International Journal of Business and Management
www.ccsenet.org/journal.html
Vol. 4, No. 5
May 2009

Demand Forecasting and Supplier Selection for Incoming Material in RMG Industry: A Case Study

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Abstract

RMG sector is the single most important manufacturing industry in Bangladesh. Almost all of the raw materials in this sector are being imported from abroad. Hence, incoming material management is of paramount importance for effective and efficient management of the supply chain in this sector. This paper deals with incoming material management of a 100% export-oriented knit composite factory. Demand forecasting and supplier selection are two major components of incoming material management. Different techniques of demand forecasting have been implemented to find the best suitable model for a particular raw material. In supplier selection, AHP technique has been implemented to select the best supplier of the concerned raw materials. Successful implementation of the recommendations of this paper can significantly improve the level of material management and thereby increase overall profit by reducing waste.

Keywords: Demand forecasting, Supplier selection, Analytical Hierarchy Process (AHP)

1. Introduction

Ready-made Garments (RMG) industry is the major export-base for Bangladesh. It has considerable impact on national economy, as well as high of degree of social implications, as a large number of female workers are employed in this labor-intensive industry. In the current post MFA era, international competition in this sector has been increased a lot. Therefore, garments companies in Bangladesh need to become more competitive and efficient to survive, to retain market position and increase market base. The foreign competitors have upper-hand basically in three areas: stronger backward linkage, more skilled manpower, and better methodology of manufacturing. Among these three, backward linkage is the most important factor as almost all of the raw materials needed in this sector are being imported from different countries. Proper management of supply chain is of outmost importance for smooth operations of the manufacturing processes in this sector that can help in maintaining the delivery schedule.

Highly competitive market is currently forcing every factory to think globally. Survival becomes increasingly difficult and critical to find new ways to grow. Looking back at North American and European business trends, it seems that strategies have been changing and updating frequently. “How to do more” was emphasized in 60s; “How to do it cheaper” became important in 70s; “How to do better quality” was in the 80s and “How to do quicker” was the key in the 90s. All of those are still important in our business, however meeting the increasing time demands of customers will become important. Shorter lead time and will be the strategic focus for at least the next decade. Time – the number of seconds, minutes, hours, days, months or years – is the yardstick by which we increasingly judge around us – particularly organizations providing manufacturing services.

Demand forecasting is an integral part of any kind of supply chain management and very important to sustain profitability. Improving demand forecasting performance has long been a concern of people involved in any kind of industry (Armstrong & Grohman, 1972). To this end, researchers have developed and disseminated increasingly sophisticated forecasting techniques, believed to be more accurately model the fluctuating demand patterns (Fildes &

Hastings, 1994). However, improved forecasting techniques are useful mainly for different management practices including decision making and planning processes (Winklehofer, 1996). Surveys of sales forecasting practice have consistently shown that qualitative methods are more widely used than quantitative methods; however an extensive body of research supporting the superiority of quantitative forecasting techniques in most situations (Dalrymple, 1987). Not all the techniques are suitable for each category of the materials used in production. Out of several techniques, proper implementation of the appropriate technique is very much important for accurate demand forecasting.

Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach and was introduced by Saaty (1977). The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP is a decision support tool which can be used to solve complex, unstructured decision problems (Putrus, 1990). It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives.

Some of the industrial engineering applications of the AHP include its use in integrated manufacturing (Boucher & McStravic, 1991), in the evaluation of technology investment decisions [Wabalickis, 1988], in location planning and layout design (Cambron & Evans, 1991; Min, 1994], in software development (Finnie et. al., 1993), in project risk assessment (Mustafa & Al-bahar, 1991) and also in other engineering problems (Wang & Raz, 1991; Shtub & Dar-el, 1989).

This paper focuses on selecting appropriate technique for demand forecasting of raw material in RMG sector. A particular raw material, which is widely used in one selected factory of this sector is taken into consideration to implement this technique. AHP technique has been implemented to find out the best suitable supplier of this raw material.

2. Forecasting Models

In this analysis, ten different techniques have been used to forecast the demand of raw materials used by the selected factory. The techniques are simple average (SA), moving average (MA), weighting moving average (WMA), single exponential smoothing (SES), single exponential smoothing with linear trend (SESLT), double exponential smoothing (DES), double exponential smoothing with linear trend (DESLT), adaptive exponential smoothing (AES), linear regression (LR), and holts-winters additive algorithm (HWAA).

Simple average (SA) method simply let the forecast equal to the average of all prior demand data. As time passed, our forecasts would stabilize and converge towards the level of the series, because in the long run the noise terms will cancel each other out because their mean is zero. The more data we include in the average, the greater will be the tendency of the noise terms to sum to zero, thus revealing the true value. Sometimes the demand for an item in a logistics system may be essentially “flat” for a long period but then undergo a sudden shift or permanent change in level. In moving average (MA) technique, the forecast would be calculated as the average of the last “few” observations. If number of observation is "small", the forecast will quickly respond to any "step", or change in level when it does occur; the "averaging out" effect is lost which would cancel out noise when many observations are included. The optimal value in any given situation depends in a fairly complicated way upon the level, the noise variance, and the size and frequency of occurrence of the step or steps in the demand process.

It might seem more reasonable to assume that historical observations actually lose their predictive value "gradually", rather than so "abruptly" as in the moving average. As a given data point becomes older and older, it becomes progressively more likely that it occurred before the step change in level happened, rather than after it did. It therefore might improve the accuracy of the forecast if relatively more emphasis is placed on recent data and relatively less emphasis on less current experience. This idea leads to the concept of a weighted moving average (WMA) forecast, where the last observations are averaged together, but where they are not given equal weight in the average.

A popular way to capture the benefit of the weighted moving average approach, while keeping the forecasting procedure simple and easy to use, is called single exponential smoothing (SES), or occasionally, the “exponentially weighted moving average”. In its simple computational form, a forecast is made for the next period by forming a weighted combination of the last observation and the last forecast using various coefficients and taking the forecasting error in consideration. An upward and downward trend in data collection over a sequence of time periods causes the exponential forecast to always lag behind (be above or below) that actual occurrence. If such a trend is observed in single exponential smoothing then exponentially smoothed forecasts can be corrected somewhat by adding linear trend (SESLT).

To develop a smoothing procedure that will separate the trend component from the noise in the series and forecast trended data without a lag is called Double Exponential Smoothing (DES). Given a smoothing coefficient of a, a simple smoothed average of the data is first calculated. This series would follow the slope of the original data while smoothing out some of the noise. A second series is then formed by smoothing the second series will also tend to capture the slope of the original data while further smoothing the noise. An upward and downward trend in data collection over a sequence of time periods causes the exponential forecast to always lag behind (be above or below) that actual occurrence. If such a trend is observed in double exponential smoothing then exponentially smoothed forecasts can be corrected somewhat by adding a new adjustment (DESLT). A quantitative forecasting method (AES) in which averages derived from historical data are smoothed by a coefficient, which is allowed to fluctuate with time in relation to changes in demand pattern. The larger the coefficient, the greater the smoothing effect.

One way to deal with trended demand data is to fit the historical data to a linear model with an "ordinary least squares" regression (LR). This procedure is an attempt to decompose the demand data observations into an initial level, a trend component, and noise components, which are modeled as the errors in the regression estimates. Once established, the model can be used for several periods, or it could be updated and re-estimated as each new data point is observed. It would often be the case that items in a logistics system exhibit demand patterns that include both trend and seasonality. It is possible to combine the logic of Holt's procedure for trended data and the seasonal index approach so as to forecast level, trend, and seasonality. This approach is embodied in Winter's Model for Trended/Seasonal Data (HWAA). Each component term of the forecast is estimated with exponential smoothing, and separate smoothing coefficients.

Out of many forecasting models discussed above, no single model is appropriate to forecast the demand of different products in the market. Best suitable of these techniques need to be selected for each individual product and the raw materials used for the respective product. In this paper, a particular type of yarn, maral combat, has been picked up to forecast its future consumption by using all the above mentioned techniques. The actual consumption and forecasted data for each of the techniques are shown in Table 1.

Few criteria have been chosen to select the most suitable technique for the particular yarn. Values of Cumulative forecast error (CFE), Mean absolute deviation (MAD), Mean square error (MSE) and Mean absolute percent error (MAPE) and Tracking signal (TS) are shown in Table 2 that are being used to select the best model to suit the material.

From the table, it is obvious that MAD, MSE and MAPE values are the minimum for the Adaptive Exponential Smoothing model. In addition, CFE and TS values are also considerably lower for Adaptive Exponential Smoothing. Thus, it can be ascertained that, for the chosen yarn, maral combat, Adaptive Exponential Smoothing is the most suitable forecasting technique to be used. Figure 1 shows the forecasting trend of few techniques those give better result in forecasting the demand of the selected material. The trends also support the Adaptive Exponential Technique among all the models.

3. Supplier Selection

Since a decision maker bases judgments on the knowledge and experience, then makes decisions accordingly, the AHP approach agrees well with the behavior of the decision maker. The strength of this approach is that it organizes tangible and intangible factors in a systematic way, and provides a structure yet relatively simple solution to the decision making problem.

Decision making process needs to consider multiple criteria, which are often qualitative and conflicting as well in nature. This requires multi-criteria evaluation using Analytical Hierarchy Process (AHP) technique developed by Satty [5]. Analytical Hierarchy Process (AHP) presents a different approach for the situations in which ideas, feelings & emotions are quantified to provide a numeric scale for prioritizing decision alternatives. Figure 2 shows the process flow of AHP technique for the supplier evaluation.

The crux of AHP is the determination of the relative weights to rank the decision alternatives. Assuming that there are n criteria at a given hierarchy, the procedure establishes a $n \times n$ pair-wise comparison matrix, A, that reflects the decision maker's judgment of the relative importance of the different criteria. The numerical results of attributes are presented to the decision maker(s) to assign relative importance according to a predefined scale. A judgment matrix is then prepared to evaluate the criteria and the suppliers. Normalized weights of each of the criteria and suppliers have been calculated using equation (1).

$$\begin{Bmatrix} 1 & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & 1 & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & 1 & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \\ a_{n1} & a_{n2} & a_{n3} & & a_{nn} \end{Bmatrix} \xrightarrow{\text{Geometric Mean}} \begin{Bmatrix} b_1 \\ b_2 \\ b_3 \\ \vdots \\ b_n \end{Bmatrix} \xrightarrow{\text{Normalized Weight}} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{Bmatrix} \quad (1)$$

here, a_{1n} = priority of criterion/supplier 1 to criterion/supplier n

a_{n1} = priority of criterion/supplier n to criterion/supplier 1

$x_1 \dots x_n$ = overall priority vectors of the selected criteria/suppliers

In supplier qualification evaluation for the mentioned yarn, maral combat, three different suppliers have been short-listed to be evaluated based on 11 different criteria. The chosen criteria are: quality, quantity, versatility, lead time, cost, reputation, experience, relationship, transportation, payment flexibility & bureaucracy advantage. The decision maker has decided the priority to be assigned to each criterion compared to the others. In Table 3, the values of the top-most row indicate which criterion is given how much preference compared to the each of the other criteria. The remaining cells are automatically calculated from the cells of the top-most row using a simulation model that confirms the consistency of priority matrix.

From Table 3, a normalized matrix has been calculated to find out the average priority for each of the criteria. This calculated priority factors is shown in Figure 3.

After prioritization of each of the criteria taken into consideration, all selected suppliers are then prioritized based on each category. For example, supplier A is 0.5 times preferred to supplier B and 3 times preferred to supplier C with respect to quality. Similar preference matrices for different suppliers with respect to few selected criteria are shown in Table 4.

Finally combining the priority matrices of both criteria and suppliers for each criterion, an overall priority matrix has been generated using the mathematical model of Analytical hierarchy Process (AHP). Table 5 represents these final overall priority values of each pre-qualifying supplier for our case study.

Twelve different criteria and three alternative pre-qualified suppliers have been considered in this study. Acceptance is checked for each priority matrix. Acceptability of alternative and attribute is measured in terms of consistency ratio (C.R.) which is the ratio between consistency index (C.R.) and randomly generated consistency index (R.I.). Here both qualitative and quantitative criteria are considered. The qualitative criteria are judged by expert opinion and quantitative criteria are judged against the collected and calculated quantitative data. By analyzing, the overall priority values are calculated for different suppliers. Supplier B has the highest overall priority value, then supplier A and supplier C respectively. So, Supplier B should be selected from three different qualified suppliers. In figure 4 below, overall priority values of the pre-qualifying suppliers for our case study is represented graphically. It is associated with its quantitative portion for its easy understanding. From the diagram and overall priority table (Table 5), we can easily find that supplier B should be selected due to its highest overall priority.

4. Conclusions

A detailed analysis has been done to customize the best forecasting model for a selected raw material used in the concerned factory. The obtained result shows that the adaptive exponential smoothing method can forecast the future demand of the particular raw material very precisely. Similarly, demand of any other raw material used in the factory can be forecasted using the most suitable out of different forecasting models through similar analysis.

Later, Analytical Hierarchy process (AHP) has been implemented to select the best supplier based on few important criteria. The same raw material that has been selected for demand forecasting was chosen to serve the purpose. Combining the priority factors of each criterion over the other as well as of each supplier over another, the best supplier has been selected for the concerned raw material. Through converting subjective judgment into quantitative form, AHP provides a better solution for selecting the best suitable supplier with less effort.

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Table 1. Actual consumption (tons) and forecasted data (tons) in 12 month period

Model	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
SA	20	21	20.5	20.7	21	21.8	22.8	24.6	25.6	26	26	25.5
MA	20	19.5	20	20.67	21	22.67	25	29.33	32	32.33	29.33	25
WMA	20.5	20	22	21	21.2	22.8	25.2	29.6	31.8	31.3	29.2	24.9
SES	20.3	21	20.85	20.87	21.04	21.64	22.59	24.45	25.73	26.22	26.19	25.26
SESLT	19.9	21	20.81	20.8	20.99	21.79	23.20	25.98	28.36	29.81	30.42	29.57
DES	20	21	20.98	20.96	20.97	21.07	21.3	21.77	22.37	22.95	23.43	23.71
DESLT	20.5	21	20.7	20.77	21.12	22.3	24.11	27.6	29.69	30.08	29.43	27.09
AES	20.7	21	20.85	21.92	24.73	27.16	24.99	34.3	28.19	26.92	25.12	19.67
LR	23.27	25.58	23.9	24.21	24.53	24.84	25.16	25.47	25.79	26.1	26.42	26.73
HWAA	20.8	22	20.9	22.3	21	20.78	23.37	27.14	30.01	31.48	34.53	31.24
Actual	21	20	21	22	25	28	35	33	29	26	20	20

Table 2. Forecasting errors using different techniques

Model	CFE	MAD	MSE	MAPE	TS
SA	23.54902	4.405283	32.15264	16.43619	5.345633
MA	0.6666679	5.333333	35.65432	20.79569	0.1250002
WMA	-7.63E-06	5.55	36.7075	21.57678	-1.37E-06
SES	23.14943	4.409149	32.93404	16.37703	5.250317
SESLT	6.2733	5.0779	41.8572	20.1208	1.2354
DES	38.488	4.9788	41.712	17.6498	7.7304
DESLT	5.104	4.5186	32.2168	17.8278	1.1296
AES	4.1353	2.6562	10.0642	10.4376	1.5568
LR	0	4.0355	24.3199	16.1576	0
HWAA	-3.5473	7.6212	75.7807	30.7724	-0.4655

Table 3. Priority matrix of different criteria

	Quality	Quantity	Versatility	Lead Time	Cost	Payment Flexibility	Transportation	Bureaucracy Advantage	Reputation	Experience	Relationship
Quality	1.00	2.00	3.00	3.00	2.00	4.00	7.00	6.00	5.00	3.00	5.00
Quantity	0.50	1.00	1.50	1.50	1.00	2.00	3.50	3.00	2.50	1.50	2.50
Versatility	0.33	0.67	1.00	1.00	0.67	1.33	2.33	2.00	1.67	1.00	1.67
Lead Time	0.33	0.67	1.00	1.00	0.67	1.33	2.33	2.00	1.67	1.00	1.67
Cost	0.50	1.00	1.50	1.50	1.00	2.00	3.50	3.00	2.50	1.50	2.50
Payment Flexibility	0.25	0.50	0.75	0.75	0.50	1.00	1.75	1.50	1.25	0.75	1.25
Transportation	0.14	0.29	0.43	0.43	0.29	0.57	1.00	0.86	0.71	0.43	0.71
Bureaucracy Advantage	0.17	0.33	0.50	0.50	0.33	0.67	1.17	1.00	0.83	0.50	0.83
Reputation	0.20	0.40	0.60	0.60	0.40	0.80	1.40	1.20	1.00	0.60	1.00
Experience	0.33	0.67	1.00	1.00	0.67	1.33	2.33	2.00	1.67	1.00	1.67
Relationship	0.20	0.40	0.60	0.60	0.40	0.80	1.40	1.20	1.00	0.60	1.00

Table 4. Priority matrix of different suppliers

Criteria	Quality			Quantity			Leadtime		
Supplier	A	B	C	A	B	C	A	B	C
A	1	0.5	3	1	4	2	1	3	1
B	2	1	6	0.25	1	0.5	0.333	1	0.333
C	0.333	0.167	1	0.5	2	1	1	3	1
Criteria	Cost			Reputation			Experience		
Supplier	A	B	C	A	B	C	A	B	C
A	1	0.75	2	1	0.3	0.5	1	0.7	2
B	1.333	1	2.667	3.333	1	1.667	1.43	1	2.86
C	0.5	0.375	1	2	0.6	1	0.5	0.35	1
Criteria	Payment flexibility			Transportation			Relationship		
Supplier	A	B	C	A	B	C	A	B	C
A	1	3	1	1	0.2	0.9	1	0.5	2
B	0.333	1	0.333	5	1	4.5	2	1	4
C	1	3	1	1.111	0.222	1	0.5	0.25	1

Table 5. Overall priority values of different suppliers

	Quality	Quantity	Versatility	Lead Time	Cost	Payment Flexibility	Transportation	Bureaucracy Advantage	Reputation	Experience	Relationship	Overall Priority Vector
A	0.079	0.075	0.043	0.037	0.037	0.028	0.005	0.026	0.008	0.030	0.015	0.384
B	0.157	0.019	0.021	0.012	0.049	0.009	0.026	0.013	0.028	0.043	0.030	0.409
C	0.026	0.037	0.011	0.037	0.019	0.028	0.006	0.004	0.017	0.015	0.007	0.208

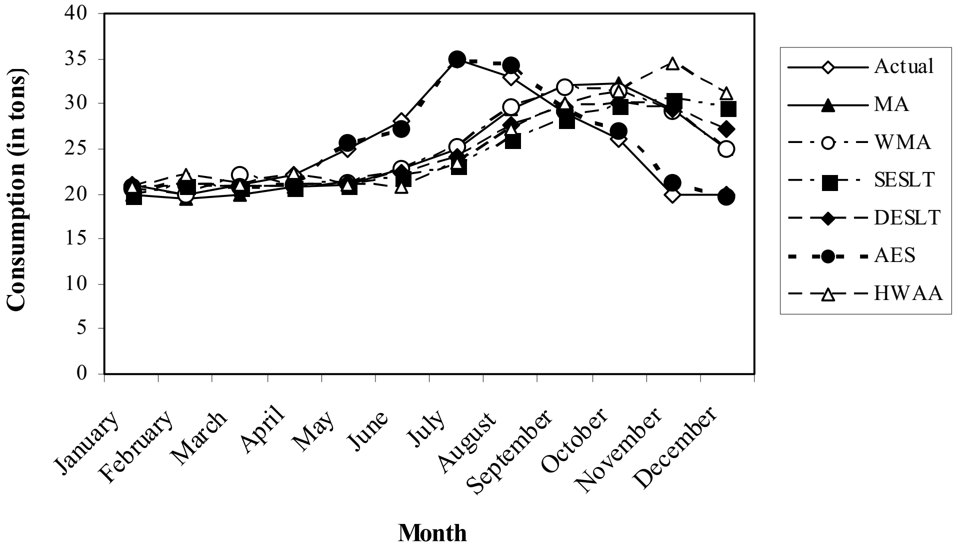

Figure 1. Forecasting trends of different techniques compared to actual consumption

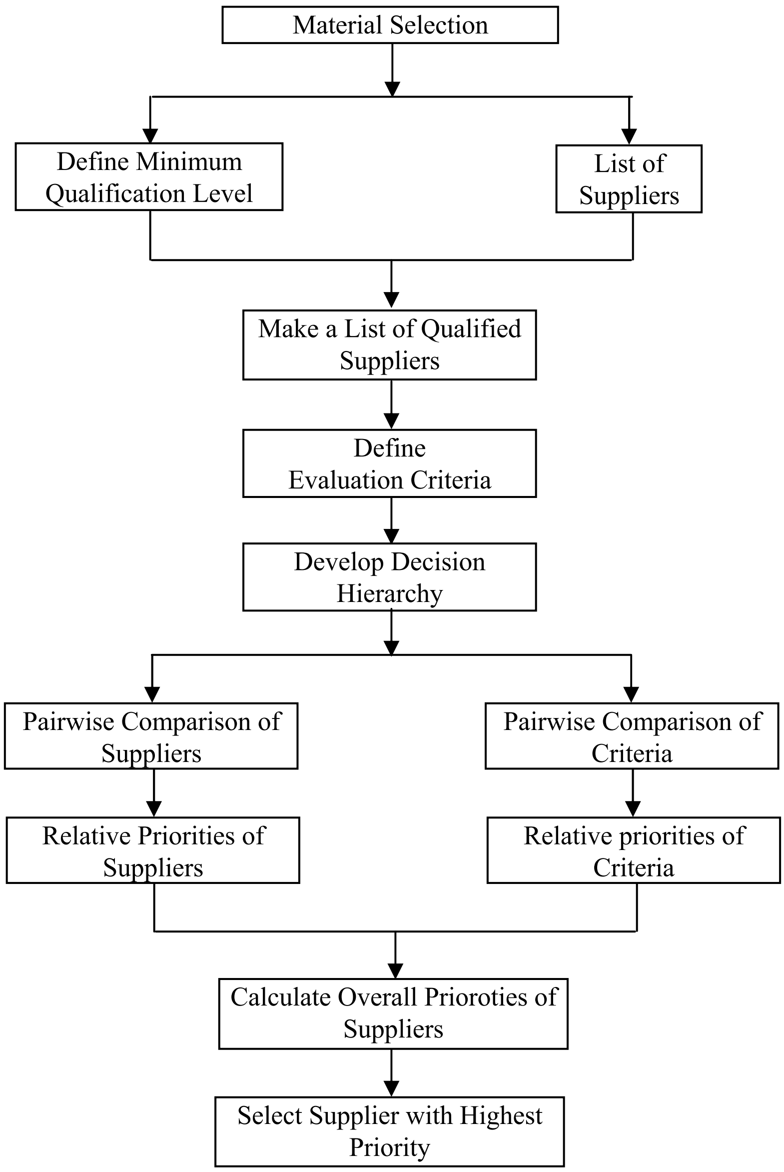

Figure 2. Process flow of AHP technique for supplier selection

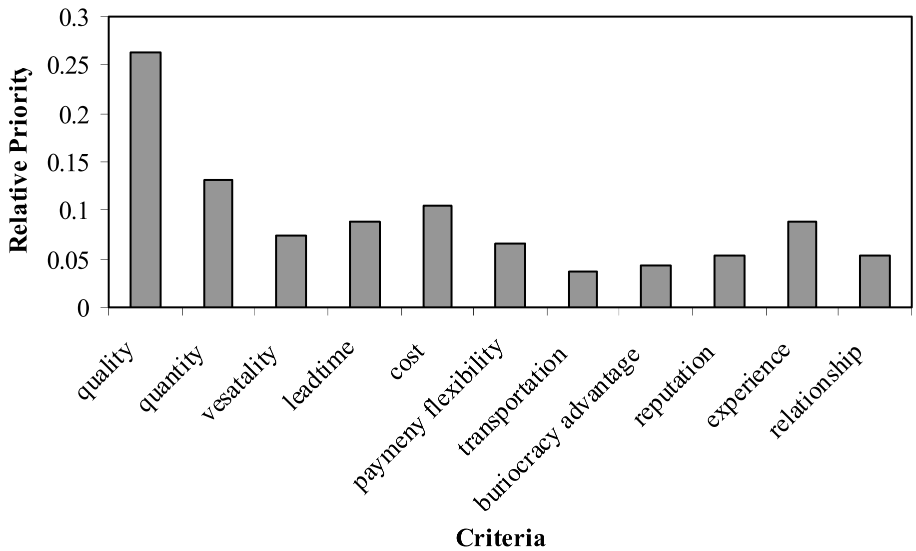

Figure 3. Calculated priority factors of different criteria

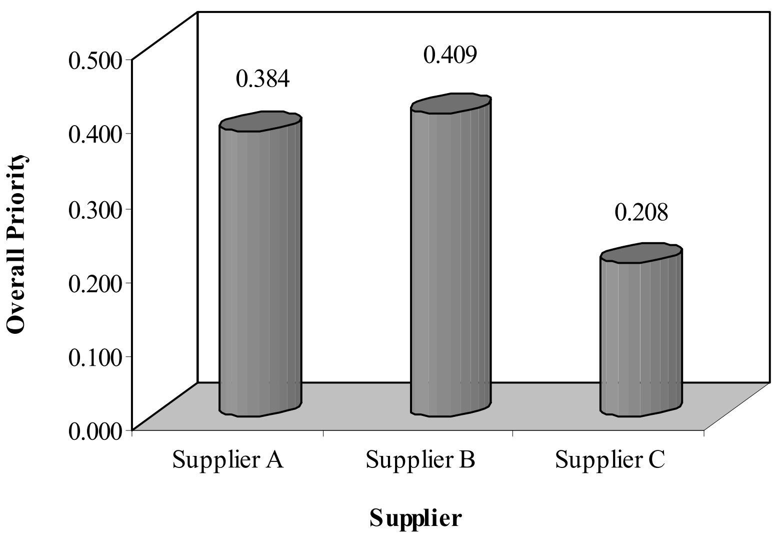

Figure 4. Overall priority values of different suppliers

International Journal of Business and Management
www.ccsenet.org/journal.html
Vol. 4, No. 5
May 2009

Managerial and Leadership Perceptions of CEOs in Leading Turkish Companies

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Abstract

The aim of this study was to examine the factors affecting the management and leadership style and managerial perceptions of managers in leading Turkish companies. The empirical research was conducted with the participation of top-level managers in the top 500 companies of Turkey and the data was statistically analyzed using the Poisson Regression Model. As a result of the analysis of the data, it was found that the number of employees working in the organization and the leadership and management styles of the managers, have significant effects on managerial perceptions of the managers. Therefore, it is suggested that the study will enable an understanding of the decision making processes of top management in Turkey.

Keywords: Management, Leadership, Managerial perception, Turkey

1. Introduction

Managers are one of the main factors that affect the success of organizations because they participate and work through the decision-making processes and have a significant influence during the organizational resource planning process. Within this framework, studies on managers' effective decision-making processes tended to focus especially on the trait theory. In the trait theory, individual factors were considered and the impact of the physical traits of the managers on the managerial processes was examined. Historically, this approach can be viewed as normal because of situational factors; it can also be said that in previous times there were no other effective factors when the subject is evaluated from the viewpoint of the managers' power source.

When this issue is evaluated historically, it can be seen that there were very successful and effective leaders, managers, kings, and strategy developers who actually applied modern management approaches. Therefore, when considering management and managerial practices, these should be assessed more widely and more rationally. In this context, it is important to find out the common values of the success of leaders throughout the centuries in order to help identify contemporary management models.

However, the process of management studies and researches occurred differently. After the theory of the "big man", the subject was examined using behavioral models. Hence, management practices were considered within organizational parameters and studies especially focused on the attitudes and behaviors of managers towards production factors. Therefore, the field of management and subject of managerial practices gained new dimensions and fresh, in-depth studies on the attributes of the general behaviors of a successful management model towards production factors were carried out. Researches were conducted in two dimensions. Before all else, a management evaluation scale was developed in order to measure how a manager acts and performs in his position. This scale was used to identify managerial characteristics from the view of employees and how the employees perceived their managers' acts and attributes could be measured with the aid of this scale. According to the findings of the scale, if the managers gained high points in the "structure" part, it meant that those managers adopted an effective process in making programs, planning, and effective communication. If their total points concerning "employee relations" were high, it meant that the managers were listening to their employees, giving them information, and trusting them. Many studies showed that giving importance to the structural and human side of the organization had positive correlations with other functions within the total organizational system.

After this, managerial studies were generally evaluated in two fields, namely, employee focused and job focused. The findings of these studies indicated three contingent factors: task structure, member-leader relation, and position power. Tasks were revealed as being "structured" and "unstructured". The tasks that had high structured property were considered as having only one method of solution and the solution was clear and evident. Leader-member relations and the manager's position were also indicated as important fields within the managerial processes. In addition, authority and power sources effective in the manager's in-group relations were found to be contingent factors which direct management processes.

The basic findings of all the management studies and researches coalesced around the same variables. The common points of the studies focused on the importance of the efficiency of managers during the decision-making processes. Especially, the resource use of organizations was considered a very important factor and a number of empirical studies were carried out on this aspect which tried to determine whether the findings supported the case or not. They concluded that existing models were inadequate to explain managerial processes and other factors also had an important effect. Despite this, all these studies and findings made an important contribution to the methodology and scientific discussion of the field. By means of these studies, management science benefited from having a well-developed model and scientific knowledge for the study of management processes emerged. These studies also contributed to the development of contemporary management models and indicated new approaches concerning today's management practices.

2. Previous Studies on the Management Process

When management researches are analyzed, it is seen that management models were examined in different dimensions and from different perspectives. In Bennis' (2004) studies, the common characteristics and behavioral models of managers, rather than the differences, were examined. The findings indicated that managers were individuals who do things right right jobs in organizations. Managers were considered as having an important role in the decision-making processes and that there were basic factors that enhanced their decision-making. One of the basic functions of managers in organizations is to concentrate on the performance of the team they manage and to inspire and motivate team members. Managers are individuals with a vision that enables the team members to reach their goals. According to Bennis (2004), one of the common characteristics of managers is the management of meaning. The managers empower the members' creativeness by means of which the members to participate in the processes and share the vision. Managers have to connect with the members' visions and the interaction that emerges leads to employees working collectively towards a common goal. Managers have to rationalize their ideas and thoughts for members of the organization and should communicate them clearly by using analogy and metaphors. An important characteristic of managers is the management of trust relations within the company. The most important property of trust is being considered trustworthy by others. This can be defined as exhibiting the same behaviors and attitudes in every circumstance. In executing the job process, being conscious of their skills during the decision-making processes and developing these skills efficiently are very important for the managers and employees. It has been emphasized that management is a process perceived by the entire workforce of the organization and which enhances collective effort, good mutual relations, and energized employees. In the organization, empowerment has a crucial role and collective effect on all employees. As a consequence of empowerment, employees feel important because they belong to a group, and opportunities for their learning and skills development are given.

All these factors indicate different dimensions of the management process and designate the variables which affect the organization and leader relationship. These factors are also important for directing the strategic decisions of managers and allowing those strategies to have an impact. Zaleznik (2004) emphasizes that the most important factor about being a manager is having "dreams". According to him, this means having the ability to transform a problem or difficulty into an opportunity. Briefly, this process means motivating others to solve problems within the organization. According to this approach, creating opportunities and finding solutions to problems are the most important factors. Being an