

# The accuracy of different forecasting techniques on Jeddah Paints Factory

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## Abstract

This research discusses forecasting disputes that many companies face while setting a new strategic plan. Jeddah Paints Factory is one of the manufacturing companies in Saudi Arabia in which its top management decided to change and improve their strategic plan to be aligned with the new Saudi vision of 2030. Data of one product line (water-based paints) of three sizes were collected using four different forecasting methodologies. Simple Moving Average, Simple Exponential Smoothing, and Trend Projection and multiplicative method were used to predict the production in the next 5 years. The accuracy was measured by Mean Absolute Deviation where the 5-Moving average method is found as the best and more accurate than exponential smoothing, Trend projection or multiplicative method.

## Keywords

Mean Absolute Deviation, Paint, Simple Moving Average.

## 2. Introduction

Recently, Saudi Arabia announced its 2030 vision, which expresses the long-term goals and expectations, and reflects the country's strengths and capabilities. According to (Alsharq Alawsat) electronic newspaper, "in 2030 vision, the Ministry of housing announced the plan of delivering more than 100 thousands of Residential products". Therefore, most of the companies should pay attention and try to predict the future that goes with 2030 vision.

It is expected that paints industry will continue to grow due to general growth in the economy. Previous studies have demonstrated that there is a link between the construction industry and the economy, the fluctuations in construction output has an adverse effect on the construction industry and the economy due to its strong linkage (Lam, Ka Chi, 2015). Knowing that Coatings provide two primary functions: decoration and protection, which has an important impact on economy. Bickle (2006), conducted a research that investigates the buyer decision conduct utilizing home stylistic layout retail channels to investigate uniqueness as a help of retail channel utilization. Research has shown that customer's choice to shop among physical stores, indexes, and e-retailers as a result of inclination or need is tended to. The significance of home stylistic theme retailers getting to be multi-channel operations. It makes opportunity for shoppers to pick items from assortment of retailers and retail channels reducing the probability that others have a similar collection.

One of the tools that used to predict demand is Forecasting. It has a great role in setting a goal for any company. There are many previous research studied forecasting and its implementations, but they have different conclusions because every company environments and needs is different (Krishnan et al., 2016).A short-term forecast is more accurate than a long-term forecast, because the further into the future you project the forecast, the more variables can affect the forecast. However, it depends on the company's field.

Unsurprisingly, a limited number of local factories are using scientific methods to forecast their production. They usually produce different kind of products based on their expectations and long-term experiences. This problem mostly affects inventory systems in factories as well as customers because the demand is undefined or inaccurate (Almaktoom, 2017; Alsaadi et al., 2016). Therefore, local factories would face under or over production problem, which will affect its reputation and quality of service. Even though forecasting methods are available and anyone can use them; however, companies use traditional ways (unscientific methods) to plan their manufacturing.

Recently, forecasting has been used in different fields, for example, stock, risk investment, economics and finance. In 1995, Mentzer wonders if a sales forecasting practice changed over the time. Mentzer did a research to measure the sales forecasting changes over the past ten years. A survey distributed via email of 207 forecasting executives was investigated this important question. Findings revealed both discrepancies and similarities between

today's sales forecasting practices and those of ten years ago. Their findings indicated greater reliance on and satisfaction with quantitative forecasting techniques today versus ten years ago. Another indicated that forecasting accuracy has not improved over the past ten years. Jun (1998) investigated how three dimensions of forecasting environments--forecast horizon, industry type and company size, were associated with forecasting processes and the types of data used. He collected data in two phases. First phase of data collection was an email survey to a total of 300 companies in computer and paint manufacturing industries, 75 small and 75 large paint and computer manufacturing companies. Second phase of data collection was structured interviews. Eight companies that appeared to have well-developed forecasting processes were selected and interviewed: four large computer and four large paint-manufacturing firms.

Most of the source of error is due to both inefficiency (a serial correlation in the errors) and bias in the forecasts. These two factors seemed to mask any contribution of contextual information to accuracy. Zhang (2011) proposed a combination of forecasting theory, which aimed completely using the information mined by the single model forecasting theory. Many scholars' show that a combination of forecasting methods is more reliable and accurate than single model forecasting theory. Therefore, all the forecasting methods have important theoretical and practical value.

The mean absolute deviation (MAD) can be used in different ways not only to evaluate accuracy of the forecasting techniques. For example, MAD is used to check the validity of the market efficiency hypothesis using (Ren and Ren, 2009). Robert (2009) investigated to identify possible reasons for a lack of accuracy. He analyzed the monthly sales plans and current data for over 15 years in different countries. Forecasting error was measured with MAD/MEAN. The paper finds no evidence of increased forecasting accuracy over 15 years. However, there is evidence from the case that the reason lies in environmental uncertainty and volatility and not in internal factors within the control of the company.

In 2000, Michael Lawrence did a research to recognize reasons behind providing the most accurate forecast estimates by the management judgment. His paper reports a field study of judgmental sales forecasting over thirteen manufacturing organizations to investigate whether these forecasts are accurate. The study shows that the company forecasts were not uniformly more accurate than a simple, un-seasonally adjusted, and naïve forecast. Most decisions are based on some kind of forecast of future demand. To illustrate, in 2008 Kalchschmidt investigates the impact of how forecasting is conducted on accuracy and operational performances. He focused on three elements that characterize the forecasting process: whether structured techniques are adopted, whether detailed information is used, and the extent to which forecasting is used in decision making processes. Analyses are conducted by means of data provided by the Global Manufacturing Research Group questionnaire. Data has been collect from 343 companies belonging to several manufacturing industries from 6 different countries. Empirical analysis shows that the relationship between how forecasting is conducted and operational performances is not fully explained only by taking into consideration forecast accuracy. Results show that companies adopting a structured forecasting process have positive impacts on operational performances not only through improved accuracy. The paper highlights the importance of proper design of the forecasting process in manufacturing environments since it can help to better understand the forecasting problem (i.e. demand variability).

Pula (2002) investigated the usefulness of business survey data in forecasting Hungarian manufacturing output growth in the short run. He analyzed the individual questions of the business surveys, and use models with different flexibility (factor model, best fitting and recursively best fitting model) to estimate the relationship between the business survey indicators and manufacturing output growth. The models are evaluated according to forecasting accuracy. Also, Sanders (1992) conducted a survey consist of 500 US companies to provide an understanding of forecasting practices in the manufacturing industry in comparison with the service industry. Out of the 82 usable responses received, 57% came from manufacturing organizations. The first observation is that manufacturing managers appear to be more familiar with quantitative methods than managers in service firms. Second, both categories of managers appear equally familiar with the simpler quantitative techniques. Finally, as expected, managers in both types of organizations are highly familiar with judgmental forecasting methods. Over half of all the respondents stated that they always use judgmental methods. The results of Sanders survey is to provide some new and interesting information about forecasting practices in the manufacturing industry. This information highlight gaps of forecasting theory and the needs of applied forecasting research. Thus this research presents a practical assessment and selection of various forecasting methods using a case study from Jeddah Paints Factory where four forecasting methods is assessed: moving average, exponential smoothing, trend projection/regression and decomposition. Moreover, the accuracy of forecasting is evaluated using MAD.

Remainder of this paper is organized as follows. Section two introduces applied methodology. In section three, a case study is performed to illustrate the effectiveness of the proposed methodology. Lastly, the paper ends with a brief conclusion and some suggestions for future work.

## **2. Methodology**

Forecasting is a decision-making tool used by many businesses to help in budgeting, planning, and estimating future growth. Therefore, companies should apply forecasting to have a clear vision for the future. Forecasting means predicting the future based on past, present data and most commonly by analysis of trends. Benefits of using forecasting is to increase productivity, keeps a company up-to-date, learn from past experience, and improve customers' satisfaction. Factories can plan and build their own forecast by knowing their market share and competitors and their growth, put a target for the company to know who your customers are. Based on this, you will build a plan to achieve your target. With the further development of market economy demands forecasting becomes not only the base of enterprises decision-making, but also the important gist for planning resources (Qu, Zhe Yi, 2005).

In General, there are two main type of forecasting. First type, qualitative forecast is based on expert's opinion and judgment, you choose this approach when no past data are available also it's useful in developing forecasts with limited scope. An example of qualitative forecast is Jury of executive, which means hiring qualified professional who provide certain activity that can give us information to predict the future. Crass root, selecting information from different places to predict the future market. Historical analogy, which means new product can use historical data from different company who have similar product. Market survey, which means asking customers about what their purchase plan. Finally, Delphi method that involves decision makers, staff and respondents. Second type, quantitative forecast based on numbers and it used when past numerical data is available. Such as simple moving average, weighted moving average, simple exponential smoothing, double exponential smoothing, trend projection (regression), and decomposition model. Factories should clearly define their goals in order to decide type of forecast that should be applied. Also, forecasting depends on observation because if there are few observations, it will be difficult to define a detailed model. The time horizon in forecasting is an important factor in deciding which forecasting method should be implemented because a forecast for tomorrow or next month is different from a forecast for next 5 years.

After you choose the right method and you implement it, you need to determine whether the forecast is accurate or not. To measure forecasting accuracy you can use Mean Absolute Deviation (MAD) method. It is the average of absolute deviation from a central point, it will allows to determine the variation of the error process from the measure of the MAD. Another method is Mean squared error (MSE), it is a measure of the quality of an estimator and it is always non-negative, values closer to zero are better. Also, factories can determine forecast accuracy by calculating average of error ( $E$ ).

## **3. Case Study**

This case represent production line of paint factory that is located in Jeddah Saudi Arabia. Jeddah Paints Factory is a manufacturing company that manufacture and export paints since 1975. The company is planning to improve its business and apply forecasting to predict the future that goes with 2030 vision. The problem is that the company is using traditional way that leads to many problems in the supply and demand such as over production. In order to resolve the problem and reach its goal, the company identified the need to apply a scientific forcasting method. The study is focused on water-based paints production line. The production line produce three sizes of water-based paints, which consist of Small 3kg, Medium 20kg, and Large 30kg. After examine the production and sales data, and its charts over 5 years. We decided to use quantitative method. Then four techniques is being applied to forecast for the next 5 years. These techniques are: 1-simple moving average, 2- simple exponential smoothing, 3-Trend projection (regression), and 4- multiplicative method). Next, MAD is being used to measure forecasting accuracy and help in choosing the most accurate forecasting method.

To be able to do that we need first to use 2012 and 2013 as an actual data to forecast 2014, 2015 and 2016 only to find the best method to use by calculating the error. After we found the accurate method, we can adopt it to forecast the next 5 years. The forecast will not appear immediately but we can complete the forecast whenever data are available.

### 3.1 Results

The first method that been applied to the collected data is five period moving average. It is based on past data, the weights assigned to the observations are the same and equal. I start with adding the number of production for the past 5 months then divide them on 5, to find the average of the first 5 months which will give me the result for the sixth moth and so on for the rest. The result will be for one month only and I can repeat that until the last year. The difference between the actual and forecast line in the chart is shows a kind of convergent, that is mean less variation in Figure1&2&3. Then I measured the error by MAD, its written in each chart.

$$MA_T = \frac{A_{T-1} + A_{T-2} + A_{T-3} + A_{T-4} + A_{T-5}}{5} \quad (1)$$

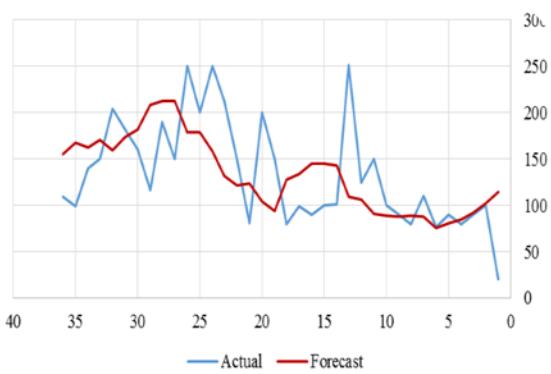


Figure 1. Five period moving average for Small Size

The mean absolute value for the method Five period moving average in the small size is **41.68**

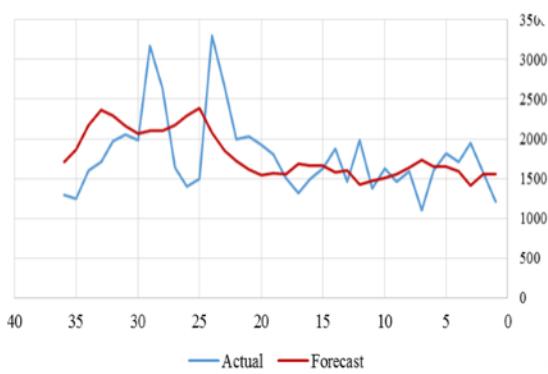


Figure 2. Five period moving average for Medium Size

The mean absolute value for the method Five period moving average in the medium size is **386.733**

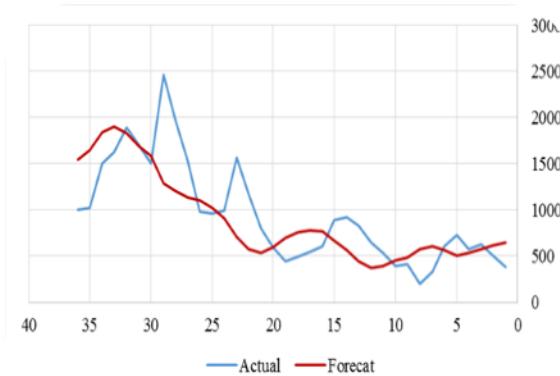


Figure 3. Five period moving average for Large Size

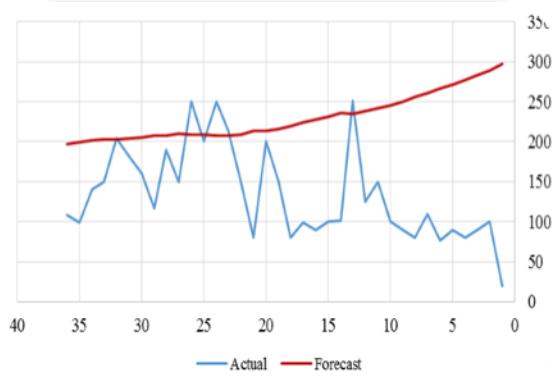
The mean absolute value for the method Five period moving average in the large size is **279.561**

The second method that been applied is Exponential Smoothing. This method is an averaging method weight most recent data more strongly, reacts more to recent changes, and it is useful when recent changes are significant and unpredictable instead of just random fluctuation. In this method we need to add Alpha (0.3). To find the forecast for the next month, we use the information of the previous month or start with the initiate forecast. Results of this forecast shows a very high increase that is not compatible with the actual. In Figure 4, the result of the forecast is a very high expectation, that mean the company needs to increase the production, but that is not true because the forecast and the actual are not close or compatible, unless if there is external causes help in that huge increase. In Figure 5&6, the result shows that the company should decrease the production and that is inconsistent with the reality, because there is a high demand for the paints.

$$F_{T+1} = F_T + \alpha [A_T - F_T] \quad (2)$$

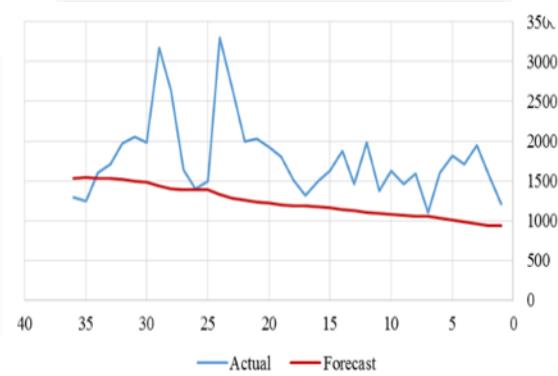
Where

- $F_T$  = Forecast for period T
- $A_T$  = Actual observation for period T
- $\alpha$  = Weighting factor, smoothing constant,  $0.0 \leq \alpha \leq 1.0$



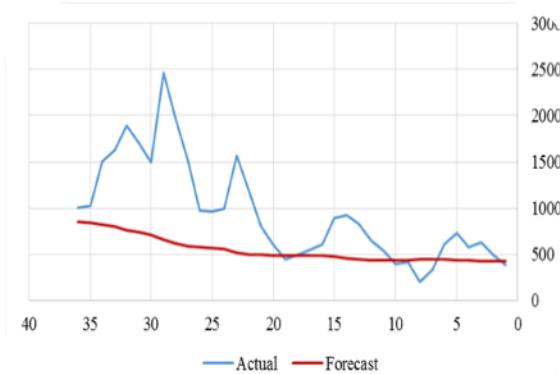
**Figure 4. Exponential smoothing for Small Size**

The mean absolute value for the method Exponential smoothing in the small size is **101.64**



**Figure 5. Exponential smoothing for Small Size**

The mean absolute value for the method Exponential smoothing in the medium size is **577.130**



**Figure 6. Exponential smoothing for Small Size**

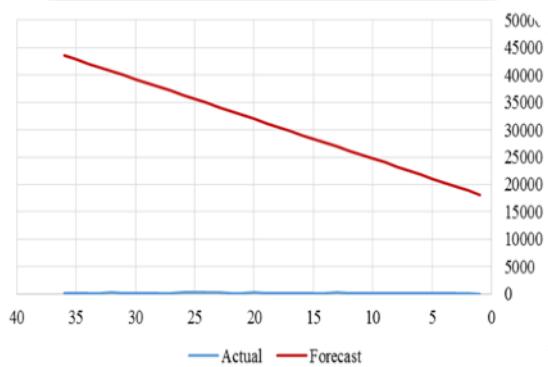
The mean absolute value for the method Exponential smoothing in the large size is **427.748**

The third method that been applied is Regression (Trend projection). Regression model is a relationship between the variable being forecasted and the factors that determine the value. Its require expertise to identify the important factors and the relationship. Regression appropriate for medium- to long-term forecasts and requires a long time series data. In Figure 7, there is a huge gap between the actual and the forecast, that indicates the incompatibility when applying trend method to the given data. Figure 8, starts with a big gap then it get closer. Figure9, the forecast match with the actual more than Figure 7&8, but its not considered the best method unless the MAD is applied.

$$y = a + bx \quad (3)$$

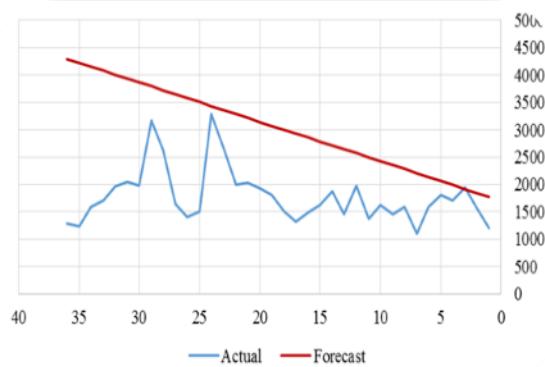
Where

- a = intercept
- b = slope of the line
- x = time period
- y = forecast for period x



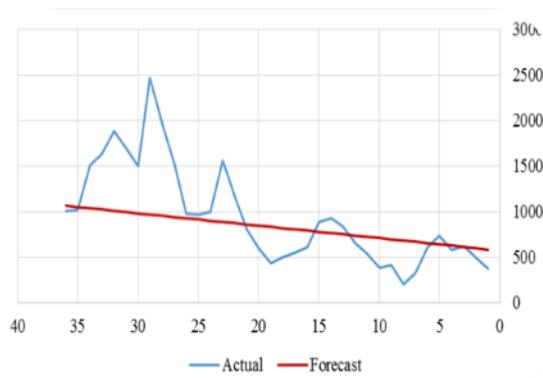
**Figure 7. Trend projection for Small Size**

The mean absolute value for the method Trend projection in the small size is **865.06**



**Figure 8. Trend projection for medium Size**

The mean absolute value for the method Trend projection in the medium size is **1257.723**



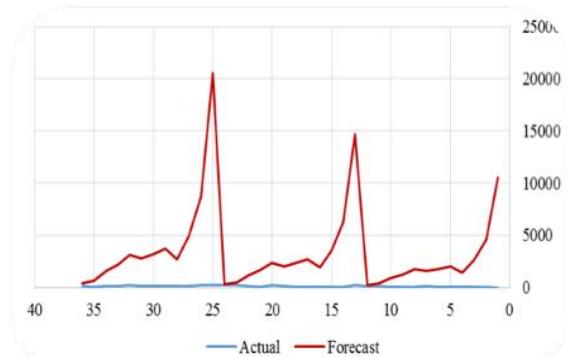
**Figure 7. Trend projection for large Size**

The mean absolute value for the method Trend projection in the large size is **320.093**

The fourth method that been applied is decomposition model (multiplicative method). It is used to describe the trend and seasonal factors in a time series. I start with estimate the trend, by modeling the trend with a regression equation. Then “de-trend” the series, by dividing the series by the trend values. After that, estimating the seasonal factors by using the de-trended series. The simplest method for estimating these monthly effects is to average the de-trended values for a specific season. For example, to get a seasonal effect for January, we average the de-trended values for all Januaries in the series, and so on. The final step is to determine the random (irregular) component. For the multiplicative model, random = series / (trend\*seasonal).

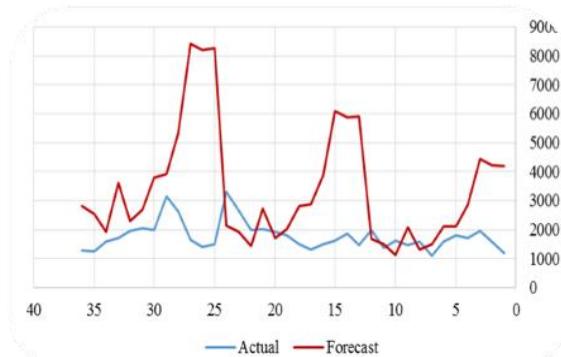
The seasonal variation usually increases as it move across time, but in this model, it seems to be the same magnitude across time. There is a fluctuation in Figure10&11, furthermore the forecast is not stable. Figure12 the forecast is convergent, but the error is more than the moving average, so its not considered the best method.

**SF (F<sub>t</sub> = T<sub>t</sub> x SF). (A<sub>t</sub> / T<sub>t</sub>).**



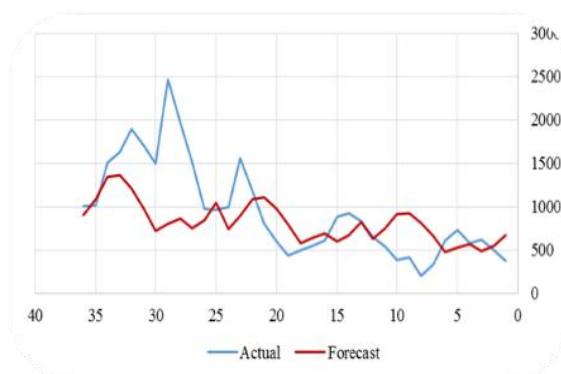
**Figure 10. Multiplicative method for Small Size**

The mean absolute value for the method Multiplicative in the small size is **1115.90**



**Figure 11. Multiplicative method for medium Size**

The mean absolute value for the method Multiplicative in the small size is **1823.726**



**Figure 12. Multiplicative method for large Size**

The mean absolute value for the method Multiplicative in the small size is **343.913**

After applying these four method, accuracy of each method is been measured using MAD method. The smaller the value of MAD, the more accurate the forecast. I calculate the MAD for each method in the same graph.

$$MAD = \frac{\sum_{T=1}^n |A_T - F_T|}{n} \quad (4)$$

Where

- T = period number
- $A_T$  = Actual observation in period T
- $F_T$  = forecast for period T
- n = total number of periods

Table 1. Mean Absolute Deviation

Methods	Mean Absolute Deviation MAD		
	S	M	L
<b>5-Moving average</b>	<b>41.68</b>	<b>386.733</b>	<b>279.561</b>
<b>Exponential smoothing</b>	101.64	577.130	427.748
<b>Trend projection</b>	865.06	1257.723	320.093
<b>multiplicative method</b>	1115.90	1823.726	343.913

From Table 1 the lowest MAD is the five period moving average method for all the sizes. By implementing the four forecasting methods and check the forecasting accuracy for each one. We found that the Moving average is the best method to apply in Jeddah Paints Factory for the three sizes. Moving average method is slightly more accurate than the other three methods for the studied data. The error is less in Moving average and the MAD are 41.68 in the Small size, 386.733 in the Medium size and 279.561 in the Large size. Therefore, we recommend the factory to use moving average method to forecast the next 5 years.

#### 4. Conclusion

After announcing the 2030 vision of Saudi Arabia, many industries decided to put a goal for its company. Especially paint industry, it is expected to continue to grow due to general growth in the economy. Jeddah Paints Factory is a manufacturing company that manufacture and export paints since 1975. Their problem is that they are using traditional ways that lead to many problems. After I examine the production and sales data over 5 years for JPF, I applied four different forecasting methods to predict the future that goes with 2030 vision. The methods are (Simple moving average, simple exponential smoothing and Trend projection (regression)) they consider quantitative method. After that, I checked the accuracy by using one of the forecasting accuracy measurement. I found that Moving average is the best method to apply in Jeddah Paints Factory. Moving average method gives slightly more accurate forecasts than the other three methods for the studied data. The error is less in Moving average and the MAD is 41.68 in the Small size, 386.733 in the Medium size and 279.561 in the large size. Forecasting is very important for any company, especially with occurring changes you need predict your future and put a new goal.

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