Forecasting Techniques and Accuracy of Performance Forecasting

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Abstract: *This article explores the impact of the different forecasting methods (FMs) on the accuracy of performance forecasting (APF) in large manufacturing firms (LMFs), in Kenya. The objective of the study was to assess if the different forecasting methods have an influence on any of the aspects of measures of APF. APF, in manufacturing operations, is seldom derived accurately. However, LMFs tend to hire skilled forecasters, to a great extent, to ensure APF when preparing future budgets. The different types of forecasting techniques have been known to influence the behavior of operations resulting in the formulation of either accurate or inaccurate forecasts resulting in either adverse or favorable organizational performance. The study used the three known forecasting methods, objective, subjective and combined forecasting techniques against measures of APF, expected value, growth in market share, return on assets and return on sales. Regression analysis was used applying data collected through a structured questionnaire administered among randomly selected LMFs. Results indicated that there was evidence that APF is influenced by each of the forecasting methods in different ways.*

Key Words: *Forecasting methods; accuracy of performance forecasting; large manufacturing firms.*

Abbreviations and Acronyms :

APF	= Accuracy of Performance Forecasting		LMF	= Large Manufacturing Firm
EV	= Expected Value		ROA	= Return on Assets
FM	= Forecasting Method		ROS	= Return on Sales
GMS	= Growth in Market Share			

1. INTRODUCTION

Business environment in manufacturing firms is dynamic. Firms that don't embrace changes in their business environment and that don't make adjustments to their business model based on these changes have a high degree of poor performance or even failure. In order to arrest underperformance or total failure, the dynamic changes in business can be addressed through accurate performance forecasting practices. Apart from the use of neural networks as an aid to accurate forecasting, there are three known forecasting techniques, objective, subjective and combined forecasting. Since changes in business environment are inevitable the use of an accurate forecasting model can address events or situations that can have a negative impact on a business. Forecasting therefore, remains a key fundamental in predicting the future of any industry. Managers wish to know about the future before it happens, hence, accurate forecasting can help in developing strategies to promote profitable trends and to avoid unprofitable ones.

Research has identified factors that cause an increase in the importance of forecasting. These factors include events that occur within an organization and events that take place outside of the organization. The cumulative interactive effect of these factors on businesses has made organizations to move towards more systematic decision making that involves explicit justifications for individual actions. Since a business does not operate in a vacuum, it has to act and react to what happens within and outside the factory and office walls. As enterprises continue to operate under conditions of uncertainty, management wishes to limit this uncertainty by selecting appropriate forecasting techniques that enhance operational performance by assigning, with some level of accuracy, expected sales volume, price, cost and interest rates.

Generally, forecasting is used to predict the future using data on hand or the formation of opinions. While it is an essential tool in operations management, its accuracy and application have always posed challenges to decision-makers and yet demand forecasts are necessary since the basic operations process takes time (Bails and Peppers, 1982)[5]. Researchers have also noted that there is no one foolproof and accurate way of forecasting as each forecasting technique influences APF in unique ways. Further, since individuals are frequently involved in forecast implementation there is the risk that they can influence how forecasts are employed (Berinato, 2001[7]; Fildes and Hastings, 1994)[21]. This study tested and identified measures of accuracy of performance forecasting that are influenced by each forecasting technique and the strength of that influence.

2. LITERATURE REVIEW

Firms must anticipate and plan for future demand so that they can react immediately to customer orders as they occur since most customers are not willing to wait the time it would take to process their order. The ability to accurately forecast demand enables the firm to control costs through levelling its production quantities, rationalizing its transportation and planning for efficient logistics operations. Accurate demand forecasts lead to efficient operations and high levels of customer service (Adam and Ebert, 2001)[1]. For new manufacturing facilities demand needs to be forecasted many years into the future since the facility will serve the firm for many years to come (Bails and Peppers, 1982)[5]. Forecasting is, therefore, a problem that arises in many economic and managerial contexts and the influence of a FM on APF can determine the success or otherwise of LMFs.

2.1 Forecasting Methods

There are two main techniques to forecasting, that is, judgmental (qualitative) forecasting, which is subjective and uses experience and judgment to establish future behaviors; and objective (quantitative) forecasting which uses historical data to establish relationships and trends that can be projected into the future. A third forecasting model has been crafted by combining judgmental and objective forecasting models. The combination process is dependent on the APF a firm desires to achieve by either minimizing the Mean Square Error (MSE) of the resulting FM or combining forecasts to attain a simple average of the different forecasts used in the combination.

2.1.1 Objective Forecasting Method

Objective forecasting approaches are quantitative in nature and lend themselves well to an abundance of data. However, where consumer behavior and market patterns are erratic, the use of historical data alone becomes questionable. There are three categories of objective forecasting methods: time series, causal/econometric and artificial intelligence. Time series methods attempt to estimate future outcomes on the basis of historical data. In many cases, prior sales of a product can be a good predictor of upcoming sales because of prior period marketing efforts, repeat business, brand awareness and other factors. When time series methods are employed, the assumption is that the future will continue to look like the past. However, in rapidly changing industries or environments, time series forecasts are not ideal, and may be redundant. Because time series data are historical, they exhibit four components that emerge over time: trend, seasonal, cyclical and random or irregular. Therefore, before any forecasting is done on time series data, the data must be adjusted for each of these components. The most common time series methods include moving average (both straight and weighted), exponential smoothing and regression analysis.

Causal forecasting methods attempt to predict outcomes based on changes in factors that are known – or believed – to impact those outcomes. For example, temperature may be used to forecast sales of ice cream; advertising expenditure may be used to predict sales. Regression analysis also falls under the causal/econometric umbrella, as it can be used to predict an outcome based on changes in other factors. Econometric forecasting methods include Autoregressive Moving Average (ARMA) and Autoregressive Integrated Moving Average (ARIMA) models. ARMA and ARIMA models are only used in certain cases. In the two methods above, catastrophic and erratic changes in the operating environment are not accounted.

2.1.2 Judgmental (Subjective) Forecasting Method

Judgmental forecasting is a forecasting technique which cannot describe in detail the activity of forecasting and, generally, one or more persons are involved in preparing the forecasts. Smith and Mentzer (2010) [47]observe that user perceptions and actions of forecasters have a significant influence on forecasts. Commonly known judgmental methods for preparing sales forecasts include the expert consensus method, which is the jury of opinion method. Here, a sales forecast is obtained by experts in three ways, a point forecast, which is a forecast for the specific amount; an interval forecast, which is the forecast for different intervals; and a probability forecast, which is the forecast based on probability of various terms. In a sales force composite, which is about asking sales executives to estimate their sales forecasts, the overall forecast is prepared when the summation of the individual forecasts is done. This technique has been known to be extremely helpful to the manufacturers of industrial products for preparing short-term forecasts. However, this method is extremely weak if there is trend or changes in the product or the market demand.

Delphi method is a method that avoids both the problems of weighting individual forecasts of experts and the effects introduced by rank and personality in the consensus method. This method consists of having participants make separate (point, interval, probability distribution, or some combination of the three), returning forecasts to the forecasters who make a new round of forecasts with this information. This process is iterated until it appears that further rounds will not result in an added degree of consensus. This method suffers from the lack of knowledge about the extent of environmental effects incorporated in the forecasts, especially in a turbulent market.

2.1.3 Combination Forecasting Method

Combination forecasting is not a commonly used forecasting technique in LFMs. However, Armstrong (2001) [4]posits that there is evidence that combining FMs can improve APF in various situations. On the other hand, contrary views are held that combining FMs on its own does not necessarily improve APF (Larrick and Soll,

2003)[31], but rather reliance on some input from practitioners in industry is desirable. On his part, Armstrong (2001) [4]asserts that combining forecasts has been found to be useful only when uncertain as to which method to apply or when the current method alone is not providing an adequate measure of accuracy. The researcher asserts that combining forecasts refers to the averaging of independent forecasts which can be based on different data or different methods or both. The averaging is done using a rule that can be replicated, such as to take a single average of the different forecasts. The more that methods differ, the greater the expected improvement in accuracy over the average of the individual forecasts. For example, a time series forecast could be combined with jury of executive opinion forecast by getting the average of the two forecasting methods.

Combining FMs tends to even out uncertainties within the different forecasts used, but erratic changes in market rivalry could render this method less accurate than hitherto anticipated. This study found that the effect of combining a more accurate FM with a less accurate FM results in a lower than average forecast. In their survey, Davis and Mentzer (2007)[16] posit that while significant advances have been made in developing sales forecasting techniques that more accurately reflect marketplace conditions, surveys of sales forecasting practice continue to report only marginal gains in sales forecasting performance. Armstrong (2001) recommends the use of at least five forecasts for combining as adding more methods leads to diminishing rates of improvement as the level of uncertainty increases. However, many things affect forecasts and these might be captured by combining forecasts to reduce errors arising from faulty assumptions, bias, or mistakes in data.

Research on time series forecasting argues that predictive performance increases through combined forecasting techniques (Armstrong, 1989, 2001[3][4]; Clemen, 1989[13]; Makridakis and Winkler, 1983[35]; Makridakis et al., 1982[34]; Terui and Van Dijk, 2002)[49]. In an experimental study, Bunn and Taylor (2001)[10] combined a judgmental method with a statistical model in which "improvements in accuracy were stated to have been considerable and difficult to benchmark". In another large-scale time series experimental study, Hibon and Evgeniou (2005)[29] conclude that selecting among combinations is less risky than selecting among individual forecasts. On his part, Synader (2008)[48] concluded that by incorporating the customer's point of view into sales strategy accurate forecasts were a natural by-product of a good sales pipeline. In a survey of how user perceptions and actions influence forecasts, Smith and Mentzer (2010)[47]concluded that combining forecasting techniques is still under-explored. According to Makridakis and Hibon (2000)[36], Newbold and Harvey (2002) and Hendry and Clements (2002), APF can be improved through a combination of forecasting methods.

A review of combination forecasting reveals that most of the studies and applications in combining FMs have been in the fields of Metrology (Murphy and Katz, 1977[38]; Clemen, 1985[11]; Clemen and Murphy, 1986a, b[12]; Murphy, Chen and Clemen, 1988)[39]; Macro-economic problems (Cooper and Nelson, 1975[14]; Engle, Granger and Kraft, 1984[19]; Hafer and Hein, 1985[27]; Blake, Beenstock and Brasse, 1986[9]; Guerard, 1989)[26]; and in social and technological events. Smith and Mentzer (2010)[47], Vieira and Favaretto (2006), Makridakis et al. (1983)[35] and Schultz (1992)[45] underscore the fact that forecasting combination application issues are still under-explored in the manufacturing industry and yet, greatest gains are perceived to be in the areas of implementation and practice. There has also been work that questions whether one should always combine forecasts. Larrick and Soll (2003)[31] showed that under some conditions it was better not to combine forecasts of experts, but rather seek management's practical input.

2.2 Forecasting Performance and Measurement

Most studies have only compared the performance of alternative approaches to time series forecasting. Results of most of the research streams offer a mixed picture of the extent that forecasting performance has improved over time. According to Makridakis et al. (1982, 2000)[34][36], the competition studies have helped to identify techniques that improve accuracy of forecasting under different demand scenarios, but practice studies have not found evidence that industry is achieving the same level of improvement. Forecast accuracy has therefore, been stated to be a contemporary issue in which more research is still needed (Makridakis et al., 1983[35]; Armstrong, 1988[2]; DeRoeck, 1991[18]; Mahmoud et al., 1992[33]; Schultz, 1992[45]; Winklhofer et al., 1996[50]; Armstrong, 2001[4]; Fildes, 2006[22]; Davis and Mentzer, 2007; Foslund and Jonsson, 2007).

Measures of forecast credibility and utilization were derived from activities concerned with factors influencing the use of various information captured by the forecasting teams. Indicators used included sales performance (Bhutta et al., 2008[8]; Daily, 1992[15]; Saini et al, 2008)[43], growth plans (Bhutta et al., 2008)[8], profit levels (Sadler et al., 2001)[42] and target achievement (Rosa, 1996)[41].

2.3 Indicators of Accuracy of Performance Forecasting

The following were identified as appropriate independent variables of accuracy of performance forecasting:

2.3.1 *Expected Value (EV)*

Known as profit growth, EV is a measure of a firm's growth in profit year-on-year in real terms. The EV gives an indication of how a firm is managing costs while increasing prices at the same time even in a market with intense rivalry. If forecasts are prepared accurately the EV yield will approximate expectations as per forecasts.

2.3.2   Return on Sales (ROS)

Is a ratio used to evaluate a company's operational efficiency; it is also known as a firm's operating profit margin. It measures a company's performance by analyzing what percentage of total company revenues are actually converted into company profits. ROS is calculated by dividing the operating profit by the net sales for the period.

2.3.3   Return on Assets (ROA)

This is an indication of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient management is at using its assets to generate earnings. It is calculated by dividing a company's annual earnings by its assets. ROA is generally displayed as a percentage.

2.3.4   Growth in Market Share (GMS)

Market share is the percentage of an industry or market's total sales that is earned by a particular company over a specified time period. Market share is calculated by taking the company's sales over the period and dividing it by the total sales of the industry over the same period. Growth in market share year-on-year indicates growth in sales of a company year-on-year against industry total year-on-year. For example, if a company's sales were S_1 in period one and S_2 in period two while the industry total sales were T_1 and T_2 respectively, then growth in market share as a ratio would be calculated as $(S_2-S_1)/T_2$.

3.   CONCEPTUAL FRAMEWORK

According to Fahy and Smithee (1999)[20] forecasting models are conceptualized on the premise that organizations' desired outcome is to achieve a sustainable competitive advantage that allows them to earn above-average returns. Other researchers (Barney, 1991[6]; Fahy and Smithee, 1999[20]; Foley and Fahy, 2004)[23] posit that the key to earning this reward is the possession of critical resources that are firm specific, valuable to customers, non-substitutable, and difficult to imitate, leading, if deployed effectively, to a sustainable competitive advantage. This perspective emphasizes firm-specific capabilities and assets and the existence of isolating mechanisms as the fundamental determinants of firm performance. Capabilities, which include accuracy in performance forecasting, have been defined as complex bundles of skills and collective learning, exercised through organizational processes that ensure superior and effective coordination of functional activities (Day, 1994)[17].

Accuracy of performance forecasting may be viewed as a subset of the larger notion of corporate performance. Research has shown that combining forecasting techniques has the potential of increasing forecast accuracy than using single forecasting methods. Lawrence (1983)[32] and Mentzer and Cox (1984)[37] posit that combining judgmental with quantitative forecasting to achieve forecast accuracy is a promising area for further research. On his part, Clemen (1989)[13] asserts that simply combining forecasting techniques does not necessarily yield accurate forecasts, but rather the selection of appropriate forecasting techniques for combining. The conceptual framework, Figure 1, demonstrates the linkages in the variables of interest for this survey study whose results showed that the different forecasting techniques had an influence not on all, but certain measures of accuracy of performance forecasting in varying degrees.

Figure 1.Conceptual Framework
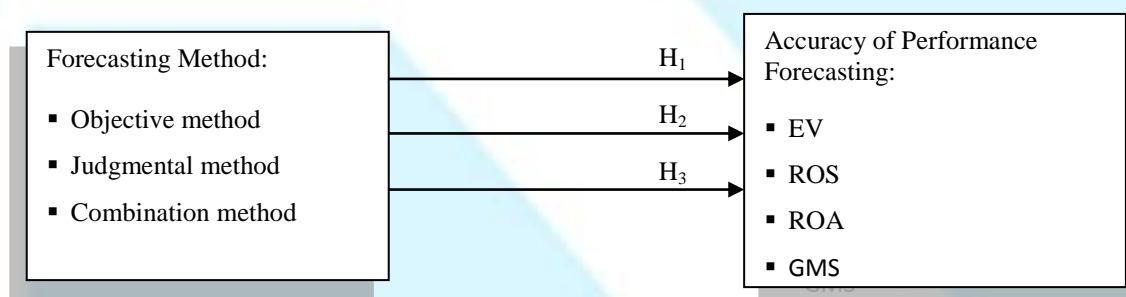
4.   HYPOTHESES

The survey leading to this article aimed at assessing the influence of forecasting methods on the accuracy of performance forecasting in LMFs, in Kenya. This was realized by answering questions in relation to two objectives, which were:

(i) Comparison of different forecasting methods in accuracy of performance forecasting.

(ii) Identification of performance measures which are influenced by the different forecasting methods.

In order to address these objectives, three hypotheses were tested and discussed:

H1: Objective forecasting method influences accuracy of performance forecasting.

H2: Subjective forecasting method influences accuracy of performance forecasting.

H3: Combination forecasting method influences accuracy of performance forecasting.

5. RESEARCH PROBLEM

In business forecasting, various research streams offer a mixed picture of the extent that APF has improved over time. Additional research has also found that empirical findings indicate that practice studies have not found evidence that industry is achieving improvement in APF. The research question which this paper examines is: What is the influence of FMs on APF in LMFs, in Kenya? The research focus included identifying specific APF indicators and examining the influence of the FMs on these predictors.

6. RESEARCH METHODOLOGY

This was a descriptive cross-sectional survey that collected panel data for one year. The researcher applied the positivist research philosophy.

6.1 Sample of Research

The sample frame comprised 487 large-scale manufacturing firms with at least 100 employees each. In their survey on small-scale manufacturers in Kenya, Gray et al. (1997)[25] classified large manufacturers as employers with of at least 100 workers. Sample size was calculated using a table for sample size determination of a "known" population by Krejcie et al. (1970)[30], which resulted in 217 firms that were surveyed having been selected using proportionate stratified random sampling (PRS) technique. Each target firm in each industry sector and geographical location was selected using simple random sampling (SRS) technique. According to Sekaran (1992)[44] this sampling design (SRS) has the least bias and offers the most generalizability.

6.2 Instrument and Procedures

The study employed secondary data that was obtained from the target sample through a structured questionnaire that was hand-delivered to the selected teams of managers within the 217 respondent LMFs. Responses were received from 176 firms, which meant an 81 per cent response rate was achieved. Prior to administering the research instrument, the instrument had been piloted on ten LMFs to assist in identifying any ambiguous and unclear questions. Respondents were assured of a high degree of confidentiality and anonymity of their responses.

Data collection included respondents either completing the questionnaire on their own or in the presence of the researcher or research assistant, in their respective locations. Secondary data involved collecting existing performance data from published and unpublished reports over a period of one year in the different LMFs. These metrics addressed the objective of the study.

6.3 Data Analysis

The data collected was analyzed using regression models to estimate the relationships among variables. Regression analysis is widely used for prediction and forecasting to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. Regression analysis can also be used to infer causal relationships between the independent and dependent variables, where APF is the dependent variable in this survey study.

7. RESULTS AND DISCUSSION

7.1 Objective Forecasting Method

7.1.1 Objective forecasting method influences expected value, resulting in the following relationship:

EV   =   1.431 + 0.065 Objective method.
                     (0.000) (0.032)

This implied that a unit marginal change in the use of the objective forecasting method resulted in 0.065 additional units in expected value

Table 7.1.1	Objective Forecasting Method – Coefficients					
		Un-standardized Coefficients		Standardized Coefficients		
Model		Beta	Standard Error	Beta	t-Value	P-Value
1	(Constant)	1.431	0.248		5.775	0.000
	Objective method	0.065	0.061	0.081	1.050	0.032
Dependent Variable: Expected Value						

7.1.2 Objective forecasting method influences return on sales, resulting in the following relationship:

ROS   =   13.9914 - 0.994 Objective Method.
                       (0.000) (0.002)

This implied that a unit marginal change in the use of the objective forecasting method resulted in a 0.994 decrease in ROS. This finding was consistent with previous

findings that the use of objective forecasting improved forecasting accuracy.

Table 7.1.2   Objective Forecasting Method – Coefficients

Model		Un-standardized Coefficients		Standardized Coefficients		
		Beta	Standard Error	Beta	t-Value	P-Value
1	(Constant)	13.914	1.291		10.774	0.000
	Objective method	-0.994	0.320	-0.232	-3.106	0.002

Dependent Variable: ROS

7.2   Judgmental Forecasting Method

7.2.1   Judgmental forecasting method influences expected value, resulting in the following relationship:

EV   =   2.308 - 0.171 Judgmental method

(0.000)   (0.003)

This implied that a unit marginal change in the use of a judgmental forecasting method resulted in a decline of 0.171 units in expected value.

Table 7.2.1   Judgmental Forecasting Method – Coefficients

Model		Un-standardized Coefficients		Standardized Coefficients		
		Beta	Std. Error	Beta	t-Value	P-Value
1	(Constant)	2.308	.216		10.701	0.000
	Judgmental method	-0.171	.057	-0.226	-3.019	0.003

Dependent Variable: Expected Value

7.2.2   Judgmental forecasting method influences return on sales, resulting in the following relationship:

ROS   =   9.093 + 0.256 Judgmental method

(0.000) (0.010)

This implied that a unit marginal change in the use of judgmental forecasting method resulted in an improvement of 0.256 units in ROS.

Table 7.2.2   Judgmental Forecasting Method – Coefficients

Model		Un-standardized Coefficients		Standardized Coefficients		
		Beta	Std. Error	Beta	t-Value	P-Value
1	(Constant)	9.093	1.180		7.705	0.000
	Judgmental method	0.256	0.310	0.063	0.826	0.010

Dependent Variable: ROS

7.3   Combination Forecasting Method

7.3.1   Combined forecasting method influences expected value, resulting in the following relationship:

EV   =   1.970 - 0.074 Combined method

(0.000) (0.002)

This implied that a unit marginal change in the use of a combined forecasting method resulted in a decline of 0.074 units in expected value. While this outcome may appear inconsistent with the assertion that a combined forecasting method yields higher accuracy of performance forecasting, the negative effect of combining a judgmental forecasting method with an objective forecasting method may have impaired the robustness of the combined forecasting technique.

Table 7.3.1   Combined Forecasting Method – Coefficients

Model		Un-standardized Coefficients		Standardized Coefficients		
		Beta	Std. Error	Beta	t-Value	P-Value
1	(Constant)	1.970	0.268		7.354	0.000
	Combined method	-0.074	0.068	-0.084	-1.101	0.002

Dependent Variable: Growth in Profit (EV)

7.3.2   *Combined forecasting method influences return on sales, resulting in the following relationship:*

ROS   =   9.307 + 0.187 Combined forecasting method

(0.000)   (0.005)

This implied that a unit marginal change in the use of combined forecasting method resulted in an additional 0.187 units in ROS. The incremental change in return on sales suggested that the combined forecasting technique was a superior method for use in forecasting future goals in LMFs.

Table 7.3.2   Combined Forecasting Method – Coefficients

Model		Un-standardized Coefficients		Standardized Coefficients	t-Value	P-Value
		Beta	Std. Error	Beta		
1	(Constant)	9.307	1.435		6.487	0.000
	Combined Method	0.187	0.362	0.040	0.518	0.005

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