216	0.003
16		0.230	0.002	39.127	0.001
17		0.070	0.177	39.586	0.001
18		-0.188	-0.027	42.989	0.001
19		0.115	-0.003	44.284	0.001
20		-0.160	-0.128	46.846	0.001
21		0.183	0.063	50.274	0.000
22		0.011	-0.070	50.287	0.001
23		-0.135	-0.065	52.226	0.000
24		-0.002	-0.067	52.226	0.001
25		0.104	0.063	53.439	0.001
26		0.067	0.131	53.944	0.001
27		-0.140	0.006	56.218	0.001
28		-0.055	0.004	56.584	0.001

Figure 4-20-1st difference correlogram chart for adult diapers large 10's data

While using EViews, equation for adult diapers large 10's has being developed.

Table 4.9-Estimated equation for adult diapers large 10's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 10:02

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 20 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	34.46910	8.917153	3.865483	0.0003
MA(1)	-0.858980	0.070705	-12.14877	0.0000

R-squared	0.467012	Mean dependent var	29.44928
Adjusted R-squared	0.459057	S.D. dependent var	625.1783
S.E. of regression	459.8115	Akaike info criterion	15.12807
Sum squared resid	14165583	Schwarz criterion	15.19282
Log likelihood	-519.9183	Hannan-Quinn criter.	15.15376
F-statistic	58.70630	Durbin-Watson stat	2.160416
Prob(F-statistic)	0.000000		

Inverted MA Roots	.86

Probability of constant variable is in at acceptable level and it's around 0.3693. R-squared value also at acceptable level and it's around 0.467012. F-statistic and Durbin-Watson stat are at acceptable levels. Depending on the preference of the forecaster these figures can be changed. Based on these figures this will be a better formula to follow for adult diapers Large 10's.

4.11. Adult Diapers Medium 4's

Table 4.10-Adult Diapers medium 4's data validation

Null Hypothesis: DP has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.485395	0.0000
Test critical values:	1% level	-3.528515	
	5% level	-2.904198	
	10% level	-2.589562	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DP)

Method: Least Squares

Date: 04/09/19 Time: 08:50

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DP(-1)	-0.619340	0.112907	-5.485395	0.0000
C	1220.639	234.0510	5.215269	0.0000

R-squared	0.309916	Mean dependent var	15.23188
Adjusted R-squared	0.299616	S.D. dependent var	799.6420
S.E. of regression	669.2121	Akaike info criterion	15.87864
Sum squared resid	30005603	Schwarz criterion	15.94339
Log likelihood	-545.8130	Hannan-Quinn criter.	15.90433

F-statistic	30.08956	Durbin-Watson stat	2.135135
Prob(F-statistic)	0.000001		

Original set of sales data consist of a non-stationery data set which cannot forecast directly. To make this data set into stationary, 1st difference was used.

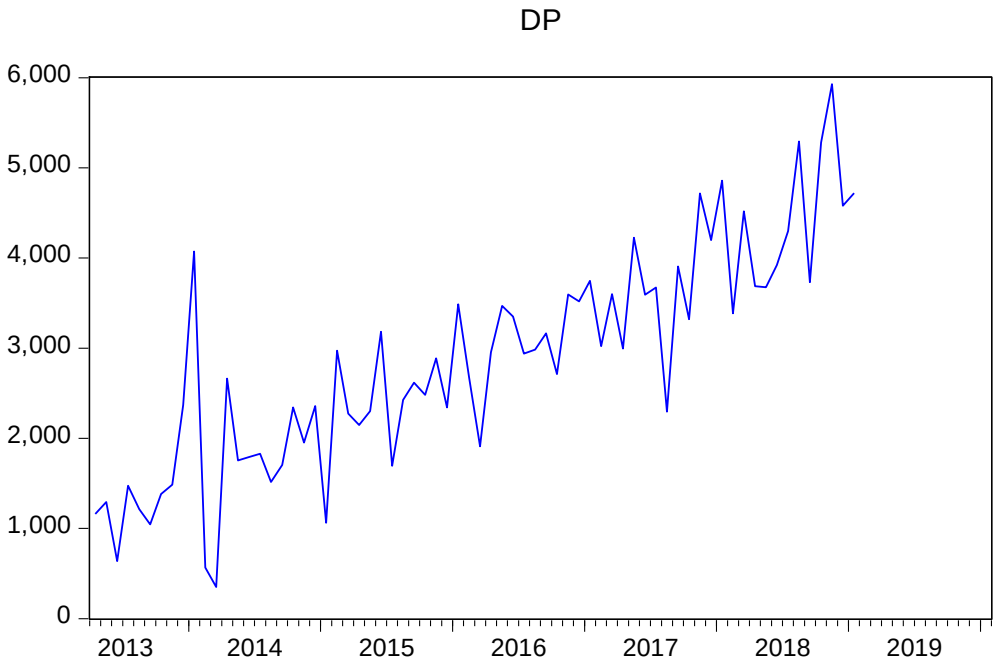
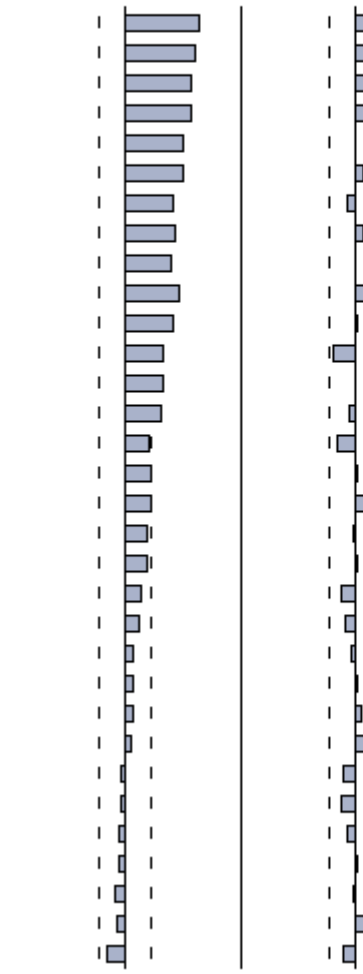


Figure 4-21-Non-stationary sales data for adult diapers medium 4's

Date: 04/28/19 Time: 10:24
Sample: 2013M04 2020M01
Included observations: 70



	AC	PAC	Q-Stat	Prob
1	0.670	0.670	32.807	0.000
2	0.639	0.344	63.042	0.000
3	0.596	0.174	89.744	0.000
4	0.586	0.154	115.98	0.000
5	0.521	0.004	136.99	0.000
6	0.518	0.074	158.14	0.000
7	0.442	-0.068	173.74	0.000
8	0.456	0.069	190.62	0.000
9	0.414	0.004	204.82	0.000
10	0.482	0.194	224.34	0.000
11	0.436	0.023	240.55	0.000
12	0.338	-0.205	250.46	0.000
13	0.343	0.006	260.86	0.000
14	0.318	-0.050	269.94	0.000
15	0.218	-0.167	274.30	0.000
16	0.230	0.023	279.22	0.000
17	0.235	0.113	284.47	0.000
18	0.192	-0.015	288.03	0.000
19	0.191	0.023	291.65	0.000
20	0.135	-0.126	293.50	0.000
21	0.120	-0.085	294.99	0.000
22	0.075	-0.049	295.58	0.000
23	0.067	0.014	296.05	0.000
24	0.071	0.064	296.60	0.000
25	0.048	0.087	296.86	0.000
26	-0.033	-0.099	296.98	0.000
27	-0.025	-0.131	297.06	0.000
28	-0.056	-0.066	297.44	0.000
29	-0.050	0.013	297.75	0.000
30	-0.082	-0.018	298.60	0.000
31	-0.072	0.125	299.27	0.000
32	-0.161	-0.099	302.70	0.000

Figure 4-22-Correlogram Chart for adult diapers medium 4's data

Time series model

1st difference data set was used to identify the model of the data set.

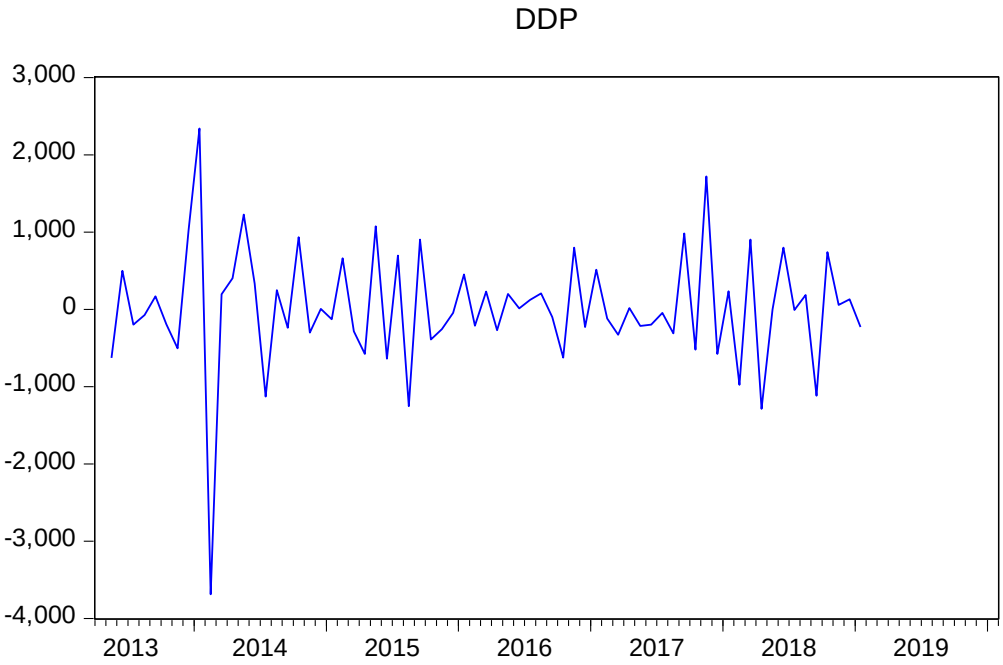
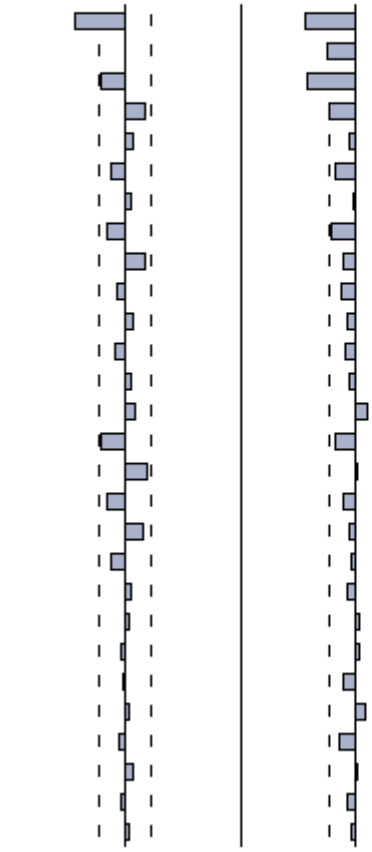


Figure 4-23-1st difference data set of adult diapers medium 4's

Date: 04/28/19 Time: 17:32
Sample: 2013M04 2020M01
Included observations: 69



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.444	-0.444	14.196	0.000
		2	-0.002	-0.248	14.196	0.001
		3	-0.214	-0.431	17.585	0.001
		4	0.184	-0.245	20.124	0.000
		5	0.070	-0.050	20.497	0.001
		6	-0.118	-0.179	21.581	0.001
		7	0.062	-0.024	21.883	0.003
		8	-0.159	-0.213	23.916	0.002
		9	0.183	-0.111	26.639	0.002
		10	-0.077	-0.115	27.136	0.002
		11	0.067	-0.079	27.514	0.004
		12	-0.096	-0.097	28.300	0.005
		13	0.054	-0.050	28.554	0.008
		14	0.085	0.103	29.191	0.010
		15	-0.215	-0.184	33.390	0.004
		16	0.198	0.020	37.032	0.002
		17	-0.157	-0.099	39.365	0.002
		18	0.167	-0.052	42.046	0.001
		19	-0.136	-0.034	43.870	0.001
		20	0.054	-0.077	44.157	0.001
		21	0.031	0.036	44.254	0.002
		22	-0.031	0.032	44.352	0.003
		23	-0.022	-0.110	44.401	0.005
		24	0.039	0.095	44.568	0.007
		25	-0.064	-0.147	45.030	0.008
		26	0.073	0.023	45.638	0.010
		27	-0.049	-0.069	45.913	0.013
		28	0.035	-0.027	46.062	0.017

Figure 4-24-1st difference correlogram chart for adult diapers medium 4's data

With the observation of autocorrelation and partial correlation graph, this can be identified as ARIMA (0,1,1) model

While using EViews 7, equation for adult diapers medium 4's has being developed.

Table 4.11-Estimated equation for medium 4's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 11:08

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 18 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.56961	3.617995	5.961757	0.0000
MA(1)	-0.982402	0.017767	-55.29329	0.0000

R-squared	0.487043	Mean dependent var	15.23188
Adjusted R-squared	0.479387	S.D. dependent var	799.6420
S.E. of regression	576.9699	Akaike info criterion	15.58201
Sum squared resid	22303916	Schwarz criterion	15.64677
Log likelihood	-535.5795	Hannan-Quinn criter.	15.60771
F-statistic	63.61522	Durbin-Watson stat	1.964861
Prob(F-statistic)	0.000000		

Inverted MA Roots	.98

4.12. Adult Diapers Large 4's

Table 4.12-Adult Diapers large 4's data validation

Null Hypothesis: DP has a unit root

Exogenous: Constant

Lag Length: 4 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.053215	0.7291
Test critical values:	1% level	-3.534868	
	5% level	-2.906923	
	10% level	-2.591006	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DP)

Method: Least Squares

Date: 04/09/19 Time: 10:53

Sample (adjusted): 2013M09 2019M01

Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DP(-1)	-0.191443	0.181770	-1.053215	0.2965
D(DP(-1))	-1.006815	0.198839	-5.063464	0.0000
D(DP(-2))	-0.829852	0.208196	-3.985915	0.0002
D(DP(-3))	-0.694255	0.187501	-3.702674	0.0005
D(DP(-4))	-0.377617	0.134590	-2.805682	0.0068
C	316.4980	233.4475	1.355757	0.1803
R-squared	0.641798	Mean dependent var		11.18462

Adjusted R-squared	0.611442	S.D. dependent var	729.4106
S.E. of regression	454.6739	Akaike info criterion	15.16480
Sum squared resid	12196975	Schwarz criterion	15.36552
Log likelihood	-486.8561	Hannan-Quinn criter.	15.24400
F-statistic	21.14231	Durbin-Watson stat	2.054100
Prob(F-statistic)	0.000000		

Probability of data validation according to Dickey-Fuller test is 0.7291 which is at an acceptable level and it clearly indicates reliability of the data set is at a prominent level. R-squared value is 0.641798 which is at acceptable level is more than 0.50 and it's also at acceptable level. According to the F-statistic, probability is low enough to reject the null hypothesis. Durbin-Watson stat indicated a value of 2.054100 and it's also between the range of 1.5 to 2.5. The Akaike info criterion value was also lower compared to other developed formulae. Accordingly this data is validated and we can derive a formula for Adult Diapers Large 10's.

Time series model

According to the pattern of the data, this can be identified as non-stationery.

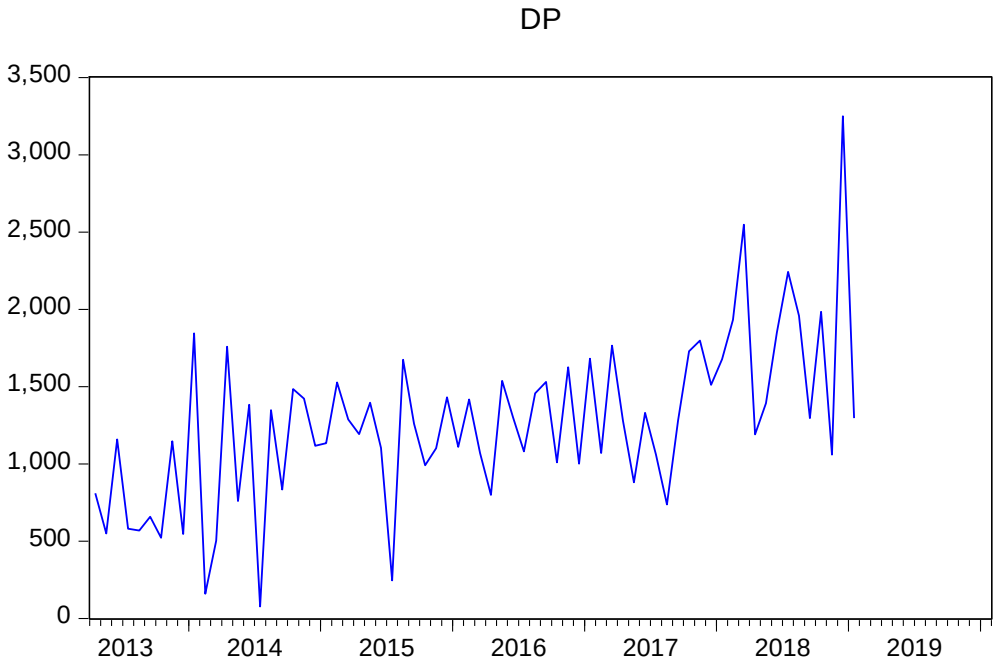


Figure 4-25-Non-stationery sales data for adult diapers large 4's

Date: 04/28/19 Time: 15:17
Sample: 2013M04 2020M01
Included observations: 70

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.115	0.115	0.9669	0.325
		2	0.329	0.320	8.9741	0.011
		3	0.237	0.197	13.205	0.004
		4	0.319	0.226	20.980	0.000
		5	0.338	0.250	29.842	0.000
		6	0.147	-0.028	31.551	0.000
		7	0.209	-0.031	35.050	0.000
		8	0.017	-0.224	35.074	0.000
		9	0.282	0.082	41.626	0.000
		10	0.194	0.163	44.779	0.000
		11	0.062	-0.036	45.106	0.000
		12	0.128	0.028	46.527	0.000
		13	0.056	-0.033	46.802	0.000
		14	0.081	-0.145	47.391	0.000
		15	0.009	-0.123	47.398	0.000
		16	0.074	0.019	47.907	0.000
		17	0.007	0.074	47.912	0.000
		18	-0.029	0.009	47.991	0.000
		19	0.051	0.028	48.252	0.000
		20	-0.017	0.007	48.280	0.000
		21	0.118	0.121	49.720	0.000
		22	0.015	0.026	49.744	0.001
		23	0.081	0.070	50.441	0.001
		24	-0.056	-0.090	50.784	0.001
		25	0.132	0.060	52.738	0.001
		26	0.010	-0.083	52.750	0.001
		27	-0.007	-0.081	52.756	0.002
		28	-0.052	-0.119	53.081	0.003
		29	0.017	0.049	53.116	0.004
		30	-0.080	-0.139	53.913	0.005
		31	0.055	0.099	54.303	0.006
		32	-0.134	-0.144	56.694	0.005

Figure 4-26-Correlogram Chart for adult diapers large 4's data

1st difference had use to make data stationary. With the observation of autocorrelation and partial correlation graph, this can identify as ARIMA (0,1,0) model

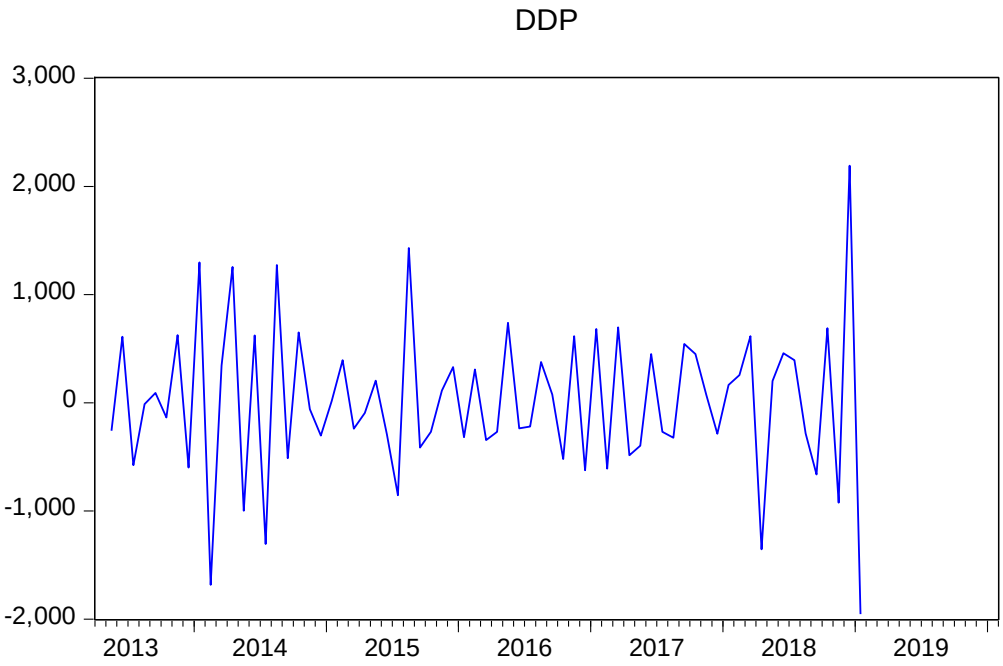
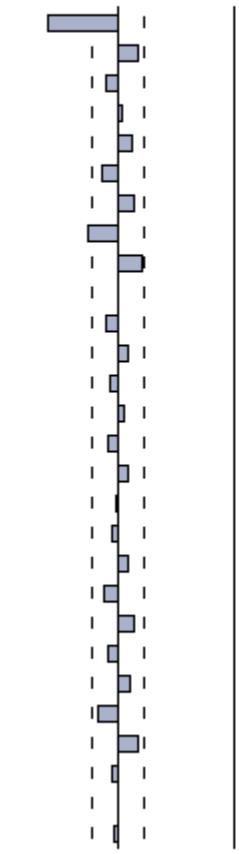


Figure 4-27-1st difference data set of adult diapers large 4's

Date: 04/28/19 Time: 15:29
Sample: 2013M04 2020M01
Included observations: 69



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.630	-0.630	28.617	0.000
		2	0.183	-0.355	31.079	0.000
		3	-0.107	-0.330	31.933	0.000
		4	0.036	-0.339	32.031	0.000
		5	0.119	-0.062	33.123	0.000
		6	-0.146	-0.055	34.780	0.000
		7	0.153	0.161	36.622	0.000
		8	-0.267	-0.138	42.350	0.000
		9	0.217	-0.190	46.212	0.000
		10	0.001	-0.000	46.212	0.000
		11	-0.108	-0.098	47.192	0.000
		12	0.095	-0.022	47.968	0.000
		13	-0.068	0.101	48.376	0.000
		14	0.063	0.091	48.730	0.000
		15	-0.095	-0.059	49.552	0.000
		16	0.092	-0.116	50.330	0.000
		17	-0.024	-0.050	50.382	0.000
		18	-0.058	-0.076	50.701	0.000
		19	0.083	-0.053	51.376	0.000
		20	-0.119	-0.135	52.787	0.000
		21	0.135	-0.052	54.649	0.000
		22	-0.091	-0.102	55.517	0.000
		23	0.112	0.050	56.862	0.000
		24	-0.186	-0.103	60.647	0.000
		25	0.179	0.048	64.231	0.000
		26	-0.064	0.064	64.695	0.000
		27	0.005	0.087	64.698	0.000
		28	-0.047	-0.074	64.958	0.000

Figure 4-28-1st difference correlogram chart for adult diapers large 4's data

While using EViews 7, quation for adult diapers large 4's has being developed.

Table 4.13- Estimated equation for large 4's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 15:50

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 14 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.21524	3.191501	4.767424	0.0000
MA(1)	-0.971177	0.018506	-52.48028	0.0000

R-squared	0.605920	Mean dependent var	7.043478
Adjusted R-squared	0.600038	S.D. dependent var	715.6531
S.E. of regression	452.5970	Akaike info criterion	15.09644
Sum squared resid	13724552	Schwarz criterion	15.16120
Log likelihood	-518.8271	Hannan-Quinn criter.	15.12213
F-statistic	103.0163	Durbin-Watson stat	2.606193
Prob(F-statistic)	0.000000		

Inverted MA Roots	.97

Probability of constant variable is at an acceptable level and it's around 0.3869. R-squared value also at a higher level and it's around 0.868977. F-statistic also at acceptable level and Durbin-Watson stat is a little bit higher and it's around 2.686447. Depending on the preference of the forecast these figures can change. Based on these figures this will be a better formula to follow for adult diapers Large 4's.

5. RESEARCH FINDINGS

5.1. Introduction

As per the analysis results the organization does not carry out any prediction or forecasting models and there is no mechanism for producing a trading system. This section discussed an extension of the ARMA model, namely the Autoregressive Integrated Moving Average model - ARIMA model. Using this model we tried to develop a formula to each diapers segment. In sectioning five past data for the last six years was analyzed and based on the results formulae were derived. As per the analysis, data model mixed with AR and MA models caused to develop autoregressive integrated moving average- ARIMA forecasting model.

5.2. Findings- Model developed

To develop ARIMA forecasting model six years of past data had been formulated through EViews 7 and those data stated below. Data from this table had been taken into consideration when developing ARIMA model. In this study adult diapers for medium 10's segment, short term difference were used.

5.2.1. Forecasting model development for adult diapers medium 10's

Table 5.1-Estimated equation for medium 10's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 13:09

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 15 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	52.52656	3.864730	13.59126	0.0000
MA(1)	-0.999983	0.000138	-7249.360	0.0000

R-squared	0.561827	Mean dependent var	51.56522
Adjusted R-squared	0.555287	S.D. dependent var	957.1299
S.E. of regression	638.2791	Akaike info criterion	15.78399
Sum squared resid	27295811	Schwarz criterion	15.84874
Log likelihood	-542.5475	Hannan-Quinn criter.	15.80968
F-statistic	85.90774	Durbin-Watson stat	2.282009
Prob(F-statistic)	0.000000		

Inverted MA Roots	1.00

Estimation ARIMA model for adult diapers medium 10's:

LS(DERIV=AA) DDP C MA(1)

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 52.5265575297 + [MA(1)=-0.999982903704,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Based on EViews generated formula sales has been calculated up to January 2020. To measure the accuracy of the formula 6 months backward sales had been forecasted. Results of the forecast are mentioned bellow.

Table 2-Forecast vs Budgeted sales difference for adult diapers medium 10's

Month	Actual sale	Budget	ARIMA(0,1,1)	Diff Forecast & Actual sale	Diff Forecast & Budgeted sale
Aug-2018	5,291	3615	4,455	- 836	- 1,676
Sep-2018	3,731	3615	5,344	1,613	- 116
Oct-2018	5,280	4012	3,784	- 1,496	- 1,268
Nov-2018	5,928	4262.5	5,333	- 595	- 1,666
Dec-2018	4,581	3775	5,981	1,400	- 806
Jan-2019	4,718	4332	4,634	- 84	- 386
Feb-2019			4,771		
Mar-2019			4,823		
Apr-2019			4,876		
May-2019			4,928		
Jun-2019			4,981		
Jul-2019			5,033		
Aug-2019			5,086		
Sep-2019			5,138		
Oct-2019			5,191		
Nov-2019			5,243		
Dec-2019			5,296		
Jan-2020			5,348		
Total error during the period				**- 0**	**- 5,918**

This will clearly indicate that forecast will reduce the over stock situation and while updating the current forecasting model to a multivariate forecasting model monthly differences can be improved.

5.2.2. Forecasting model development for adult diapers large 10's

To derive a formula to adult diapers for Large 10's segment, 7 months short term difference was used.

Table 5.3-Estimated equation for large 10's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 10:02

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 20 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	34.46910	8.917153	3.865483	0.0003
MA(1)	-0.858980	0.070705	-12.14877	0.0000

R-squared	0.467012	Mean dependent var	29.44928
Adjusted R-squared	0.459057	S.D. dependent var	625.1783
S.E. of regression	459.8115	Akaike info criterion	15.12807
Sum squared resid	14165583	Schwarz criterion	15.19282
Log likelihood	-519.9183	Hannan-Quinn criter.	15.15376
F-statistic	58.70630	Durbin-Watson stat	2.160416
Prob(F-statistic)	0.000000		

Inverted MA Roots	.86

Estimation ARIMA model for adult diapers large 10's:

LS(DERIV=AA) DDP C MA(1)

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 34.46910111 + [MA(1)=-0.858979673292,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Table 4-Forecast vs Budgeted sales difference for adult diapers large 10's

Month	DP	Budget	ARIMA(0,1,1)	Diff Forecast & Actual sale	Diff Budgeted sale & Actual sale
Aug-2018	2820	2,294	2,824	4	- 526
Sep-2018	2816	2,294	2,858	42	- 522
Oct-2018	3196	2,552	2,893	- 303	- 644
Nov-2018	4061	2,660	2,927	- 1,134	- 1,401
Dec-2018	3986	2,378	2,961	- 1,025	- 1,608
Jan-2019	3009	2,720	2,996	- 13	- 289
Feb-2019			3,030		
Mar-2019			3,065		
Apr-2019			3,099		
May-2019			3,134		
Jun-2019			3,168		
Jul-2019			3,203		
Aug-2019			3,237		
Sep-2019			3,272		
Oct-2019			3,306		
Nov-2019			3,341		
Dec-2019			3,375		
Jan-2020			3,410		
Total error during the period				**- 2,429**	**- 4,990**

This will clearly indicate that forecast will reduce over stock situation and while updating current forecasting model to a multivariate forecasting model monthly differences can be improved.

5.2.3. Forecasting model development for adult diapers medium 4's

To derive formula to adult diapers for Medium 4's segment, 2 months short term difference was used.

Table 5.5-Estimated equation for medium 4's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 11:08

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 18 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.56961	3.617995	5.961757	0.0000
MA(1)	-0.982402	0.017767	-55.29329	0.0000

R-squared	0.487043	Mean dependent var	15.23188
Adjusted R-squared	0.479387	S.D. dependent var	799.6420
S.E. of regression	576.9699	Akaike info criterion	15.58201
Sum squared resid	22303916	Schwarz criterion	15.64677
Log likelihood	-535.5795	Hannan-Quinn criter.	15.60771
F-statistic	63.61522	Durbin-Watson stat	1.964861
Prob(F-statistic)	0.000000		

Inverted MA Roots	.98

Estimation ARIMA model for adult diapers medium 4's:

LS(DERIV=AA) DDP C MA(1)

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 21.5696076017 + [MA(1)=-0.982401541204,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Table 6-Forecast vs Budgeted sales difference for adult diapers medium 4's

Month	DP	Budget	ARIMA(0,1,1)	Diff Forecast & Actual sale	Diff Budgeted sale & Actual sale
Aug-2018	2889	2,513	2,583	- 306	- 376
Sep-2018	1769	2,513	2,605	836	744
Oct-2018	2507	2,780	2,627	120	273
Nov-2018	2564	3,026	2,648	84	462
Dec-2018	2692	2,648	2,670	- 22	- 44
Jan-2019	2463	3,051	2,691	228	588
Feb-2019			2,713		
Mar-2019			2,734		
Apr-2019			2,756		
May-2019			2,777		
Jun-2019			2,799		
Jul-2019			2,821		
Aug-2019			2,842		
Sep-2019			2,864		
Oct-2019			2,885		
Nov-2019			2,907		
Dec-2019			2,928		
Jan-2020			2,950		
Total error during the period				**940**	**1,647**

This will clearly indicate that forecast will reduce the over stock situation and while updating the current forecasting model to a multivariate forecasting model monthly differences can be improved.

5.2.4. Forecasting model development for adult diapers large 4's

To derive formula to adult diapers for Large 4's segment, 2 months short term difference was used.

Table 5.7-Estimated equation for large 4's

Dependent Variable: DDP

Method: Least Squares

Date: 04/28/19 Time: 15:50

Sample (adjusted): 2013M05 2019M01

Included observations: 69 after adjustments

Convergence achieved after 14 iterations

MA Backcast: 2013M04

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.21524	3.191501	4.767424	0.0000
MA(1)	-0.971177	0.018506	-52.48028	0.0000

R-squared	0.605920	Mean dependent var	7.043478
Adjusted R-squared	0.600038	S.D. dependent var	715.6531
S.E. of regression	452.5970	Akaike info criterion	15.09644
Sum squared resid	13724552	Schwarz criterion	15.16120
Log likelihood	-518.8271	Hannan-Quinn criter.	15.12213
F-statistic	103.0163	Durbin-Watson stat	2.606193
Prob(F-statistic)	0.000000		

Inverted MA Roots	.97

Estimation ARIMA model for adult diapers large 4's:

LS(DERIV=AA) DDP C MA(1)

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 15.2152376012 + [MA(1)=-0.971177370129,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Table 8-Forecast vs Budgeted sales difference for adult diapers large 4's

Month	DP	Budget	ARIMA(0,1,1)	Diff Forecast & Actual sale	Diff Budgeted sale & Actual sale
Aug-2018	1958	1,578	1,693	- 265	- 380
Sep-2018	1295	1,578	1,973	678	283
Oct-2018	1984	1,748	1,310	- 674	- 236
Nov-2018	1059	1,874	1,999	940	815
Dec-2018	3250	1,654	1,074	- 2,176	- 1,596
Jan-2019	1295	1,899	3,265	1,970	604
Feb-2019			1,310		
Mar-2019			1,325		
Apr-2019			1,341		
May-2019			1,356		
Jun-2019			1,371		
Jul-2019			1,386		
Aug-2019			1,402		
Sep-2019			1,417		
Oct-2019			1,432		
Nov-2019			1,447		
Dec-2019			1,462		
Jan-2020			1,478		
Total error during the period				**475**	**- 510**

This will clearly indicate that forecast will reduce the over stock situation and while updating the current forecasting model to a multivariate forecasting model monthly differences can be improved.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

After examining research analysis and findings from previous chapters we come to the conclusion and recommendation chapter to give a summary of the key findings. This study is based on three main objectives. Section 5.2 will elaborate the objectives of the research and section 5.3 will demonstrate how objectives are achieved with this study. Section 5.4 and 5.5 further elaborate contribution to the industry and further research directions.

6.2. Aim and objectives of the research

To protect the current market share and face rapid competition in the industry, the organization had to adopt a proper product plan. This will realize the importance of managing adult diaper stocks in implementing a comprehensive organizational strategy and policy. According to the research problem this study was intended to explore factors affecting adult diaper forecast from local and global context and suggested to provide feasible attributes that can enhance the accuracy of the adult diaper's forecast. In order to achieve this objective data were collected from the industry which directly impact on the diaper forecast.

6.3. SUMMARY OF KEY FINDINGS

A thorough literature survey was carried out to identify critical factors affecting the diapers industry. Lack of direct literature for the study compelled to find factors from other industries. Identified factors from the literature survey, was further analyzed through a pilot survey to check validity of the factors to the local industry perspective. The first objective was achieved through primary survey & for that identical factors from the pilot survey were used.

Objective 01 - Identifying the factors that are affecting the accurate demand forecasting of adult diapers.

According to findings, seven factors were identified as critical factors having an impact on the diapers forecast. Those factors are poor prediction reliability, ignorance of the

importance of forecasting, no one is accountable for demand forecast, poor communication among relevant parties when forecasting, planning done around the goals which do not become reality, sales figures did not reflect the actual demand pattern, product planning issues. Factors were validated through the literature survey. Applicability to local context is validated from pilot survey.

Objective 02 - Analyzing the effect of identified factors for the accurate demand forecast.

Based on factors the primary survey was developed and distributed among employees of the organization who are directly involving in the forecasting procedure. 34 participants were included in the survey which was almost the same as the research population. That means viability of the results are identical. While evaluating results, highly effective factor found as there is no proper forecasting technique and predictions are not reliable. This can be a cause for other implications also.

Objective 03 - Suggestions for reducing the error in demand forecast in adult diapers industry.

While using EViews 7, Six years sales data were evaluated. Based on observations all four segments of the adult diapers consist of AR2 data models. For further evaluation the ARIMA model was used and based on that for each unit forecasting model was developed. It is highly recommended to use the bellow mentioned formulas to develop sales budgets.

Forecasting model development for adult diapers medium 10's

Estimation Equation:
DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]
Substituted Coefficients:
DDP = 52.5265575297 + [MA(1)=-0.999982903704,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Forecasting model development for adult diapers large 10's

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 34.46910111 + [MA(1)=-0.858979673292,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Forecasting model development for adult diapers medium 4's

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 21.5696076017 + [MA(1)=-0.982401541204,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Forecasting model development for adult diapers large 4's

Estimation Equation:

DDP = C(1) + [MA(1)=C(2),BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Substituted Coefficients:

DDP = 15.2152376012 + [MA(1)=-0.971177370129,BACKCAST=2013M05,ESTSMPL="2013M05 2019M01"]

Based on forecasted sales figures from equation purchasing plan can be developed. In addition by using EOQ formula optimal order quantities can be calculated. This will provide better solution to the stock out and over stock situation of the organization.

6.4. CONTRIBUTION TO INDUSTRY

Implications of this research were mainly focused on suggesting proper forecasting technique in the adult diapers industry. Based on these factors similar models can develop

to other pharmaceutical items which may have similar features. This study will encourage industry people to make proper forecasts and upgrade their standards. Proper forecasts will guide them to achieve realistic targets while minimizing costs.

6.5. FURTHER RESEARCH DIRECTIONS

This study open forum to Sri Lanka and global diaper industry how to develop proper forecast techniques. Study in same unit of analysis in different contexts. All the equations are developed based on the assumption of all other factors effecting to diapers sale is constant and only quantities will vary. Further a researcher can develop multivariate models for this segment. The findings of this study can be changed in different contexts, especially how EOQ impact to diapers demand forecasting. Thus, a study on different contexts seems a good research option.

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APPENDIX A: PILOT SURVEY QUESTIONER

Section A

Information about the Organization

Which industry are you in :

A. Position you are holding :

General staff		Middle manager		Senior managers		Top manager		Executive	

B. Average Annual Turnover (Rs. Billion) :

<1		1>5		5>10		10>15		15>	

C. Target market :

Local		Export		Local & Government		Export & Local		All	

D. Number of employees in your organization :

<100		100-200		200-1000		1000-5000		5000>	

Section B

1. **Does your organization practicing any systematic forecasting technique?**

Strongly disagree		Disagree		No idea		Agree		Strongly agree	

2. **Is forecasting done in systematic way? (Not for strongly disagree answer in question 1 in section B)**

Strongly disagree		Disagree		No idea		Agree		Strongly agree	

3. **Are you satisfied with your organization forecasting technique? (Not for strongly disagree answer in question 1 in section B)**

No		Not much		No idea		Yes		Yes very much	

Section C

4. **Do you know, which are the techniques use to forecast demand in your organization?**

No		Not much		Slightly		Yes		Very well	

5. **Do management prefer to use forecasting techniques?**

No		Not much		No idea		Yes		Yes very much	

6. **Do you think forecasting important to the organization?**

Almost never true		Usually not true		Occasionally true		Usually true		Almost always yes	

Section D

7. **Is there someone allocated for demand forecasting?**

Never		Regularly		No idea		Yes but not specifically		Yes specifically	

8. **Is relevant parties involving for the forecasting procedure?**

Almost never true		Usually not true		No idea		Usually true		Almost always yes	

9. **Is there anyone accountable for demand forecasting?**

No		Not directly		No idea		Usually true		yes	

Section E

10. Is field staff giving proper information for better forecasting?

Never		Rarely		Occasionally		Frequently		Very frequently	

11. Do you think communication among relevant parties is important for better forecast?

Unimportant		Of little important		Moderately important		Important		Very important	

12. While in demand forecast, is there better communication with staff?

Almost never true		Usually not true		No idea		Usually true		Almost always yes	

Section F

13. Do you think better demand forecast help to achieve goals of the organization?

No		Not much		No idea		Yes		Yes very much	

14. Are these forecast accepted by higher management?

No		Not much		No idea		Yes		Yes very much	

15. Is planning done around the goals which do not become reality :

No		Not much		No idea		Yes		Yes very much	

Section G

16. Different types of promotions use to achieve the sale

No		Not much		No idea		Yes		Yes very much	

17. Do field staff try to achieve their target anyhow?

Never		Rarely		Occasionally		Frequently		Very frequently	

18. Do you think sales figures reflect the actual demand pattern of the market:

Almost never true		Usually not true		No idea		Usually true		Almost always yes	

Section H

19. Frequently sock out situations courses in the market : (Not for service industry)

Never ☐ **Rarely** ☐ **Occasionally** ☐ **Frequently** ☐ **Very frequently** ☐

20. Products are not available as for the marketing plan : (Not for service industry)

Never ☐ **Rarely** ☐ **Occasionally** ☐ **Frequently** ☐ **Very frequently** ☐

21. Deliveries got delayed from suppliers : (Not for service industry)

Never ☐ **Rarely** ☐ **Occasionally** ☐ **Frequently** ☐ **Very frequently** ☐

APPENDIX B: PRIMARY SURVEY QUESTIONER

Section A

Information about sample surveyor's background

E. Position you are holding :

General staff		Executive		Middle manager		Senior managers		Top manager	

F. Department :

Marketing		Finance		Logistics		IT		Other	

Section B

The factors causing variances between actual diaper sale and budget. Mark effectiveness of the individual factor to the adult diaper sales forecast.

Scale: 1 (Not Effective) 2 (Minimum) 3 (Moderately) 4 (Highly) 5 (Extremely)	1	2	3	4	5
• Poor prediction reliability (Using systematic forecasting technique)					
• Unawareness of importance of forecasting					
• Accountability for demand forecasting					
• Poor communication among relevant parties when forecast					
• Planning done around the goals which do not become reality					
• Sales figures did not reflect the actual demand pattern					
• Product planning issues					