IMPACT OF BUSINESS FORECASTING ON DEMAND PLANNING

A strategy for improving business forecasting and reducing inventories throughout the supply chain for fast moving consumer goods in the Middle East market

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ABSTRACT
Poor quality of information and forecasting create a number of problems for manufacturing companies, such as poor planning of products and insufficient service levels, which leads to increased inventory and stock holding or stockouts and increased total costs.

Cussons (UK) Limited is experiencing precisely these problems. Apart from these problems normally associated with forecasting demand for fast moving consumer goods there is an additional problem of reconciling the Western calendar with the Muslim calendar, and a recognition of the effects that Muslim religious holidays, as opposed to Christian religious holidays, have on demand. Muslim religious holidays rotate backwards with regard to the Western calendar, but in fact they occur at known dates and therefore the effect they have on demand for products can be taken into consideration when attempting to forecast demand.

An additional problem that influences Cussons' sales in the market is the seasonal pattern of demand. Due to this, there is an increase in demand for Cussons' products during summer months. From the analysis of both data sets it was identified that the warehouse movement data is less variable and more reliable for business forecasting than order data.

In this thesis, these forecasting problems are examined as a case study, focusing on these particular problems. To overcome these problems and to improve business forecasting of Cussons' products in the Middle East market, a forecasting strategy has been suggested which will enable Cusson's to reduce the inventories throughout the supply chain and to improve their customer's service.

DEDICATION

To my parents, my wife and my children

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Introduction

1.1 Fast moving consumer goods industry

Generally fast moving consumer goods (FMCG's) are known as consumables. These are the archetypal 'marketed' goods and are heavily advertised to build awareness among the consumers about their particular characteristics. Examples of such goods are toiletries, oils and liquids, alcohol, medicines, and fast foods etc.

The industries that made consumer goods also increased in number during the later part of the 19th century. The demand for consumer goods increased as a result of a larger population, growing wages and the decrease of the traditional economy. People who moved into the cities and started to work in the factories could not make sufficient consumer goods which they needed.

FMCG's manufacturers increasingly support geographically extended supply chains in a fast changing market. As a result, the gathering and processing of data across the extended supply chain has now become critical to survival in the industry. New product or brand development and introduction is key and equally requires optimisation and integration of both internal and external processes.

The FMCG industry includes thousands of manufacturers. The industry is dominated by a few companies selling well known brand name products. Typical of such companies are Proctor and Gamble, Colgate Palmolive, Lever Brothers etc. Due to tough competition in the market place and special response by manufacturers, delivery patterns in this sector are changing rapidly. Retailer-owned regional warehouses have been reduced in number and are being replaced by deliveries direct to store. In this industry there is little room for wholesalers, which are becoming virtually extinct. For retailers and manufacturers alike, inventory control mechanisms have become very sophisticated and information technology has contributed significantly.

1.2 The Importance of Business Forecasting

It is important to mention here that in just in time (JIT) systems, customers expect timely product deliveries in the right quantity at the right place. In any industry if the producer's lead-time is greater than the customer's lead-time, it is necessary to forecast customer's demand and produce to stock. This phenomenon is clearly shown in figure 1.1.

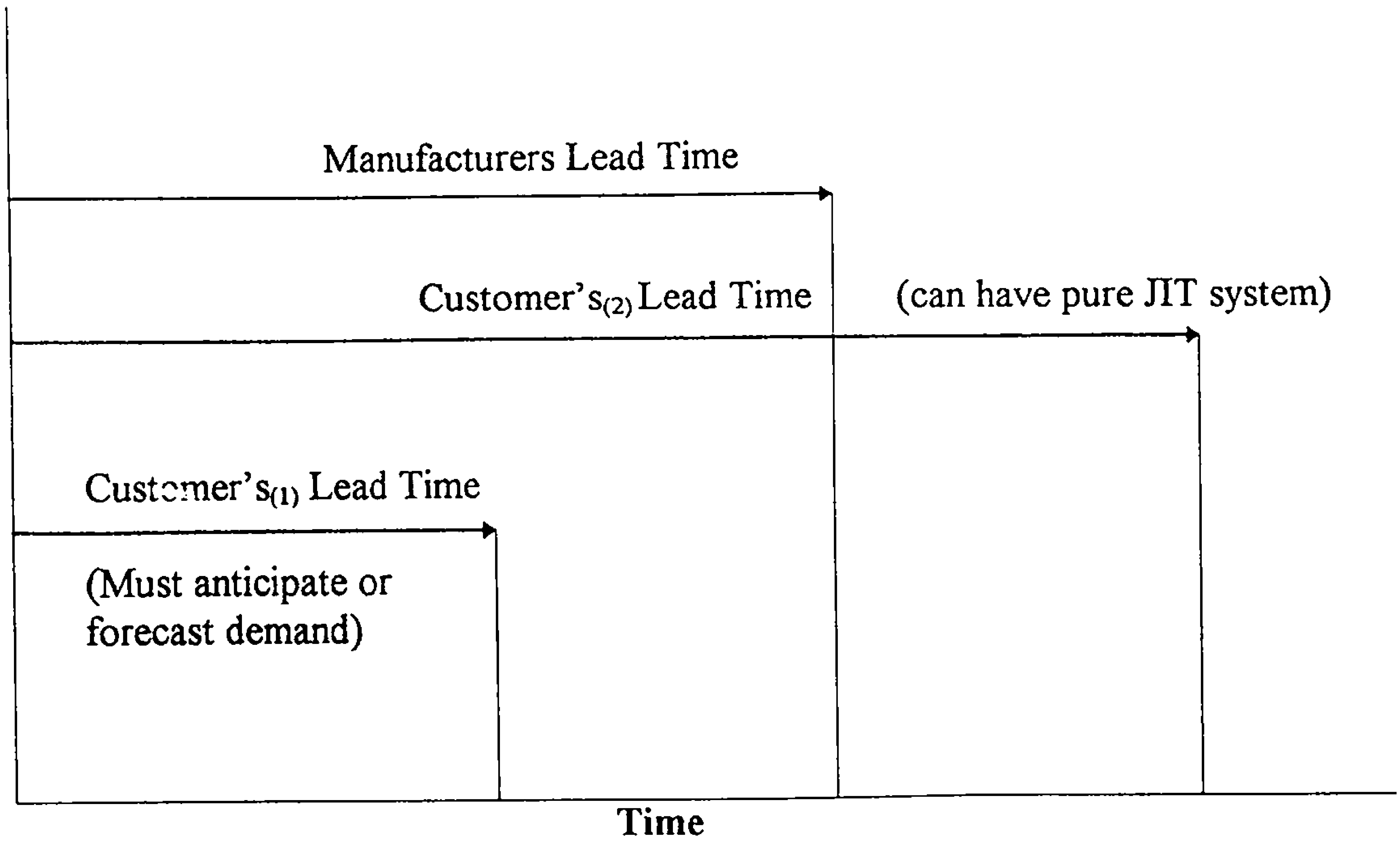


Figure 1.1. Forecasting the demand in JIT manufacturing systems.

In this situation forecasting is an indispensable activity in production planning. Forecasting accuracy is always a problem when demand patterns vary considerably over time, however availability of computing hardware and forecasting software has facilitated the forecasting process with improving accuracy (Sanders, 1995). Accurately forecasting future demand is very difficult, but is necessary if firms are to succeed. The American Production and Inventory Control Society (APICS) dictionary defines forecasting as " the business function that attempts to predict sales and use of products so they can be purchased or manufactured in appropriate quantities in advance". Thus demand forecasting is central to the planning and control functions of the firm.

Forecasting is one of the oldest management activities. The choice of forecasting method must start by a clear statement of the purpose for which the forecast is being made. Some managers believe that there exists an all purpose forecast which once made can be used for a wide variety of purposes. This is not so. Forecasts which form the basis of decisions about the development of new products or the construction of new factories are different in terms of the time span they must cover and the detail which is needed from those which are concerned with which products should be next manufactured, in what quantities, in what size or colour. In logistics most decisions are of two types, medium term concerning such matters as locating and sizing warehouses and sources of supply, and short terms usually up to six months, concerning what to manufacture, ship and stock. Forecasting is therefore an important aid in effective and efficient planning. Production planning and controlling logistics activities require accurate estimates of the product volume to be handled by the logistics system. These estimates are typically in the form of forecasts (predictions). Forecasting demand level is vital to the company as a whole as it provides the basic input for the planning and control of all functional areas including logistics, marketing, production and finance. Demand levels and their timing greatly effect capacity levels, financial needs and general structure of the business. Each functional area has its special forecasting problems such as materials deliveries and plant capacity etc.

Organisations often rely on two types of forecasting, namely judgmental and statistical. The best forecasts are usually arrived at from a combination of these methods. Some companies still un-necessarily rely on judgmental forecasting. Makridakis et al (1993) state that any alternative which involves judgmental forecasting will inevitably fail as the amount of effort and the monotony of the work involved excludes the possibility of any human doing the job without getting seriously bored and being ineffective. Judgmental forecasts are greatly influenced by wishful thinking and special considerations. Furthermore, judgmental biases are common in forecasting (Hogarth and Makridakis 1981; Moriarty and Adams 1984; Schnaars 1984). Judgmental forecasts can lead to large and systematic errors caused by bias, in the way information about the future is processed.

On the other hand, there are many situations where judgement ought to override quantitative forecasts. For example to modify modifying a forecast in order to incorporate additional information, for instance inside knowledge, known changes, and market intelligence. This improves the accuracy of predictions because quantitative methods can only identify and extrapolate established patterns and relationships assuming constancy of conditions. That is future patterns are assumed to be a continuation of past ones. Given the importance of accurate forecasting, business organisations need to increase acceptance and the use of statistical forecasting methods, where appropriate, to better manage their forecasting function. This is increasingly possible as sophisticated statistical forecasting methods are becoming available through computerisation. But purely statistical approaches have met with several challenges. First, in empirical comparisons, statistically sophisticated techniques have not performed as well as simpler approaches. Second, though a considerable number of companies have instituted the use of such techniques at one time or another, many have abandoned them because decision-makers find them difficult to use or understand (Lawrence, 1983 and Dalrymple, 1987). Finally, managers possess important information that goes largely untapped by purely statistical approaches. As a consequence, many managers choose to rely upon unaided judgement instead.

A good forecasting strategy should address these issues. It should be relatively accurate, at least in comparison with the results of assuming that things never change. It should be usable and understandable by managers and other decision-makers, and it should incorporate knowledge that they consider important. In short, models and human judgement need to be integrated and delivered to decision-makers in a useful form.

Lines (1996) claims that the driving force for a company's operations is forecasted demand which will have to be met. Without a forecast there is no basis on which to determine what to stock, what to ship or what to manufacture.

Forecasting is also an effective part of inventory management. A good inventory management system should produce forecasts that are stable in the face of random fluctuations, but responsive to real changes in sales. Forecasting should be used to reduce lost sales whilst minimising the amount of inventory held within the business. Forecasting employs historical sales data and uses advanced forecasting methods to make accurate estimates of future demand. Organisational forecasting serves as a basis for all other business decisions. The quality of these business decisions can only be as good as the forecast on which they are based.

Furthermore, forecasting is the prediction or estimation of the occurrences of uncertain future events. Forecasting offers an organisation some foresight in the premeditation of appropriate courses of action. Its purpose is to make use of the best available information to guide future activities toward organisational goals; Tersine (1988). In short, the need to forecast cannot be managed away in many situations. The real question is how forecasts can best be prepared.

A crucial aspect in determining demand in the FMCG industry is market intelligence. This covers aspects that influence demand that cannot be incorporated in demand planning, which functions on historical data alone. Aspects of market intelligence are promotional activity, the effect of competitor's advertising and promotions activities, price increases or decreases, new account listings or delistings, new product launches, etc. With such behaviour, there is an increased need for demand forecasting in the FMCG's business environment. The reason why forecasts are necessary in the FMCG industries is because manufacturing lead times are usually greater than customer lead times. On the basis of forecasting, manufacturers are providing the product deliveries required by their customers on time.

Cusson's major customers are the supermarket chains, namely Asda, Somerfield, Morrison, Safeway, Sainsbury, Tesco, Waiterose, Boots, Makro, Nurdin and Peacock, and Londis. In these supermarkets, Cussons has adopted a quick response system (QR).

Cussons has also a very long list of competitors in the market place which in many cases are much larger companies. Its competitors are Lever brothers, Proctor and Gamble, Colgate Palmolive, Sara Lee, Elida Gibbs, Boots etc. Due to this, Cussons has always tried to compete by providing a better service to their customers.

Cussons (UK) Limited is a modern manufacturing company within the FMCG industry. It competes in a market place in which its major competitors are large multi-nationals, and yet it has gained a reputation with its customers as the leader in quick response. QR is the ability to provide customers with high service levels and short delivery lead times, less than 24 hours from receipt of order to delivery to the customer's distribution centre. Service level refers to the number of units that can be supplied from stock currently on hand. For example, a service level of 98% implies that orders will be met on time with a probability of 0.98. Cussons has gained this reputation over the last five years with QR initiatives in partnership with a number of large multiple retailers. QR at Cussons was installed and developed under a teaching company programme between Cussons (UK) Limited and the University of Bradford, half financed by the Science and Engineering Research Council (SERC) and half by Cussons (UK) Limited. Benefits of this work are being seen by retailers in reduced inventory investment; up to 90 percent reduction in one particular case. These initiatives are described in Betts et al (1994).

The development of QR initiatives, which reduce customer's stocks and delivery lead times is of great commercial benefit, but if the companies operating in the FMCG sector are to extend these benefits further down the supply chain, they must look at their internal processes. An unresponsive planning process will create delays and bottlenecks both within the company and also with their suppliers.

1.3 Background of Cussons (UK) Limited

Cussons (UK) Limited is a medium sized manufacturing company with a long history of producing household cleansing products and toiletries. It is one of the UK's leading manufacturers of soap, toiletries, and household products. Among its famous brands are names like Imperial Leather, Cussons Pearl, Morning Fresh, and 1001 (Carpet Cleaner). All of the products are known for their quality, consistency and affordability. From a modest beginning in the north of England, Cussons has become an international company. In many parts of the world, particularly Australia and the Far East- its products are well established.

Throughout this development, though, the company's headquarters and ownership have remained in Manchester. In 1837, the start of the dynasty, Thomas Tomlinson Cussons was born. At the age of 32, he opened Chemist Shops in Ossett and Louth. After about two decades at the age of 54 years, he opened another shop in Swinton with his 16 year old son Alexander. He made his elder son William, incharge of other two shops. Sixteen years later in 1907, Cussons further expanded their business by making and packing Cough Sweets and Turpentine and packing Chocolates, Cough cures, and Jam under contract. In 1920, a soap plant was installed at Kersal Vale. Production continues there today and the building was also the company's UK head office. After one year in 1921, Cussons acquired Bayley of Bond Street, Perfumers who have held warrants for four successive monarchs. Bayley of Bond Street hold the distinctive fragrance, which later formed the basis for Imperial Leather soap. Three years later in 1924, Leslie Cussons joined the company. After two years in 1926, South Africa became Cusson's first export market receiving baby powder and soap. Soon after that in 1927, the Tower soap company of Radcliffe was acquired. Keeping in view the demand for their products, Cussons established their first factory outside the UK in South Africa in 1930, run by Alex Stockton Cussons. In 1941, the Kersal Vale factory was commandeered by the Royal Navy. During the war Cusson's products were made by Lever Brothers. In 1946, Imperial Leather was a sizeable brand and by now, supported by advertising worth 100,000 pounds per annum. Five years later in 1951, Alexander Cussons died and was succeeded by Leslie Cussons as chairman. Cussons acquired Gerald Brothers Limited, soap manufacturers in 1955. Gerald Brothers were the founder members of the company.

During 1957, Cussons also acquired PC Products Limited, which developed the 1001 product and made it available nationally. In 1962, one continuous soap plant was installed followed by a second in 1970. One year later in 1963, the company's name was changed to Cussons Group Limited and an export company, which formed Cussons (International) Limited. Alex Cussons became its chairman. In 1972, Cussons Group acquired World Agencies in Australia to strengthen its presence in the country. The present owner of the company is Peterson Zochonis, who acquired Cussons in

1975. In 1982, the new soap finishing room was built and was moved from Manchester (Kersal Vale) to Nottingham in 1983.

During the 1990's, Cussons (International) Limited became the main operating company of the Peterson Zochonis group in the UK, which serves the group world-wide. Today, Cusson's manufacturing facilities are available in 10 countries world-wide and one or more Cusson's products are sold in virtually every country. Of many markets, the Middle East is the most erratic market for Cusson's products.

At the moment the company is producing 340 different items and has 27 manufacturing lines. Every product which has a unique stock number is considered an item. Some people use other terms and one common alternative is stock keeping unit (SKU) instead of item. The Nottingham plant has 11 manufacturing lines of which five lines are reserved for Imperial Leather soaps. It is only a manufacturing plant, sales, marketing, purchasing and accounts being run from Cussons House in Stockport. Cussons soap products comprise Imperial Leather (IL), Pearl, Mild Cream, My Fair Lady (MFL), Buttermilk and soap base contract manufacture. There are different combinations which comprise SKU's. Cusson's manufacturing capacity is 1000 tons/week of bulk soap and 1000 tons/week of finished soap.

Cussons has adopted 3 shift system of 8 hours each, the plant runs 24 hours per day without any break. Presently, in the Nottingham soap plant about 370 employees are working, of whom 40 are clerical staff. Cusson's budget for Nottingham plant is 10.5 million pounds per annum, excluding raw materials. Cussons annual finished soap production is roughly 180 million tablets, of which 9 million dozens are Imperial Leather, 2 million dozens are Pearl, and one million dozen is Mild Cream, and the remaining a balance of other products. On the administration side Cussons has one manager for every section.

1.3.1 Cusson's Market Size and Shares

Cussons (UK) Limited has also shown significant improvement in its market sector. It has maintained a good record of market share for the different products. In a competitive world, most companies are striving for survival. Cussons has not only achieved its target in its market sector, but at the same time, it has improved the quality of its products. Cusson's market size for the different products is depicted in table 1.1.

Table 1.1. Market sizes and shares of different Cusson's products.

Serial no:	Cleansing, toiletories and househlod products	Market size	Cusson's share
1	Bath soaps	£123.874 million	1.9%
2	Carpet cleansers	£14.887 million	38.1%
3	Lime scale remover	£11.458 million	16.8%
4	Liquid soaps	£22.582 million	22.2%
5	Shower gels	£72.450 million	11.9%
6	Toilet soaps	131.534 million	23.0%
7	Washing up liquids	£114.844 million	10.2%

QR is a major area of interest in the FMCG. The majority of work in this area is being undertaken in the United States, with the major supermarket chains including Wal-Mart and K-Mart. The UK, however, is much better placed to take advantage of the benefits QR can deliver to the supply chain. This is due to its geographical size and its established standards for electronic data interchange (EDI).

Cussons has a very successful QR system operating with Tesco Stores Ltd., one of its largest customers. It has endeavoured to remain flexible in meeting individual customer's needs rather than imposing a standard system. The Tesco process is based on the customer ordering replenishment stock six days per week with the delivery being made the following day. This requires the customer to hold a small safety stock in its central distribution centre to cover a daily variation in demand and a one day lead-time (Betts et al, 1994).

Cussons holds a small inventory in a satellite depot, close to customers' distribution centres. The cost of this local inventory holding is offset by the reduction in inventory level provided by reduced uncertainty of service, due to the shortened geographical distance between Cusson's warehouse and the customer. Cussons have employed several replenishment techniques such as holding inventories close to their main customers to meet the customers orders on time and to reduce distribution costs. For further explanation see Betts et al (1994).

Currently four supermarkets are co-operating with Cussons with the object of further improving Cussons service to its customers. These customers are supplying Cussons with data on movements of Cusson's products from warehouses to supermarkets. Warehouse movements data are the monthly movement of a product from customer warehouse to retail outlets. The variation of these movements over time is far less erratic than the order data. Because this co-operation exists and the order data behaves so erratically Cussons is building demand forecasting models using time series data on movements from warehouses instead of order data. Demand is being forecast by product by each large customer. The residual demand, that is demand by the remaining customers, is being forecast as before. The residual demand, which represents demand from smaller customers, is forecast by Cussons using the order data. This is because it is unrealistic to expect smaller customers to cooperate to the same degree as large customers. In fact smaller customers probably will not capture the data necessary for building forecasting models in the same way as large customers. Furthermore, it would become far too complex if models were developed to predict demand for each product by customer for all customers irrespective of the size of demand. The problems Cussons have with forecasting demand by customers in the home market, however are small compared to those it faces in the Middle East market.

1.4 Brief Overview of Business Forecasting Requirements in the Middle East

The common approach to forecasting is to attempt to identify decision making methods that, through understanding the past, can be used to predict what might happen in the future. Developing and evaluating these decisions making methods has been the work of scholars and practitioners for decades. Various survey and study findings are still openly discussed, as there seems to be no one common forecasting approach or method that is superior to all others (Armstrong and Lusk 1983, and Makridakis 1986).

Cussons sells approximately 120 SKU's in the Middle East with an annual turnover of around £ 4.7 million per annum. Cussons like many modern manufacturing companies organises its production by initially forecasting demand for each SKU. Forecasted demand is then expanded into the demand for components and raw material that are used in each SKU using Manufacturing Resource Planning (MRP-II) software. Demand for raw material and components are then aggregated across SKU's and orders placed with both internal and external suppliers.

As mentioned earlier, the most erratic market for Cusson's products is the Middle East. It is perceived that the behaviour of the market generates a large proportion of 'noise' that exists in the demand for Cusson's products. The randomness often found in time series data is frequently referred to as noise (Coyle et al, 1992). This term comes from the field of electronic engineering where a filter is used to eliminate noise so that the information in a signal can be identified. Customer orders have shown large variance in demand. Cussons has always been compelled to hold large inventories to ensure that they meet customer demand with a high service level. The historic need to carry high stocks has not always been because of the behaviour of the customers, the company itself often contributes to erratic demand behaviour through constant promotional activity.

To smooth out demand it is in Cusson's interest to collect the downstream data from large customers for forecasting. This in fact Cussons does. Much smaller customers mostly populate the Middle East market. Smaller customers both at home and in the Middle East probably will not capture the sales data. In this situation, Cussons can collect warehouse movement data from the distributor, which is automatically collected. Order data is usually not as effective in forecasting demand as warehouse movement data, because it usually behaves very erratically. However attempts at forecasting demand can be made using both data sets.

The Middle East region is mostly populated by Muslims. Muslims celebrate Islamic holy festivals twice a year, which are Ramadan and Zil'haj occurring in the 9th and 12th months of the Islamic calendar. Once a year, in the 12th month of Islamic calendar millions of Muslims from all around the world perform the Hajj in Saudi Arabia. These Islamic festivals generate increased sales of goods. Generally, the demand pattern in the Middle East is seasonal, because it is north of the equator and subject to seasonal weather patterns. Peak demand for the toiletries occurs in the summer, with low demand in winter. In these situations, the requirements of business forecasting in the company are even greater. It would therefore seem to be of the value to take these festivals and seasonal factors into consideration before making business forecasting plans.

Forecasting often has little impact on decision making. This may be caused by a lack of relevance of the forecast, in terms of what, when, how, and in what form such forecasts are provided. It is also the case that forecasters tend to concentrate on the well behaved situations that can be forecast with standard methods, and ignore the more dynamic change situations that decision makers most need to forecast. It is important; therefore to look at ways of forecasting when patterns or relationships change, and to measure the extent of uncertainty involved.

The forecasting software being used by Cussons is Manugistics, supplied by a United States company of the same name. Manugistics uses Fourier analysis on time series data. Although it is unusual to employ Fourier analysis in time series forecasting models the software was chosen because it was the closest product available on the market to meet Cusson's needs (Betts et al, 1994).

1.5 The plant behaviour

Figure 1.2 shows the actual soap production against the potential soap production on a weekly basis for 26 weeks provided by the soap finishing room (SFR). The output shown in this graph is much less than the plant capacity.

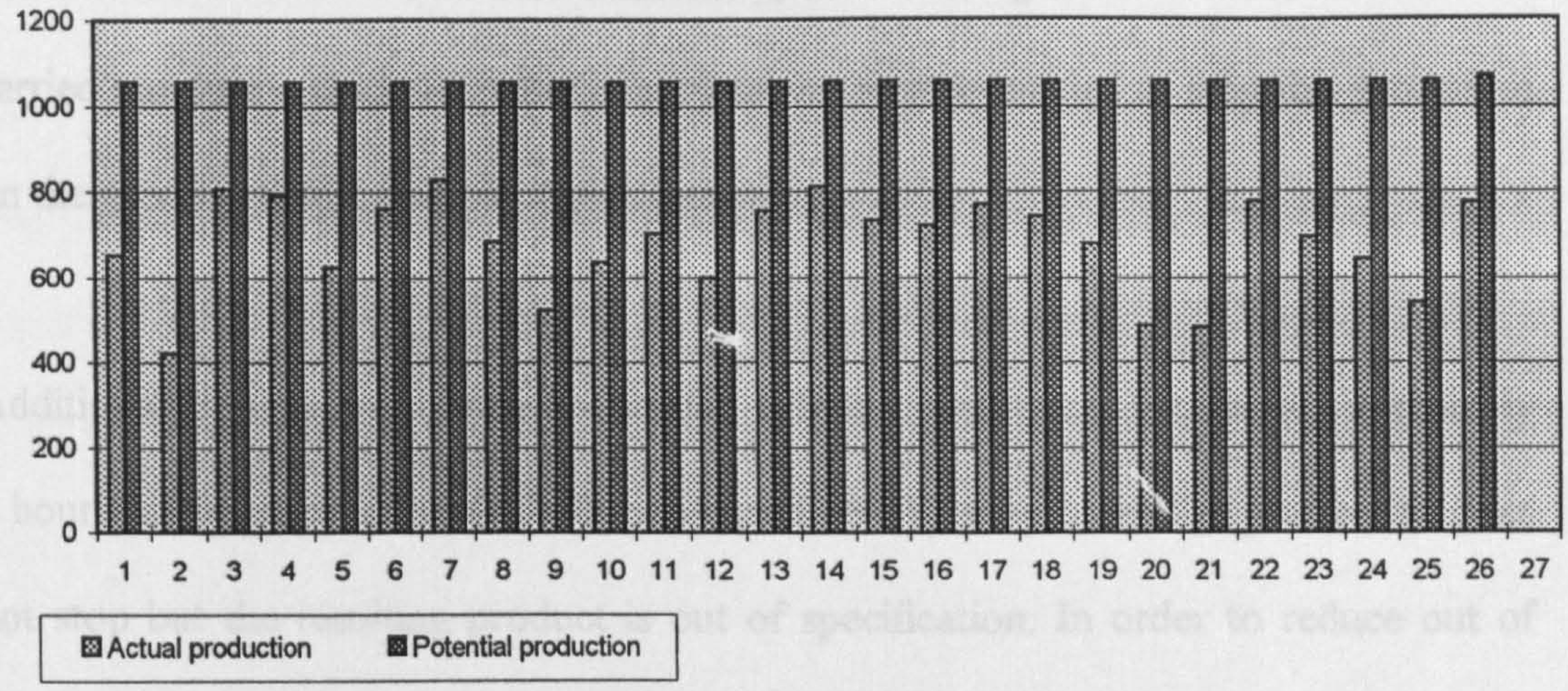


Figure 1.2. Actual soap production as compared to potential soap production.

Discussions with various company managers and personnel revealed and there was general consensus of opinion that due to heavy demand for soap by Cussons' customers, the plant is running 24 hours a day, seven days a week without any break. In this situation, the plant lacks proper maintenance which resulting in frequent breakage and shut-downs.

It became apparent that there is no policy of preventive maintenance (PM) but the company's maintenance policy amounts to little more than a run to breakdown policy. This has evolved because of the high demand at the soap manufacturing (SM) plant.

The maintenance department had a maintenance-scheduling programme but again because of the need for the machines to be in constant use, the scheduling was put aside or deferred to a later date. Previously, the servicing and maintenance had been carried out during the holiday periods. However, it was decided to stop this procedure on the grounds that it was not cost-effective.

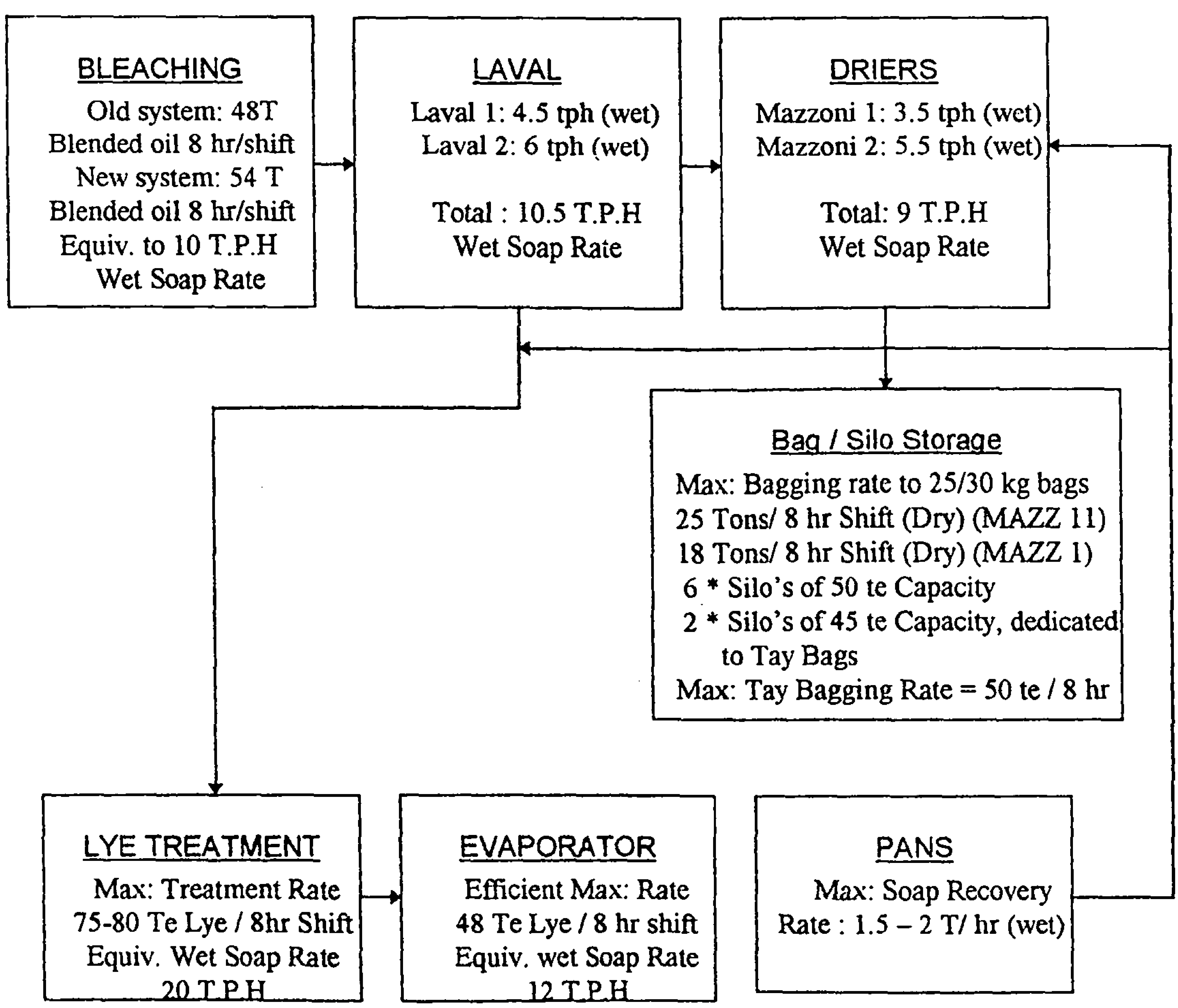
Additionally, there is no proper policy for different soap basis. It takes approximately 2 hours to changeover from 40:60 soap base to 83:17 soap base. The production does not stop but the resulting product is out of specification. In order to reduce out of specification material, some planning and co-ordinating between the SM plant, the SFR, the logistics department and marketing is needed. Then it should be possible to set a schedule to limit the number of changeovers and thus the amount of out of specification. In this connection, the close co-ordinating and planning between various departments could lead to reduction in out of specification soap.

Furthermore, the interviews with the company personnel's revealed one thing in common that the plant is old and lacks proper maintenance, so its efficiency has been reduced. At the moment, the achieved productivity in the Nottingham soap plant is approximately 50-60%, which is not world class. This is one of the many reasons, by which supply variability occurs in Cusson's products.

1.6 Sources of supply variability

Table 2.2 reports Cussons' production process constraints. The theoretical capacity of each process is mentioned in this table. For the purpose of this review an in-depth study of each process was necessary so direct observation was followed up by interviews with the management staff, shift managers, technicians and all the other personnel's involved in the SM process and SFR.

Table 1.2. Cusson's production process constraints.



In this table, the old system is shown in the bleaching department. The old system rate can be reduced by the slow filtering of fat. This can transfer the overall production constraints to the bleaching department. The new system rate is governed by the cycle time of the bleaching vessels.

Discussion with various employees revealed and there was consensus of opinion that the bottle-necks stemmed from the 'Drier'. Laval capacity utilisation is negatively affected by the capacity of the Drier. Presently Laval just meets the Dryer's capacity of 8 tons wet soap per hour against a demand of 11 tons wet soap per hour. But when Mazzoni 1 commonly known as Drier 1 with a capacity of 3.5 ton wet soap per hour is replaced with a Drier of the higher capacity this may not be the case. At this stage, the drying capacity will increase 2-3 ton wet soap per hour and theoretically it will reach the target level but there is a danger that the bottle-necks may stem from other departments, namely Laval and Bleaching even though this should not happen theoretically. In this connection, the Bleaching and Laval capacity is also below the target level. It is important to check the planned targets against the achieved production. This should be done by every shift and it is also important to record the production consumption and the capacity utilisation of the individual plant.

Furthermore, the quality of the tallow affects the drying process, so quality checks are needed to avoid this type of delay. By taking some concrete measures within the plant, Cussons can reduce the supply variability by a significant amount.

1.7 Sources of demand variability

Figure 1.3 shows the demand information flow from the customers of Cusson's SFR. The orders for soap products are passed from SFR to MPS. This demand signal triggers a forecast but it is less than 100% accurate, therefore this is one of the sources of demand variability.

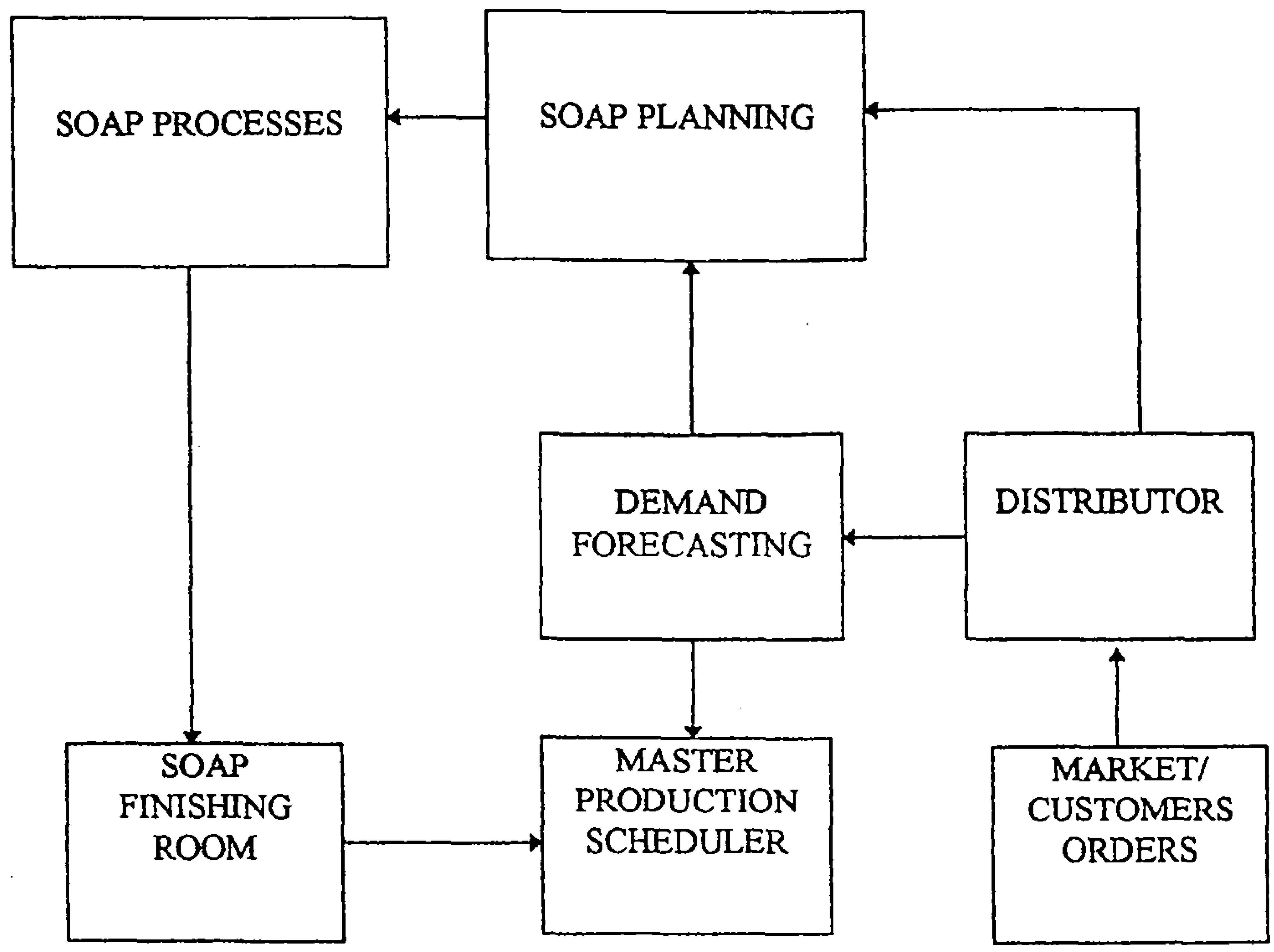


Figure 1.3. The demand information flows from the customers to the soap finishing room (SFR).

Cussons in the Middle East market distributes their products through the distributor and receives the aggregated orders for their products from the distributor for the whole market. Generally these orders are not based on actual sales and due to the lack of proper communication, sometimes Cussons unexpectedly receives large orders, which can create an imbalance between the supply and demand which affects the customer service in the market.

Another factor for demand variability can be Cusson's lead-time. In the Middle East market its lead-time is 3 months but for the same market its cycle time is 4 months, due to this factor demand amplification occurs. Forrester, the pioneer of 'industrial dynamics' clearly points out this issue of demand amplification in the product's demand and it is generally referred to as 'Forrester effect'. For the further explanation of this phenomenon see Forrester (1962).

In this era of saturated and highly competitive market place, it is important for Cussons to reduce these variabilities in the demand and better manage their supply to improve customer service because today's customer is service demanding.

Furthermore, if these factors are not taken into account they can be the cause of poor service levels. Generally this situation is not in the company's interest and the company can loose the customers if this situation prevails longer.

1.8 Reducing demand variability by reducing the cycle time

During the process when the lead-time and the cycle time of any company does not match with each other variability in supply and demand occurs. This variability leads to frequent stock-outs or huge inventories at a time and can be a cause of un-satisfactory service level to customers.

As mentioned earlier Cussons is also passing through this process of variability in the Middle East market. Due to this variability and at the same time commitment to provide better service to their customers, Cussons is always holding large inventories in the market. The reduction in cycle time and setting it to equal the lead-time may reduce this variability.

Demand variability arises from two sources namely the distributor and the customer. Customer demand has inherent statistical fluctuations. The accuracy of demand forecasting will vary as well. The imperfect nature of the demand information leads to poor forecasting and increases demand variability. Demand variability is used to set safety stocks depending on the company's planning system. In MRP-II, the demand is derived from the sales forecast, which is aggregated to provide the MPS the forecast of weekly or monthly products.

Cussons does not adopt re-order point system (ROP) in the Middle East market. Hence Cussons requires forecasts for the market. The relevant demand is Imperial Leather soap demand history, which can be used to establish target inventory levels. Taking all these factors into consideration Cussons can reduce these variabilities, which is the important factor of today's competitive business.

1.9 Organisation of the Thesis

The literature survey provides a basic framework for this research. The problem description includes consideration of the special features of the Middle East market, which has significant impact on business forecasting of Cusson's products.

Chapter 2- begins with an introduction to forecasting and it's applications and logistical planning. This chapter is based on a literature survey, and provides the basis for forecasting improvement for a medium sized manufacturing company.

Chapter 3- reviews the importance of inventories in a forecasting driven manufacturing company and their impact on forecasting and customer service.

Chapter 4- describes the case study methodology employed in this research. The criteria for selecting the medium sized manufacturing company, data collection methods and interview structure are discussed.

Chapter 5- discusses the ARIMA models and their uses in time series data.

Chapter 6- describes statistical analysis and provides a critique of the results.

Chapter 7- analyses the results by consistency tests and then discusses the hypotheses.

Chapter 8- presents the conclusions of the research together with recommendations for the future research.

Chapter Two

Forecasting and Logistical Planning

2.1 Introduction

Forecasting has a long history. An understanding of such a history coupled with the study of empirical evidence can provide invaluable information for improving the accuracy and usefulness of forecasting. Accurately forecasting future demand is very difficult, but often necessary if the firms are to succeed, and so demand planning can become central to the planning and control function of the firm.

Stock and Lambert (1987) define the aim of the demand forecasting is to estimate the amount of product and accompanying service that customers will require at some point in the future. They further explain that service levels and business forecasts are interrelated to each other. Logistics managers can decide how much of each product must be transported to the various markets served by the company, how much of each product must be placed or stored in each market area, and how the resources should be allocated to activities in order to satisfy demand. Forecasting as a logistics activity is further emphasised as companies go through the evolution stages in their approach to logistics management and organisation.

According to Bowersox et al (1986) the fundamental input to planning and co-ordinating logistics is a forecast of customer demand. By forecasting, companies aim to anticipate future uncertainty in operations. The demand forecast links a company to its market environment.

In this regard, the definition of Gattorna (1988) is of value. He compares the linkage between demand forecasting and distribution logistics planning with an open system concept. In the context of a company's logistics system, the input includes elements like finished goods inventory, transport modes, and facilities. The output of the logistics system is customer service and the process is the way the input is transformed into customer service. The process is often affected by restrictions which are factors external to the logistics system such as government regulations, competitors performance, etc.

Thus, the efficiency and effectiveness of the system depends on the effects of the restrictions as well as the internal organisation of the system. This feed back loop is the means by which output is related to input for planning and control purposes. The link between demand forecasts and distribution planning is established by the feed back loop as the forecasts form the basis for production and procurement plans, and transportation and facility decisions. The formulated plans are usually rather inflexible in many companies which means that the accuracy of the forecasts has a significant impact on the level of customer service.

Bowersox et al (1986) claim that logistical forecasting covers the projection of customer demands by location, product, and time period. Logistical forecasting is based on analysing data, such as historical demand patterns, customer intelligence, scheduled promotions, and programs. Logistical forecasts consist of the following components which all need to be considered by the forecaster.

- The seasonal component, which is a recurring upward and downward movement in the demand pattern, depending on the seasons of the year.
- The trend component, which is a long ranging general movement in sales over extended time.
- The irregular component which covers completely unpredictable, random events or in other words most erratic events.

Finally, firms are tending to place sales forecasting activity within the logistics area, rather than within the marketing area. This not only acknowledges that timely and accurate sales forecasting is important to the firm's logistics work, but also highlights sales forecasting as another interface area between marketing and logistics.

2.2 Forecasting Concepts and Methods

The future demand for an item is generally the most important input to the inventory control model. It is the factor which has most impact on the stocks held. It is usually estimated by projecting past demand patterns into the future.

Ross (1996) describes the implicit definition of forecasting. He claims that the forecast is an objective estimate of future demand attained by projecting the pattern of the events of the past into the future. Literally, the word forecast means "to throw ahead", to continue what has historically been happening. Forecasting is also important for many other aspects of the business. Organisations make plans which become effective at some point in the future, so they need information about prevailing circumstances.

Forecast users often complain that too much uncertainty about the future makes planning and strategy extremely difficult or impossible. Although it is true that uncertainty in forecasting can be enormous. There is not much those who prepare forecasts can do apart from pointing out that it is not realistic to pretend that future uncertainty does not exist or can be eliminated (Makridakis, 1988).

Dealing with future uncertainty in a realistic manner requires considering the trade-offs involved in making different kinds of errors. In an uncertain environment gains cannot be made without taking risks. The role of forecasting is to point out and help management assess uncertainty and risks, but uncertainty cannot be eliminated.

The roles of forecasting, planning, and strategy are interrelated. The more accurate the forecasts, all other things being equal, the more effective the planning and the less great the need for a strategy. However, in an uncertain environment where large non random errors are possible, planning can go wrong and uncertainty is high, thus making the need for an effective strategy imperative.

2.2.1 Forecasting Applications

The application of forecasting is not limited to predicting factors needed to operate a business. Forecasting can be used to estimate housing prices, cost of living, and the average family income for any year of the future. Vonderembse and White (1991) explain forecasts as an essential part of planning. It would be illogical to plan for tomorrow without some vision of what might happen.

Forecasting is part of planning for any type of the organisation, whether it is in public or private sectors, whether it produces services or goods, whether it operates in the global economy or in a neighbourhood. For the important areas of sales forecasting, production planning, and decision making, these are interrelated as depicted in figure 2.1.

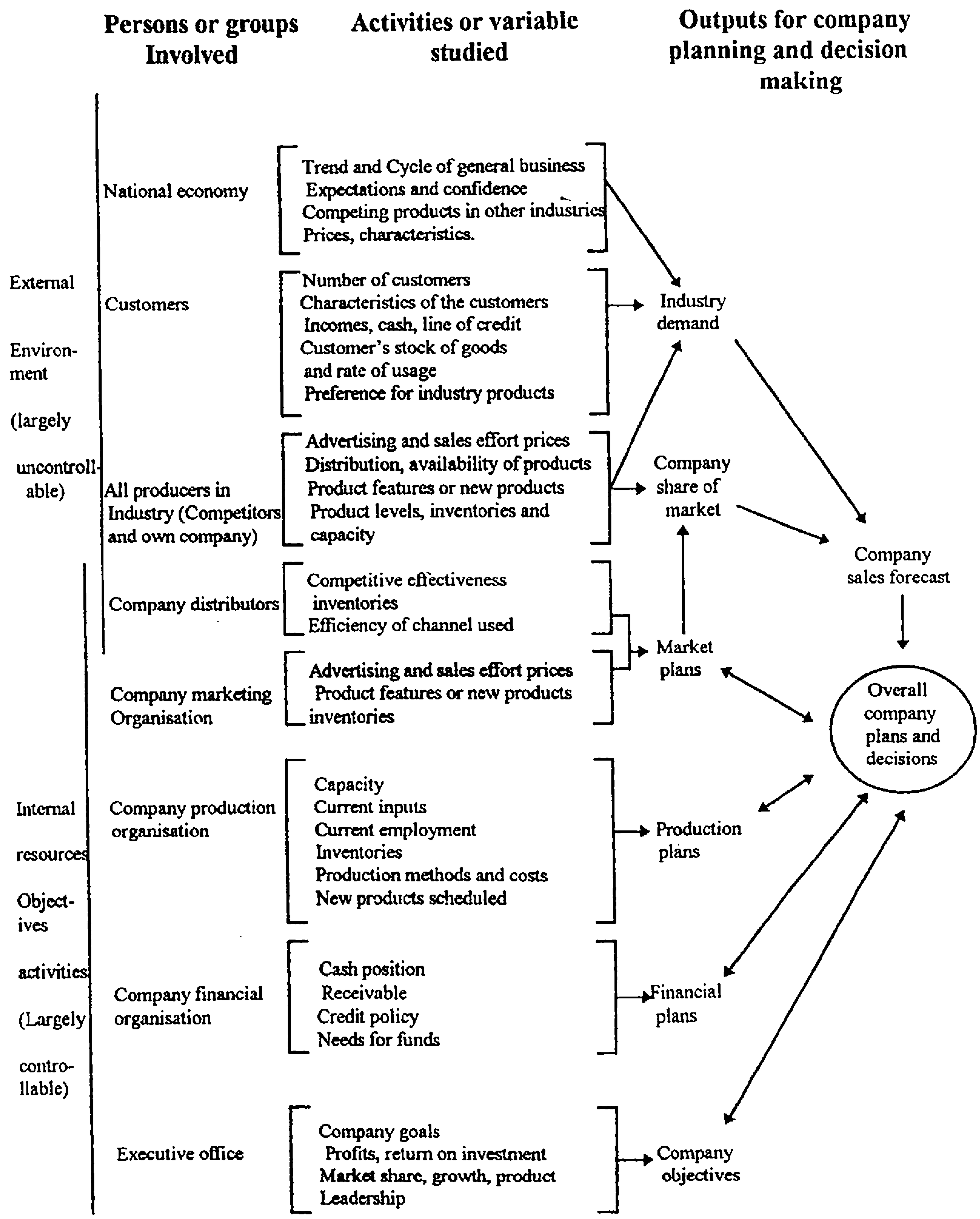


Figure 2.1. Information flows in sales forecasting and business planning. (Source: Makridakis et al, 1983).

The figure shows how an information system helps a company in forecasting and business planning. There is a clear distinction between uncontrollable external events, such as, competitors, customers, and government rules etc., and controllable internal events, such as manufacturing decisions within the company. The overall success of the company mostly depends on these two events. Forecasting directly applies to the uncontrollable external events, whereas decision making applies to controllable internal events. Planning is the source of linkage which integrates them.

In business there are many areas which need forecasting. Nowadays, business organisations mostly depend on three categories of forecasting, namely short term, medium term, and long term forecasting. These require that a company develop multiple approaches to predicting uncertain events and build-up a system for forecasting.

There is a high degree of interdependence among the forecasts of various divisions or departments, which cannot be ignored if forecasting is to be successful, and so forecasting should be co-ordinated across company departments.

2.2.2 Forecasting Methods

The ultimate test of any forecast is whether or not it is capable of predicting future events accurately. Planners and decision makers have a wide choice of ways to forecast, ranging from purely intuitive or judgmental approaches to highly structured and complex quantitative methods (Makridakis and Hibon, 1979).

A large number of forecasting methods are available but no single one is suitable in all circumstances. However, some methods are more efficient than others. Makridakis and Wheelwright (1977) clearly identify, the following criteria for the evaluation of the applicability of certain methods: (1) accuracy, (2) the forecast time horizon, (3) the value of forecasting, (4) the availability of data, (5) the type of data pattern, and (6) the experience of practitioner at forecasting.

Boldt (1982) mentioned seven factors important for selecting and implementing appropriate forecasting techniques.

1. Identify the problem to be addressed by the forecast.

2. Gather available factual data covering both internal and external environments of the company.

3. Determine which forecasting method is most compatible with the objectives of the company, and the type of data available.

4. Generate good assumptions concerning each of the forecast elements with as high an accuracy as possible.

5. Compare the forecast to expectation, which means reviewing the initial forecast and comparing its outcome with the results expected.

6. Analyse variance.

7. Adjust the forecast in order to make it a more accurate reflection of reality.

In predicting the future the first choice to be made is whether to use a formal forecasting method or to rely on judgmental forecasting. Forecasting literature reveals that in repetitive situations, quantitative methods outperform judgmental methods (Hogarth and Makridakis, 1979).

Qualitative forecasting is based on personal opinions, such as expert judgement or subjective evaluation, and is best used for forecasting marketing, product development and promotional activities. For example the opinion of senior managers and sales and marketing personnel can be solicited and weighed. The major problem lies in consolidating these opinions. Often more weight is given to the opinions of senior managers, because of their rank, even though they may not have as much knowledge of the market as the sales personnel. Nevertheless, in a particular situation where there is not enough historical data, or sometimes when a new product is introduced, the use of this type of method is valid.

Quantitative forecasting employs time series analysis and projects the historical patterns into the future. For the analysis of historical data the forecaster can use a wide range of statistical forecasting models. Time series analysis is composed of two elements, the data series and the time period used. Time series techniques always assume that patterns of activity recur over time.

Time series analysis assists the forecaster to diagnose and isolate patterns in the data. The time series patterns which frequently occur in the raw data are horizontal, trends, seasonality, cycles, and random error.

Horizontal patterns show stable patterns in data. Trends are consistent upward or downward patterns in the data for seven or more periods. For this type of data, the forecasters normally employ regression techniques and moving average techniques for calculating trends.

Seasonality is considered to be a repetitive pattern of activity that occurs in a similar period year after year. Forecasters employ decomposition techniques, which are based on statistical forecasting methods and can be used on the data subject to seasonality.

Johnson and Schmitt (1974) have suggested that analysts can do better without using quantitative methods provided that they have access to accurate economic and industrial information. However Johnson and Schmitt make no attempt to find out if a model can do better when this extra information is incorporated.

Mabert (1975) reports a direct comparison between judgmental and quantitative methods of forecasting. He found that forecasts based on opinions of the sales force and corporate executives gave less accurate results over the five year period covered by the study than did quantitative forecasts using three methods namely exponential smoothing, harmonic smoothing and Box-Jenkins methods. Furthermore, he also found that quantitative techniques cost less and took less time than subjective estimates. He further describe that the main difficulties with judgmental predictions are stated to be lack of application of valid principles, anchoring effects, regression biases, the assumption that specific cases can be generalised (representation biases), lack of reliability and the basing of predictions on irrelevant information.

Quantitative forecasting can be classified into two types: econometric, which is explanatory, and time series, which is mechanistic. The main reason for the popularity of autoregressive integrated moving average (ARIMA) models has been that several studies have found them to be at least as accurate as the complex econometric models of the USA economy. Naylor et al (1972) explain that "the Box -Jenkins results were significantly better in all cases except for GNP. They provide better forecasts by a factor of almost two to one".

Causal methods predict the future by using additional related data as well as time series data, which is captured for a specific purpose. The main purpose of this method is to take account of other occurrences within a market place, over and above historical data, to predict future demand.

The main difference between causal forecasting and quantitative forecasting is that quantitative methods describe the mathematical relationship of events occurring in the past, whereas, casual methods try to explain why those events occurred in the past. Quantitative forecasting methods are useful for short and medium term forecasting. However, causal methods are useful for long term forecasting.

For example, Arthur Anderson and company (1992) claims that this method expresses mathematically the relationships between the forecast objectives and factors, such as political, technological, economic and socioeconomical forces.

Causal methods are more costly to develop than quantitative methods because additional cost is required for data collection and analysis. This is because causal methods are rarely used in operational forecasting systems (Stephen and Bhame, 1991, Fogarty et al, 1991 and Makridakis and Wheelwright, 1989). The techniques associated with each forecasting method, along with their particular applications, are given in Table 2.1.

Forecasting classification

Forecasting Technique	Accuracy Range			Business Area Application					
	short	medium	long	Business Strategy	Marketing	Procurement	Sales	Inventory	Pricing
Judgmental									
Individual Judgement	X	X	X	X	X	X	X	X	X
Sales estimates	X	X			X	X	X	X	
Panel consensus		X	X	X	X	X	X		X
Market research	X	X			X		X		X
Dalphi			X	X	X				
Visionary forecast			X	X	X				
Quantitative									
Simple average	X						X	X	X
Moving average	X	X				X	X	X	X
Exponential smoothing	X	X			X	X	X	X	
Decomposition		X			X	X	X	X	X
Focus forecasting	X	X			X	X	X	X	X
Causal									
Econometric		X	X	X	X	X	X	X	X
Regression analysis			X	X	X	X	X	X	X
Historical analogy			X	X	X				
Leading indicator		X	X	X	X	X	X	X	X
Life cycle analysis		X	X	X	X				X

Table 2.1. Forecasting methods and their related techniques (Adapted from Chambers et al, 1992).

2.3 Role of Logistics Management in Business Forecasting

The role of logistics as a key element of an organisation's business strategy has steadily increased during the last 20 years. During the 1970's, logistics was probably more familiar to military tacticians than business people. In 1980's, a more holistic approach to managing logistics was adopted and many of the discrete functions were grouped under the label 'distribution'.

In business, logistics can be defined as the set of functions associated with flow of goods, information, and payments among suppliers and consumers from origination of raw material to final recycling or disposal of finished goods.

Companies increasingly view logistics as a crucial element in their corporate strategy. If modern enterprises are to meet customer demand for responsiveness, customisation, quality, and value, they must effectively link their entire global supply chain and information system to forecasting and demand planning.

The main objective of logistics is to simplify the supply chain to control total cost, improve total quality, maximise customer service, and increase profit. Logistics is a complex discipline, getting the right balance between ways of buying, moving and storing goods. Furthermore, it adds value to activities and makes them more competitive.

According to Bowersox and Daugherty (1992), escalating competitive pressures and increased performance requirements have resulted in greater recognition of importance of logistics activities. Fuller et al (1993) claim that logistics has the potential to become the next governing element of strategy as an inventive ways of creating value for customers, a source of savings, an important discipline on marketing, and a critical extension of production flexibility.

Gattorna and Walters (1996) define logistics as follows, "it includes raw materials, components, manufactured parts, and packaging materials within an overall flow of materials expanded the responsibilities of management into a broader logistics concept". A typical logistics management view is shown in figure 2.2.

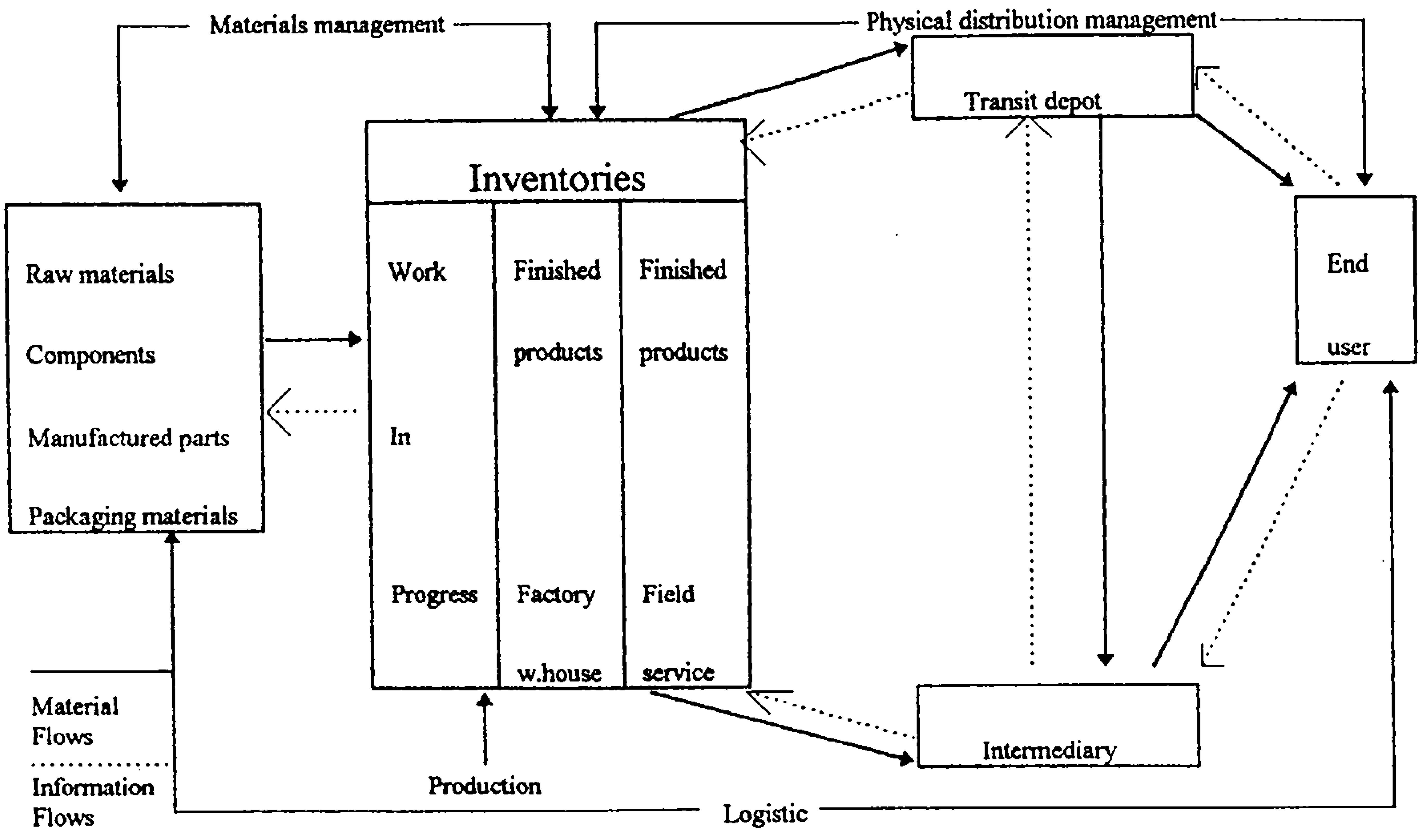


Figure 2.2. Typical logistics management view (Adapted from Gattorna et al, 1996).

Copacino et al (1987) state that, "logistics has been recognised not only as a group of important functions, but as functions that have important strategic impacts as well". The issues in today's business which lead to a strategic approach for managing logistics are enormous. The strategic importance of logistics is steadily increasing and companies need effective logistics support to achieve competitive advantage.

Pirttila and Niemi (1996) describe logistics strategy as goals to achieve competitive performance in the business. This is the priority of logistics function that also helps to formulate the decisions and programmes on strategic decision areas to attain these goals.

Bovet (1986) point outs the increased significance of logistics strategy with the following global changes in the competitive environment.

(1) Time to market competition is tightening as companies strive to beat competitors into new markets.

(2) Global sourcing is becoming more common.

(3) Globalization of markets and competition are accelerating.

(4) Product proliferation is increasing.

(5) Demand for "zero defects" is increasing.

The role of logistics activity in a business forecasting is further emphasised when companies go through the evolution stages. McGinnis and Kohn (1990) divide evolution of logistics into three main classes.

In class 1, the logistics organisation is responsible only for the most basic logistics activities. In class 2 and 3, the responsibilities are expanded as additional activities are added to logistics organisation. Demand forecasting is one of the activities that are added to the responsibilities of the logistics organisation in class 3. The evolution of logistics responsibilities is illustrated in Table 2.2.

Table 2.2. The evolution of logistics organisation. (Source: McGinnis and Kohn, 1990).

Class 1	Class 2	Class 3
Out bound transportation Logistics management Intra company transportation Logistics control Finished goods field warehousing Logistics systems planning	Order processing Customer service Finished goods plant warehousing Finished goods inventory management Inbound transportation	Logistics engineering Production planning Purchasing Raw material / WIP Inventory management Sales forecasting International logistics

Another activity that can be assigned to the logistics area is inventory forecasting. Sales forecasting is based upon market knowledge as well as manipulation of data with statistical techniques. Sales forecasting is frequently used with marketing logistics to facilitate deliveries to various market areas. However, logistics managers making forecasts for inventory purposes may use sales forecast as input.

2.3.1 Cussons Logistics

Over recent years, Cussons planning and inventory management functions have been subject of radical change. This has reflected the changing needs within the business and the introduction of a logistics structure.

The implementation of Manugistics demand planning software enabled transfer of responsibility for sales forecasting from brand managers to a single inventory manager located in the logistics function. This released brand managers to focus their attention on brand development and also ensured that standardised methods and procedures for sales forecasting and stock targeting were used throughout the business. This inclusion of sales forecasting/demand planning within logistics is unusual in the fast moving consumer goods industry where it is traditionally the responsibility of the marketing department. This leads to the generation of forecasts for true demand rather than the tendency to forecast to budget or to meet sales targets (Betts et al, 1994).

Today's customer is service sensitive requiring availability of supply at short notice. Due to intensive competition in the market place, Cussons logistics department is always trying to improve service levels by responding to customers in the shortest possible time, because they know that the era of time based competition has arrived (Stalk and Hout, 1990).

2.3.2 Adding value through Logistics

In recent years, marketing strategies have been concentrated on creating added value for customers. This added value can come in many forms, but a particularly powerful means of adding value to the basic offer is through the way we service customers (Cooper, 1993). Managing the service effectively by placing the right product at the right place at the right time. The improvement in customer service leads to longer term relationships with customers, improved retention rates, and greater profitability. The logistics performance and profitability are connected with each other as depicted in figure 2.3.

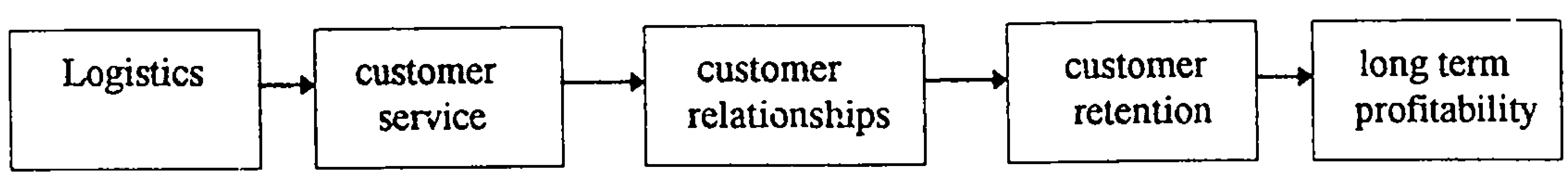


Figure 2.3. Logistics and profitability (Source: Cooper, 1993).

2.3.3 Role of information systems

Logistics information system play a crucial role in shaping the direction of logistics management. The ability to process transactions, monitor operations, and perform quantitative analysis has extended the ability to manage a complex process (Schary and Coakley, 1991).

The concept of the logistics information system, described by Burbidge (1988), Strenger (1986) and Tage (1977), is familiar to most practitioners considered as a pyramid, on the basis of the transaction flow through an organisation from customer to supplier.

The development of information system technology has changed much of our perception of management organisation in general. The direction of this change has been the focus of a large volume of in-conclusive research dealing with its effect on management structure (George and King, 1991). Millman and Harwick (1987) claim that change in the role of the middle managers has been one measure of change wrought by the rapid adoption of information technology in our society.

An information system is essential to support both operational activity and development of distribution systems. The information system should provide all basic data plus amendment service for operating procedures.

The basic purpose of collecting, retaining, and manipulating data within a company is to make decisions, ranging from strategic to operational. With the availability of high speed computers, with their ever-increasing data storage capabilities, procedures surrounding data handling have become more structured. Information systems is the new label attached to collection of these activities (Ballou, 1992).

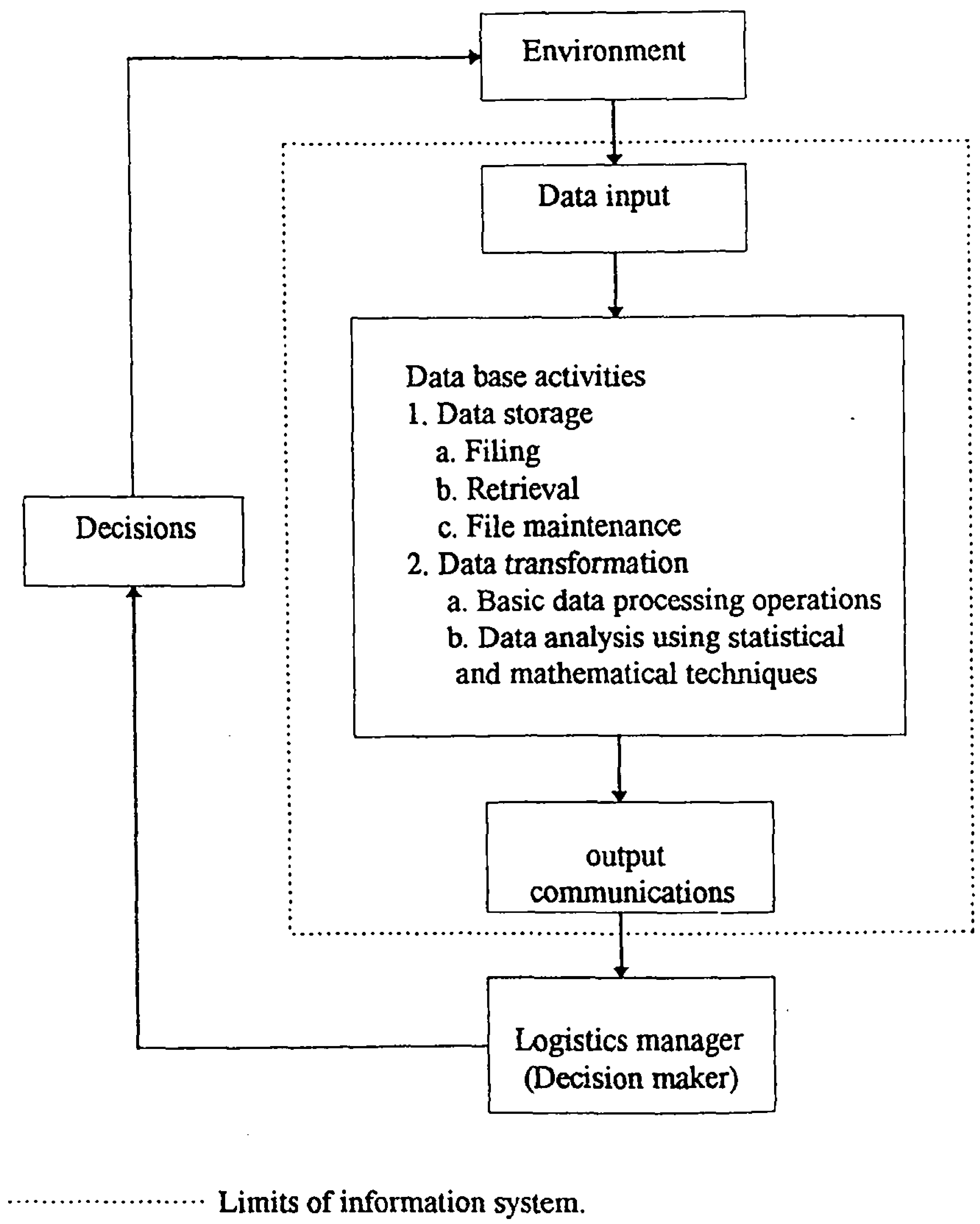


Figure 2.4. Overview of the logistics information system (Adapted from Ballou, 1992).

Logistics information system, which is shown in figure 2.4, reveal clearly the connected activities by which information is collected and processed to facilitate logistics 'managers' decision making.

Information systems deal with the management of information. One issue, which is important in the information system, is how to make information useful to managers. To do this effectively, one needs to be concerned about past, present, and future. In all cases, the problem is how to develop information systems that allow managers to make better decisions.

The first activity in the information system is to acquire data. This can be obtained from many sources, namely customers, published data, management and company records. These types of data are mostly useful for forecasting and demand planning.

The data base activities, depicted in figure 2.4, are related to the selection of data to be stored and retrieved, and selecting methods for the analysis. Data analysis is the most sophisticated aspect of the information system. The final activity is the output of the information system, which can be transmitted to logistics managers for decision making.

2.3.4 Supply chain management

Logistics can be viewed as an integrated management function. Whereas supply chain refers to the specific intermediaries, both intra and inter-company which handle raw material, finished goods and information flows to and from an organisation's supply market. Often few materials pass directly from their source to their sink, which is described as an 'End customer'. They flow through a series of interacting companies, whose role may be to extract (e.g mining companies), transform (e.g manufacturing companies), move (such as distribution companies) and store (wholesaler/retailer companies) material to satisfy end customer demand for products. This system of interacting companies is responsible for production and distribution of products. The supply chain is the core activity in all areas of business.

Lummus et al (1998) describe that the management of a supply chain mean managing all the different processes and activities that produce value in the hands of the ultimate consumer. A supply chain can be viewed as the network of entities through which material and information flow. These entities may include suppliers, carriers, manufacturing sites, distribution centres, retailers and customers. They further describe that supply chain management has become an important for the 1990s for a number of reasons. A primary reason stems from increased national and international competition. Customers have multiple sources from which to choose to satisfy demand; locating product throughout the distribution channel for maximum customer accessibility at a minimum cost becomes crucial. Another reason is that companies have become more specialised and search for suppliers who can provide low cost, quality materials rather than providing their own source of supply. It becomes critical for companies to manage the entire network of supply to optimise overall performance.

Effective supply chain management has become a vital business activity, as customer demands for high quality service have increased and suppliers can no longer rely on brand loyalty and product reputation. In addition, suppliers are under constant economic pressure to keep costs down and increase profits, while maintaining high customer service levels. Control of the supply chain is an area where operating companies within organisations can improve their sales margins. This can be achieved by recovering lost sales and increasing market share through high levels of service or developing new market areas. Supply chain management is essential for supporting current business activities but is also necessary for supporting new products and services. The supply chain must be made to work effectively, if new products are to be introduced to the market in a timely and efficient way.

Woodward (1992) intuitively explains the supply chain as an approach aimed at co-operating, managing and controlling distribution channel relationships for the benefit of all parties involved, to maximise efficient use of resources in achieving supply chain's customer service goals.

Ellram (1991) describes the use of term chain in supply chain management as an over simplification. Supply chain management really represents the new work of firms interacting to deliver products or services to end customers, linking flows from raw material supply to final delivery.

A typical supply chain network is shown in figure 2.5. This particular example has been taken from manufacturing industry. It is a simplified representation of a chain representing four echelons namely raw material supplier, manufacturer, distributor, and end customer. An individual business can also be a part of many supply chains at the same time. This can be due to a policy of multiple sourcing or multiple outlets for particular products. Each echelon within a supply chain embraces the following constituents which are shown in the figure.

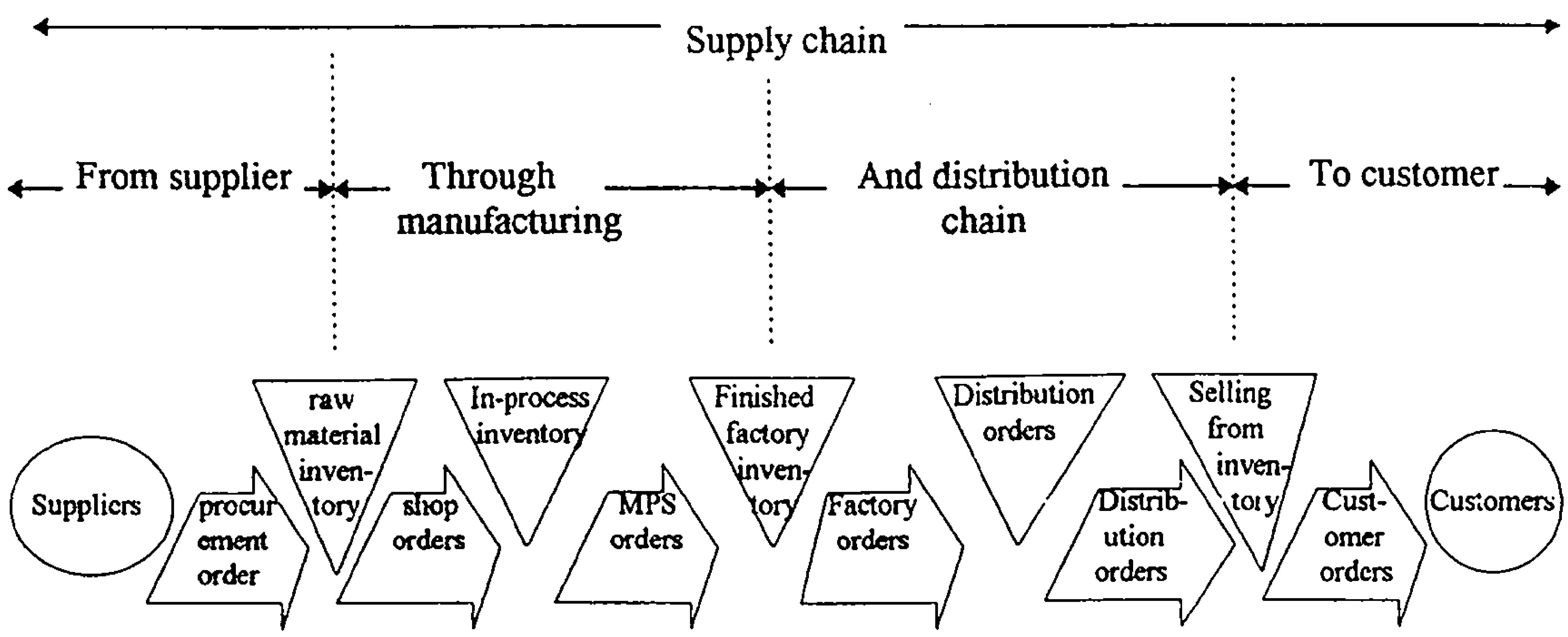


Figure 2.5. Schematic view of supply chain management. (Adapted from Jones and Riley, 1985)

Jones and Clark (1990) emphasise the need for managing the entire chain of raw material supply, manufacture, assembly and distribution to the end customer. Managing a supply chain is very different from managing one site. It includes managing inventory stockpiles at the various sites, including both incoming materials and finished products, which have complex inter-relationships. Efficient and effective management of inventory throughout the supply chain significantly improves the ultimate service provided to customers (Lee and Billington, 1992).

"Taking control of all goods within the supply chain, all material no matter how awkward to handle or manage, each activity no matter how small has an effect on the rest of the chain and everything in the entire supply chain equation must be considered" (Grange, 1992).

Lummus and Vokurka (1999) claim that to compete in the future, companies must learn to "pull" products through the supply chain, from raw materials through manufacturing to distribution to customers, in the right amount and in the right assortments, when needed.

The chain will increasingly provide information flows and build knowledge bases too. The main role of supply chain is logistical. Supply chain management is the natural outcome of process improvement efforts like, JIT, total quality management (TQM), process re-engineering and time compressed management. Supply chain management uses each of these tools but seeks to work comprehensively on the series of processes and activities that together make up the supply chain.

Christopher (1992) claims that the goal of supply chain management is to link market place, distribution net work, manufacturing process and procurement activity in such a way that customers are serviced at higher levels and yet at lower total cost.

Objectives of managing the supply chain is to synchronise the requirements of customers with flow of material suppliers, in order to effect a balance between what are often seen as conflicting goals of high customer service, low inventory investment and low unit cost. The design and operation of an effective supply chain is of fundamental importance to every company.

Supply chain management is really an approach to improving business processes. This approach is based on the realisation that what happens before and after manufacturing actually produces something at least as important to business's bottom line as how manufacturing produces it. For many years, the focus of companies has been on improving manufacturing through Robotics, manufacturing resource planning (MRP-II), Quality efforts, and number of notable topics such as bench marking processes, JIT manufacturing, which are associated with modern operations management. US manufacturing has got a lot better at what it does that is because of adopting bench marking principles in the business. To continue to improve, many manufacturing processes have to improve the process that feeds material into manufacturing first.

Others have found that process improvement now depends on the downstream process of inventory management being improved.

Regardless, supply chain management strategies tend to be a good thing, because they help managers think more about what they do, and how what they do affects what others do. For any company, the supply chain begins at the point of planning both production activities and acquisition of materials, and ends with monitoring of customer service in terms of delivery and production quality.

2.3.5 Just in time supply scheduling

Just in time (JIT) supply scheduling has significant importance in logistics management. JIT is based on the principles of making resources available precisely where and when they are needed, rather than letting them be stacked up partially unused for long periods in centralised locations.

JIT scheduling is a philosophy of operation that is an alternative to the use of inventories for meeting the goal of having the right goods at the right place at the right time. It is way of managing materials supply channel that was first made popular by the Japanese, perhaps because of particular economic and logistical circumstances that have prevailed in that country during the last 35 years.

Ballou (1999) describe JIT scheduling as a philosophy of scheduling where the entire supply channel is synchronised to respond to the requirements of operations or customers. The main emphasis of logistics management is on supply side. However, tough competitions in the market place have forced logistics management to apply JIT principles while making the decisions about supplying to particular markets. It is characterised as follows.

- Close relationships with a few suppliers and transport carriers
- Information that is shared between buyers and suppliers
- Frequent production/purchase and transport of goods in small quantities with resulting minimal inventory levels
- Elimination of uncertainties wherever possible throughout the supply channel
- High quality goods

Guerra (1985) in his research work has described that Hewlett-Packard applied JIT scheduling concepts to its distribution center operations. Over a one-and-a-half-year period, the company was able to achieve a 40 percent reduction in finished goods inventory, a 2 percent per month compounded growth in labour productivity, and a 44 percent improvement in the quality of consumer shipments.

The overall effect of scheduling under a JIT philosophy is to create product flows that are carefully synchronised to their demands. Although more effect is likely to be expended in managing the supply channel under a JIT philosophy than with a supply-to-inventory one, the benefit is to operate the channel with minimal inventory and with the attendant savings or service improvements.

2.3.6 Materials requirement planning in a logistical firm

Materials requirement planning (MRP) deals with supply scheduling. It is method primarily used for scheduling high-valued custom-made parts, materials, and supplies whose demand is reasonably well known. The purpose of MRP, from a logistical point of view, is to avoid as much as possible, carrying these items in inventory. Theoretically, inventories do not need to be created when the amount and timing of the end-product requirements are known. The main emphasis of the MRP is on the completion of shop-floor orders on schedule and the assurance of proper operation of production line (Pun et al (1998), Mejabi and Wasserman (1992), O'Grady (1988), Schniederjans (1993), and Wasco et al (1991)).

Ballou (1999) defines MRP as an important scheduling alternative to the supply-to-inventory philosophy of scheduling. Except for the manner in which statistical inventory control procedures are used in Kanban, they do not perform as well in the physical supply channel as they do in the physical distribution channel. The reason is that the assumptions on which statistical inventory control is based too often are not met. That is, demand is not regular, random, independent, and unbiased. Rather, demand patterns for parts, materials and supplies that go into end products are derived from the end-product demand.

Derived demand patterns result from the knowledge that predetermined number of parts, materials, and supplies, as specified by the bill of materials, goes into an end-product. Therefore, the demand patterns for these materials of production are lumpy. If statistical inventory control procedures were used to set inventory levels, these levels would be unacceptably high due to the high variance of the lumpy demand patterns.

As a result, the supply inventory for a component that goes into the production of the end-product must be even larger to meet the production requirements. If the rate of depletion of the inventory level can roughly be anticipated, components may be ordered just ahead of the depletion with a resulting substantial savings in inventory carrying costs.

2.3.7 Customer service performance

This term is widely being used in logistics literature. Competitive pressures in the market place have forced business organisations to improve their customer service according to wishes of customers. Many companies and business organisations have adopted customer service as a part of their corporate strategy.

Customer service is a very wide term and varies from one company to an other. Moreover, vendors and customers often view this concept quite differently. The level of customer service depends on wide range of diversified factors, nevertheless, it is generated mainly by the situation of the market such as market size and mutual relations between buyers and sellers (Moron, 1996).

In their research conclusions authors like Heskett (1973), Porter (1985), Shapiro (1984), Sharman (1984) and Sterling and Lambert (1987) have suggested that customer service is an integral and a necessary component of the marketing mix and provides firms with significant opportunities to gain a competitive advantage. Furthermore, they have indicated the importance of logistics in strategic management and strategic planning activities. The linkage between logistics and strategic management is customer service.

Kelle and Peak (1996) have suggested that increasing variability in customer demand and greater competition requires higher service level. Lalonde and Zinszer (1976) describe the customer service as follows: "it is customer oriented corporate philosophy which integrates and manages all of the elements of customer interface within a pre-determined cost service mix".

Ballou (1994) and LaLonde and Zinszer (1976) have presented and classified the elements commonly associated with customer service into three groups: pre-transaction, transaction, and post-transaction.

The pre-transaction elements of customer service relate to the corporate policies or programmes such as written statements of service policy, adequacy of organisational structure and system flexibility. The transaction elements of customer service are those which are directly involved in performing the physical distribution function namely product and delivery reliability. The post-transaction elements of customer service are generally supportive of the product while in use, namely product warranty, parts and repair service, procedures for customer complaints, and product replacement.

Table 2.3. The components of customer service (Adapted from Christopher, 1992).

Pre-transaction Elements

- Written customer service policy
  (Is it communicated internally and externally, it is understood, is it specific and quantified where possible?)
- Accessibility
  (Are we easy to contact /do business with?. Is there a single point of contact?)
- Organisational structure
  (Is there a customer service management structure in place? What level of control do they have over their service process?)
- System flexibility
  (Can we adapt our service delivery systems to meet particular customer needs?)

Transaction Elements

- Order cycle time
  (What is the elapsed time from order to delivery? What is the reliability/variation?)
- Inventory availability
  (What percentage of demand for each item can be met from stock?)
- Order fill rate
  (What proportion of orders are completely filled within the stated lead-time?)
- Order status information
  (How long does it take us to respond to a query with the required information? Do we inform the customers about the problems or do they contact?)

Post-transaction Elements

- Availability of spares
  (What are the in-stock levels of service parts?)
- Call-out time
  (How long does it take for the engineer to arrive and what is the 'first call fix rate?)
- Product tracing/warranty
  (Can we identify the location of individual products once purchased? Can we maintain/extend the warranty to customer's expected levels?)
- Customer complaints, claims etc.
  (How promptly do we deal with complaints and returns? Do we measure customer satisfaction with our response?)

Elements of customer service under these three headings are summarised in table 2.3. Every market has different requirements of customer service level, so some of these elements will be more important than others.

2.3.8 Transport considerations

Transport considerations are a necessary part of a logistics system. The major focus in logistics is upon the physical movement or flow of goods and upon the network that moves the product. Network is composed of transportation agencies that provide services for the company. Usually, a logistics manager is responsible for selecting the transportation modes, which are to be used for the movement of company's raw materials, semi-finished and finished products.

There are many transportation modes namely air transport, road, rail, and canals. For most routes there is choice. In many companies this choice is made after cost analysis. For each link in the logistics channel particular modes have particular advantages. Most freight within the UK is now carried by road. This is a mode which has the clear advantage of speed, flexibility and cost. Rail transport is suitable for very heavy individual items. Air transport is very expensive but it is very fast. Transportation by sea is only suitable when a company's production be planned a long way ahead. They can seldom afford to have critical supplies arriving via sea, which can take up to six weeks to reach the final destination.

Bowersox et al (1978) state that the company has three alternative ways to obtain transportation capacity. First, a private fleet of equipment may be purchased or leased. Second, a specific contract may be arranged with transport specialists to provide movement of goods and services. Third, a company may engage the services of any legally authorised transport company that offers point to point transfer at specified charges. Generally these three types of transport are known as private, contract, and common carriage. In logistics, their importance is that the company can achieve transport economies by incurring minimum transport costs, alternatively deliveries will be quick and consistent.

Nowadays, companies are striving hard to achieve transport economies to improve their service levels. Owning transport is very expensive. Increasingly, companies are looking hard as to whether they should own their own transport. In Europe, it is a general trend to contract out the distribution to third parties to reduce transportation costs. Because they handle a high volume of products from different clients, contract warehouses can offer significant freight savings by consolidating freight into full truckloads.

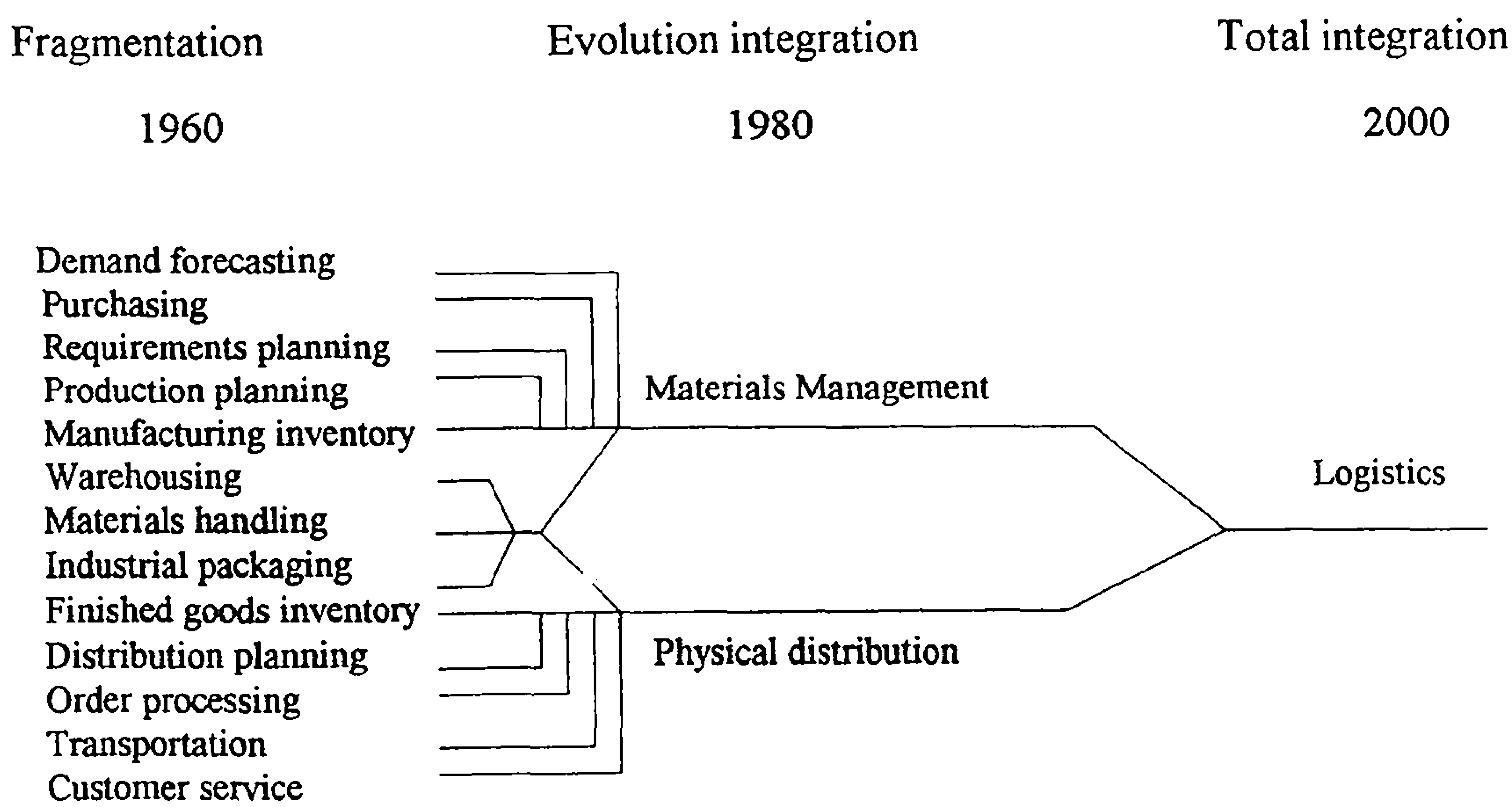


Figure 2.6. The Logistics evaluation.
(Source: Council of Logistics Management 1985).

The Council for Logistics Management (CLM), in their definition regarding logistics has described many activities for which logistics managers are responsible. One of the main activities of logistics is transportation. All those activities, which are associated with logistics managers are depicted in figure 2.6.

2.3.8.1 Materials handling

Materials handling is a very important aspect of a warehouse's efficient operation, both in terms of transferring goods in and out, and moving goods to various locations in the warehouse.

Coyle et al (1992) describe materials handling as efficient short distance movements that usually take place within the confines of a building, such as plant or warehouse, and between building and transportation agency.

Auguston (1991) claims that distribution should work with customers to understand their requirements. It means having warehousing systems and more specifically, materials handling systems that can consistently deliver high levels of customer service at high levels of efficiency.

Generally, within a node, warehouse, plant, and retail store goods have to be moved between incoming transport, storage, processes, and outgoing transport. The spectrum of available systems ranges from one person with a supermarket trolley to fully automated system incorporating robot order picking and automated guided vehicles (AGVs).

Analysing the effectiveness of materials handling systems involves assessing their cost and appropriateness to the rest of the operations. It also means that knowing something in advance about the characteristics of different systems. The key factors for assessing materials handling technology are:

- Physical characteristics of loads.
- Number of loads to be moved.

- Distance to be moved.
- Speed of movement required.

There are many methods of materials handling which have been summarised into four basic methods, namely manual, trolleys, forklift trucks, and conveyors.

The manual method is a very old method of materials handling but it is still relevant. Operatives lift light components and stack and unstack cartoons as well as move them. It is still valuable to perform simple transportation of anything for small distances.

The trolley method is not being used to a very large scale. Hand trolleys are relatively small and are slow to move. This method is also efficient for small volumes over short distance.

With the introduction of pallet loads, a major breakthrough was the use of forklift trucks for materials movements. This method has been rightly accepted as an excellent universal handling machine. The main advantage of this method is that it can load and unload other vehicles and lift pallet loads up to high levels for storage.

The conveyor method is a very useful method of materials handling. Conveyors excel at straight forward transportation because they eliminate re-handling before and after each function. For this method no extra labour is needed but one disadvantage of this is that cost increases with distance travelled. Its advantage is that they can be loaded and unloaded automatically. They can deliver cartoons or unit loads as they become available. Figure 2.7 illustrates the most cost-effective means of the transport for different combinations of distance and throughput volume.

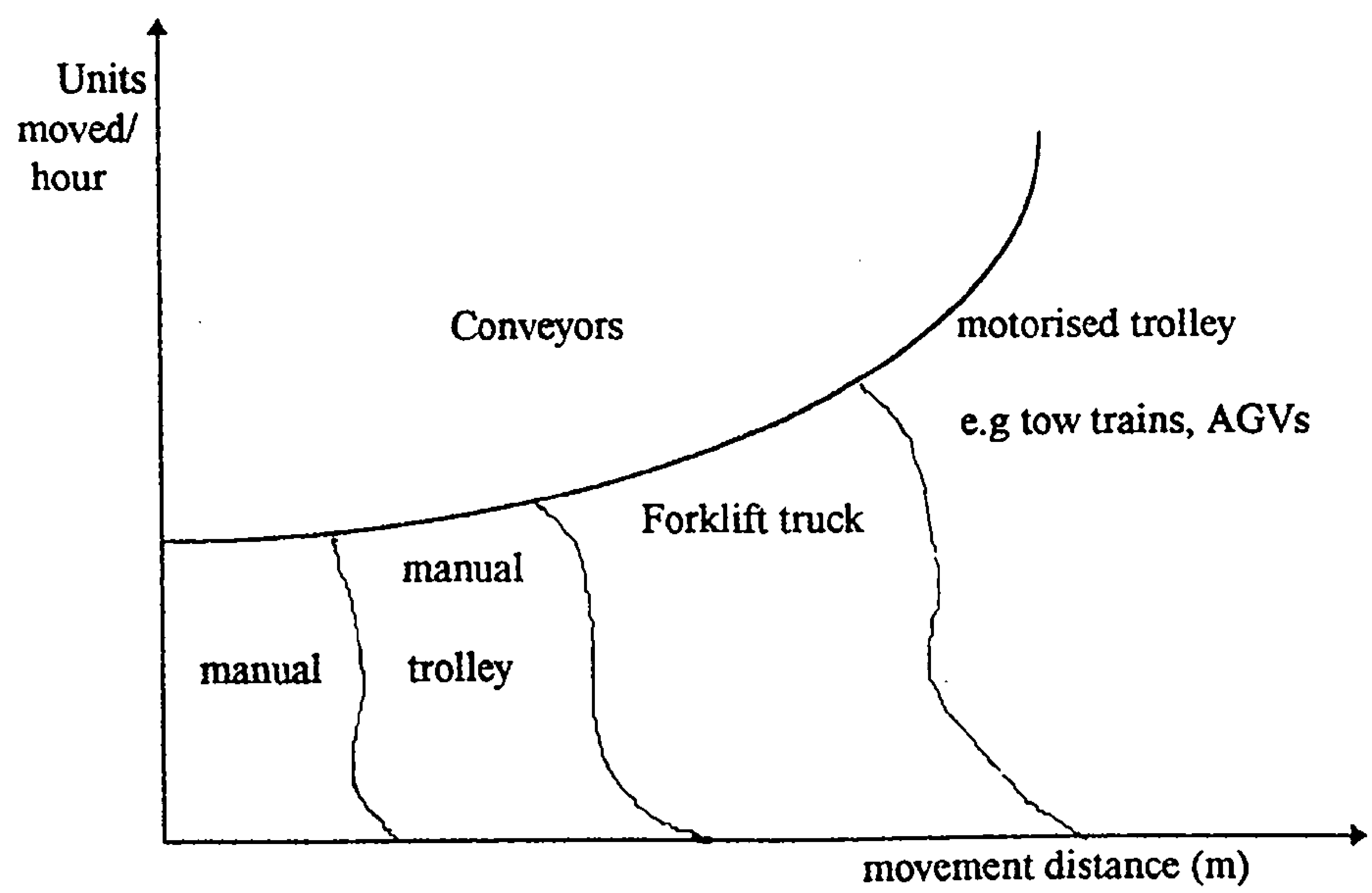


Figure 2.7. Transport for different combinations of distance for material handling. (Gattorna, 1990).

Furthermore, materials handling improves efficiency by making the logistics system capable of responding quickly and effectively to plant and customer requirements. The materials handling system plays a key role in getting goods to customers on time and in proper quantities.

2.3.8.2 Storage

Storage is one element of logistics planning that has trade-off relationships with transportation. It involves two separate but closely related activities, namely inventory management and warehousing. A direct relationship exists between the transportation agency used and the level of inventory and number of warehouses required.

Bowersox et al (1986) claim that in early stages of economic expansion, the United States (US) consisted of individual households which functioned as self sufficient economic units. As such consumers performed storage and accepted attendant risks. They further claim that due to the rapid development in transportation facilities product storage was shifted from households to retailers, wholesalers, and manufacturers.

The early literature clearly indicates that warehouses were initially viewed as a storage facilities that were necessary to accomplish basic marketing processes, for instance supplying markets with products to satisfy their demand. Storage was necessary to match products in the timing sense with consumers.

Benson et al (1994) claim that storage is inseparable from distribution for variety of reasons. Goods are often produced seasonally but consumed continuously. Fawcett et al (1992) find the answer to some questions in their research work which is published in a book titled "Logistics Management" regarding storage. One of the questions is why logistics and distribution still require storage? They justify the existence of storage with the following reasons.

- Optimising production cost saving.
- To provide a buffer, when the supply and demand does not match each other.
- To mitigate seasonal factors.
- To maintain the service level requirements.

Storage function may involve many types of expertise often referred to as 'merchandising' knowledge. Every product has its peculiar properties, its own inherent vice, which must be controlled by appropriate treatment.

Furthermore, it is very important for companies to protect their investment in all types of inventory and manufactured goods. A suitable environment for these manufactured goods is a storage unit where risk to inventory from damage, deterioration, and unauthorised removal will be reduced.

2.3.9 Warehousing

In a logistical system, need for a warehouse will exist if it can render services or cost advantages. The number and geographical locations of warehouses are determined by manufacturing locations and markets.

Warehouses represent one part of the overall efforts to gain time and place utility. From a policy point of view, one or more warehouses will be utilised in a logistical system only if sales and marketing impact is increased or total cost is reduced (Bowersox et al, 1986).

Taff (1972) precisely defines warehousing as storage of goods before their use. In broader terms this definition includes a wide spectrum of facilities and locations that provide warehousing including storage of any solid product in open fields, storage of finished goods in production facilities, and storage of raw materials, semi-finished and finished goods while they are in transport. Coyle et al (1992) state that a warehouse is a fixed point or node in the logistics system, where firms store or hold raw materials, semi-finished and finished goods for varying period of time.

2.3.10 Physical distribution management

Physical distribution is a basic logistical activity. Physical distribution management is the control of a wide range of activities, which take place after goods have been produced and before they reach consumers. These activities include materials handling, storage and warehousing, packaging and utilisation, and freight transportation by all modes of the transport. Related activities such as vehicle routing and scheduling and vehicle maintenance are also included. The purpose of these activities is the bridging of gaps between producers and consumers (Benson et al, 1994).

Ross (1996) has examined and subsequently modified these activities in a systematic way. He explains these activities which include warehousing, transportation, finished goods handling and control, customer order administration, site analysis, product packaging, shipping, and return goods management. Depending on the scope of the company, these activities occur in one or more levels of field warehouses.

Johnson and Wood (1993) associate physical distribution with outbound logistics, they claim that both interface with each of the four basic parts of the marketing mix, namely place, price, product, and promotion. Sometimes these are referred as four Ps.

The term physical distribution is still widely employed in marketing circles. Kotler (1976) identifies the term, "marketing" with two different but related processes, first dealing with the search for and stimulation of buyer's and the second with physical distribution of goods.

Slater (1978) points out the role of physical distribution management at the international level. He clarifies that it is not merely a marketing support system, but it is an integral part of marketing mix which helps to create and develop the international marketing process. Even though physical distribution does not portray the glamour which is associated with international marketing, it should not be forgotten as a part of marketing mix. However, in future, international marketing success may depend more and more upon the efficiency and practices employed to ensure the economic physical distribution of goods.

Physical distribution is not a significant cost for many businesses. It has direct impact on competitiveness through speed, reliability and its controllability in getting goods to the customers on time. Most customers have become more service demanding over recent years. Producers of intermediate goods are finding that their customers are demanding JIT scheduling of deliveries. While specialist transport operators have developed their services to meet these needs, still many firms have been slow to adapt.

Physical distribution management is now not merely about storage and movement of goods; it is about obtaining the 'utility' of time and place in support of marketing mix.

2.4 Role of Purchasing

The fundamental role of purchasing in all manufacturing activities, wholesaling, and retailing companies is the acquisition of materials, components, and finished goods. In business, it is characterised by two terms, namely purchasing and procurement.

The concept of purchasing has received a great deal of attention in logistics and marketing literature, which is described in Cavinato (1991), Cavinato (1992), Cooper and Ellram (1993), Houlihan (1988), Jones and Riley (1985) and Magnet (1994). Leenders et al (1985) define purchasing as concerned with procurement and movement of materials, parts, and finished inventory from the supplier locations to manufacturing plants, warehouses, and retail stores.

According to William and Dukes (1993) purchasing can be defined as follows: "a body of integrated activities that focus on purchasing of materials, supplies and services, which is needed to reach organisational goals". In a narrow sense, purchasing describes the process of buying. In a broader context, it involves determining the need, selecting the supplier, arriving at the appropriate price, terms and conditions, issuing a contract for the order and following up to ensure the delivery.

Cannon (1994) in a major series of articles has re-examined the role of purchasing in commercial life. He elaborates that for purchasing, the customer is internal source to the company. He provides valuable information to the company for purchasing necessary materials on time. The desires, wishes, and needs are those of the internal customer. In that sense, the role of purchasing should be opposite of marketing. Purchasing should be carrying messages from its internal customers to the vendors.

The changing purchasing situation has increased the importance of materials supply. In many industries, the value of purchased materials and components represents between 60 and 80 percent of the variable costs (Mitens et al, 1987).

Some authors have suggested that firms have sought to improve their performance in this critical area because of growing importance of purchasing and its linkages within a firms supply chain. [Metthyssens and Christophe (1994), Novack and Stephen (1991) and Wagner (1991)].

The American bureau of Industrial Economics (ABIE) defines purchasing as buying the right quality, in the right quantity, at the right place, from the right source, at the right time. This definition of purchasing addresses major decision-making areas of the purchasing, such as how much to buy, what quality is needed, what the cost is, from whom goods should be purchased, and when and where goods should be delivered.

Purchasing is another business activity that can be included in logistics. The basic rationale for including purchasing in logistics is that transportation costs relate directly to geographical locations of raw materials and component parts purchased for the company's production needs.

2.4.1 Raw materials and Components

Raw materials and components are items purchased from the suppliers to be used as inputs into the production process. Subsequently these will be modified and transformed into the finished goods.

In logistics, it frequently appears that raw materials are ordered in bulk quantities because it is most economical way to buy them. To keep costs low, bulk carriers can deliver thousands of tones of materials, which cannot be immediately passed into the production. The usual solution is to stockpile, though this may involve problems depending on the types of materials (Benson et al, 1994). However, many companies are now using the JIT systems for the ordering and purchasing of raw materials and components, in a view to avoid handling too much stock.

2.4.2 Procurement

The primary objective of material procurement is to make sure that the right materials are delivered at the right time and at the minimum costs. In recent years, many authors have written about the changing role of materials procurement.

Aleo (1992), Burt (1989), Cammish and Keough (1991), and Ellram (1991) have categorically described procurement as follows, "the increasingly competitive world markets and growing cost of purchasing goods as a percentage of the sales leads to re-evaluation of supplier relationships".

Bragg and Haln (1989) claim that the adoption of materials requirement planning (MRP) systems force purchasing departments to assume new responsibilities for planning and controlling suppliers as outside factories and to develop ways of identifying and following through on items that need to be expedited or de-expedited.

Vaart et al (1996) state that "materials procurement is the process of obtaining materials from outside suppliers. This includes activities like requirements planning, supply sourcing, negotiation, order placement and co-ordination with suppliers generally referred to the scheduling, supply continuity and expediting. It also requires the cluster of activities which are related to physical inbound material flow, inbound transportation, receiving, inspection, storage and handling". They also relate the procurement system with boundaries and specification of external and internal relationships of the system. The system boundary is established operationally by specifying inflows and outflows from the environment into the system and vice versa.

Inflows from the environment to the procurement system are incoming materials and product structure such as bill of materials (see section 2.4.3), engineering changes and requirements information, namely master production schedule (see section 2.7) and actual demand.

Outflows of the system environment are the sourcing decisions, material procurement orders and the availability of materials. These boundaries of procurement system are shown in figure 2.8.

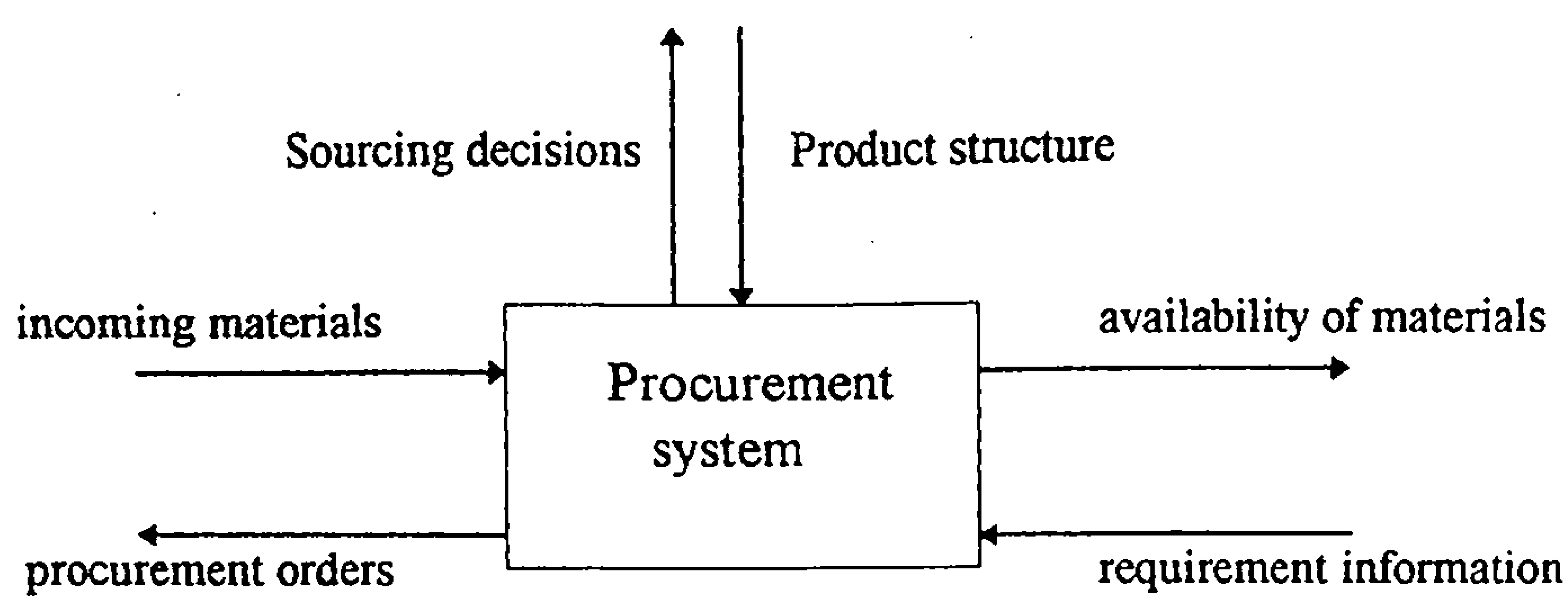


Figure 2.8. Boundaries of the procurement system (adapted from Vaart et al, 1996).

2.4.3 Bill of materials

The bill of materials (BOM) lists components of each assembly and sub-assembly. In the case of complex products, the bills for the products are usually not maintained and the file contains only bills for major assemblies.

Chase and Aquilano (1992) explain that the BOM file contains complete product descriptions, not only the lists of materials, parts, and components but also the sequence in which the product is created. The BOM file is one of the three main inputs to the MRP program, the other two are the MPS and the inventory record file.

The origin of BOM lies in simple parts lists which merely itemised all the components required to manufacture a single product as described by Ballcerak and Dale (1986). Such lists were frequently unstructured. With the advent of MRP and the associated BOM processors, it was quickly found that these simple BOM structures were inadequate.

There are two main reasons for this. Firstly, it became necessary to identify sub-assemblies with a part number so that they could be scheduled for manufacture. Secondly, BOMs based on the simple parts lists were cumbersome and wasteful of file space when many of the same parts were repeatedly specified for several products.

This was a launch pad for the development of BOM structuring. The general structure of a bill of materials is shown in figure 2.9.

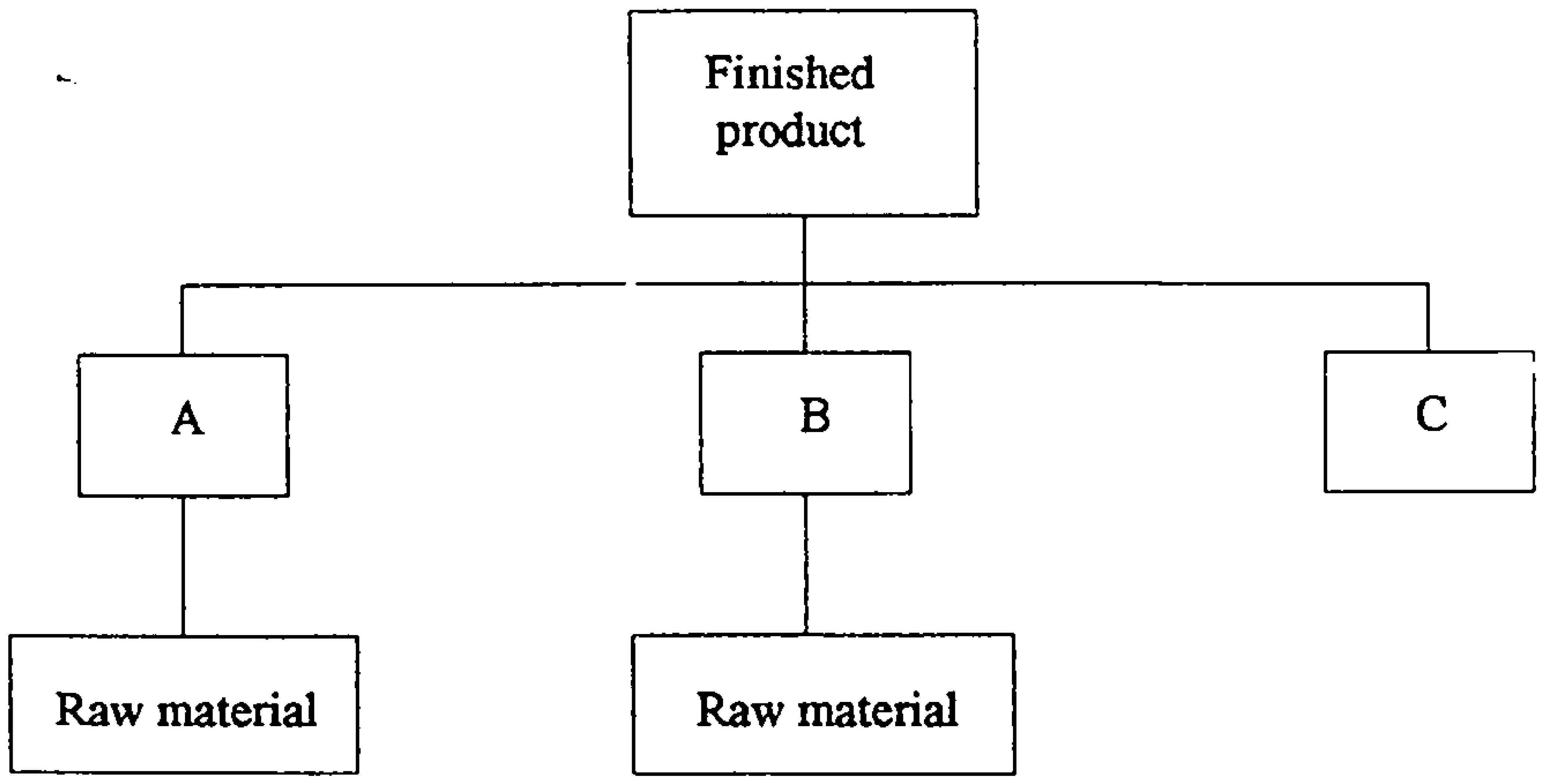


Figure 2.9. Bill of material based on material flow (Adapted from Luscombe, 1993).

Figure 2.9 shows that the finished product is assembled from two components A and B, which are manufactured in house together with a purchased item C. Three work orders control the entire manufacturing process, while work order issues and receipt transactions manage the physical flow of materials.

Furthermore, the bill of materials often called the product structure file or the product tree because it shows how a product is put together. It also contains information to identify each item and the quantity used per unit of product of which it is a part. The bill of materials must reflect the way in which a product is actually made.

2.5 The effect of distribution strategies on demand planning

Demand forecasting is the sequence of steps which decision-makers take, either implicitly or explicitly to reach a satisfactory prediction of some future values. Since, distribution links suppliers and customers, companies involved in the distribution will be wise to draw up a strategic plan after examining the detailed requirements of their own or their customer's activities. The aim of this strategy is to achieve possible economic operations in given circumstances.

Benson et al (1994) suggest that greater efficiency in the movement of goods will reduce storage, while greater warehousing efficiency will enable the goods to wait safely and economically while transport is organised. The plan must weigh up total distribution problem from start to finish and devise a system of operations, which will achieve desired results at the least possible cost.

In satisfying demand, the aim is to reduce the time between receipt of an order and its actual completion by the delivery. The development of an international distribution strategy is critical for those enterprises seeking to enter global markets. An effective strategy must identify first the nature and scope of international trade agenda, define appropriate marketing and logistics strategies, operational objectives and structures, and develop appropriate performance metrics to measure the success and point out regions for the improvement in demand forecasting.

Keegan (1989) suggests that an effective international distribution strategy must be composed of five elements, namely environmental analysis, strategic planning, organisational structure, implementation, and performance measurement. Without evaluation of these strategies, manufacturing companies cannot possibly succeed in achieving their targets and ultimately it will effect their process of logistics planning and demand forecasting.

2.5.1 The Supplier

The highly tense markets and JIT philosophies (see section 3.8.1) demanded by suppliers to deliver very high quality products on a regular basis at the right time, at the right place, and at a reasonable cost.

Burt (1989) points out that managing supplies effectively means achieving supply at the lowest total cost, which is not necessarily the same as the lowest contract price per unit. Due to poor quality and delivery performance, component suppliers have a major impact on further manufacturing or assembly processes. Customers should consider total impact of suppliers characteristics, including initial cost per unit, quality related costs, and cost of imperfect delivery performance of the suppliers.

Hill and Vollmann (1986) compare suppliers performance in a JIT delivery environment. They argue that, "deliveries are critical in the JIT environment and customer pickup from local vendors can be a better alternative than vendor delivery". When manufacturers manage their own inbound local deliveries, its benefits will be in the shape of reduced transportation costs and most importantly reduced uncertainty in deliveries.

Both the above facts provide a necessary framework for companies to reconsider their relationships with suppliers to ensure product delivery reliability. A poor delivery performance, poor quality, and higher total cost will effect a company's overall performance including the demand forecasting on which company's overall demand planning is based.

2.5.2 The Manufacturer

Manufacturers focus primarily on the development and creation of products. The role of manufacturers in distribution process is placed at the opening stage. The primary supply channel depicted in figure 2.10 indicates the materials and information flows from both suppliers and customers.

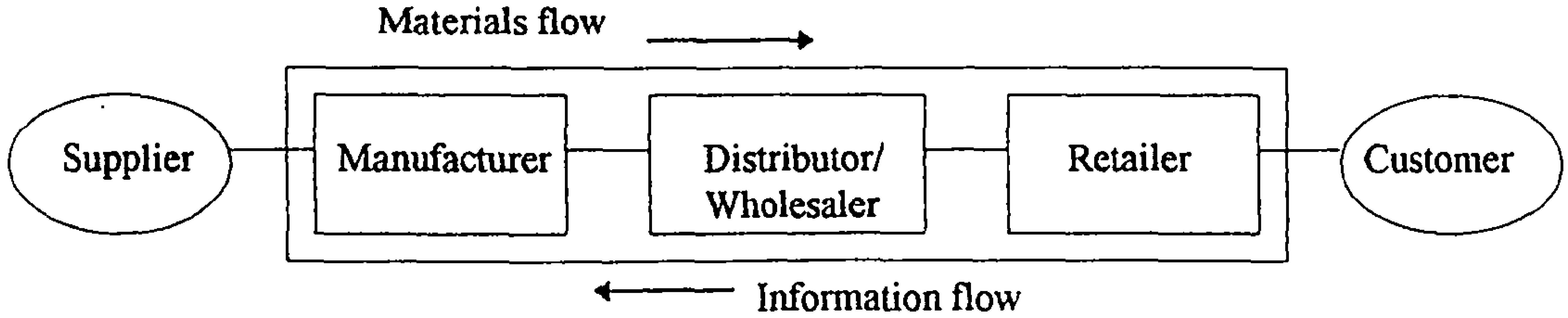


Figure 2.10. Distribution Supply channels. (Adapted from Ross, 1996).

Manufacturers are the primary source for manufactured goods. If a company has experience in international distribution, it is beneficial for the company to deal directly with the customers rather than through an intermediary. It will not only be cheaper, but also the chances of miscommunication are less when dealing directly. Practically this is not possible for many international companies.

In this competitive business era, it is necessary for manufacturers to make their supply channel more effective. Today's business demands JIT response from manufacturers and in return manufacturers expect timely and accurate information from downstream channels. This co-operation between manufacturer and customers will help companies in making accurate estimates of demand for their products.

2.5.3 The Distributor

The distributor usually carries a stock of manufacturer's goods and he has exclusive sales territorial rights. In underdeveloped countries these rights can vary widely. American Production and Inventory Control Society (APICS) Dictionary describes a distributor as follows, "A business that does not manufacture its own products but purchases and resells these products. Such a business usually maintains finished goods inventory".

Bowersox and Cooper (1993) define a marketing channel as a system of relationships existing among businesses that participate in the process of buying and selling products and services. From such statements it could be easily assessed that these provide a concise functional definition of the essential activities performed by distributors.

A distributor has not only to perform the duty of a salesman but as a information source for the manufacturers for a particular territory. Distributors can provide timely information of customers demand. In other words, it is a source of bridging the information gap between manufacturers and customers. Distributor activities can significantly help companies in their decision-making process.

2.5.4 The Retailer

The traders who supply products and services to the general public are retailers and they, of course, must obtain those products from somewhere and pass them on to customers. These days many retailers, particularly the large ones, obtain these supplies directly from manufacturers. Retailers sell these products in small quantities to individual customers.

Coyle et al (1996) describe the principal function that retailers serve is to make products available for consumers and industrial users to purchase. Retailers may take the form of traditional stores and places of business or may sell through an innovative, non store approach, such as by telephone, mail order, computer, and door to door, etc.

Gattorna and Walters (1996) point out that to be successful in today's business environment, retailers have become more aware of the leverage offered by effective logistics management. However, successful retailers are improving the cost-effectiveness of their marketing, finance and operational activities.

Recently, however, retailers both in Europe and elsewhere have begun to develop interest in logistics. In some cases they operate their own distribution systems. They are arranging collections from the suppliers and delivering to the distribution centres and retail outlets. Other retailers concentrate on controlling the supply chain rather than operating it.

Marks and Spencer the big name in the retail world controls its supply chain through use of electronic point of sales (EPOS) data and electronic data interchange (EDI) which links directly to the suppliers by providing quick and accurate information on consumer demand.

Manufacturers and retailers are two important parts of the chain. Manufacturers solve retailer's problems by responding to the retailers on time, whereas, retailers responsibilities are to provide timely information of consumer demand to manufacturers. In this way, retailers also contribute to the companies in their decision-making processes.

2.6 Decision support system for business planning

Significant advances in computer technology and increasing uncertainty about the economy, competition in the market place, material resources, and government regulations are stimulating increased interest in computer aided tools to improve the effectiveness of logistics management decisions. These tools are generally referred to as decision support systems (DSSs).

The concept of DSS was first articulated in the early 1970's by Scott-Morton (1971) under the term management decision systems. He describes interactive computer based systems, which help the decision makers to utilise data and models to solve unstructured problems.

Thierauf (1991) claims that DSSs are designed to help users to derive numerical solutions. Lawler (1992) points out that DSS features often include statistical capabilities, linear programming options, data base management features, and simulation abilities.

Peterson and Peterson (1988) suggest that people react adversely to the introduction of DSSs. Kotteman and Davis (1991) reported that people often avoid computer based aids in favour of simpler but less accurate approaches. On the contrary to this, Aldag and Power (1986) and Bronner and De Hoog (1983) have found that people prefer to use computerised decision aids and are more satisfied with such processes. Beach and Mitchell (1978) claim that the effects and desirability of decision aids depend on the characteristics of decision makers, type of the problem and the environment.

Little (1970) describes the DSS as follows "a model based set of procedures for processing the data and judgements to assist managers in their decision making". He further clarifies that in order to be effective; such systems must be simple, robust, easy to control, adaptive, complete on important issues and easy to communicate with.

Keen and Scott-Morton (1978) describe the DSS in a more classical and systematic way. They believe that a decision support system couples the intellectual resources of individuals with the capabilities of computers to improve the quality of decisions. It is a computer based support system for the management decision makers who deal with the semi-structured problems.

Bonczek et al (1981) express that DSS accommodates the unstructuredness of the problem. In their opinion, human investigate into the decision making process and during this investigation computer supports the process by furnishing pertinent information, thus creating human computer decision making system.

Different authors throughout the 1970's have defined DSS differently. Researchers and practitioners accepted some of those described previously. By the end of decade new ideas and definitions began to emerge. Authors like Bonczek et al (1980), Keen (1980), and Moore and Chang (1980) have written about DSS. The main emphasis of their work is on the system capabilities, system components, and development processes.

Above definitions of DSS do not provide any consistent focus. Authors have ignored the main issues in DSS, namely improvement and support in the decision making process.

2.6.1 Requirement evaluation

In logistical process design, the range of DSS models can be classified on the basis of mathematical techniques to be utilised in arriving at design solutions and their ability to represent the uncertainty. Each available solution technique, such as optimisation or simulation can be useful depending on the specific logistics issues under consideration.

Turban (1995) points out that large scale manufacturing support systems (MSS) often require greater investment of money, time, and personnel. At the same time, the results may be neither measurable nor tangible. He further advises that MSS should be evaluated once they are implemented.

The DSS evaluation must be an integral part of the DSS development and implementation encompassing all phases of the DSS development process. The emphasis on decision support must be the focal point of DSS evaluation (Guimataes et al, 1992).

The special characteristics of DSS and its impact on decision making call for special approaches to its evaluation. The intent of these evaluations is to assess different outcomes. These evaluations do not help the companies by revealing what factors lead to which outcome, and how or why they occurred. At the same time, some evaluations provide useful information in addition to end product assessment. These DSS evaluations are depicted in figure 2.11.

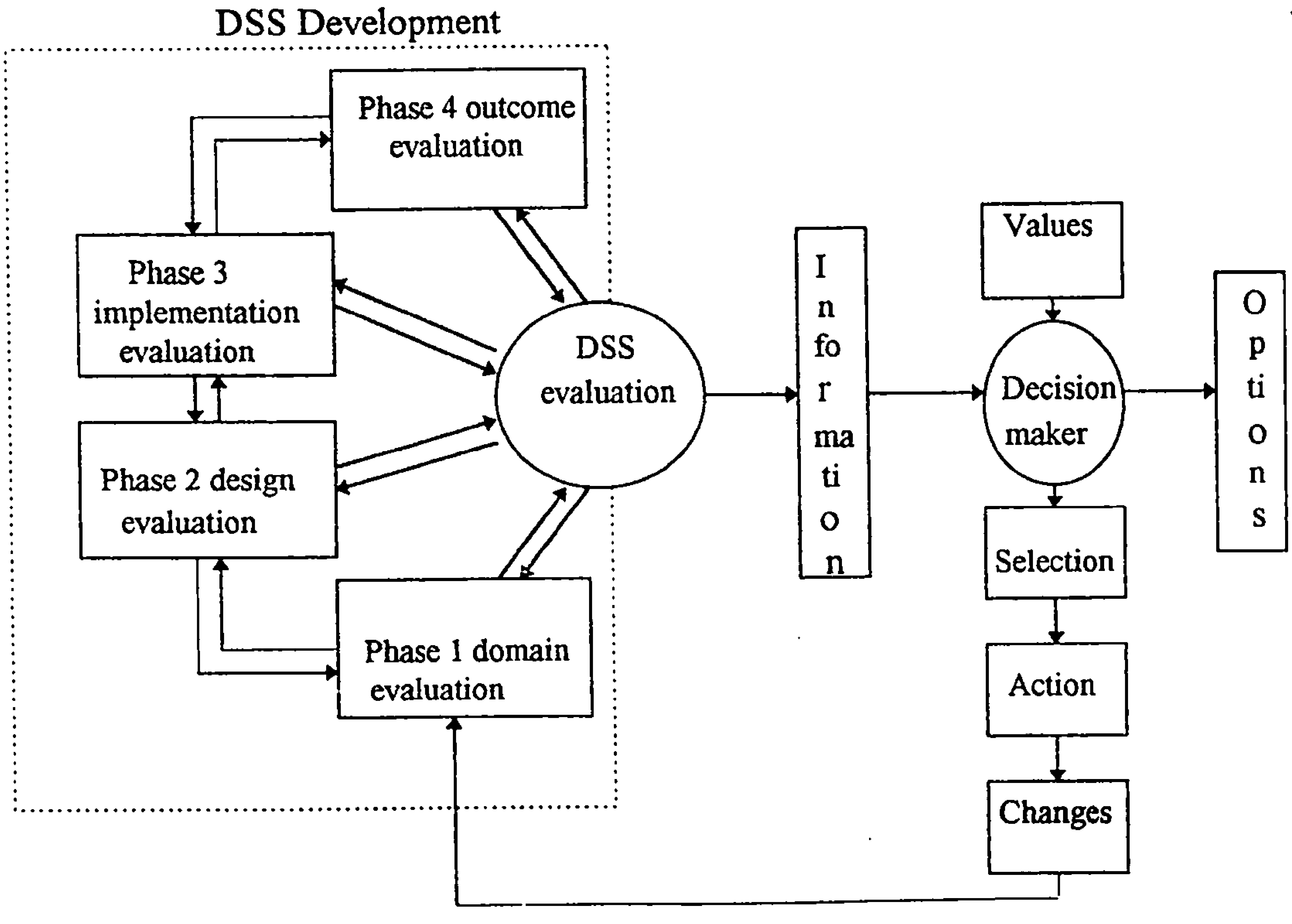


Figure 2.11. A dynamic DSS evaluation model (Source: Apthappily 1985).

The evaluation process consists of four phases.

Domain: The domain is concerned with the analysis of the project as a whole, its justification, constraints, and DSS objectives. This phase is mainly dependent on qualitative judgements.

Design: This phase identifies system capabilities, assesses input data and provides suggestions for the design. The purpose of this DSS phase is to select the design and its modifications. The evaluation is descriptive in nature.

Implementation: This phase provides periodic feedback and detects drawbacks in the procedural design and provides information about the pre-defined decisions and maintains records and procedures. This phase of evaluation can be executed with tools.

Outcome: This can be measured and interpreted during the construction of DSS and at the end variance analysis is performed. Many tools can be used, namely value analysis, system analysis, and outcome assessment. Furthermore, the result of this phase may be continuation, modification or termination of DSS.

2.6.2 The evaluation of components, variables and parameters

Data preparation is a most difficult and time consuming process. In logistics, this process has very significant importance. Data can be classified according to their use in computerised techniques for modelling process. The aspects of modelling which require data are components, variables and parameters.

2.6.2.1 Components

This type of model consists of entities, which are described by equations. These components constitute the software portion of the DSS. They are objects of primary interest in the system design. In logistical terms, the components are facility type and size, communication, transportation, inventory and materials handling.

Bowersox et al (1986) describe these factors which constitute the resources of a company that must be integrated to formulate a logistical system. Data must be collected for each system component.

2.6.2.2 Variables

The main purpose of variables is to relate components. In model structures there exist a limited number of variables. Different authors have described the effects of variables on the effectiveness of decisions makers. McIntyre (1982) analyses effects of variables such as mathematical ability and cognitive style. Zinkhan et al (1987) in his study describe effects of risk aversion, cognitive differentiation, involvement, age, and both managerial and DSS experience. The most common types of variables are: status, exogenous, and endogenous variables.

Status variables

These are variables, which describe a system's state. In a logistical model, conditions of all components depend on the system's state along with particular design relationships. Each system state is based on a set of relationships among components that will have system service capacity and associated cost (Bowersox et al, 1986). The fundamental purpose of the model is to modify state variables as a result of processing flow data, thereby isolating improved system design.

Exogenous variables

Exogenous variables can be viewed in terms of their purposes to the model whose values are determined external to the model. These variables can be classified as a set and flow variables. With respect to input, set and flow variables constitute the data necessary to establish and use the model.

Endogenous variables

On the basis of interaction between status variables and exogenous variables, endogenous variables are generated internal to the model. These variables depend upon the system performance and constitute the outputs. Depending upon the model under consideration, such outputs may take the form of operational status reports, special analysis of the problem situation or profit and loss statements.

2.6.2.3 Parameters

Parameters represent the variables that do not change and they constitute restrictions upon the model. American Heritage Dictionary (1983) defines a parameter as a variable or arbitrary constant appearing in a mathematical expression each value of which restricts or determines specific form of the expression.

Parameters define the components that will be formulated by the system state variables and setting the limits of endogenous variables that define the system boundary. The parameters are different from managerial constraints identified during the planning stages (Bowersox et al, 1986).

Both parameters and constraints by the modification of set data can be varied. The general procedure during initial design of the logistical system is to hold both constant. Once a system design that meets specific operating requirements is isolated, parameters and constraints may be varied for sensitivity impact upon the design solution.

2.6.3 The functional relationship of decision support factors

These relationships define clearly the interaction between all types of variables as a function of the model. In logistical systems, it is important to formulate relationships among all variables included within the system structure. By the change of one system variable there will be significant change in the overall modelling process.

An important part of the transformation of the model is the feedback mechanism. It is essential to rendering the model dynamic. The impact of feedback transformation influences derived system states. Thus, stability is introduced into the model's structure.

Given a stable system, disturbance such as two weeks out of stock on fast moving products, would be expected to result in temporary adjustments in the stock levels to protect the desired level of inventory availability. The typical manager may not view out of stock performance in terms of stability. It is often seen that instability is created by actual operations. This situation seldom improves until the intervention of external forces. These forces may well be controllers of inventory imbalances. The logistical system can reduce this conflict by the development of stability.

2.7 The Importance of the master production schedule (MPS) in business forecasting

The MPS in broader form is a process by which manufacturing capability of a company is reconciled with the statement of distribution requirements which are determined from forecasts, customer orders, back orders, and planned requirements.

Chase and Aquilano (1995) state that the MPS is a time-phased plan specifying how many and when company plans to build each end product. The MPS must be flexible. The question of flexibility within MPS depends on several factors, namely production lead times, commitment of parts and components to specific end items, the relationship between customers and manufacturers, the amount of excess capacity, and the willingness of management to make changes.

Slack et al (1995) describe that the MPS as most important planning and control schedule in a business. In manufacturing, the MPS contains a statement of volume and timing of end products to be made. This schedule drives the whole operation in terms of what is assembled, what is manufactured, and what is bought.

In modern manufacturing companies, it is essential to consider all the aspects of demand before the creation of the MPS. Inputs that may be taken into account in the creation of the MPS are shown in figure 2.12.

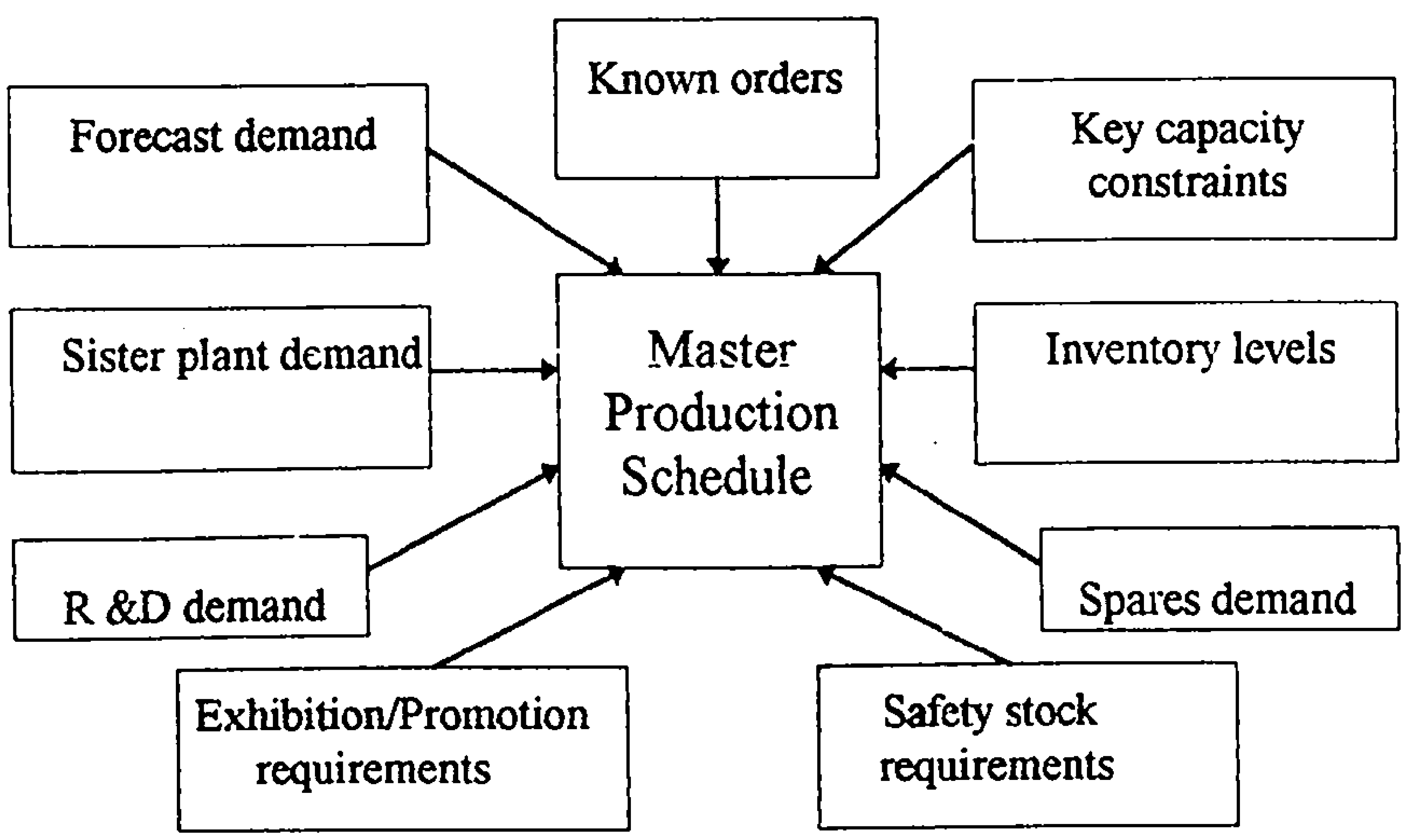


Figure 2.12. Inputs into the Master Production Schedule. (Adapted from Slack et al, 1995).

Usually the MPS is based on the forecast demand for a specified period. The period over which this demand is expected will depend on the type of products concerned and capacity planning procedures used by the company. Because of the need for flexibility in the MPS the production time period should allow enough time for the acquisition of all materials, parts and sub-assemblies, manufacturing of all the in house made components, and the assembly of the final product.

2.8 Causes of failure in demand planning

Business forecasting has been described as a sequence of steps that decisions makers take, either implicitly or explicitly to reach a satisfactory prediction of some future values (Goodrich, 1989). However, due to complexities, uncertainties, geographical problems, and non-co-operative attitudes of customers to achieve forecasting accuracy for many companies is hard. Some of the factors, which can be considered as causes for forecasting failure are described in the following section.

2.8.1 Bottlenecks in the system

A bottleneck is defined as a resource whose capacity is less than the demand placed upon it. Coyle et al (1992) define that a bottleneck is a constraint within the system that limits throughput. It is that point in the manufacturing process where flow thins to a narrow stream. A bottleneck may be a machine, a scarcity of skilled worker or a lack of a specialised tool. During the last decade much attention has been given to alternative methods of planning and control in the manufacturing system to improve the working efficiency of the plant.

There are many different ways to find bottlenecks in the system but usually two methods are being used practically. One is to run the capacity resource file, it is one of the functions performed by MRP-II software which describe total capacity of the plant and other is to use knowledge about particular plant, look at the system during operation and talk with particular persons. In this way, by gathering all the available information, loads on each machine, on each worker or on each specialised tool helps managers to find where bottlenecks most likely exist. Bottlenecks can be divided into two categories, namely productive bottlenecks and non-productive bottlenecks.

Productive bottlenecks

These are bottlenecks, which occur within the system. These types of bottlenecks are, machines capacity, machine breakdown, machine working efficiency, machine set-up time, worker's efficiency, and shortage of materials.

Non-productive bottlenecks

These are bottlenecks, which greatly influence production performance. These bottlenecks can occur any time due to internal and external forces. These types of bottlenecks are, worker's strikes, power breakdown, and Government policies.

In this competitive environment, it is imperative for manufacturing companies to get rid of productive and non-productive bottlenecks to keep their demand planning process up to desirable level.

2.8.2 Information delays

Delays in information retrieval and transmission make it impossible for companies to build accurate forecasting models of demand. When a manufacturer develops a production plan, he has to retrieve information on order forecasts, current backlogs, inventory status, and production capacities. The production plan becomes the master production schedule, which will be fed in to the MRP system. This entire process will force manufacturers to plan on a monthly basis. Long planning cycles will increase forecast errors and reduce manufacturing's ability to respond to updated order information. Manufacturing ends up building incorrect volumes of products. This leads to high inventory levels and high backorder levels.

Mason-Jones and Towill (1998) claim that each echelon in the traditional supply chain receives an order from its customer from which the business makes a decision on what it needs to produce to satisfy its stock targets. The decision process normally involves a certain amount of judgement to forecast what is thought to be happening within the market place in order to try and ensure the company stays ahead of the game. So in theory trends in consumer demand such as seasonality will be monitored via general trade reports etc., but in practice this often extremely difficult when denied direct access to market place data. In this way, if there are restrictions to transfer information through a supply chain in a sequence manner then this gives rise to the theory of Burbidge (1970), which may be stated as, "if demand for products in transmitted along a series of inventories using stock control ordering, then the demand variation will increase with each transfer".

Stalk and Hout (1990) neatly point out the difficulties associated with information delays when they state, "the underlying problem here is that once information ages, it loses value, old data caused amplifications, delay and over-head. The only way out of this disjointed supply system between companies is to compress information flow time so that the information circulating through the system is fresh and meaningful. So the key to gaining control of the whole supply chain and hence meeting customer demand more efficiently is to directly access end sales and hence redesign the way the chain used this market place information.

Forrester (1961) in his work has clearly written about information delays from one source to another. He points out that information delays are the main cause of demand amplification. He further claims that there is no attempt from companies to co-ordinate ordering policies, so not only does demand amplification takes place, but also it is accompanied by horrendous stock fluctuations. In turn, this leads to product stockouts, obsolescent products left in warehouses leading to all sorts of panic actions. To reduce demand amplification, it is necessary for companies to attack all the causes, which are given in the figure 2.13.

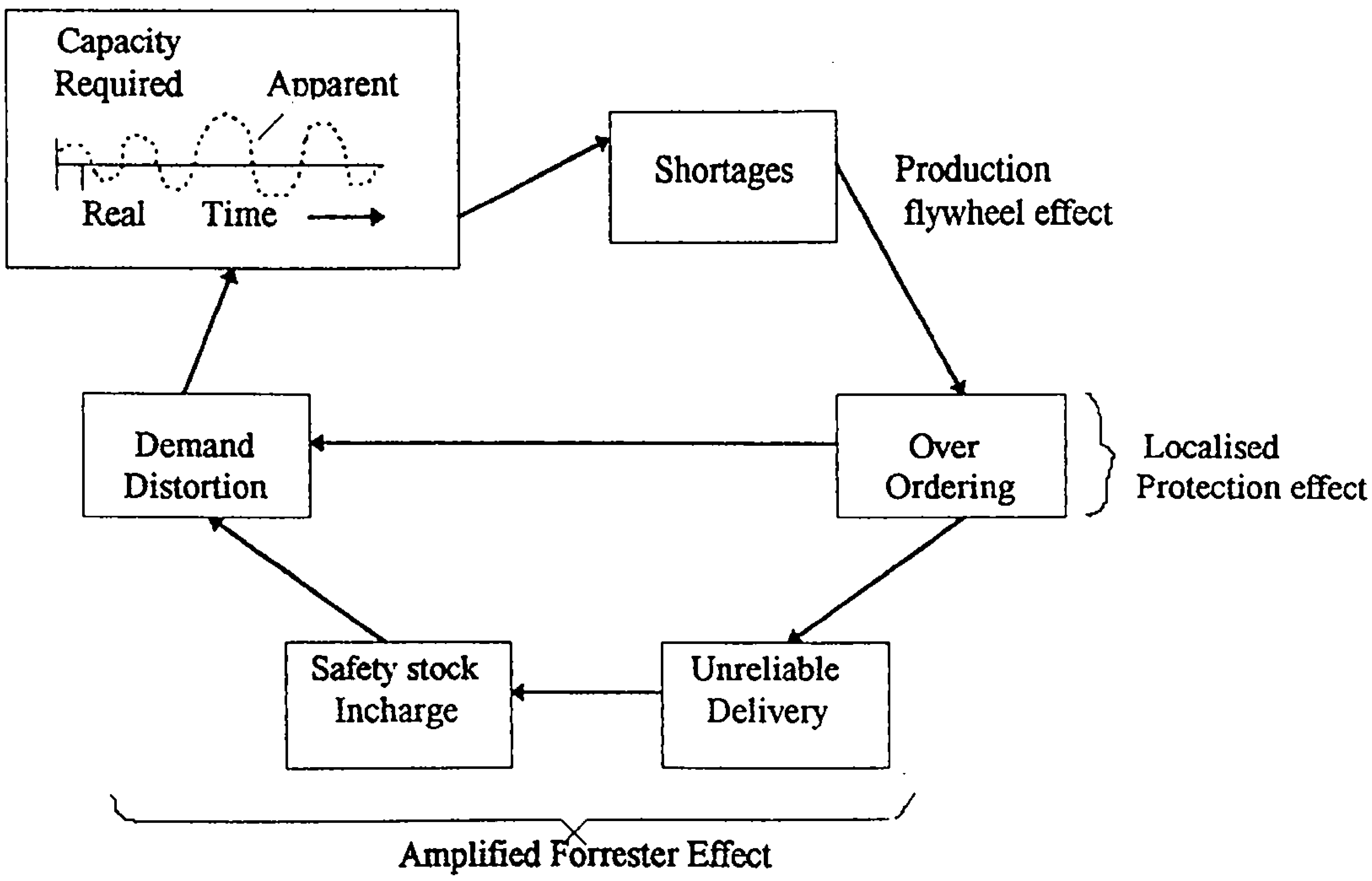


Figure 2.13. The consultants flywheel explanation of demand amplification. (Adapted from Towill and Naim, 1993).

Much has been written about information delays and demand amplification. Authors like Brace (1989), Burbidge (1987), Houlihan (1987), Parnaby (1991), and Towill and Vecchio (1991) have clearly mentioned the behaviour of various players in the chain and their actions, which significantly contribute towards demand amplification.

In the present situation, the work of Forrester is of value. Various authors also have written much about Forrester's philosophies regarding information flows and demand amplifications. It is beneficial for companies to adopt Forrester's guideline. It will help them in solving many complex problems of demand forecasting, the supply chain, and it will also be helpful in other corporate strategies.

2.8.3 Information distortion

Information technology is changing the nature of logistics organisation. It is reducing transaction costs and redefining organisations and their inter-connections. Information systems have already been identified as key factors in the success of business forecasting and demand planning. Intensive business needs good quality information, not distorted information.

Lee et al (1994) claim that information about consumer's demand for any product becomes increasingly distorted as it moves upstream in the manufacturing process. This distortion leads to excessive inventory throughout the system, poor product forecasts, insufficient or excessive capacities, product unavailability, and higher costs generally.

Lee et al (1997) emphasise the need of important mechanism for co-ordination in a supply chain in the information flows among members of the supply chain. These information flows have a direct impact on the demand forecasting, production scheduling, inventory control and delivery plans of the individual members in the supply chain.

Carley and Lin (1997) claim that organisations often face information distortions. These distortions range in their potential to cause a crisis, inevitability and severity. Information distortions are important to consider as they are pervasive and yet potentially reducible, if not preventable. Information distortions can be caused in numerous ways; turnover, personnel unavailability, incorrect information due to technology.

Whang (1995) suggests that information about demand at the site farthest downstream must be made available to upstream sites. In another words, retailers must tell manufacturers exactly how many of various products they are selling. This gives manufacturers necessary data for making sound plans about future demand. Whang further points out that, "if I know more about real demand patterns, I can reduce my inventory, but I have to have my retailer's information". It is quite clear that information plays a key role in any type of business. It is imperative for manufacturers and suppliers to collect the information from downstream channels for forecasting and demand planning. It will help companies to make sound plans for the future.

2.9 The relationship between forecasting and business performance

Forecasting is the main source of improving business performance. Forecasting is not only confined to products or components but also supports manufacturing, distribution, and sales operations of the producers. On the basis of forecasting demand, manufacturing, distribution, and sales operations can be planned.

Hagdorn et al (1994) claim that forecast quality has an important effect on the overall business. Higher quality of forecast enables better planning of operations. Forecast quality has direct influence on customer service and stock levels. If the forecast is more accurate and acceptable, it will enable companies to make effective planning of customer's demand. Customer requirements like delivery reliability, order process improvement and better overall service level can thereby be achieved.

Business performance can be significantly improved by the quality of forecast. Forecasting and business performances are interdependent on each other. If quality of the forecast is poor, it will affect business performance and the company will be compelled to keep huge inventories to satisfy customer demand. In general, forecasting can bridge the gap between sales and manufacturing by providing accurate figures of future demand.

Chapter Three

Inventory Planning and Management

3.1 Introduction

The objective of this chapter is to trace the development of the subject of inventory planning and management to highlight the different strategies, which have significant importance in today's business.

Because inventory management strategies are mostly being taught in academic business institutions, business organisations generally have not employed all the strategies in their business that are available. It is important to understand all the strategies and their advantages in a competitive business environment.

The main focus of this chapter is to identify and describe various factors which significantly contribute to inventory planning and management and also have significant impact on overall customer service, which lead to the nature of inventory management as we understand it today.

3.2 Inventory management policies

Inventory management policies consist of guidelines concerning what to purchase or manufacture, in what quantity, and when. The development of sound policies is the most difficult area of the inventory management.

Inventory results from management policies and procedures regarding the operations of the business. These policies and procedures are derived from external expectations about product demand and material supply as well as from internal constraints such as available capabilities, capacities, and financial resources.

Inventories are stocks of goods that are maintained for many purposes, such as resale to others, use in further manufacturing or assembling processes, and maintenance of existing equipment (Beard et al, 1983 and Jones and Riley, 1984).

Peterson and Silver (1979), Headley et al (1963), Leenders et al (1980), and Buffa and Miller (1979) claim that prior to widespread use of computers in inventory management, from 1960's onwards, inventory requirements were often treated stochastically. Orlicky (1975) points out that stochastic based replenishment systems were independent of future demand, therefore when demand fluctuated away from historical patterns then a shortage could occur.

Inventory management policy varies from one company to an other. Some companies replenish their inventories periodically, whereas some companies replenish their inventories when they reach the re-order level.

With the passage of time, during 1960's, planning and control systems became available to link replenishment with demand. Nowadays, inventory management policy has been changed drastically. A long time ago, inventory was considered as a measure of wealth, but today inventory is viewed as a current asset that should earn more than it would simply by keeping it. If it incurs more costs than benefits, it is a negative asset. Many companies have reduced their inventories tremendously. This reduction has immediate impact on the net cash flows and on the improvement of a company's performance.

3.3 Inventory policy and control in a performance cycle

Effective inventory control requires that the company closely define the physical and financial boundaries surrounding its inventory. The establishment of an inventory control plan is the responsibility of logistics management. The objective of the planning process is the definition of control functions that ensure the accuracy, financial accounting, and timely status reporting of inventory throughout the distribution pipeline.

Knutton (1993) believes the inventory should be seen for what it is; a burden. The problem is that manufacturers, particularly those in the make- to- stock sector, face a dilemma when trying to control stock levels. They must avoid holding too much wrong stock and not enough right product, but they must not keep customer's waiting. Figure 3.1 shows the inventory planning process of a manufacturing company.

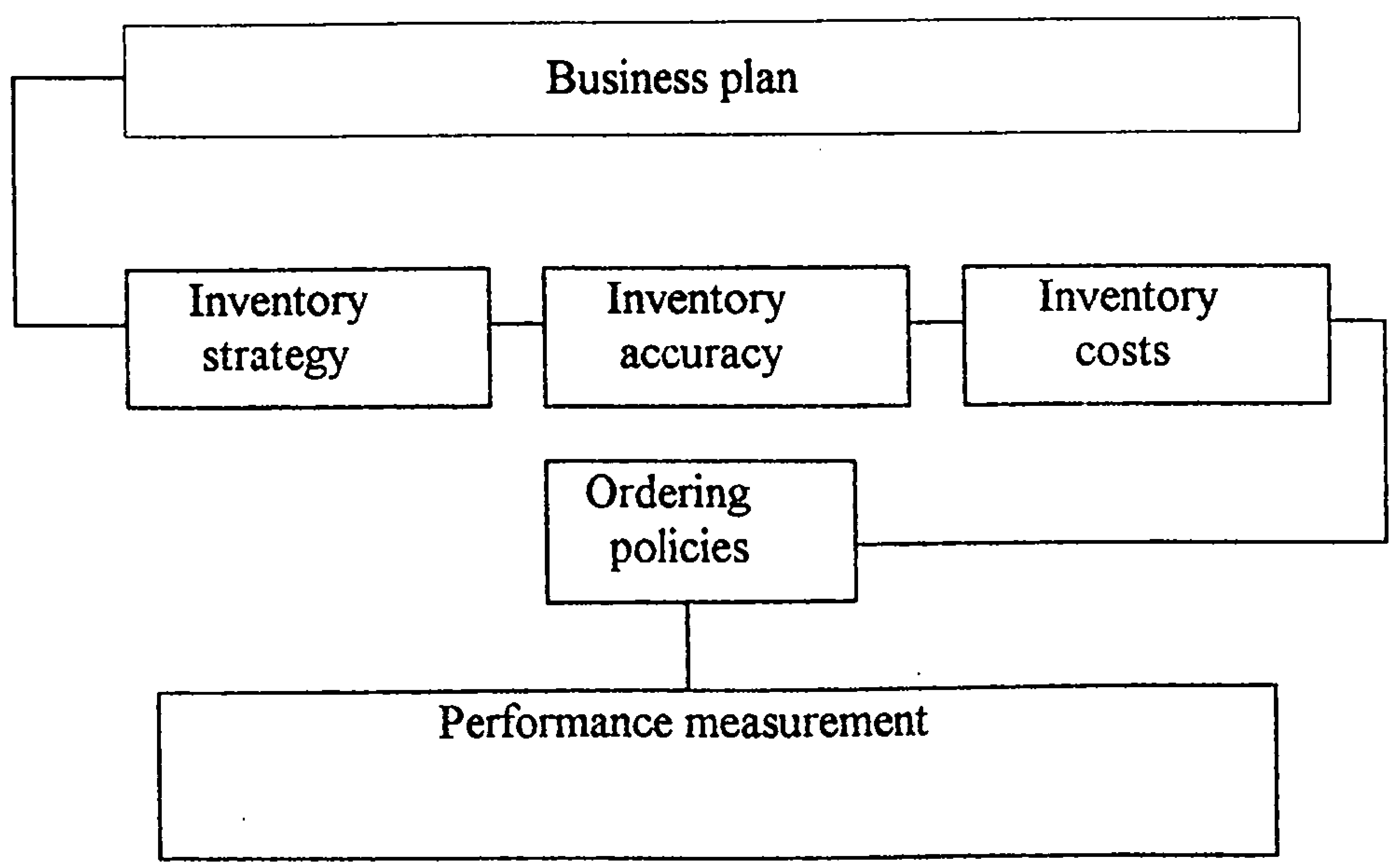


Figure 3.1. Inventory planning process. (Adapted from Ross 1996).

Gopal et al (1993) define this as a planning process that seeks to optimise customer's satisfaction through the changes in one or in all the components of integrated network including manufacturing processes, distribution and customer delivery locations, and product filament processes, rules and policies. Such strategy requires that inventory goals, policies, and decisions be consistent with overall corporate objectives. Bowersox et al (1986) claims that inventory control is a mechanical procedure for implementing an inventory policy.

One major problem in inventory management is the failure to separate the formulation of policy from control. The formulation of inventory policy is an executive responsibility. The determination of policy guideline integrates inventory into the overall logistical process. In turn, all other functional areas of the company are influenced by the implementation of inventory policy through logistical performance. Problems in control normally do not create the same disruption to achieve goals as problems of an improper policy.

3.4 Inventory management techniques

Effective inventory management permits the company to ensure targeted customer service levels and corporate profitability objectives and to utilise the capabilities and capacity of the company to attain and sustain competitive advantage.

According to Orlicky (1975), the nature of product demand provides the real key to selection of inventory ordering techniques and applicability. Selecting the proper ordering technique is the primary responsibility of inventory management who must facilitate the actualisation of business objectives.

In many business situations, different variables affect the decisions of managers regarding inventory targets, therefore, it is important to develop the models to aid managers in their decision making process. In other words, models generally make simplifying assumptions about the real world they attempt to represent.

Coyle et al (1992) state that model complexity and accuracy relate to the assumptions made of the model. The simpler the model is the easier it is to work with and understand, however, the output of simple models is often less accurate. The model developer or user must decide upon the proper balance between simplicity and accuracy.

In today's competitive business environment logistics managers are trying to improve overall business performance by applying different approaches and techniques to reduce costs of the company and to improve customer service. The most common inventory management techniques, which logistics managers use for the improvement of business performance are as follows:-

3.4.1 Economic order quantity

The economic order quantity (EOQ) is the replenishment order quantity that minimises the combined cost of inventory maintenance and ordering. In other words, the most common approach to decide how much of a particular product to order when a stock needs product replenishment which is commonly known as economic order quantity approach. Essentially this approach attempts to find the best balance between the advantages and the disadvantages of holding stock. It is very simple to use.

Vollmann et al (1992) claim that due to its simplicity, people often use economic order quantity formula as a decision rule for placing orders in the requirement planning system. The standard formula for calculating economic order quantity is as follows:-

$$EOQ = \sqrt{\frac{2C_o S}{C_m U}}$$

Where

$C_0 = Cost$ per order

$C_m = Cost$ of maintenance or carrying cost per year

S = Annual sales volume or usage in units

U = Cost per unit

3.4.2 Setting safety stock

Safety stock is generally considered as an inventory that protects against stockouts. If a company's planning system is based on forecasting then safety stock will be used when demand exceeds forecasted demand. The safety stock levels should be proportional to the forecast error. If the forecasts are accurate then little safety stock is required. If the forecast error tends is large then higher safety stock levels are needed (Yale, 1985).

Wilkinson (1996) describes safety stock as a buffer against any uncertainties that exist in the supply chain. If no forecasts are made then safety stock is required to buffer the variability in demand. However, if the forecasts of demand are available then safety stock will only be required to buffer the variability in forecast error. Any other identifiable variability, such as supplier lead-time, should be catered for within the safety stock, to provide the required service.

Kruff (1982) points out that the safety stock may also be calculated depending on the unique statistical variation of each individual item, using mean absolute deviation (MAD), standard deviation (SD) etc.

Furthermore, companies hold safety stock in addition to cycle stock. The purpose of safety stock is to protect against such uncertainties and their consequences. Holding safety stock helps a company to avoid the negative customer related consequences of being out of stock when demand increases unexpectedly.

The difficulty associated with decision maker's decisions is deciding about the quantity of safety stock to have on hand at any time. Having too much safety stock on hand will mean excess inventory. Whereas, not having enough stock will mean stockouts and lost sales. Developing information for deciding the level of safety stock is a difficult task. Measuring the carrying cost associated with different safety stock levels can be similar to measuring carrying cost in general. The safety stock calculation assumes a normally distributed forecast error over unit time and a constant lead-time.

$$SS = z * \delta * \sqrt{LT}$$

Where

δ = stan dard deviation

SS = Safety stock

LT = Lead-time

z is the number of standard deviations from the mean corresponding to the service level required, i.e. 98% service level equates to a probability of demand greater than the safety stock of 0.02, and 0.02 probability from normal distribution tables gives Z = 2.05.

3.4.3 Re-order level

The re-order level is a system in which stock is replenished usually with a fixed quantity or replenishment order is made when stock falls to a fixed reorder level. Wild (1995) describes the reorder level as "if the usage or consumption of products is perfectly constant and accurately known the stock replenishment time is zero, then the stock order level may be zero and the orders for stock replenishments can be placed when stock falls to this level".

The reorder level under the basic model is the inventory level sufficient to satisfy customer's demand until the new order arrives. Calculating the reorder level is very straight forward when demand or usage and lead-times are constant. In this situation, a company can multiply weekly or monthly demand or usage by lead-time in weeks or months and place an order for the determined quantity when inventory reaches the reorder level (Coyle et al, 1992).

Under uncertainty, the company must reformulate the reorder level to allow for safety stock. In effect, the reorder level becomes average weekly or monthly demand during lead-time plus safety stock. The inventory model under the conditions of uncertainty is graphically shown in figure 3.2.

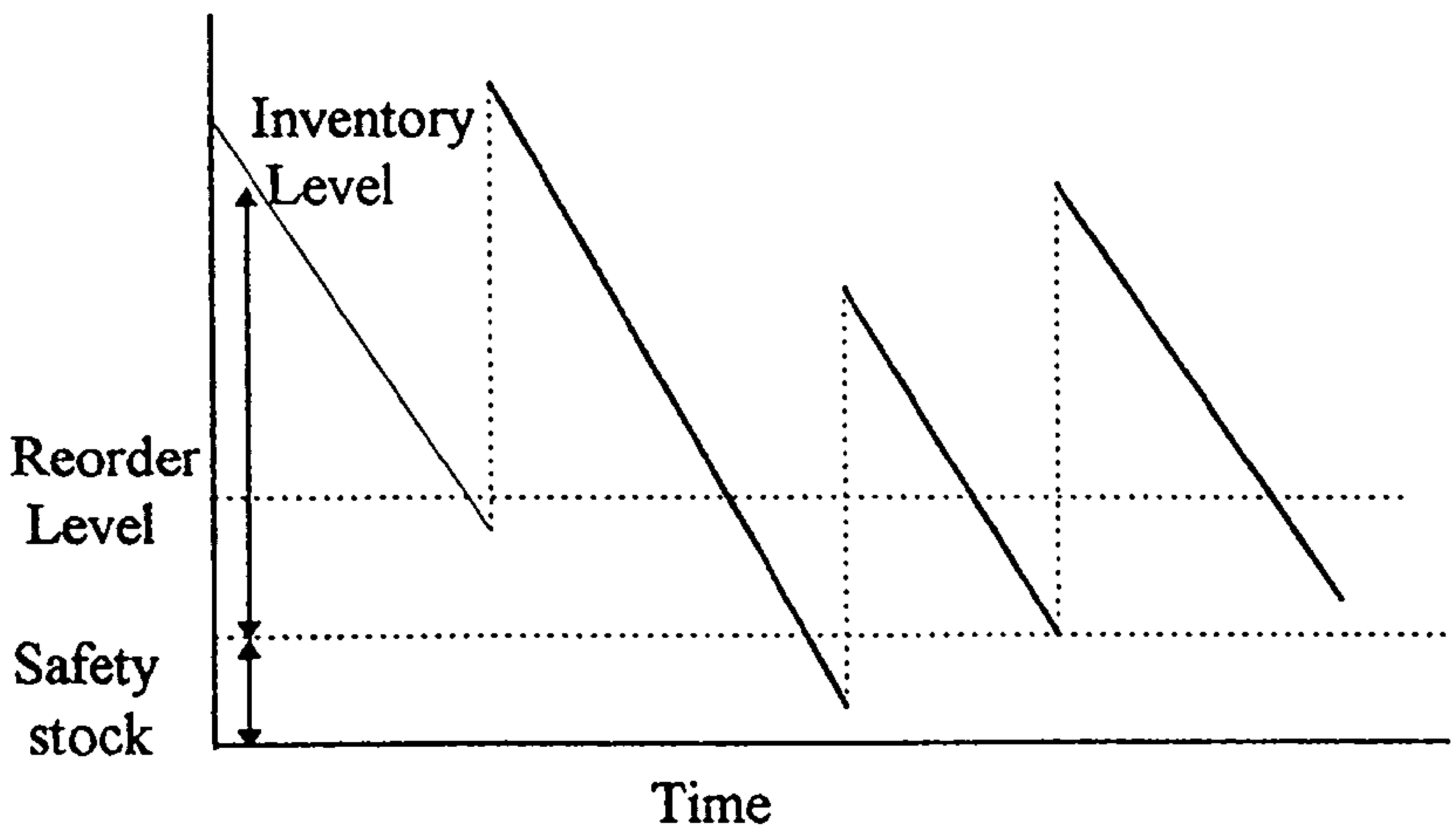


Figure 3.2. The inventory level under uncertainty conditions. (Adapted from Coyle et al, 1992).

A variety of inventory reorder systems exist. The most of the systems are based on either perpetual or periodic review.

Perpetual review

Perpetual review is basically a reorder level system. To utilise this type of control system, accurate accountability is necessary for all the SKUs. If there are a large number of SKU's then computer assistance is necessary to implement the perpetual concept effectively. This approach can be calculated by the following formula.

$$ROL = SS + s * t$$

Where

ROL = Reorder level

SS = Safety stock

s = Average expected weekly or monthly demand

t = Duration of expected inventory replenishment cycle

Periodic review

Periodic review is a system which assumes that the item status is reviewed at a specified time. This approach can be calculated by the following formula.

$$ROL = SS + s\,(t + P/2)$$

Where

ROL = Reorder level

SS = Safety stock

s = Average expected weekly or monthly demand

t = Duration of expected inventory replenishment cycle

P = Review period in weeks or months.

3.4.4 Replenishment policy

Replenishment is a concept forcibly grafted onto manufacturing inventory. It is in conflict with basic management objectives and policies of low inventory and high return on investment. The term replenishment means restoration to a state of fullness. Stock replenishment systems are based on the principles of having inventory products in stock at all times, so as to make them available at poorly predictable times of the need (Orlicky, 1975).

Replenishment can be categorised according to the size, pattern, and lead-time. Replenishment size refers to the quantity of the order to be received into inventory. When a replenishment order is received, it usually goes into storage and becomes part of the company's inventory. The replenishment pattern refers to how the products are added to inventory. Replenishment patterns are usually instantaneous, uniform, or batch.

There are many replenishment policies. Every company replenishes the inventory according to the market behaviour towards their products, their own manufacturing capabilities, and overall business requirements of the company.

According to Wild (1989) today's business is very complicated, where ideal situations for the business rarely exist. In practice, two complications can arise. First, the usage may not be absolutely constant and consequently there is risk that the stock may be pre-maturely exhausted. Second, if this is not immediate it becomes necessary to place orders some time before the products are needed and replenishment times may fluctuate".

Hill (1991) suggests that the inventory should be checked on a quantity and time basis. These both will highlight the inventory item for review and orders are placed only if fixed re-order quantities have been used.

Furthermore, in a distribution inventory environment, the demand for each inventory product must be forecast. Uncertainty only exists at product level and the principle of stock replenishment can be applied. Two basic questions when to re-order and in what quantity arise here. The first question cannot be answered with certainty, whereas, the second question is answered through the computation of some form of an economic order quantity. Three crucial questions of distribution-oriented inventory management are commonly being considered in companies, which are as follows.

1. When to order.
2. How much to order.
3. What the investment level should be.

The answer to the first question is simple, when and if required. The answer of second one is often given by the production schedule, but the general rule is to order as much as is needed to cover more than one period ahead. The answer to third question is not a matter of policy, but is dictated by the production schedules and lead-times. Usually, the replenishment level can be calculated as follows.

$$L = SS + s\,(t + p)$$

where

L = replenishment level

SS = safety stock

s = average weekly or monthly sales

t = duration of expected inventory replenishment cycle

p = review period in weeks or months

3.4.5 Materials requirement Planning

The focus of materials requirement planning is the procurement of materials and components to support manufacturing. The MRP logic was first originated in the United States during 1960s, the early development stages of these MRP concepts are described in Miller and Sprague (1975), Orlicky (1975) and Plossal and Wight (1971).

MRP is a computerised system that combines known orders and forecasts of future demand, then calculates volume and timing requirements of future demand. Exploding higher level requirements through product structures commonly known as bill of materials, subtracting existing inventory and then performs the calculation. The demand for lower level materials is dependent on the higher level requirements (Wight, 1982, Hall and Vollmann, 1978, and Vollmann et al, 1989).

Vollmann et al (1984) claim that the essential concept necessary for MRP is the recognition that manufacturing demand can be classified as dependent. Dependent demand is directly related to, or derived from the demand for other products.

MRP is based on the master production schedule (MPS). The MPS shows a detailed time-table for production of each item, which is typically broken down by week. MRP uses this master schedule, which also uses the bill of materials to plan material requirements. It starts looking at what production is planned and uses this planned production to calculate the materials needed. Then it develops a timetable for orders so the materials arrive in time for use. A typical MRP process is shown in figure 3.3.

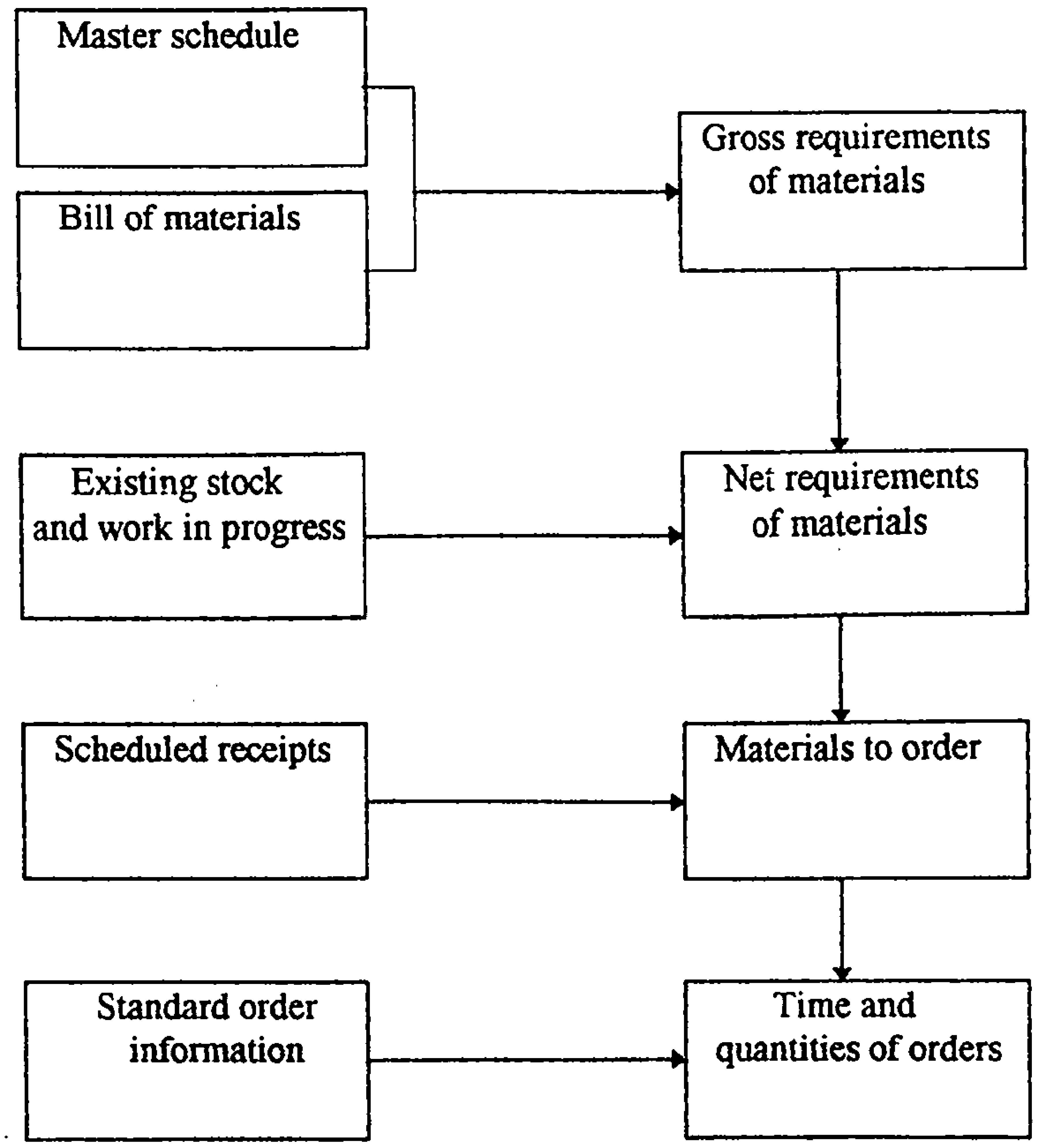


Figure 3.3. A typical MRP process (Adapted from Waters, 1992).

Porter et al (1994) comment on the obsolescence of MRP packages in manufacturing business. They say that there is strong evidence that the MRP approach has given major benefits to firms. But today's business climate and market pressures have made this production control method un-satisfactory in many environments. Nowadays customers are demanding shorter lead-times for product deliveries. Near perfect or even 100 percent delivery service is being increasingly demanded.

MRP makes recommendations to release replenishment orders for the materials. It also makes recommendations to reschedule open orders when due dates and need dates not in phase. It also establishes and maintains valid dates such as priorities on orders. In addition, MRP also produces orders and schedules for suppliers and in that sense plans and controls across an organisation's boundaries.

3.4.6 Distribution requirements planning

The ability to time-phase interplay of supply and demand is the very foundation of distribution requirements planning (DRP). According to Martin (1990) and Ross (1993), the application of DRP was first implemented in 1975 at Abbot Laboratories Montreal in Canada. During the following years, the basic concept of DRP was expanded to embrace not only inventory planning and control but also the company's logistics functions.

DRP extends the principles of MRP down the supply chain through distribution. Ho (1993), Binder et al (1988), Martin (1983), Stanley (1991), and Strenger (1979) implicitly refer to supply chains that are owned by the same company. They refer to the part of the downstream manufacturer as a distribution function or distribution network.

The typical business situation that supports DRP is a make-to-stock manufacturing operation. From a physical distribution perspective, the objective of DRP is to forward allocate as little inventory as possible while satisfying customer service goals. DRP logic is positioning the forward warehouse as a dependent demand point for planning and executing inventory allocations. Gross requirements from forward warehouses are accumulated to help establish the master production schedule.

The fundamental tool for distribution requirements planning is the DRP display, which time-phases requirements across the planning horizon. The horizon is typically divided into weeks. The display reports the current on-hand balance, the safety stock, replenishment cycle time, and order quantity for the product (Bowersox et al, 1986).

A planning system does not use either a fixed re-order point or a fixed order point in time. Instead it uses requirements at a customer level and the time required to move the product through the distribution channel for arrival on time. The DRP approach theoretically does not need safety stock, since time phasing should make the product available when and where it is required. However, when demand or cycle time uncertainty exists, the planning system may utilise safety stock to compensate for uncertainty.

To make the inventory planning system effective, a detailed and accurate forecast is required on a time-phased basis at each warehouse. This is important to direct the flow of goods through the distribution channel. The forecast must be timely and accurate at the warehouses and product detail levels. This means forecasts must be made for each warehouse and product with adequate lead-time to allow transport. In this sense, the mechanics of DRP permit planners to have inventory available to respond effectively to customer needs while minimising inventory costs throughout the distribution channel.

3.4.7 Sales uncertainty and the nature of demand uncertainty

A common occurrence for every manufacturer is a large and unexpected customer order. Demand is uncertain under most circumstances and lack of visibility beyond current open customer orders increases the need for a distribution centre (DC) buffer stock and necessitates expediting when the unexpected occurs.

Davis (1993) claims that the major source of uncertainty in the supply chain is customer demand. Depending on the company's location in the supply chain, this may reflect irregular purchases by a fickle public. It may stem from irregular orders from an industrial customer responding to its own up and down demand.

Although it is useful to review basic inventory relationships under conditions of certainty, formulation of inventory policy must take into consideration the realistic situation of uncertainty. One of the main functions of inventory management is to provide safety stock protection against sales and demand uncertainty. Demand uncertainty concerns the fluctuation in rate of orders during the inventory performance cycle.

Bowersox et al (1986) points out that the purpose of unit sales forecasting is to project sales during the inventory performance cycle. Even with accurate forecasting, demand during replenishment typically exceeds or falls short of anticipated demand. To provide protection against a stockout when demand exceeds forecast, safety stock is added to base inventory. Under conditions of demand uncertainty, average inventory is defined as one half-order quantity plus safety stock. Second, the demand potentials during periods of stockout must be gauged. Finally, a policy decision is required concerning the degree of stockout protection to introduce into the system.

Ballou (1999) suggest that if the variability in requirements can be represented by a probability distribution then the amount of safety stock needed in the schedule can be determined in a way that is similar to inventory control. However, this may be impractical, because the requirements for any product or component are likely to show wide variations due to changes in production schedules, cancelled customer orders, and missed forecasts. This will lead to inaccurate estimates of the safety stock levels.

Furthermore, in any event, true build-to-order companies are relatively rare, and most companies keep some stock, filling the orders from inventory as needed. The more variable the orders, the more stock required to reliably meet customer demand. Knowing average demand and the variability of that demand makes setting inventory goals more scientific and less seat-of-the-pants.

3.4.8 Balancing supply and demand

A third function of inventory is balancing that involves elapsed time between consumption and manufacturing. Balancing inventory exists to reconcile the supply availability with demand. There are many sources of uncertainties, namely supplier lead-time and delivery performance, quality of incoming materials, manufacturing process time which includes machine downtimes, process yields, reworks, transit times, and demand. To reduce the impact of these uncertainties in the supply chain, inventory managers must first understand their sources and magnitude of their impact (Lee and Billington, 1992).

It is surprising that for many supply chains these variables are not tracked. Consequently, companies may over stock some items but under stock others, miscalculate the lead-times for materials movements along the supply chain, and invest in the wrong resources for performance improvement.

Slack et al (1995) describe two entities, time and quantity that if rightly handled can provide the right balance between supply and demand. They also identify the resources of operation, which have the capability of supplying customers, but as yet have not been given instructions on how to do so, and a set of both general and specific demands from actual and potential customers for the operation's products.

Planning and control activities provide the systems, procedures, and decisions, which bring these two entities together. It connects up the resources of the operations, which are capable of supplying goods and services with the demand that it was designed to satisfy. All planning and control activities in the same way are concerned with balancing supply capabilities of an operation with the demand placed upon it. The most notable example of balancing is seasonal production and year round consumption. The managerial reconciliation of time legs in manufacturing and demand involves a difficult planning problem. When seasonal demand is concentrated in a very short selling season, manufacturers and retailers are forced to take an inventory position far in advance of the peak selling period.

Furthermore, customers are frequently unpredictable and seldom loyal. Vendors may slip on delivery timing and quality. Supply management seeks to quantify these problems and adjust the inventory levels for each product so that acceptable levels of balance are maintained.

3.4.9 Avoiding delays by reducing batch sizes

The batch sizes have a major effect on the ability of the firm to meet its overall objectives. Company's main strategy for competitive advantage may not be the price, but the offer of prompt responses for customised products or a higher dependability on delivery dates. Therefore, it is desirable to have a rapid throughput time, which will require smaller batch sizes.

It is often not feasible to produce a lot size of one. The economic batch size will depend upon the cost of setting up the machine relative to the total cost of the component and the stock holding cost. The batch quantities which are too large will result in high stock levels and cause a large amount of capital to be tied up in stock, which might otherwise be invested elsewhere.

One of the main reasons for delays is the large batch size. Inventories will pile-up during production of large batch sizes whereas, smaller batch sizes and frequent processing will promote a steady in the order filling and also a significant reduction in inventories. Additionally, unduly high stock levels will incur other costs, such as, the cost of stock keeping, insurance and depreciation etc.

Furthermore, the competitive pressures in the market place have forced suppliers to reduce inventories. The reduction in inventories and timely deliveries will significantly improve customer service. A smaller batch size is one of the major sources of inventory reduction as well as customer satisfaction.

3.5 Marketing strategy

Strategy is one of the most over used words in the business vocabulary. Corporate planners deal with financial strategies, and marketing strategies. Within the domain of marketing, there are product strategies, sales strategies, promotion strategies, and advertising strategies (Baker, 1991).

A strategy describes the direction, which the organisation will pursue within its chosen environment, and guides the allocation of resources. A strategy also provides the logic that integrates the parochial perspective of functional departments and operating units and points them in the same direction (Day, 1984).

Kotler (1984) defines strategic marketing as a process of strategically analysing environmental and business factors affecting business units and forecasting future trends in business areas of interest to the company, participating in setting objectives and formulating corporate and business unit strategy, selecting target market strategies for the product-markets in each business unit, establishing marketing objectives, and developing, implementing, and managing program positioning strategies for meeting target market need.

Many authors have written about marketing strategies. Kerrin and Paterson (1985) define them as a scheme or principal idea through which an objective could be achieved. Luck and Ferrell (1985) points out that the strategy concept can be encapsulated into two core elements, such as product market investment decisions which encompass the product-market scope of the business strategy, its investment intensity, and the resource allocation in a multiple business context.

Aaker (1984) emphasises the development of a sustainable competitive advantage to compete in those markets. This core concept encompasses underlying distinctive competencies or assets, appropriate objectives, functional area politics and creation of synergy.

Some authors have suggested that strategy is the reverse of formal logic. Strategy explicitly links together the activities of business. Others indicate that a strategy can emerge from a set of decisions and its need cannot be explicitly stated (Mintzberg and Waters, 1985).

Strategy originally referred to the skills and the decision-making process of the executive, while 'stratagem' translated as 'an operation or act of generaliship' referred to a specific decision made by the executive. Over time, the term 'stratagem' has fallen into dispute in present usage it indicates an artifice or trick, whereas now strategy has dual connotations as both the art itself and the output of practising the art.

From the various definitions of above authors regarding marketing strategy, only Kotler, Kerrin and Peterson's definitions' emphasis is on the process of strategy, while Day and Aaker emphasise the output of strategy. The critical factors of marketing strategy are shown in figure 3.4.

An effective niche strategy attempts to align the three "Ps" of successful marketing plan namely product, price, and promotion with the four "Cs" namely customer, cost, channels, and competition. Additionally, marketing strategy requires that the distributors understand the investment and market potential for each new product and service required by the customer and quickly develop strategies to build the business to a critical mass.

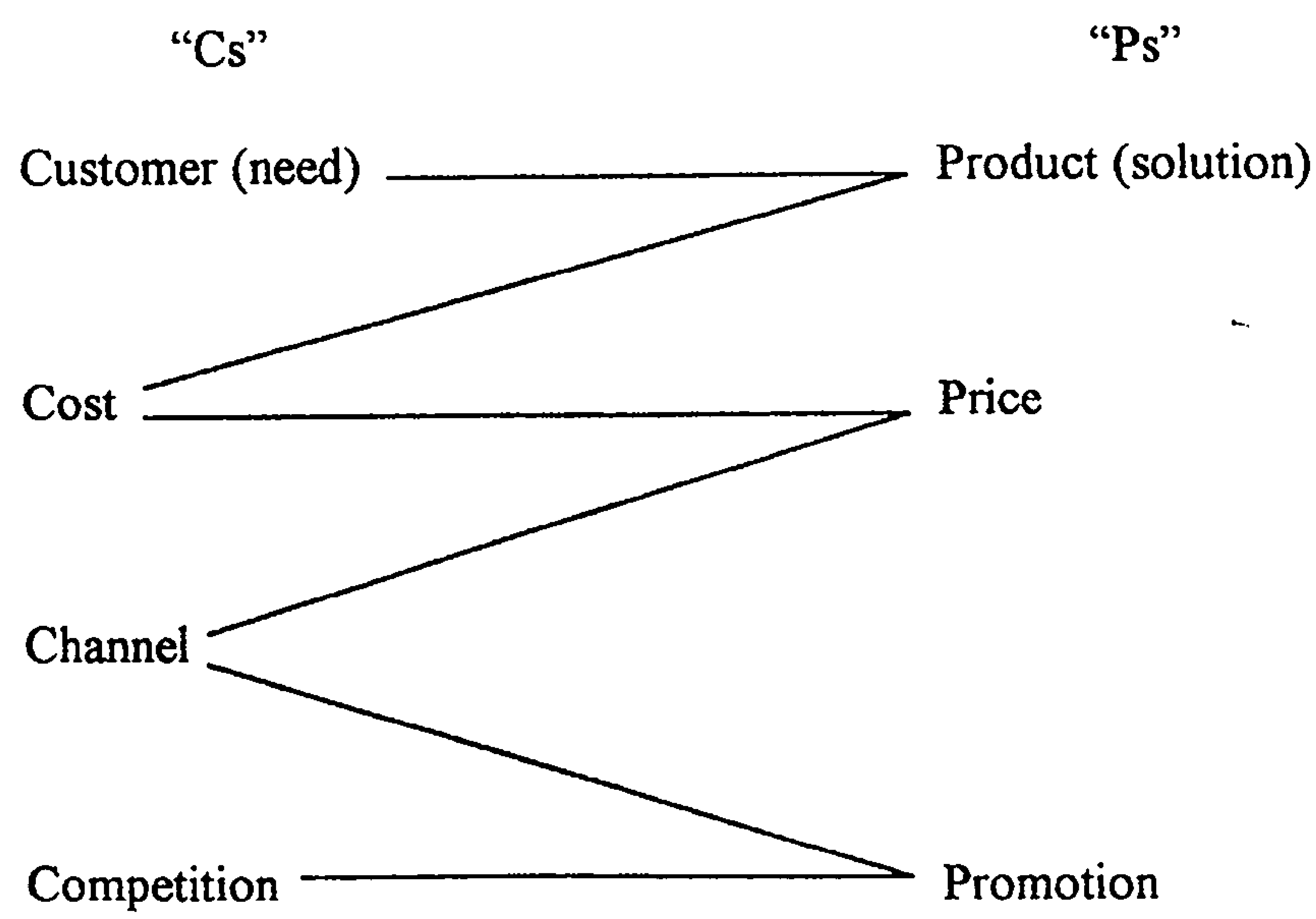


Figure 3.4. Factors of marketing strategy.

3.5.1 Marketing concepts

Marketing is the process of determining consumer demand for the products or services, motivating their sale and distributing them into ultimate consumption at a profit. After world war two, the marketing concept emerged during the shift from a seller's market to a buyer's market.

Standt et al (1976) claim that a marketing concept is a market-based planning philosophy which is based on identifying customer needs and mobilising resources to serve specific needs. Drucker (1954) claims that marketing is not only broader than selling but it is not a specialised activity at all. It compasses the entire business. It is the whole business seen from the point of view to its final result. The responsibility for marketing must therefore permeate all areas of the company.

Many authors have defined marketing in a quite different way. Kotler (1972) defines marketing as the set of human activities directed at facilitating and consummating exchanges. Levitt (1983) claims that the purpose of a business is to create and keep a customer. Cherington (1920) defines that function of the marketing as the establishment of contact.

According to Kotler (1984), marketing is the business function that identifies current unfilled needs and wants, defines and measures their magnitude, determines which target market organisations can best serve, and decides on appropriate products, services, and programs to serve these markets. Thus marketing serves as a link between a society's needs and its pattern of industrial response.

Barlets (1968) has described marketing as the process which fulfils the consumption needs of the society by the distributive systems composed of participants, who interacting under constraints technical, economic, ethical and social, create the transactions or flows, which resolve market separation and result in exchange and consumption.

Some of these definitions are discussed in an article titled "What exactly is marketing", in the Quarterly Review of Marketing in which Keith Crosier (1975) reviewed over fifty definitions and classified them into three major groups. These three groups of definitions are namely, marketing as a process, marketing as a concept or philosophy of business, and marketing as an orientation. However, one cannot argue with Crosier's final group of definitions, which seem agreed only on the point that marketing is a complex and confusing phenomenon that combines both the philosophy of business and its practice. There is a general consensus in these definitions but there is no single definition to serve all the purposes.

3.5.2 Market paced manufacturing

Competitive pressures from world-wide markets has forced manufacturing companies to introduce new techniques for manufacturing to lower unit costs, while simultaneously improving quality. The change in manufacturing logic is as far reaching as was Fredrick Taylor's original concept of "scientific management" in the early 1900s (Taylor, 1911).

The new logic of manufacturing places primary emphasis on responding as rapidly as possible to market requirements. Nowadays, it is very common that a product would never be manufactured or a component purchased until a customer order is received.

In business terms, this is generally referred to as the pull concept of manufacturing. In this concept, the purchasing remains totally flexible to accommodate market requirements. To some extent in business situations, the market paced manufacturing strategies are realised, so the anticipatory nature of purchasing, manufacturing support, and physical distribution would be eliminated. Typical classification of manufacturing with respect to forecasts and orders is namely, make to stock, assemble to order, fabricate to order, and engineer to order. The initial impact of pull logic within this classification is on the make-to-stock and assemble-to-order classes. The manufacturing lead-times in both situations would be increased when work-in-progress and component inventories were not available as needed. The main purpose is to maintain acceptable inventories and response times while maintaining maximum flexibility.

Bowersox et al (1986) claim that the ideal result of pull manufacturing philosophy is improved efficiency owing to the elimination of waste and production stock. They further claim that under this system components or materials necessary are purchased to arrive at the specified production plant as needed and in the exact quantity required.

The concept of market paced manufacturing is based on a capability to rapidly switch what is being produced while maintaining production control. The demand placed upon manufacturing support are exacting with little or no tolerance for error. The variance must be eliminated to adequately support market paced manufacturing. The ultimate appeal of a pull logic is its focus on inventory minimisation throughout the system.

Jackson (1983) define that the emphasis of the market paced manufacturing is on the flexibility which has resulted from adoption of just in time strategies. Initially the pull concept to manufacturing was established by the Japanese in the 1950s when the Toyota Motor company introduced a system known as Kanban. The popular appeal of JIT was the potential elimination of work in process inventories by limiting production and assembly to only what is required to support planned manufacturing or customer orders (Monden, 1981).

The basic philosophy of JIT is that inventory only exists to cover problems. By reducing inventories, problems in the manufacturing process are exposed. These problems must be solved before inventories can be reduced.

3.5.3 Lead-times

Lead-time is the total amount of time that spans the period beginning from the date when an inventory replenishment order is struck until the date the stock is received, located and recorded in the inventory control system, and available for sale.

Coyle et al (1992) describe lead-time in a simple way. They say that it is the total time that elapses between an order's placement and its receipt. Their definition includes the time required for order transmittal, order processing, order preparation, and transit.

Many authors have emphasised on lead-time reduction, to improve customer service. Plossal (1985), Waters (1992), Harding and Harding (1991), and Graham (1987) have described customer service strategies becoming firmly focused not only on providing firm lead-times but also on investigating how they can be consistently shortened.

Christopher (1992) describes lead-time as the elapsed time from order to delivery. This is a crucial competitive variable as more and more markets become increasingly time competitive. Nevertheless it represents only a partial view of lead-time. From the supplier's perspective, it is the time it takes to convert an order into cash and indeed the total time that working capital is committed from when materials are first procured through to when the customers payment is received.

Christopher and Braithwaite (1989) suggest that to overcome these problems and ensuring timely response to demand requires a new and fundamentally different approach to the management of lead-times. The proposed approach will achieve the objectives of securing a more profitable mix of orders and a more reliable delivery performance. One way of giving short lead-times is to allow some orders to have priority at work centres, and not having too many queues for the normal time. Figure

3.5 illustrates the way in which cumulative lead-time builds up from procurement through to payment.

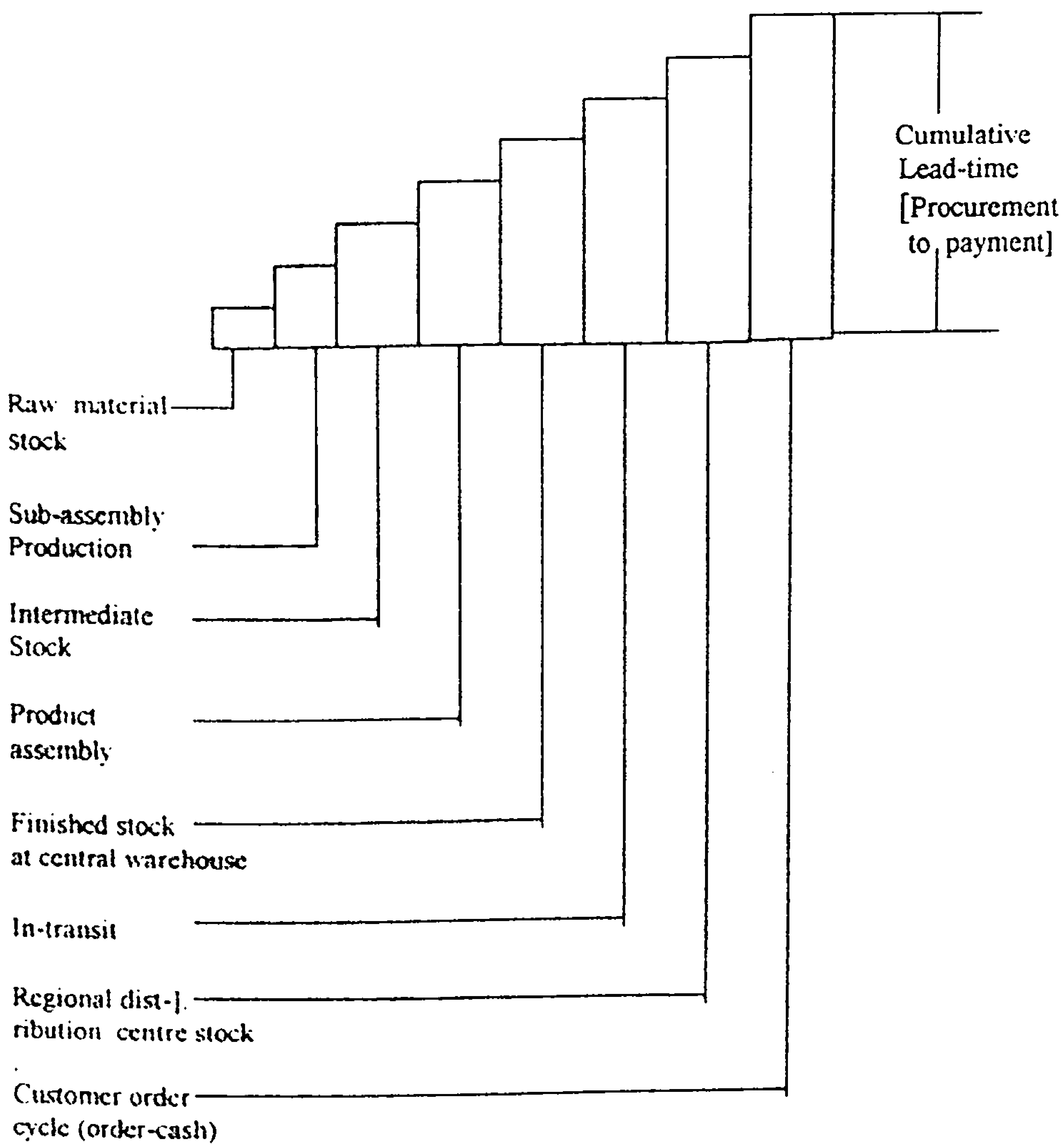


Figure 3.5. Strategic Lead-time Management [Source: Christopher, 1992].

Almost every author has emphasised the reduction of lead-times. Shorter lead-times are one of the most important parts of running a manufacturing business successfully.

The shorter lead-times, to enter customer orders, to make products and to buy materials will make company less vulnerable to forecast error. Consequently, it is better to ship what the customer's want and when they want it.

3.5.4 Cycle time management

Cycle time is the period between placing orders with a company and receiving its products. Cycle time is composed of manufacturing, marketing, and distribution time.

Miltenburg and Sparling (1996) points out that cycle time management and reduction is the manufacturing philosophy that follows after total quality management (TQM) and JIT. Cycle time management seeks to reduce total cycle time, which is the time required to perform the activities that occur during order processing, design, supply management, production and distribution. According to Nicol and Sirkin (1991) cycle time management examines all the activities that occur during the manufacturing cycle. Many activities that constitute the manufacturing cycle can be organised into five sub-cycles, which are depicted in figure 3.6.

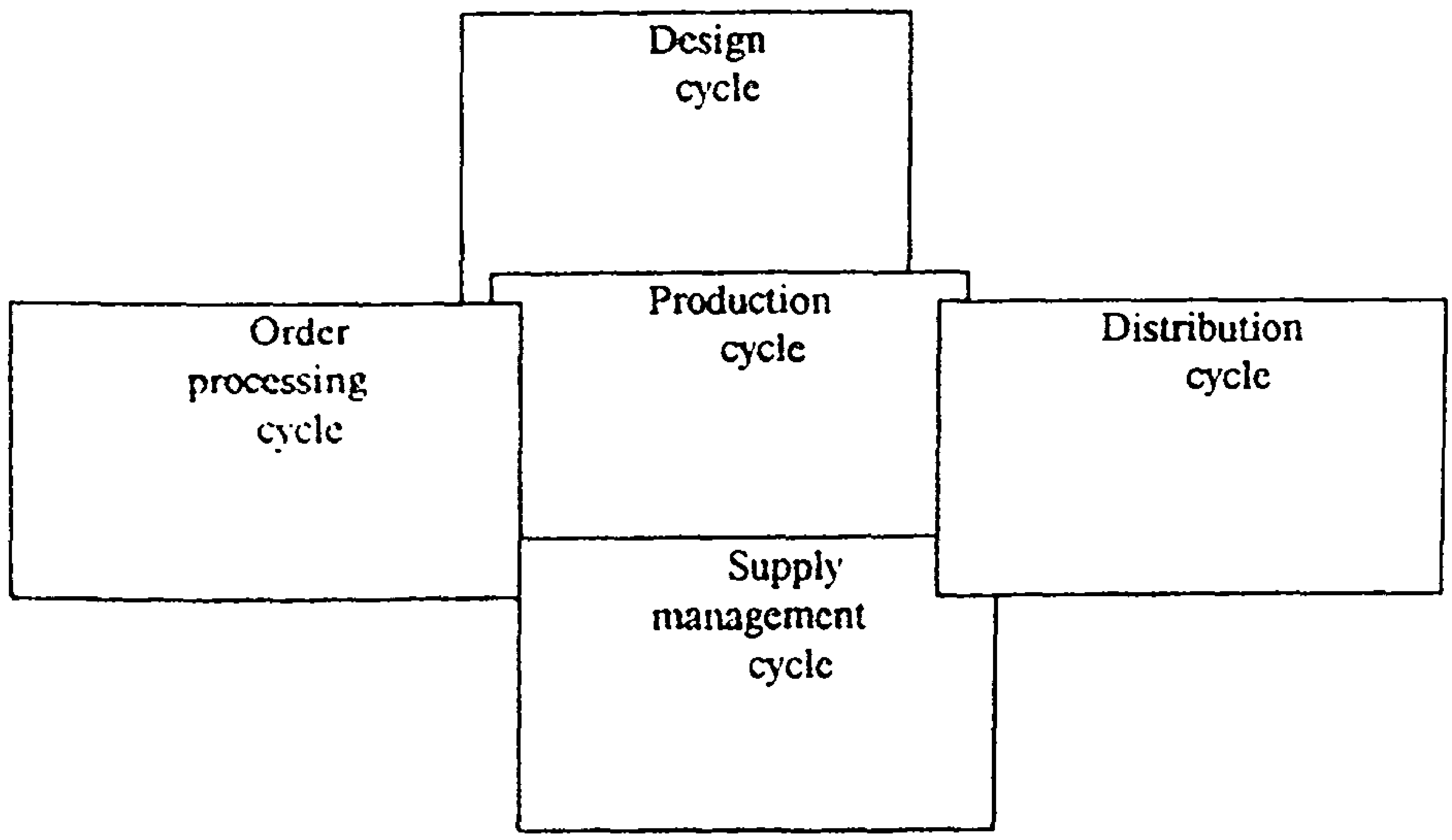


Figure 3.6. The five sub-systems comprising total cycle time. (Source: Nicol et al, 1991).

There are two types of cycle time management, namely incremental and breakthrough. Incremental approaches seek to make a steady and continuous stream of small improvements in the five sub-cycles. They are used when the urgency for making improvements is moderate and the resources available for making them are limited. Whereas, the breakthrough approach is used when large improvements are needed urgently and sufficient resources are available for making the changes. Reengineering is a technique that is usually used here. Additionally, like TQM and JIT, cycle time management's objectives are to reduce costs further, to improve quality, to reduce delivery time, and to increase flexibility.

3.6 Manufacturing resource planning in a business environment

Manufacturing resource planning (MRP-II) is a method for effective planning of all resources of a manufacturing company. MRP-II began life in the 1960s as MRP. All MRP-II systems addresses the operational planning in units, financial planning in dollars, and has simulation capability to answer what-if questions. MRP-II is a direct growth and extension of closed loop MRP. MRP-II has been defined as a management system based on network scheduling.

Wallace (1990) defines MRP-II as a company wide management system based on network scheduling, which enables people to run their business with high levels of customer service and productivity and simultaneously lower costs and inventories.

Many authors have pointed out the role of MRP-II within modern manufacturing. Luscombe (1993) and Tersine (1994) claim that the MRP-II covers all operational business functions in accordance with company policy to meet customer delivery requirements. Usually MRP-II performs or is made up of five functions:

- Business planning
- Production planning
- Master production scheduling
- Material requirements planning
- Capacity requirements planning.

The process starts with business planning which is associated with the strategic plan of the company. Once the strategic plan is in place then an operations plan must be put in place. This plan balances both actual and forecasted demand with the capacity of a company at a "family" level. The word family means that the planning at raw materials and products level.

The next step is to breakdown families into end items. This is called the master schedule. Detailed material requirements planning then breaks the entire product into all the components by using the bill of materials and netting the on-hand and on-order inventory. The routing file is then accessed to develop a detailed capacity plan. Once this task is accomplished then priorities can be sent to the plant and to the suppliers.

Correll (1995) describes that the MRP- II as simple when one thinks about it but not so simple when companies try to implement it. This is because it requires a radical change in the way people operate throughout the company to support data accuracy and properly manage the information. Initially software is simple compared to achieving the behaviour change required throughout the company. Figure 3.7 depicts the MRP-II flow diagram.

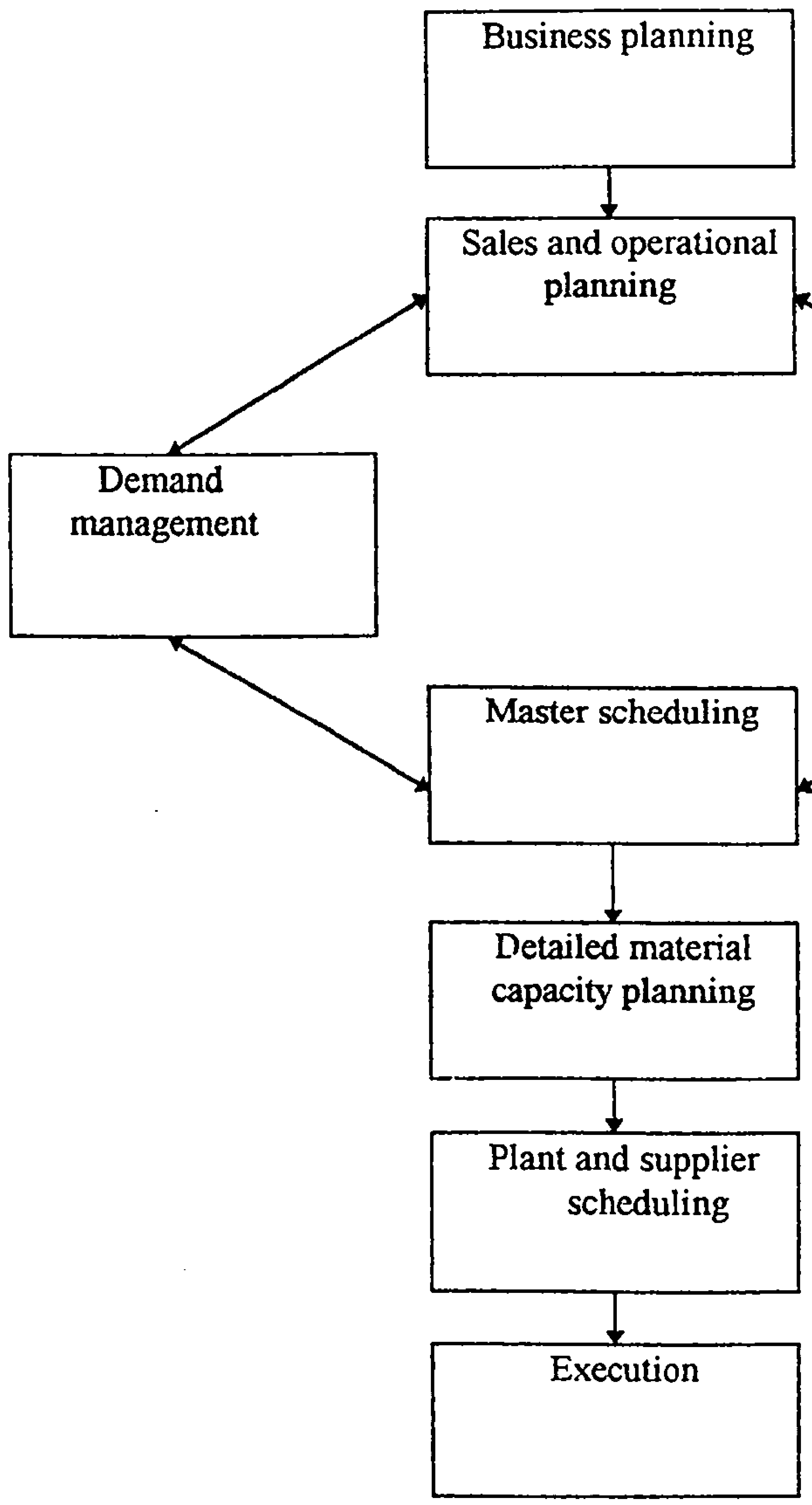


Figure 3.7. MRP-II flow diagram.

MRP originally was seen as a superior method of ordering inventory. As it evolved its major emphasis shifted to scheduling such as establishing and maintaining valid due dates on orders. Today, it has been expanded further into MRP-II to include effective planning of all the resources of a manufacturing company.

A sophisticated system of MRP-II is shown in figure 3.8, which incorporates the information from manufacturing, marketing, engineering, and finance into total operations plan for the company. The evolution of MRP to closed-loop MRP to MRP-II results in a single game plan to meet the overall goals of the company. This is possible because it ties together strategic, financial, and capacity planning areas.

Additionally, MRP-II provides overall business requirements, which help managers to plan their business timely and efficiently. Today's business needs solid planning from managers to compete in highly competitive markets.

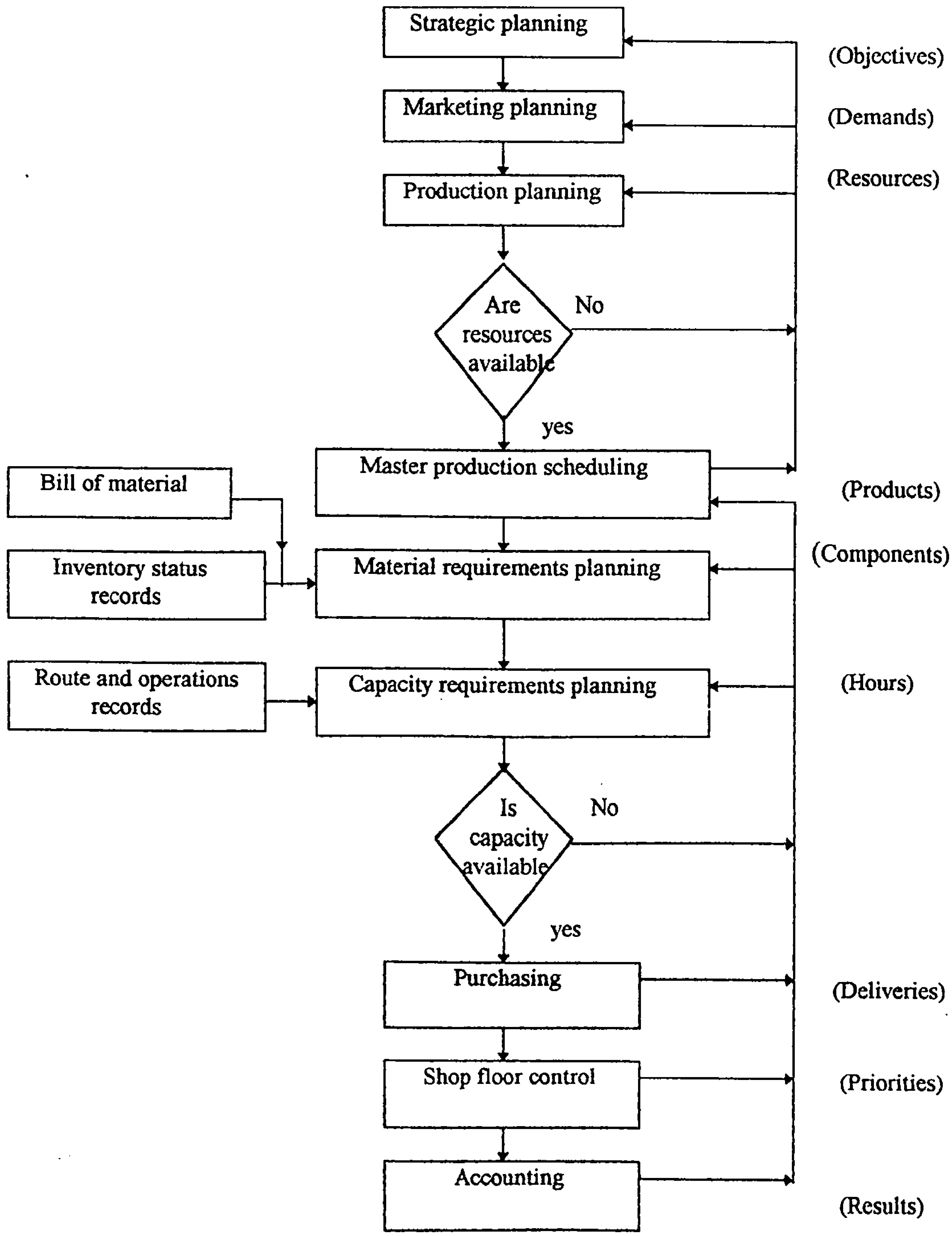


Figure 3.8. Manufacturing Resource Planning. (Source: Tersine, 1994).

3.7 Capacity requirement planning in a MRP-II driven manufacturing system

The process of determining how much labour and machine resources are required to accomplish the tasks of production and making plans to provide these resources is known as capacity requirement planning. Open shop orders as well as planned orders in the MRP system are inputs to capacity requirement planning (CRP), which translates these orders into hours of work by the work centre and by the time period.

The main purpose of CRP in MRP-II driven manufacturing environment is to plan the capacity by work centre, to compare the capacity of the company with demand and to meet current production goals (Orlicky 1975, Bowersox et al 1986, and Luscombe 1993).

Storey (1994) claims that the applicability of this technique to an operation will depend on many factors but the operations which have work centres producing many different types of products will be the main beneficiaries. In any forward planning technique, accuracy of forecasted demand, and stability of production schedules limit CRP. Once a good CRP is available, the provision of capacity through the use of extra shifts, movement of labour, overtime and revision of the master schedule can be considered in a timely and measured way.

Within the framework of MRP-II, capacity management validates the feasibility of manufacturing plans with respect to capacity in each stage of the planning process namely production plan, master production schedule, and MRP, so that the major problems can be anticipated and avoided.

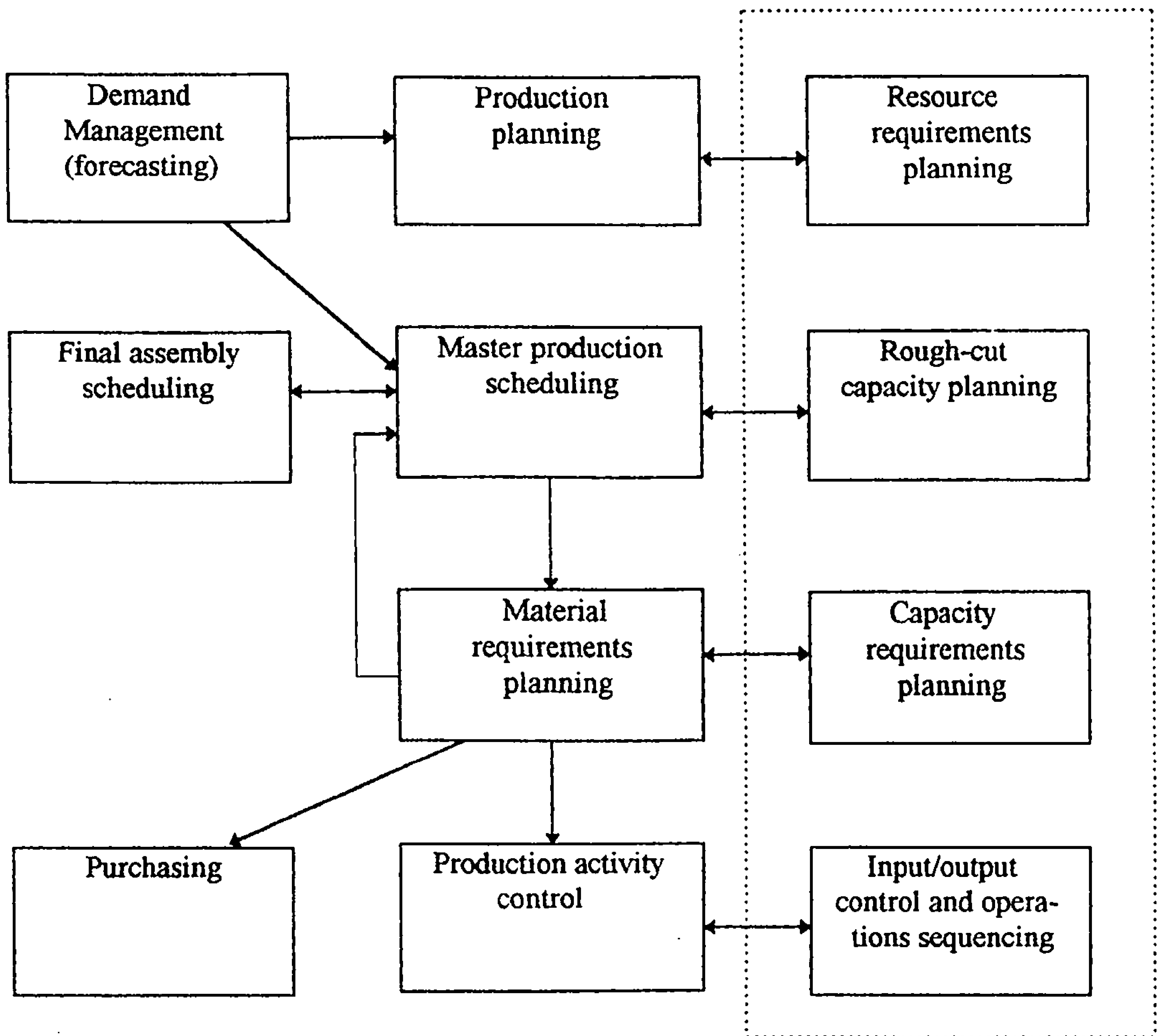


Figure 3.9. Capacity planning and control (Source: Tersine, 1994).

Figure 3.9 and Table 3.1 clearly illustrate the three levels of capacity planning, which are resource requirements planning (RRP), rough-cut capacity planning (RCCP), and capacity requirements planning (CRP). All of the three planning tools are time-phased and predict the required resources but differ in the amount of detail produced. The objective of RRP is to identify the aggregate level of major resources required to meet the production plan, and the objective of the RCCP is to identify the resources required to meet the master production schedule.

Table 3.1. Capacity planning (Adapted from Tersine, 1994).

Capacity tool	Time horizon	Plan	Change options
Resource requirements planning	Long range	Production plan	Land, facilities, equipment, and work force
Rough-cut capacity Planning	Medium/long range	Master production Scheduling	Work force, routings, make/buy, tooling, and sub-contract
Capacity requirements Planning	Short/medium range	Material requirements Planning	Work force, routings, overtime, and sub-contract

CRP is the tool used to identify those problems and to validate the material plan generated by MRP. CRP determines the amount of specific labour and equipment resources required to meet the material plan over the short to medium range horizon.

Furthermore, the development of CRP as a tool within the MRP-II closed loop system forces a company to develop policies on how to deal with capacity issues.

3.8 Effect of specific techniques on production performance

The ever-increasing pressure on companies to be more productive, to react faster to market changes, and to maintain smaller inventories has demanded and is still demanding significant changes to the traditional ways of managing a manufacturing business. The way in which production is organised, the technological methods used, the location of plant and degree of specialisation of direct operators will affect the production performance.

In today's business environment, where many companies are trying to become world class companies, most of them have introduced new techniques in their businesses to improve production performance. These companies have achieved many benefits by applying these techniques. The most significant benefits are huge reductions in inventories, improvement in customer service by providing timely deliveries, and an overall improvement in business performance. These techniques are discussed in the subsequent section.

3.8.1 Just in time

The JIT manufacturing philosophy involves the elimination of waste and continuous productivity improvement in the execution of all manufacturing activities required for producing a final product.

Increasing numbers of manufacturers are taking a serious look at the JIT strategy of production to become more competitive in the global markets. There are many different interpretations of JIT, the early definition of Schonberger (1982), saw JIT as primarily being a system of synchronising the delivery of parts to their desired location at the right time. However other authors consider JIT as an all encompassing philosophy of production comprising three essential elements namely elimination of waste, total quality management and employee involvement (Ohno and Mito, 1988).

Ansari and Modarress (1990) claim that the important element of the JIT strategy is the purchasing function. The procurement of parts and materials plays a key role in the successful implementation of JIT strategy because it has direct impact on increased productivity, reduced costs and improved quality and of course inventory often detrimentally.

Some writers have described JIT as a holistic management approach consisting of various practices that contribute to the elimination of waste and the continual improvement of a manufacturing system (Hall, 1987, and Schonberger, 1986). JIT systems may include any number of different management practices (Baldwin, 1989, Celley et al, 1986, and Shingo, 1981). Although writers often differ about which practices make-up the JIT concept.

Golhar and Stamm (1991) identify the rapid growth of JIT in their review of literature, which showed a large increase in the number of articles published on JIT in the past five years. The benefits expected by the companies from the implementation of JIT were:

- Improvement in quality.
- Lead-time reduction.
- Reduction in work in progress.
- Raw material and finished product stock reductions.
- Material handling improvement.
- General employee involvement.
- Introduction of cellular manufacture.

Companies were experiencing problems in many areas. By the implementation of JIT systems, frequent deliveries of raw materials and components of the correct quality, there is need to significantly reduce set-up times. This can possibly be achieved by management commitment and worker participation.

Some researchers indicate that the benefits typically achieved from JIT implementation including reduced throughput time, improved labour productivity, improved quality, decreased inventory levels and reduced requirements for space (Hay, 1988, Celley et al, 1986, and Golhar et al, 1990).

A few writers suggest functional area improvements achieved from implementing JIT are all related to changes in throughput time which may reflect the progress made in the implementation of JIT (Hall, 1987, and Wacker, 1987).

The above definitions of different authors and researchers are of value. In the light of above mentioned work, JIT techniques in today's business environment for improving the business performance can be described as follows.

JIT is an approach to achieving excellence in a manufacturing company based on the continuing elimination of waste, which is considered as those elements of the total process, that do not add value to the product. JIT systems support movement of materials to the necessary place and at the right time. The implementation of such systems is based on manufacturing capabilities that each operation is closely synchronised with subsequent operations.

Helms (1990) concludes that in theory it is easy to understand the concepts of JIT that eliminate waste and improve productivity. However in reality these concepts are difficult to implement because JIT implementation requires many fundamental changes in a company's structure. It involves changes in several basic elements of the company such as people, procedures and processes.

The holding of both raw material stocks and finished goods stock are generally a function of planning activities. Such stocks do not tend to exist unless they are planned for. However, in-process stocks are likely to exist in any manufacturing company whether they are planned for or not. They often exist because manufacturers like to semi de-couple sequential work stations. This is effected by having buffer stock between work stations, which is of course totally contrary to the concept of JIT.

In the production process, work in progress (WIP) tracking is necessary with products that have long lead-times. WIP tracking becomes un-necessary when companies cut their manufacturing lead-times from months to days. Production remains under control because the work is not on the floor long enough to get out of control and the WIP is so small that it may be controlled visually and counted perhaps in minutes.

Ohno and Kumagai (1980) one of the pioneers of the JIT technique at Toyota claim that "if the meaning of production control is truly understood, inventory control is un-necessary". One of the sources, by which the reductions in WIP inventories can be achieved, is through the integration of operations. Further reductions in inventories can be facilitated by shorter set-up times which leads to the possible economic production of smaller batch sizes.

3.8.2 Manufacturing Agility

The main purpose of agility is to identify, design, manufacture and deliver goods and products to meet customer desires, while maintaining stringent cost and quality standards. It is becoming a powerful differentiating strategy in high velocity business environments.

Narasimhan and Das (1999) claim that the search for competitive differentiation has led firms to move from a dominantly cost-based focus during the 1950s-70s period, to quality and cost during the 1980s. Cost and quality have become market entry qualifiers in the globally competitive 1990s, and firms are now turning to manufacturing agility to achieve customer satisfaction and expand market share.

Manufacturing agility has been described as the ability to produce a broad range of low cost, high quality products with short lead-times in varying lot sizes, built to individual customer specifications [Fliedner and Vokurka (1997), Upton (1995)]. Richards (1996) describes manufacturing agility as the concurrent realisation of cost, quality, dependability and flexibility competencies in a firm.

From a manufacturing point of view, agility can be viewed as an outcome of flexible operations that meet stringent cost, quality and dependability requirements. The ability to vary production volumes economically in response to market demands, implement minor changes in product design for customisation purposes, reduce delivery lead-times to meet customer requirements, and develop and introduce new products efficiently are examples of operational flexibility manufacturing needed to meet agility goals.

Strategies such as just in time manufacturing, organisational reengineering and cycle time reduction have also been used in firms facing flexibility challenges. The use of technology and management philosophies to attain operational flexibility has been studied extensively in the literature [Dodgson (1987), Hayes and Jaikumar (1991)].

From a strategic perspective, companies for whom agility is a competitive priority should focus on developing high levels of operational flexibilities. One way to attain operational flexibilities is through supply chain management strategies. Supply base strategies would focus on the selections development and certification of suppliers with the requisite responsiveness and technological competencies to fulfil operational agility goals.

3.8.3 Quick Response systems

The ability to respond to the customer with the proper product, quantity, price and location at the minimum cost has been noted as a benchmark of a "world class" distributor. In the 1990s, this operating paradigm has been termed as quick response (QR).

Sullivan and King (1999) describe that QR is a type of just in time manufacturing system specifically developed for the apparel industry to help firms respond to consumers' demands within a changing competitive environment. They further describe that a business can gain sustainable competitive advantage by innovations in technology or concepts as well as in products. Quick response as a program developed by textile and apparel manufacturers and retailers as a way to cope with problems challenging the apparel industry, uses a combination of strategies to reduce inventory levels, improve merchandise quality, increase worker productivity, increase stock turnover, and reduce merchandise mark-downs and inventory costs. QR strategies combine a just in time operations philosophy with technological innovations in order to increase operational profits. QR requires that manufacturers implement bar-code systems and engage in electronic information sharing with retailers.

In US, QR movement developed out of the efforts of a number of major retailers and their key suppliers who recognised the need and the advantages of working together much more co-operatively. QR originated in North America in the 1990s, driven by the power retailers such as Wal-Mart and K-Mart, who were looking for a better service from their suppliers. These retail outlets sell shelf space direct to manufacturers and retailers to build greater responsiveness and more efficient daily flow of products. This, in turn, leads to improved customer service, increased sales, lower costs and improved margins (Smart, 1995).

Iyer and Bergen (1997) points out that QR is a movement in the apparel industry to shorten lead-times. Under QR, a retailer has the ability to adjust orders based on better demand information.

QR systems refer to P:D ratio. The typical make to stock operation such as those making consumer durables, demand time D is the sum of the times for transmitting the order to company's warehouse or stock point. Reduction in the finished goods stock will trigger the decision to manufacture a replenishment batch (Slack et al, 1998). This cycle generally known as make cycle, involves scheduling work to the various stages in the manufacturing process. Physically this involves with drawing materials and parts from input inventories and processing them through the various stages of the manufacturing route. Behind the make cycles lies the purchase cycle which is the time for replenishment of the input stock that involves transmitting the order to suppliers and awaiting their delivery. This type of manufacturing involves the demand time which the customer sees is very short as compared with the total 'throughput' cycle. At this stage, D is the same as P. Both include the 'purchase' 'make' and 'delivery' cycles.

In a study conducted by Kurt Salmon Associates published in 1992, it was noted that 36% of retailers responding felt that QR was a vital business strategy that yields competitive advantage throughout the business. The impact of QR is even more dramatic when applied to three major areas of retail sales namely: basic goods, seasonal goods and fashion goods.

QR enables orders to be placed closer to the start of the selling season. Skinner (1992) in his work has associated QR with fashion products. He argues that QR lowers lead-times by one to four months or from weeks to days, which is around 90% reduction in lead-time. The essential benefit from QR for fashion products is that the information gathered regarding sales of related items could be used to decrease forecast errors. The magnitude of this reduction in forecast error can be substantial. Blackburn (1991) reports forecast error reductions from 20% to 40% as lead-time is decreased from six to four months.

Contrary to this, Bergen et al (1992) and Stern and El-Ansary (1988) claim that the manufacturers and retailers are often separate companies with individual goals and incentives. The literature on channels of distribution reveals that individual incentives of manufacturers and retailers can have large effects on wholesale prices, service levels and contractual terms required to co-ordinate the channel members.

Park (1994) suggests that companies implement QR systems in an effort to satisfy customer's orders quickly with a minimum amount of inventory in a shorter time. Additionally, intense pressure to improve customer service and to remain competitive have forced retailers to look at their current business practices and to explore ways in which they can become more responsive. Those that have implemented quick response systems have enjoyed the expected benefits, such types of some companies are Lever brothers, Sara Lee, Boots etc.

3.9 Factors affecting business forecasting

Forecasting is one of the most emotive subjects in the whole field of management. In which developing, maintaining, and using forecasting techniques are critical functions in the successful execution of various planning processes of the company. The most successful companies anticipate the future demand for their products and translate this information into inputs which are required to satisfy expected demand.

There are many factors that influence the demand for company's products and services. It is never possible to identify all of the factors or to measure their probable effects. In forecasting, it is necessary to identify the major influences and to attempt to predict their direction. Some major factors that affect demand forecasting are discussed in subsequent section.

3.9.1 Promotions

Promotion is primarily concerned with persuasion, which is largely aimed at securing and increasing market share (Wild, 1995). The major emphasis of the research in this area has been on the duration of advertising effects. While it is generally accepted that advertising effects may last over a long period, there is no certainty about the duration of the benefits. According to one source, the cumulative effect depends on the loyalty of customers, their frequency of purchase and competitive effects. Each of which may be influenced in turn by a different set of variables (Dhalla, 1978).

In business, it is generally believed that promotions increase sales but also adversely effect demand forecasting by causing large fluctuations in demand, a point that is often ignored when decisions to promote are made. Furthermore, sales promotion as well as the other factors influence demand to such an extent that predictions based on intuitive judgements and experience may override statistical extrapolation of past data. They also distort demand over the period of the promotion, such that some of the data on which future forecasts are based cannot be used.

3.9.2 Pricing

Traditionally, price has been one of the main negotiating points between manufacturers and retailers. This will not change, and at the same time marketing people need to know how many customers will buy their products. The number of customers willing to buy and how much they will buy are influenced by price.

Forecasting demand is based on a variety of considerations, one of which is price. Demand analysis involves predicting the relationships between the price level and demand while considering the effects of other variables on demand. This relationship between change in demand due to change in price is called the price elasticity of demand (Jain, 1985).

Demand for a product is considered to be elastic if by lowering the price, the demand can substantially be increased. Due to competition in the market place and high prices demand may decrease. Both of the above situations can affect demand forecasting. Wang (1995) claims when manufacturers offer bargains or price incentives, retailers stockpile the inventory and don't order again for months.

Most researchers are agreed on one point that the pricing issue must be solved between the manufacturers and retailers before manufacturing any product. Stable prices will lead to long-term relationships between manufacturers and retailers and provide the stability in demand and facilitate improvements in forecasting demand.

3.9.3 Advertisements

Advertisements have traditionally been seen as a major part of the branding effort of manufacturers. It is the most visible part of the communication of brand values to consumers. It develops awareness, promotes reassurance, and reminds buyers about the brand's quality. Advertisements can add real value and personality to a brand (Randall, 1994). Wild (1995) claims that the demand related objectives of advertising are to attract new customers both from the actual market and from the potential market to increase the existing customer's rate of consumption. The persuasion process through which this objective is pursued involves the enterprise which sends the message through various media to a target group. The effectiveness of this whole process is subject to assessment through feedback.

At the beginning of the life cycle, advertisements may enable a company to gain time by achieving quicker market penetration and an earlier break-even. In the long term planning, advertisements may be used to secure a market share to combat the effects of any external influences on demand and to combat seasonal variations.

Many authors have emphasised the need that advertisements should be effective, timely and scheduled in a proper way. If advertisement effort can affect the level of demand, the timing of such efforts will affect the demand patterns and ultimately it will affect the forecasting process of the company. Scheduling decisions are required in order to ensure an overall favourable demand pattern.

3.9.4 Abnormal sales

The orders for the products, which come abruptly or without any particular information at any time of a month or a year and filled from the available stock or from the available inventory, are generally considered as abnormal sales.

Forecasting and sales are interdependent on each other. Forecasting estimates the future demand by projecting past sales into the future (Ross, 1996, Gill, 1985, Delurgio et al, 1991, and Waters, 1992).

Abnormal sales cannot be included in the forecasting process. It is difficult for managers to predict the timing and quantity of abnormal sales. It is also a matter of judgement for managers that take into account the quantitative values arising out of a forecasting calculation and the qualitative data derived from such events in the business environment for the purpose of determining the course of future events. Additionally, these abnormal sales if not taken into account may greatly affect the future demand forecasting process and may also create frequent stockout situations.

3.9.5 Product life cycle

Marketing utilises one of the important product characteristics and understands the product's life cycle. The theory behind the product life cycle is that the average product can be divided into distinct sales stages, each characterised by differing marketing, investment and distribution requirements. The demand for a product and its acceptance by the market generally tends to follow a predictable pattern (Kluyver, 1977, and Schmenner, 1983).

Tersine (1994) claims that the demand patterns for products are subject to change over during a product's life cycle. Such changes dictate revisions in the forecasting process. There are many tests that can indicate the need for a permanent change. Also there are external environmental conditions that cause demand changes and managers are well aware of their existence and influence. Kotler (1988) describes four underlying assumptions for the product's life cycle.

1. Products have a limited life. Changes in taste and technology dictate that no product will remain in demand by the customers indefinitely.
2. Products pass through distinct stages. These stages can be described as introductory, rapid growth, maturation and decline.
3. Profits rise and fall at different stages in the product life cycle.
4. A company's marketing effort, sales volume, distribution channels size and financial investment is also affected by a product's life cycle stage.

Figure 3.10 depicts the various stages of a product's life cycle from introduction of the product to its decline.

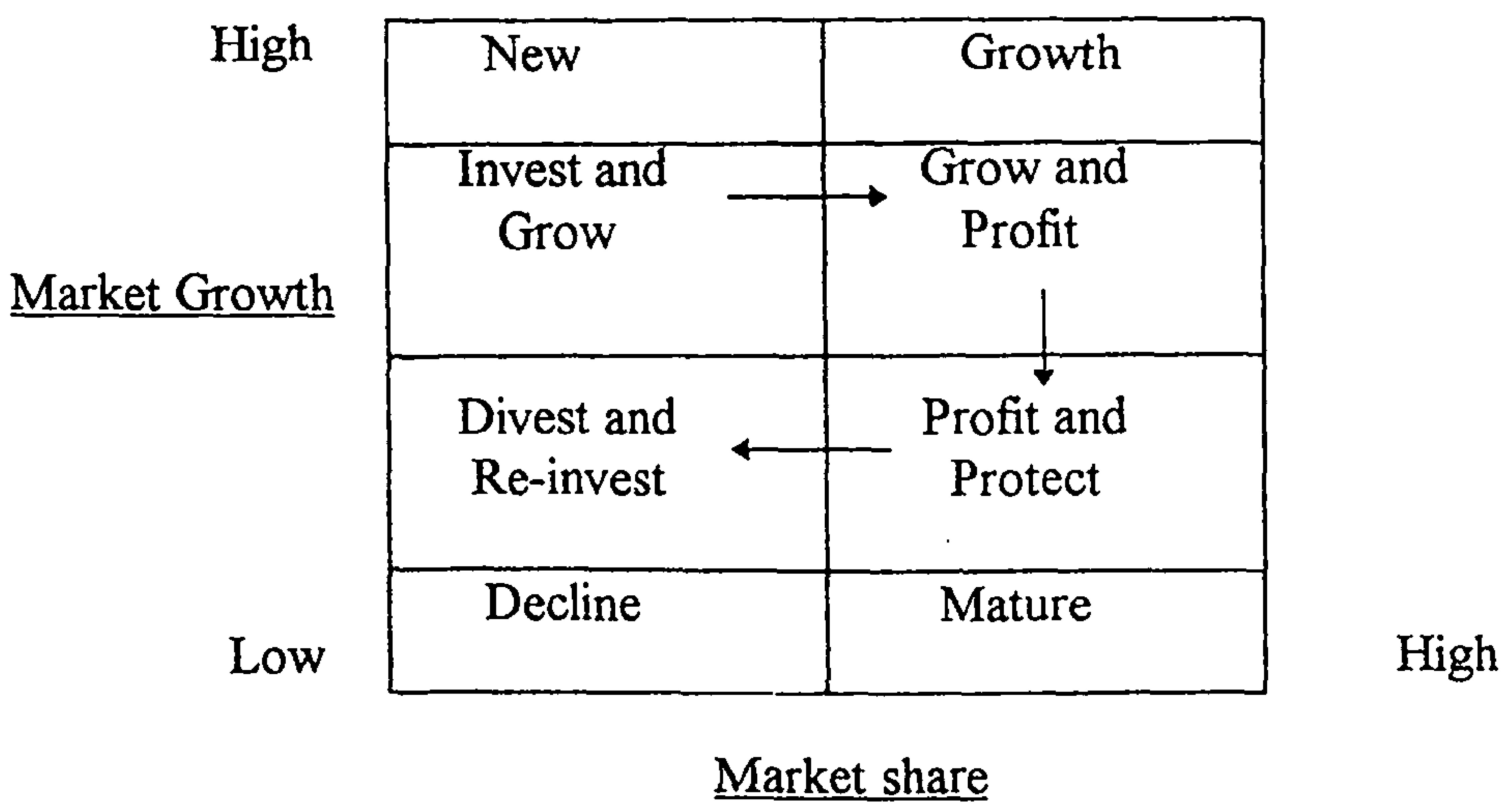


Figure 3.10. Product life cycle (Source: Ross, 1996).

In the different stages of a product's life cycle, the demand will vary considerably and will significantly effect the quantitative forecasting methods employed by the company for their demand forecasting. Because these methods mostly depend on the past data and if used, they will not produce satisfactory results. Practically it is not necessary that the new product will follow the same demand pattern of the replaced product. Judgmental forecasting methods are suitable for this purpose.

Finally, the product's life cycle illustrates the importance of planning before launching the new product. Without effective product planning and estimation the whole production process will be affected which may result in dramatic changes in inventories or frequent stockouts.

Chapter Four

Methodology

4.1 Introduction

A methodology is a system of explicit rules and procedures on which all research is based and against which a claim for knowledge is evaluated. Hindess (1977) claims that methodology lays down procedures to be used either in the generation or in the testing of propositions by those who wish to obtain valid knowledge. Parsons (1971) has also noted and justified these procedures by philosophical arguments.

The main purpose of this chapter is to describe various research methods and methodologies in general and the research methodology adopted in this piece of work in particular.

4.2 Research methodology

There appears to be significant controversies about the definition of methodology and methods. The two terms are being used synonymously; therefore, the definitions of both the terms will be treated together. Originally, methodology referred to science or study of method. This term has been used to describe the system behind the method in a particular discipline.

Oliga (1988) defines methodology as opposite to method. He considers that methods are research techniques such as case studies or questionnaires. Methodologies are propositions and assumptions necessarily normative, which is why hard scientists find them meaningless refusing to accept that there is a theory behind the knowledge rather than just knowledge itself. Avison and Fitzgerald (1988) claim that a method is like a recipe and it is a collection of procedures, techniques, tools and documentation aids, whereas, they claim a methodology is usually based on a philosophical view. These terms will be discussed in more detail in the following topic.

4.2.1 Available approaches

Different research approaches appear in the literature. These approaches are scientific research approaches, social science research approaches and organisational research approaches. In addition, qualitative and quantitative approaches are frequently appearing in the literature.

4.2.1.1 Scientific, Social science and Organisational approaches

In research approaches, the distinguishing factor will be between scientific, social science and organisational approaches. Oliga (1988) points out that the social sciences developed as a field of study later than natural sciences. Research in social sciences tended to adopt a scientific approach and scientific methods as used in studying the natural sciences. The majority of social science research continues to try to apply scientific approach even though the object of enquiry is significantly different.

Bryman (1989) presents each terms meaning. He says that science is based on the fundamental belief in hard facts. Investigating a one true reality increases scientific knowledge. Social science does not believe in one hard truth but rather believes in different perceptions of and influences on situations. Organisational study is a particular area of social science. It recognises the influence of and the perceptions of people. It contains certain characteristics particular to studying organisations as opposed to researching in the community.

Chechland (1981) claims that a scientific approach is based on the concepts of repeatability, reductionism, and refutability. Bryman (1989) discusses the scientific approach in a following way.

- Hypotheses that are derived from theory and which can be measured by observing behaviour of certain variables.
- The belief in causality that involves observing effects on dependent variables as independent variable change, with an underlying implication that the independent variables caused the observed changes in the dependent variables.

- The extension of particular results by generalisation to offer some laws about reality.
- The belief in replicability; different researchers should be able to generate the same or very similar results using the same methods. Replication not only checks the validity of the results of previous research but it also checks their generality.

Bryman (1988) clearly identifies the relationship of these approaches with further discussion provided in later works (Bryman, 1989). He claims that the social science approach recognises the impossibility of guaranteeing repeatability, reductionism and refutability in the context of a social world. Organisational study recognises that accessibility to researching problem is a critical feature of this approach.

Some business disciplines have expressed concern about the preponderance of researchers to be scientific in their approach when referring to the information systems. Galliers and Land (1987) describe this situation as an applied discipline not a pure science. It is based on the fact, if the results of our research are not applicable in the real world situations then researchers endeavours are relegated to the point of being irrelevant.

Several authors have criticised the scientific approach particularly in the operations management area. They have questioned whether the findings of scientific research in operations management have been of any value to operations managers in practice (Miller and Graham, 1981, and Buffa, 1980). Flyn et al (1990) suggest that the continuation of the scientific approach in operations management has been caused by a desire for respectability on behalf of the researcher.

However, the research hypotheses for this piece of work recognise that there is not only one factor which influences the forecasting process rather there are many factors, which are the main causes of forecasting failure. These factors are described in chapter 1 and chapter 2, which highlight many strategies and approaches, by which these problems can be reduced or minimised and forecasting can be improved. Similarly, chapter 3 presents many approaches and strategies for the reduction of inventories within the supply chain.

This piece of research is to adopt a more social science approach realising the difficulties of the problem in the context of a particular case study. In this context, it has to be decided that the approach should be qualitative or quantitative.

4.2.1.2 Qualitative and quantitative research approaches

Different authors have used these terms in quite different ways. Some authors feel that the distinction between these approaches is far more than merely the distinction between the data collection methods. They realise that quantitative research supports the belief in the applicability of the natural science model to social research, whereas qualitative research opposes this view (Morgan and Smircich, 1980).

Many supporters of the scientific research approach believe that qualitative research is based on a collection of methods. Bryman (1989) claims that the distinction between quantitative and qualitative should not be taken to be the presence or the absence of quantification.

This research is social science rather than science oriented and by virtue of its hypotheses it is an investigation of market behaviour towards a company's products. Therefore it appears appropriate for this research to be the mixture of quantitative and qualitative approaches.

4.2.2 Available Methodologies

Many researchers have identified and discussed different research methodologies. Oliga (1988) identifies three main methodologies which are described as follows.

- Empiricism
- Hermeneutics
- Critique

Empiricism

Empiricism is based on the functional paradigm. It means that the world is made up of hard social structures, which can be studied. There are variants of empiricism of which positivism is the most widely recognised and adopted.

Positivism believes scientific knowledge to be made up of the aggregation of empirical knowledge based on observed phenomena. Structuralism believes that the empirical events are only part of knowledge; the rest being made up of unobserved events and what potentially could have happened. Taking these assumptions into account the researcher can be objective and not influence findings with his own values.

Hermeneutics

Hermeneutics is only based on interpretation. The foundations of this methodology are very different to empiricism. In this methodology, the world is taken as being a social world of subjective meaning and intentions. Social phenomenon needs interpreting to try and find out, why and how they occurred.

Bauman (1978) describes the unique configuration of thoughts and feelings, which preceded the social phenomenon and found its manifestation, imperfect and incomplete in the observable consequences of action.

In social science research, where the subject area is difficult to study, the researcher brings to the situation his own set of values, traditions and experiences. Bleicher (1980) points out that the interpreter already has pre-understanding of the subject of study and cannot approach it with a neutral mind. It will make objectivity difficult.

Burrell and Morgan (1979) analyse the work of different authors including Bleicher (1980) and Dilthey (1976) who tried to develop an objective science of sociology, which could satisfy the requirements of positivist science. From the above definitions it is very clear that hermeneutics is only the methodological response to the interpretative paradigm.

Critique

Critique is the methodological research process which involves making individual and social processes transparent and open to criticism to enable change through self-help.

Oliga (1988) explains that critique raises concerns with approach reliant solely on either explanation, whether it is empiricism or interpretation. Critique somehow comes armed with the assumption that change should occur. In the light of above statements provided by various authors, the appropriate methodology for present research is the combination of empiricism and hermeneutics but criticism is also involved to make the whole process transparent.

These methodological approaches can be applied to solve any research problem whether it is in scientific or social science research. The selection of appropriate research methodology depends on the nature of the problem and its importance to the particular research. Having selected a particular research methodology the methods of research will be selected subsequently.

4.2.3 Available Methods

Many research methods are available but the main purpose of this section is to provide brief descriptions of each method to make an appropriate choice of the methods for the researchers in general and for this research work in particular.

Different authors have provided lists of the main research methods. The following list of research methods is compiled from Bryman (1989), Merideth et al (1989) and Ein-dor and Segev (1981).

- Field experiments
- Action research
- Case studies
- Field research
- Structured observation
- Structured interviewing

- Un-structured interviewing
- Historical analysis
- Expert panels
- Surveying
- Delphi
- Prototyping
- Normative analytical modelling
- Descriptive analytical modelling
- Physical modelling
- Conceptual modelling
- Mathematical simulation
- Laboratory experiments

A brief description of each method follows.

Field experiments

In this research, the important field variables are under the control of researcher. Here the independent variables are altered and researcher will observe the resulting effect on dependent variables.

Action research

In this research, the researcher involves himself and tries to influence the situation while observing the effects on dependent variables. Here the researcher becomes part of the investigation field.

Case studies

In this research, the researcher will focus intensively on only one site over a period of time. In this type of research, the independent and intervening variables are not controlled but only the processes and the results are observed and measured by using various sources of data.

Field studies

In this research, the researcher carefully selects the site of study to examine one or more factors. Here the researcher will not attempt to intervene or manipulate the factors during analysis and observation.

Structured observation

This research is more or less similar to field study but in this research, the researcher has already a pre-defined schedule of observations to make about particular things at particular times.

Structured interviewing

This research has a similarity to case studies and field studies. The data is collected by interview. The main advantage of structured interviewing is the interviewer's ability by which he controls the situation and responses. In this research, the results can be analysed quantitatively or qualitatively depending upon the type of information, which the interviewer collects.

Un-structured interviewing

In un-structured interviewing the interviewee is allowed to use the open-ended questions to talk about the research issue. Looking to interviewee's response subsequent questions may be asked. The main advantage of un-structured interview is that it does not prevent the researcher to find and ask some questions from interviewee's prior to the interview for which he was not familiar.

Historical analysis

The historical analysis research approach examines historical or recorded data to give some new insights. In this research, it is not possible for the researcher to manipulate the variables because the research is detached from the time of observation.

Expert panels

In this form of research, the researchers ask questions of a set of experts. The researchers then record the differences and similarities in responses from the experts for final analysis.

Surveying

Surveying method is more time efficient than interviewing and within limited resources it allows greater sample size to be tested. There are also some difficulties associated with this method. These are described as follows.

- Following up non-respondents.
- Following up to clarify information provided by respondents.
- Low response rate with particular reference to postal surveys.
- Reliability of test instrument.

Delphi

In this research, proper and well-defined methods are used for collecting the information from a group of experts. Each expert provides the information on the particular issue. The results are fed back to all participating experts for the next meeting, which develops the basic insights obtained in the first meeting. This process can be repeated for several meetings and then the entire information is documented.

Prototyping

In this method, the researcher builds a working model of a system. This is generally used to pilot test a system that is being designed to know the effects of the system before implementation.

Normative analytical modelling

In this method, mathematical representations are used to give numerical or prescriptive result. It is not necessary that results of all the models guarantee optimisation.

Descriptive analytical modelling

The main difference between normative and descriptive analytical modelling is that like normative, descriptive does not produce prescription results rather its output is based on the description of the situation.

Physical modelling

Physical modelling method represents the model physically; for example an Architects' scale model.

Conceptual modelling

In conceptual modelling, the researchers construct the model mentally then evaluate by means of some analytical framework.

Mathematical simulation

In this method, the real data values may be used to set parameters in the simulation. Here the test data or real data may be used to represent the data flowing in reality. Hence this is a very important and special type of the analytical modelling.

Laboratory experiments

In this research method, the independent variables remain closely under the control of researcher, and the effects on the dependent variables are recorded systematically.

Generally, researchers and practitioners for any type of research select from these methods. The selection of a particular method depends on the type of a problem, availability of data and a research methodology chosen to solve a particular problem. Each research method has a particular advantage in a particular research.

4.3 Case study

The case study may be defined as events or processes occurring over a specified period which the researchers study and investigate the single or multiple problem areas and try to find out their solutions.

Miles and Huberman (1994) claim that the case study is in effect a unit of analysis. Studies are concerned with just one case or with several cases. Stake (1978) claims that the case need not be a person or an enterprise. It can be whatever bounded system of interest. The case can be an institution, a program and a responsibility.

Denny (1978) defines the case study as an intensive or complete examination of a facet, an issue or perhaps the events of a geographic setting over time. MacDonald and Walker (1977) claim that the case study is an examination of an instance in action.

The case study is not so much a unique method of investigation. It is the application of all relevant techniques to the study of anything. A major difficulty of the case study as a research technique is not to obtain dependable data in the perspective of the problem under study (Mouly, 1978).

Case studies are generally oriented towards the solution of a particular problem at the individual level. The research will lead to the discovery of generalised relationships that apply beyond the individual case.

The case study is primarily a clinical procedure and secondarily a research technique. Probably it makes its significant contribution as a source of hypotheses to be verified by more rigorous investigation.

The content of the case study is determined chiefly by its purpose, which typically is to reveal the properties of the class to which the instance to be studied belongs. This general statement gives quite different meanings as one becomes more specific about the purpose.

In this piece of research the case chosen for the study is demand forecasting problems associated with Cusson's products in the Middle East market. The initial approach in this case study was to collect all the relevant information from all the relevant sections including the company's management and the distributor in the Middle East Market. The information regarding other important events such as market behaviour with particular reference to seasonality and Islamic festivals were also collected to find out their influence on market demand.

4.3.1 Interviews

Researchers collect their data by many methods. One of the data collection methods is by the interviews. The central problem of the data collection in human sciences is that the interview usually involves personnel, social interaction between the observer and the observed or between the interviewer and the respondent. The two most common techniques for interviews are face to face interview and interview by telephone.

The main objective of these interviews was to get understanding about the company's service level in general, and market behaviour in particular. All the questions were asked in a un-structured way.

The principal application of the interview in social science, as Madge (1965) says, "is its use for the purpose of making people talk about themselves". Goode and Hatt (1962) examine the interview as a process of social interaction. They stress the need to learn to recognise subliminal cues, those which are below the threshold of normal perception, through which we gain insight with by "reading" such subliminal cues, and make them conscious. They then suggest that friendliness must be established between the interviewer and his subject, but the interviewer must also command respect from the subject for his professional competence.

Oakley (1981) claims that the interviewees are viewed as experiencing subjects who actively construct their knowledge base. The primary issue is to generate data, which give an authentic insight into people's experiences. The basic way to achieve this is unstructured, open-ended interviews usually based upon in-depth participant observations.

Sapsford and Jupp (1996) identify three techniques of data collection by interview. These techniques are described as follows.

1. Face to face interview employing interview schedule.
2. The telephone interview
3. Face to face interview in free format.

1. Face to face interview employing interview schedule

This method of interview uses a standard schedule for each interview and questions carry the same wording and are asked in the same manner.

2. The telephone interview

This method of interview is very fast and comparatively cheapest method of data collection. Due to its efficiency, it is commonly being used in research. It is much favoured by market researchers.

3. Face to face interview in a free format

In this method of interview, the interview is conducted approximately like a natural conversation between two people. The whole process of the interview can be tape-recorded for later analysis or the interviewer may take continuous and contemporaneous notes but this is difficult to do while concentrating on the management of the interview. There are three dimensions, which can be used to compare the methods of asking questions: procedural, structural, and contextual.

Procedural

Procedural is the first dimension on which methods of data collection can be compared and the procedures are employed. These interviews are conducted in a form of conversational type of interaction between the investigator and the respondent. Obviously, the respondent usually knows that the interview is for research and the form of the questions follows a natural line. The replies are recorded in full for later analysis rather than being summarily reduced to a measurement or series of measurements.

Structural

Almost all the methods of data collection are based on some degree of structure. Generally the comparison is between highly structured and less structured methods. A highly structured method is one in which procedures of data collection are carefully laid down so that individual interviewers are required not to depart from them in any way. Less structured methods of data collection include the naturalistic or unstructured interview. In this type of interview, the questions are not asked in an invariant order and the phrasing of each question can be varied according to what has gone before, what the interviewer has already found out, and according to the respondent's understanding (Sapsford, 1996).

Contextual

The contextual dimension of data collection includes a number of issues and is perhaps less of a single dimension of comparison than the procedural and structural ones. Some times an effect of context on the response is a critical one.

The context of interview greatly affects the response rates. It is generally believed that less than 50 percent response is achieved on market research interviews. The reason is refusals rather than failure to contact selected respondents. Dijk et al (1990) in their research on crime in 17 countries, conducted by telephone achieved response rates 45-60 percent only. William (1990) has also explained response rates in a similar way. He argues that good response rates are most difficult to obtain in surveys of the general public on topics not directly relevant to their lives.

The adopted strategy in this research was to collect the relevant data for demand forecasting and to conduct the interviews with key customers about the overall company's performance and the same interview was conducted with the distributor in the Middle East market to get information regarding market behaviour towards Cusson's products. All the interviews were based on face to face interview in a free format manner.

4.4 Company as a sample

The main purpose of the case study is to identify the problem, study that problem and hopefully to solve that problem. The focus of research is to formulate a strategy to solve forecasting problems and to reduce inventories throughout the supply chain for FMCG's in the Middle East market. Also this research will look into different factors and try to find out their influence on the demand.

Cussons is one of the many companies in the FMCG's industry which is facing several problems in the forecasting area in many markets. The forecasting problems in other Cusson's markets are much shorter as compared to Middle East market, so those forecasting problems in the Middle East market were chosen as a case study.

4.5 Research Overview

The logic behind this research is to explore the forecasting problem area and to find out possible solutions for this medium sized manufacturing company in the Middle East market.

This piece of research has been divided into two parts. The first part is concerned with the data collection based on the customer orders, which companies place with Cussons and warehouse movement data. The second part is concerned with a market survey and interviews. The results of both the analyses are presented and discussed in the later part of the thesis.

4.5.1 Objectives of the Research

The purpose of this study is to find out the different factors, which affect forecasting and demand planning of Cussons in the Middle East. It will include a review of specific techniques, barriers, problem areas, and other features of the successful application of forecasting and provide measures for future improvement.

In this competitive era, it is imperative for manufacturing companies to improve in all the areas, which contribute the success and competitiveness of the company. Rockart (1979) describes, 'The limited number of areas in which results, if they are satisfactory, will ensure competitive performance of the organisation. They are the few key areas where things must go right for the business to flourish. If the results in these areas are not adequate the organisation's effort for the period will be less than desired".

This research will look into the behaviour of the market, with particular reference to Muslim festivals. Muslims have different traditions and on some occasions in every year they celebrate holy events. The effect of these holy events on business forecasting is to be found out and how business forecasting can be improved to help company in their demand planning. Another objective of the research is to allow for the impact of seasonality on demand. Nowadays, information systems play an important role in forecasting and demand planning. If these are not working well forecasts will tend to be unreliable.

The Middle East market for Cusson's products is highly uncertain. A company will contribute most effectively towards its desired objectives. When, and only when, all of its complex elements are synchronised. Forecasting will work successfully, when an appropriate strategy is implemented through the effective use of data and information regarding these events. The hypothesis of this study attempts to focus on the complex interaction between seasonality, culture, information, and the company's structure and technical systems which when adopted, the company will achieve the desired objectives in the forecasting.

4.5.2 Research Questions

Almost all research in every business sector depends on exploring the answers of some of the questions by the scientific methods and sophisticated techniques. The companies often solve their problems with intensive market surveys and keeping close contacts with their customers by sharing information regarding their requirements to improve company's performance and customer's service level. The following questions associated with Cusson's Middle East Market have been selected for the problem investigation.

- What are the factors, which affect business forecasting in the Middle East?
- How can forecasting be improved?
- What possible benefits to the company will be achieved by improving forecasting?

The focus of this study is to find the answers to these questions. The outcome of this work will be presented and discussed in the later part of the thesis.

4.5.3 Research Hypothesis

The basic hypotheses of the research is that

1. Demand for Cusson's products in the Middle East market is associated with the Islamic Calendar.
2. Demand for Cusson's products in the Middle East market is seasonal.
3. Warehouse movements data are more reliable for forecasting and demand planning than order data.
4. A significant reduction in inventories can be achieved when warehouse movements data are used for the forecasting.

4.5.4 Methodology of the Research

There appears to be significant difference of opinions in the literature regarding the methodology of research. Oliga (1988) describes methodologies as, "the propositions and assumptions behind methods; these propositions and assumptions are necessarily normative which is why hard scientists find them meaningless, refusing to accept that there is a theory behind knowledge itself".

4.5.5 Data Collection Process

This is an integral part of any analytical research. The research presented in this thesis mainly depends on numerical data. The data collection process begins with the statement of the problem and ends with the analytical analysis. The quality and integrity of the data are critical. Turban (1995) states that, "the data issue should be considered in the planning stage of the system development. If too many problems are anticipated, the project should not be undertaken".

Data should form the basis for analysis, decision and action, and their form and presentation will obviously differ from process to process. Information is collected to discover the actual situation. It may be used as a part of a product or process control system and it is important to know at the outset what the data are to be used for (Oakland 1996).

Data collection is generally much different in the initial stages of forecasting than it is later on. Initial decisions on data are of great importance, because once made organisations show substantial inertia and are reluctant to change collection procedures.

In the recent past, forecasters have witnessed substantial increases in the published data. This is because government and business managers have realised that more and better information increases the effectiveness of planning and decision making. The methods of data collection and the amount collected must take account of the need for information and not the ease of collection.

4.5.5.1 Data Collection Methods

Data collection is a very important process in any type of research. In social research, this process has significant importance although social research is often difficult. A major difficulty in conducting social research is that the researcher often study social behaviour in its natural surroundings, where there are many factors that are difficult to control (Baily, 1978).

Social scientists use a wide range of techniques to collect their data. There are many methods of data collection. These include, observation which are accompanied by audio-taping, interviews, action experiments, questionnaires, participants written cases, observations, warehouse's movements, government statistics, projective tests, physical evidence and financial records.

The researchers and practitioners often rely on all these methods of data collection. Usually three methods of data collection namely questionnaires, interviews and company's records are commonly in use. The data collection method will be chosen on the basis of the problem and its type. Researchers need to write an explicit research proposal that details hypotheses, sample and method by which data will be gathered and analysed.

Many researchers have shared the problem with a time dimension to data collection. Because the variables collected at the early stages may not anticipate theoretical developments at the later stages with a result that the crucial data may not have been collected.

Magnusson and Bergman (1990) claim that due to the time lapse in doing longitudinal studies, there is a risk that the theoretical framework that served as a basis for the design of the study, for the choice of variables and for the construction of indexes has become obsolete by the time of data collection is complete and the results can be published.

In this research, the methods of data collection used are order pattern data and warehouse's movement data, and interviews. The order data of twenty six SKU's was collected from the company for two years (1994 and 1995) the same was collected for the warehouse's movement from their central warehouse, which is located at Dubai and covers all the markets in the Middle East for Cusson's products.

The data collection methods adopted in this research are order pattern, warehouse movements and interviews. The order data can be collected in a variety of ways. The most straightforward way is to simply to have all n items numbered from 1 to n. In this research, monthly order data was collected from the company for two years, the same was collected for movements from a central warehouse, located in Dubai, which supplies the whole Middle East for Cusson's products.

4.6 Analysis of the data

It is generally believed the analysis of the data depends on the level and types of data with which the researcher deals, and has a significant influence on the type of analysis. Other different factors such as influence of a particular event or events also play a key role in determining the approach used for the analysis.

Additionally, one of the key points that must be established as early as possible is which of the variables are seen as being dependent and independent. In this case demand would be the dependent variable and different factors which influence the demand would be independent variables. The independent variable is always antecedent and the dependent variable consequent.

After identifying the dependent and independent variables, sometimes the data that have been obtained from a study appear to bear little relationship to the goals of the project. The measures used have produced an incomprehensible array of isolated facts or results are so unexpected that it is difficult to explain how the outcomes are related to what was done (Struening and Guttentag, 1975).

Researchers analyse the data in different ways. The most sophisticated analysis today is conducted by the use of computers. The computer through manipulation of programs can solve most of the limitations. The computer can be programmed to examine several variables simultaneously and to compute a variety of statistics. Second, if the data is stored in the computer it can be passed from one machine to another machine very quickly and safely. Moreover, the capability for simultaneous extensive manipulations further speeds the overall analysis. Finally, the researcher can use statistical or simulation packages for the analysis of quantitative data. Nowadays, the most quantitative social scientific data analyses are achieved through the use of statistical computer packages.

4.6.1 Use of statistical packages

The use of any statistical package largely depends on the type of data. With regard to forecasting Llewellyn et al (1985) identify four types of quantitative forecasting techniques, namely time series analysis, statistical indicators, single-equation econometric models and multi-equation models.

Time series analysis

Time series analysis is the simplest of quantitative approaches to forecasting. It is based on the underlying assumption of regular and repeating patterns of movement in components whether trend, seasonal or cyclical of time series. Demand forecasting using time series analysis involves identifying these components on the basis of past movements in a given series, projecting them and then aggregating them to obtain a projection for the series in question.

Statistical indicators

The use of statistical indicators as an approach to forecasting involves the study of the evolution of one or more statistical series. They lead to general movements in economic activity with a view to inferring the probable direction of future macroeconomic trends on the basis of observed movements in the leading indicators.

Econometric models

Mathematical equations have now become the principle means by which many theories of economic behaviour are expounded. Such models are simply the expression of economic theory in mathematical form involving a set of formalised relationships among a set of economic variables.

Multi-equation macroeconomic models

Multi-equation macroeconomic model is a formal articulation in explicit and quantitative terms. This is a way in which a set of jointly-considered economic variables are interrelated. It consists of a set of simultaneous equations, each of which represents some important feature of the economy. The number of equations involved depends on the detail with which the behaviour of various groups of economic agents is to be represented. The various equations interact with each other because a variable explained by any one equation serves as an explanatory variable in other equations.

Demand and warehouse movements data of Cusson's products have been collected in the form of monthly observations. These time series can be used to forecast future demand. The nature of the pattern incorporated in the time series determines which forecasting method to use. Another factor that will determine the method to be used is the horizon of the forecast. It is usual to divide forecasts into short term, medium term, and long term. It would be wrong to identify this classification with the actual time units that are used as a boundary for the forecast. If we are interested just in the next month's sales figures namely forecasting one period ahead short-term methods can be used. Equally, just one year ahead represents one period if we are using annual figures and is treated as a short-term forecast. One to three periods ahead regardless of time unit could be considered as medium term. More than five periods ahead are considered as long term methods (Pecar, 1994).

Given the availability of both the order pattern data and warehouse movement data and access to a suitable statistical package such as Minitab, it was possible to set about forecasting demand for Cusson's products. Of many methods available on Minitab, Autoregressive Integrated Moving Average (ARIMA) models were the most suitable to use because it gives good results. The concept and notation used here follow that of Box and Jenkins. ARIMA models were fitted to time series data using a statistical package written by Professor W.Q.Meeker Jr. of Iowa State University. Meeker also helped with the adaptation of his routine to minitab. The computations follow for most part the outline given by Box and Jenkins, which is described in Makridakis et al (1983).

4.7 Integrated framework for research

The nature of forecasting is not a new one but is not clearly understood by many researchers and it is also mathematically complex. Sometimes the selection of forecasting method can significantly influence the forecasts, which may result in forecasting failure.

Particularly in this research, the problem is so complicated therefore it appears to be inappropriate to use only one method of research and instead case study, interviews, and historical analysis such as order pattern and warehouse movements appears more appropriate. However, the interviews were conducted only to collect information about the market behaviour.

In this research the author will try to find out possible solutions of forecasting problems. These problems have already been discussed in earlier chapters, so their analysis and possible solutions will be presented in remaining chapters.

Chapter Five

ARIMA Models

5.1 Introduction

There are many forecasting methods available to predict the future demand in any sector of economy. The forecasting methods such as autoregressive (AR), moving average (MA), and mixed ARMA have been in use for some time. AR models were described by Yule (1926, 1927) more than 70 years ago. In 1937 Slutsky proposed MA models, and in 1954 Wold described mixed ARMA models. In spite of such early work on all three classes of models, their development and applications were severely limited, primarily for computational reasons. Building on Wold's work, ARMA models have developed in three directions with an efficient identification and estimation procedure which is used for AR, MA, and mixed ARMA processes, extension of the results to include seasonal time-series, and the simple extension to include non-stationary processes. A non-stationary process in which a time-series exhibits non-stationary if the underlying generating process does not have a constant mean or a constant variance. In practice, a visual inspection of the plotted time-series can be used to confirm the presence of non-stationary.

Later in mid 1970s, Box and Jenkins developed a modified autoregressive integrated moving average (ARIMA) method by variations in mixed ARMA. Complementing these variations were more efficient approaches for modelling and forecasting time-series situations.

The rapid developments in information technology and widespread availability of computers has facilitated the forecasters and practitioners to use a wide variety of forecasting methods available on various forecasting software packages. For each forecasting method, there is a choice depending upon the data characteristics. Such a choice is not value free as it has a major impact on the forecast. People must decide what method or model to use. Adaptive models, for instance, are reactive, emphasising, non random changes in the recent past. Single exponential smoothing provides conservative forecasts, as it assumes a horizontal extrapolation. In contrast, trend regression ignores pattern changes, emphasising the long term trend in the data. Similarly, for forecasting purposes there is a big difference if a logarithmic transformation is made, how the data is differenced, or if an autoregressive versus a moving average ARIMA model is selected. The implications of such a choice are enormous for forecasting.

Basically, ARIMA is a stochastic model with an autoregressive and moving average component where the non-stationary empirical series was created through summation of the white noise process and the passage through a linear filter. If we make it stationary, and if it happens to be a combination of AR and MA components, then it is known as an ARIMA model.

Stationary and non-stationary models could take several forms, namely AR, MA and ARMA models. Each of these models could be of a certain degree providing it was a stationary one. If the series is non-stationary, it should be made stationary, which should be done by differencing the series. For AR models, it can be said that they are of order p; for MA models, it can be said that they are of order q; and if the series is to be differenced, then the order d can be applied. If the model is an integrated autoregressive moving average, then it could be described with notation ARIMA (p,d,q) where d is greater than zero, which means that the model is to be differenced d times to make it stationary.

5.2 Description of ARIMA

ARIMA is generally known as one of the sophisticated forecasting methods developed by Box and Jenkins. It is a unique approach to forecasting in many ways, especially because it is based on very solid theoretical foundations. But the difficulty in use is associated because of complicated mathematical notations using Greek letters that are used to describe various models. Furthermore, when Box and Jenkins mention various stochastic models, they constantly switch from a theoretical one to a concrete model, changing at the same time, the mathematical notation, as one is representing the total population of models while the other is just a sample. One way or other the text can be quite confusing if the gaps in knowledge of statistics are significant (Pecar, 1994).

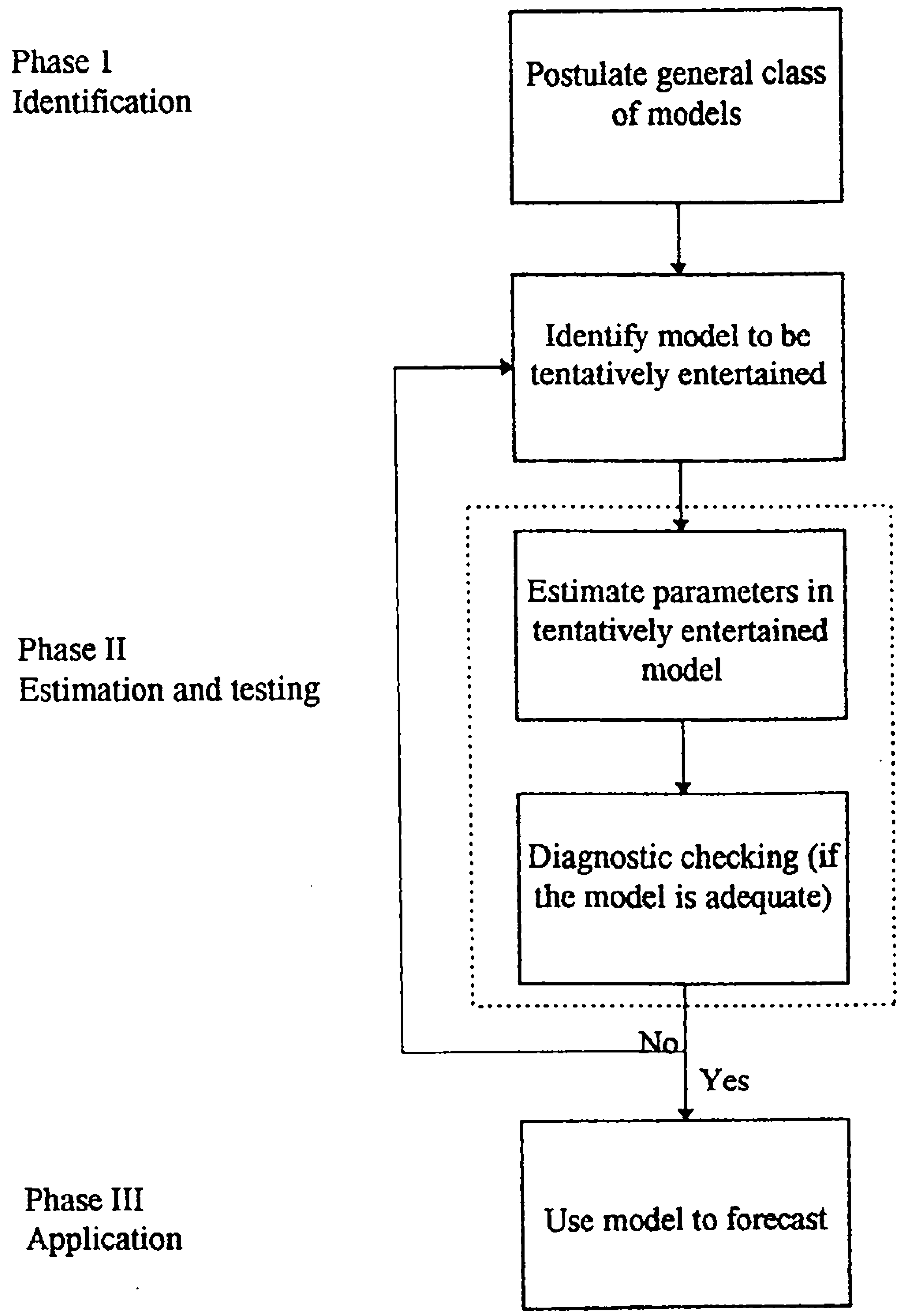


Figure 5.1. Schematic representation of the Box-Jenkins approach (Adapted from Makridakis et al, 1983).

However, the theoretical underpinning described in Box and Jenkins (1976) are quite sophisticated, as it is possible for the non-specialist to get a clear understanding of the essence of ARIMA methodology. Figure 5.1 depicts the schematic representation of the Box and Jenkins approach, which is described in three phases.

Nelson (1973) describes these three aspects of ARIMA as follows.

1. The notation will be established for a general ARIMA model, and the various special cases of the general model will all be treated in the same notational framework.
2. Use will be made of a simulation program to generate time-series data, according to any specified ARIMA model.
3. The simulated data from a specified ARIMA model will be analysed to see how closely the empirical properties of the time-series match the known theoretical properties.

Furthermore, the Box and Jenkins ARIMA methodology is a powerful model-building approach to time-series analysis. It deserves careful study, but it cannot be applied meaningfully unless it is well understood. It is a remarkable fact that for very small values of p, d, q, P, D, and Q in the general ARIMA (p,d,q) $(P,D,Q)^S$ model, an enormous range of data sets can be comprehended (Makridakis et al, 1983). For the selection of appropriate model, it will be helpful to see a plot of the data, it will not be enough merely to see such a plot. The statistical properties of the series have to be examined carefully to decide on an appropriate model.

5.2.1 Stationary and non-stationary

It is important to note that most time-series are non-stationary, and the AR and MA aspects of an ARIMA model refer only to a stationary time-series. Therefore, it is necessary to have a notational distinction between the original non-stationary time-series and its counterpart, after differencing. This phenomena is described by the equation, which is as follows.

$$BX_t = X_{t-1} \qquad (1)$$

In this equation, a very useful notational device is the backward shift operator B. In other words, B operating on X_t, has the effect of shifting one period data back. Two applications of B to X_t shifts the data back two periods, which is described in equation 2.

$$B\,(BX_t) = BX_t = X_{t-2} \qquad (2)$$

The backward shift operator is convenient for describing the process of differencing. If a series is non-stationary, it can be made stationary by taking the first difference of the series which is described as follows in equation 3.

$$X'_t = X_t - X_{t-1} \quad (3)$$

Using the backward shift operator, the equation 3 can be rewritten as follows.

$$X'_t = X_t - BX_t = (1-B)X_t \quad (4)$$

The purpose of taking differences is to achieve stationarity. Generally, it takes a dth-order difference to achieve stationarity. It is rewritten as follows.

$$\text{dth-order difference} = (1-B)^d X_t \quad (5)$$

For this type of series, the general ARIMA model will be described as follows.

ARIMA (0,d,0)

$$(1-B)^d X_t = e_t \quad (6)$$

Where e = error term

5.2.2 Autoregressive process

Autoregressive is a form of regression, but instead of the dependent variable (the item to be forecast) being related to independent variables, it is related to past value of itself at varying time lags. Thus an autoregressive model would express the forecast as a function of previous values of that time-series.

The autoregressive process describe the simple ARIMA (1,0,0) or AR (1) model and generally is known as first-order autoregressive model. In general, pth-order AR process is designated as follows:

ARIMA (p,0,0)

$$X_t = \mu^{'} + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \dots\dots\dots + \phi_p X_{t-p} + e_t \qquad (7)$$

where

$\mu^{'}$ = Constant term

ϕ_j = j_{th} autoregressive parameter

e_t = the error term

It should be noted that there are specific restrictions on the values of parameters.

5.2.3 Moving average process

The moving average is obtained by finding the average for a set of values, then using that average as a forecast for the coming period. It is often used as a basis for eliminating seasonality in data. The term moving or rolling is used because as each new observation becomes available a new average is computed that excludes the oldest value previously included and adds the most recently observed value.

Generally, the moving average process of order one, and the MA process of order q can be written as follows:

ARIMA (0,0,q) or MA (q)

$$X_t = \mu + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \dots\dots\dots - \theta_q e_{t-q} \qquad (8)$$

where θ_1 and θ_q are the moving average parameters, which are subject to certain restrictions in value.

$\mu = \text{constant}$

5.2.4 Mixture of AR and MA (ARMA) process

This type of time-series forecasting model can be autoregressive (AR) in form, moving average (MA) in form, or a combination of the two (ARMA). In an ARMA model, the series to be forecast is expressed as a function of both previous values of the series (autoregressive terms) and previous error values from forecasting (the moving average terms).

As mentioned earlier that the general ARIMA (p,d,q) model involves an enormously large family of model types. Even the simple AR and MA processes show great variety. The general model for a mixture of a pure AR (1) process and a pure MA (1) process would be ARIMA (1,0,1) and is written as follows:

$$X_t = \mu' + \phi_1 X_{t-1} + e_t - \phi_1 e_{t-1} \quad (9)$$

or

$$(1-\phi_1 B)X_t = \mu' + (1-\theta_1 B)e_t \quad (10)$$

5.2.5 Mixture of ARIMA processes

ARIMA is an abbreviation for autoregressive (AR), integrated (I), and moving average (MA). This name describes a broad class of time-series models. If the non-stationary is added to a mixed ARMA process, then the general ARIMA (p,d.q) model is implied. The simple equation for ARIMA $(1,1,1)$ is described below:

$$(1-B)(1-\phi_1 B)X_t = \mu' + (1-\theta_1 B)e_t \quad (11)$$

In this equation the backward shift operator is used which describes the following terms.

1. The first difference
2. The AR (1) portion of the model
3. The MA (1) aspect.

These terms can be multiplied out and rearranged as follows:

$$1-B(1+\phi_1)+\phi B^2]X_t = \mu' + e_t - \theta_1 e_{t-1},$$

$$X_t = (1+\phi)X_{t-1} - \phi_1 X_{t-2} + \mu' + e_t - \theta_1 e_{t-1} \qquad (12)$$

In the above equation, the ARIMA model looks more like a conventional regression equation, except that there is more than one error term on the right hand side.

5.3 Seasonality and ARIMA models

Seasonality is defined as a pattern that repeats itself over fixed intervals of time. For example, the sales of any product are high in summer and low in winter, indicating a seasonal pattern. If the pattern is consistent one, the autocorrelation coefficients of 12-month lags will have a high positive value indicating the existence of seasonality. If it were not significantly different from zero, it would indicate that months one year apart are unrelated (random) with no consistent pattern emerging from one year to the next. Such data would not be seasonal.

For stationary data, seasonality can be found by identifying those autocorrelation coefficients of more than two or three time lags that are significantly different from zero. Any autocorrelation that is significantly different from zero implies the existence of a pattern in the data. To recognise seasonality, one must look for such high autocorrelations.

Seasonality can easily be seen in a graph of autocorrelations or by simply looking at the autocorrelations of different time lags if it is the only pattern present. However, it is not always easy to identify when combined with other patterns such as trend. The stronger the trend, the less obvious the seasonality will be, since relatively large positive autocorrelations result from the existence of non-stationary in the data. As a rule, the data should be transformed to a stationary series before determining seasonality.

One of the characteristics of ARIMA models is their ability to fit seasonal and nonseasonal data series with a higher accuracy. In this connection, the final addition to ARIMA models is seasonality. In exactly the same way that consecutive data points might exhibit AR, MA, mixed ARMA, or mixed ARIMA properties, so data separated by a whole season may exhibit the same properties.

For example, consider a data series that is collected monthly, a full season's difference would be computed by the following formula:

$$X_t' = X_t - X_{t-12} = (1 - B^{12})X_t \qquad (13)$$

The ARIMA notation can be extended readily to handle the seasonal aspect, and the general short hand notation is ARIMA (p,d,q) $(P,D,Q)^S$

Where p,d,q, represent the non seasonal part of the model.

P,D,Q, represent the seasonal part of the model.

S is the number of periods per season.

For illustration consider the following general ARIMA model.

ARIMA (1,1,1) $(1,1,1)^4$

$$(1-\phi_1 B)(1-\varphi_1 B^4)(1-B)(1-B^4)X_t = (1-\theta_1 B)(1-\Theta_1 B^4)e_t \qquad (14)$$

$1-\phi_1 B$ = Non seasonal AR (1)

$1-\varphi_1 B^4$ = Seasonal AR (1)

$1-B$ = Non seasonal difference

$1-B^4$ = Seasonal difference

$1-\theta_1 B$ = Non seasonal MA (1)

$1-\Theta_1 B^4$ = Seasonal MA (1)

All the factors can be multiplied out and the general model is written as follows:

$$X_t = (1+\phi_1)X_{t-1} + (1+\varphi_1)X_{t-4} - (1+\phi_1+\varphi_1+\phi_1\varphi_1)X_{t-5}$$
$$+(\phi_1+\phi_1\varphi_1)X_{t-6} - \varphi_1 X_{t-8} + (\varphi_1+\phi_1\varphi_1)X_{t-9}$$
$$-\phi_1\varphi_1 X_{t-10} + e_t - \theta_1 e_{t-1} - \Theta_1 e_{t-4} + \theta_1\Theta_1 e_{t-5} \qquad (15)$$

Where $\phi_1, \varphi_1, \theta_1, \Theta_1$ are coefficients, which have been estimated from the data, equation 15 can be used for forecasting. The process of identification of a seasonal model depends upon familiar statistical tools, namely, autocorrelations, partial autocorrelations, and a knowledge of the system under study.

5.4 Model selection

Practically, a forecasting procedure often is chosen without adequately checking whether the underlying model is appropriate one for the application. The beauty of ARIMA method is that it carefully co-ordinates the model and the procedure. There is a systematic approach to identifying an appropriate model, chosen from a rich class of models. Historical data are used to test the validity of the model. The model also generates an appropriate forecasting procedure.

Basically, the ARIMA method is iterative in nature. First, a model is chosen. To choose the model, it is necessary to compute autocorrelations and partial autocorrelations and examine their patterns.

5.4.1 Autocorrelations

An autocorrelation measures the correlation between time-series values separated by a fixed number of periods. The fixed number of periods is called the lag.

An autocorrelation is a series of correlations between the original and lagged observations of the empirical variable. This is a very important measure of stationarity and seasonality. When plotted as a series, autocorrelation coefficients constitute the autocorrelation function. The maximum practical number of autocorrelation coefficients that should be calculated should not exceed one third of the length of the original series.

If we lag our series by one observation, and then measure the correlation between the original series and the lagged series, we have, in fact, measured the first correlation factor between the series and its previous values. We can go on lagging the series for more and more observations, and finally end up with a series of autocorrelation coefficients. These correlations, when lined one after another, represent an autocorrelations function that provides the following information.

1. Whether the data in our series are random
2. Whether the data are stationary
3. Whether the data are seasonal
4. What the length of the seasonality is.

Generally the autocorrelations are calculated by the following formula:

$$r_k = \frac{\sum_{t=1}^{n-k}(X_t - X')(X_{t+k} - X')}{\sum_{t=1}^{n}(X_t - X')^2} \tag{16}$$

Where n = number of observations

k = number of autocorrelations

X' = mean of the observations.

5.4.2 Partial autocorrelations

The partial autocorrelation is a conditional autocorrelation between the original time-series and the same series moved forward a fixed number of periods, holding the effect of the other lagged times fixed. The series of partial autocorrelation coefficients constitute the partial autocorrelation function.

If we try to measure the correlations of the series and its previous values shifted k times but this time one at a time, by keeping the influence of every shifted series out of the equation, we get partial correlation coefficients and the series of these coefficients is called the partial autocorrelation function.

Partial autocorrelations are calculated for the same number of lags k as autocorrelations. For the first lag it is easy to calculate the first partial autocorrelation as it is equal to the first autocorrelation, i.e. for k = 1.

$P_{1.1} = r_1$

For a number of lags greater than one, i.e. k = 2,3,............,L.

$$P_{k.k} = r_k - \frac{\sum_{j=1}^{k-1} P_{k-1.j} r_{k-j}}{1 - \sum_{j=1}^{k-1} P_{k-1.j} r_j} \qquad (17)$$

Where j = 1,2,..............., k - 1

$$P_{k.j} = P_{k-1.j} - P_{k.k} P_{k-1.k-j}$$

To calculate $P_{2.2}$, the second partial autocorrelation, we can use the following formula:

$$P_{2.2} = \frac{r_2 - P_{1.1}r_1}{1 - P_{1.1}r_1} \qquad (18)$$

From the autocorrelation and the partial autocorrelations, we can identify the functional form of one or more possible models because a rich class of models is characterised by these equations.

5.5 Forecasting with ARIMA models

With the advent of widespread computer availability in organisations, the much more general and statistical methods of time-series analysis such as ARIMA process have been developed further and applied to forecasting. The essence of this class of methods is similar to smoothing and decomposition in that forecasts are based on historical time-series analysis. However, the approach used in identifying the patterns in such historical time-series and the methodology for extrapolating those patterns into the future are based on well developed statistical theory.

These ARIMA approaches are theoretically and statistically very appealing, their complexity has in many instances hindered their widespread adoption as a basis for forecasting in organisations. In order to use these methodologies, substantial analysis of historical time-series data must be performed, appropriate models must be estimated, and those models must be applied for forecasting purposes.

Various research findings have revealed that ARIMA methods perform better in short and medium term forecasting. A disadvantage frequently attributed to ARIMA models is the difficulty in interpreting them in terms of the classical trend, seasonal, and irregular components (Chatfield, 1977; Harvey and Todd, 1983).

The forecasting robustness showed by ARIMA models is due to the fact that these models with constant parameters, imply forecasting functions with a linear permanent component whose parameters change with time.

Makridakis and Hibon (1979) state if the series conforms to an ARIMA model, and the model has been fitted correctly, then the forecast based on this ARIMA model must, by definition, be optimal. They further state that apart from the ARIMA model, all other forecasting methods considered are of an adhoc nature. The ARIMA method involves model fitting and its performance depends to a large extent on the ability of the user to identify correctly the underlying model.

Generally, ARIMA models are more appropriate for engineering, business and economic applications. In engineering, great majority of data series show stable patterns. Whereas, in business data series show changes in patterns, discontinuities, and most unstable patterns. It is the ability of ARIMA models to fit stable and unstable data sets satisfactorily and produce better forecasts that can be used to make accurate estimates of future demand.

Chapter Six

Statistical analysis of the forecasting problems

6.1 Introduction

This chapter deals with the forecasting problems faced by the fast moving consumer goods industry in the Middle East market and presents the statistical analysis of the factors, which greatly influence the forecasting. All the constructed forecasting models are compared with each other and their results are presented in this chapter. It is also pointed out that the inappropriate approach of Cusson's distributor is one of the many causes of forecasting failure in the Middle East market, resulting in huge inventories throughout the supply chain. Taking into account the effects of forecasting problems, the hypothesis have been developed, which clearly describe the factors that are possible causes of forecasting failure in the Middle East market.

6.2 Data availability

Forecasting can be easy if sales follow a simple pattern, however sales can often appear to be very erratic which presents a major problem to company managers. Company success or failure can revolve around the company's ability to forecast demand with reasonable accuracy. For Cussons, the Middle East market is highly erratic. This is illustrated by figure 6.1, which depicts a two year monthly time series of warehouse movements and shipments of one of the Cussons' products in the Middle East market. The product in this case is Imperial Leather Bath Soap.

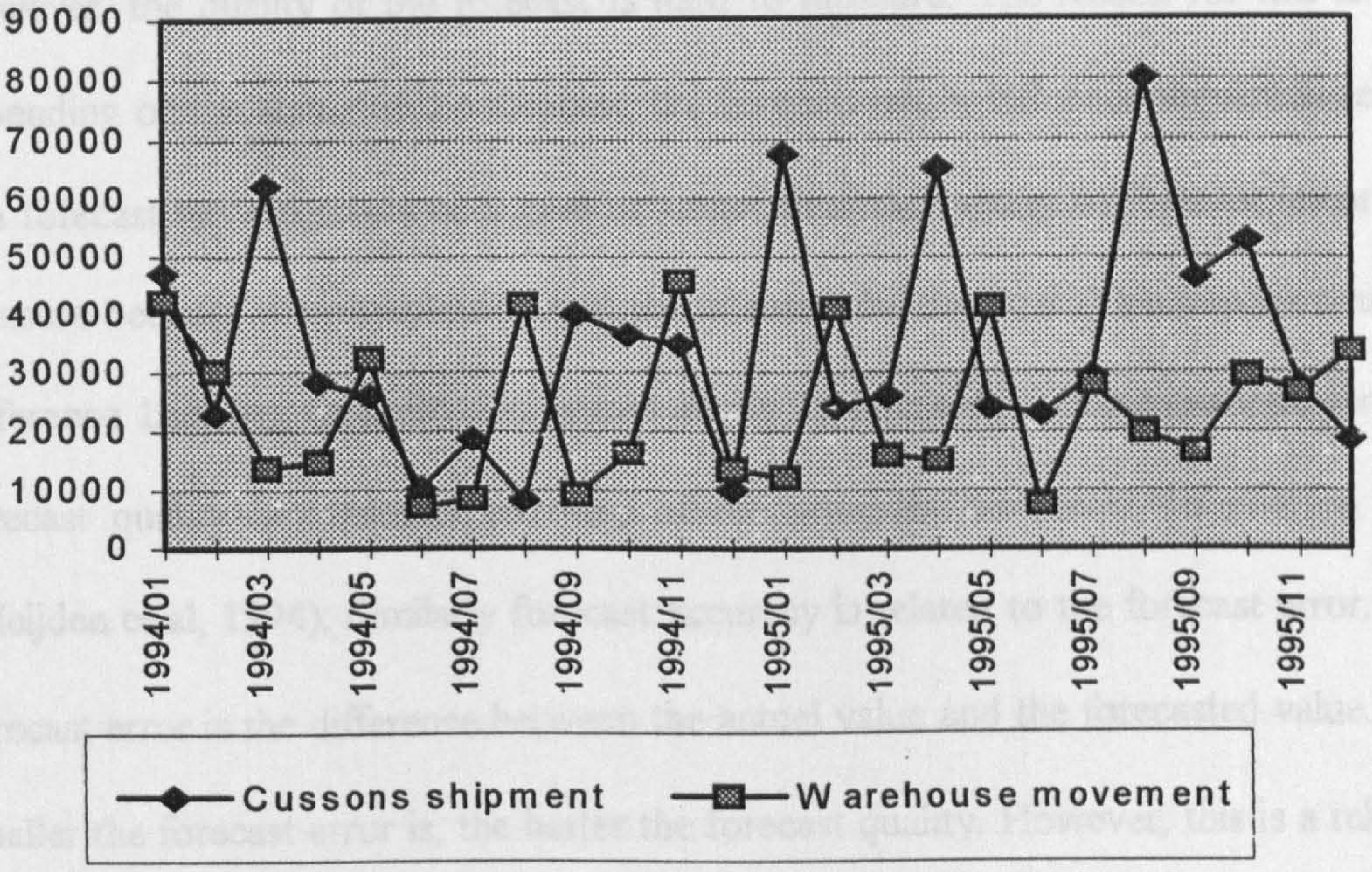


Figure 6.1. Two year monthly time series of warehouse movements and Cusson's shipment based on customer's orders.

As can be seen in figure 6.1, the warehouse movements are far less erratic than shipments. The figure shows clear-cut large variations in demand which is not the result of normal seasonality. These large variations generate the problem of accurate forecasting resulting in poor planning which can lead to huge inventories and poor customer service. However forecasting has to be carried out and errors in forecasts estimated so that they can be allowed for when supplying the market. It is important that the size of the forecast errors can be predicted from an analysis of past errors if any attempt is to be made to improve the quality of the forecast itself (Lines, 1996). However, the quality of the forecast is hard to measure. The reason for this is that depending on the status of the forecast, the forecast might influence the actual result. If a forecast has the status of a goal or target then the quality of forecast is hard to measure because the organisation will try to reach the forecast. This implies that the difference between forecast and actual result is not only a measurement for the forecast quality but for the activities of the company to reach the goal as well (Meijden et al, 1994). Similarly forecast accuracy is related to the forecast error. The forecast error is the difference between the actual value and the forecasted value. The smaller the forecast error is, the better the forecast quality. However, this is a relative measure for products that are difficult to forecast such as products with a demand pattern with a large standard deviation, the same forecast error represents a better forecast quality for products that are easy to forecast (Mahmoud, 1987).

With regard to demand in the Middle East for Cusson's products, the company concluded that forecasting using time series data was not appropriate. This conclusion was possibly due to the complications generated by the effects on demand for fast moving consumer goods due to Muslim religious holidays, coupled with seasonality and the fact that the Islamic Calendar has ten less days than the Christian Calendar. ARIMA models available on Minitab were applied to both shipment data and warehouse movement data for the Middle East market on all Cussons' soap products.

The demand for each SKU display very large variances over time and possible causes for this were investigated. Data on movements of Cussons' products from wholesalers to retailers were obtained which is commonly known as warehouse movements. They were aggregated for each SKU and plotted against time. In all cases the warehouse movements displayed a much smaller variance than the order data. This can only be explained by wholesalers changing aggregated orders from retailers in accordance with what the wholesalers had in inventory and their anticipation of future demand. Effectively the aggregated data being received by Cussons in Dubai and therefore the UK was not the same as the aggregated order data from retailers. For each SKU two separate time series were analysed with the view to developing forecasting models which could enable Cussons to better control the Middle East market for its products. Generally, these variations can be witnessed from the mean and the standard deviations of both series presented in Tables 6.1 and 6.2. All the values are in dozons.

Table 6.1. Mean and standard deviations of Cusson's shipments data.

Product description	Mean	Standard deviation
Family 200G	20192 dozons	11664 dozons
Bath 125G	34625 dozons	19415 dozons
Mild 125G	7710 dozons	8930 dozons
Toilet 75G	8432 dozons	11961 dozons
Gold 125G	13764 dozons	9694 dozons
Gold 200G	9984 dozons	7826 dozons

Table 6.2. Mean and standard deviations of Cusson's warehouse movements data.

Product description	Mean	Standard deviation
Family 200G	20437 dozons	11152 dozons
Bath 125G	30550 dozons	13603 dozons
Mild 125G	10870 dozons	4935 dozons
Toilet 75G	7768 dozons	5536 dozons
Gold 125G	17250 dozons	6812 dozons
Gold 200G	8752 dozons	3066 dozons

The pattern of the data is important in selecting a forecasting model because different models can cope with only certain kinds of data patterns. The following ARIMA models were selected after careful analysis of all the data series representing Cusson's different SKU's in the Middle East market.

ARIMA $(1, 0, 1)(2, 0, 1)^5$ (1)

ARIMA $(1, 0, 1)(2, 0, 1)^6$ (2)

ARIMA $(2, 0, 1)(2, 0, 1)^6$ (3)

ARIMA $(2, 0, 0)(1, 0, 0)^6$ (4)

ARIMA $(2, 0, 2)(1, 0, 1)^6$ (5)

After having made a tentative model identification, the AR and MA parameters, seasonal and nonseasonal, were determined in the best possible manner. For instance in model one, four parameters are used, these are two seasonal and two nonseasonal parameters. There are fundamentally two ways of getting estimates of such parameters.

1. Trial and error that examine many different values and choose that value (or set of values, if there is more than one parameter to estimate) which minimises the sum of squared errors.
2. Choose a preliminary estimate and let a computer program refine the estimate iteratively.

Generally the latter method was preferred. The output of time-series data using ARIMA model with parameter values and raw data are depicted in Appendices D and E respectively.

6.3 Comparison between Cusson's shipments and warehouse movements

Initially the Cussons' shipments and warehouse movements of six different SKU's of Cussons' Imperial Leather were compared. In all cases both order data and their warehouse movement data were plotted. These data were later used to fit forecasting models using Minitab. Some of the forecasting models from a total of twenty six, which have been developed for the Middle East market are described in this chapter. The graphs of the time series fitted with models for Cussons' order data are depicted in figures 6.2a-6.7a. Similar graphs involving the warehouse movement data are depicted in figures 6.2b-6.7b. Figures A1-A14 depict the data and fitted models associated with other SKU's are included in Appendix A.

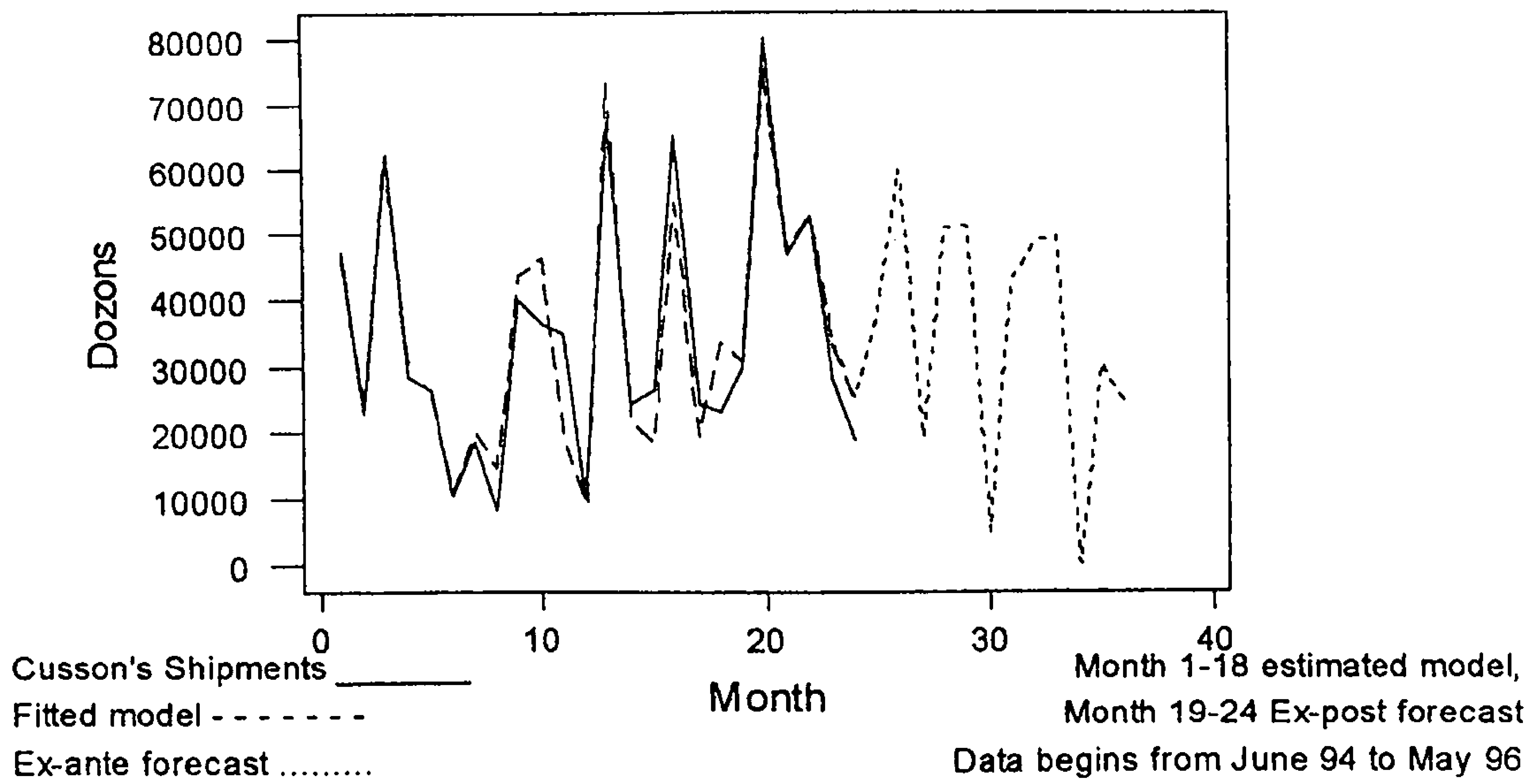


Figure 6.2a. Cusson's shipments of IL Bath 125G to the Middle East market.

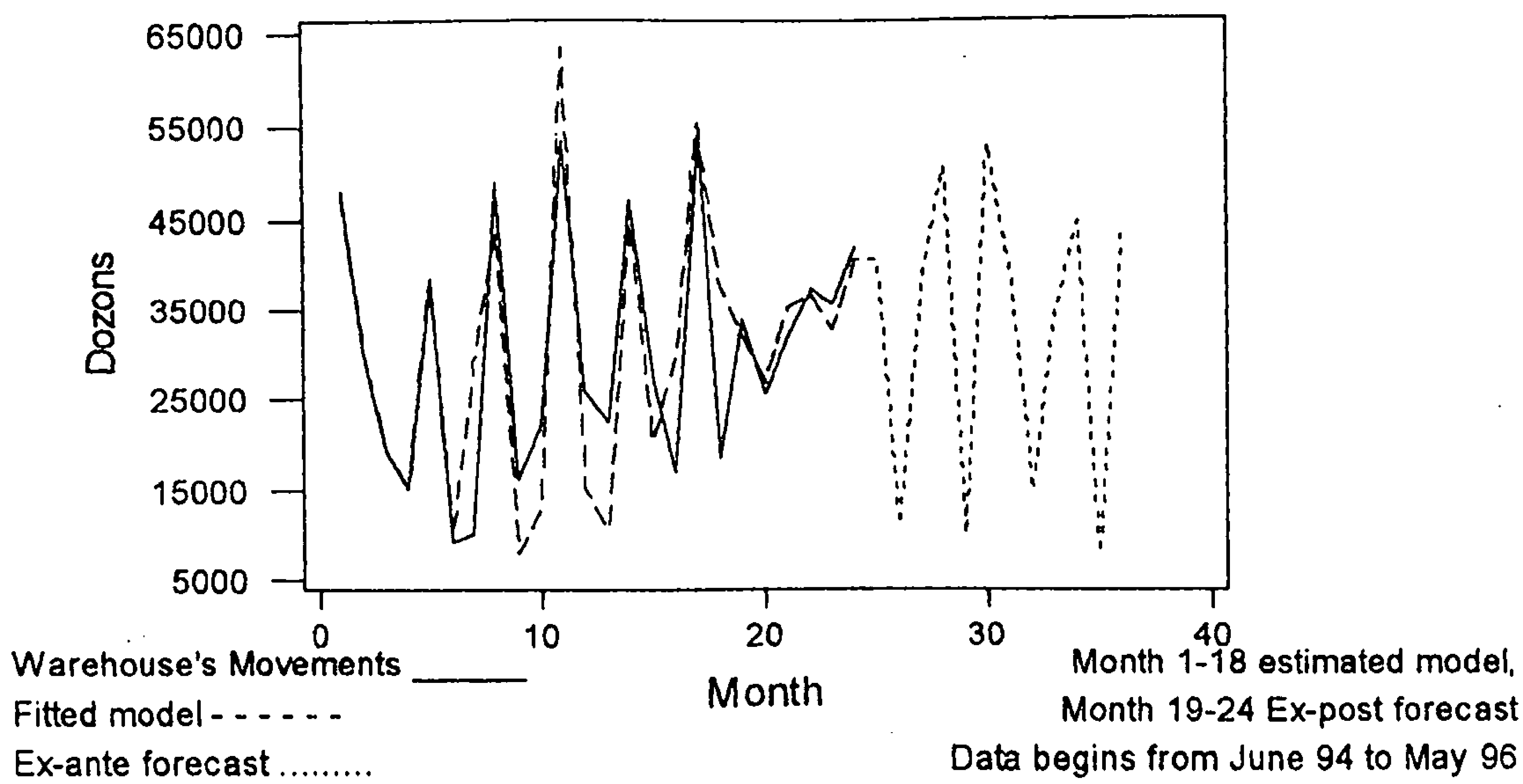


Figure 6.2b. Warehouse's movements of Cussons IL Bath 125G in the Middle East market.

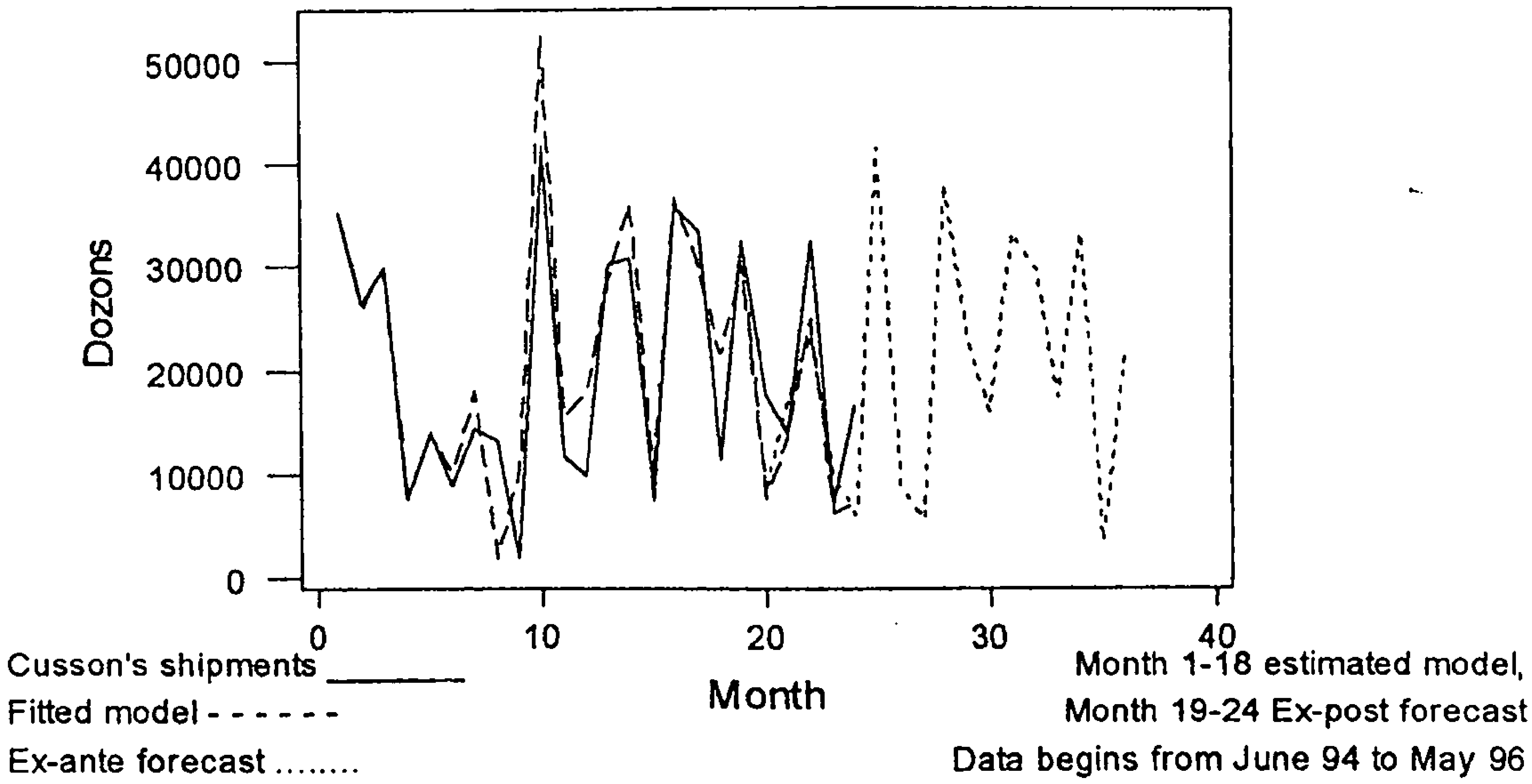


Figure 6.3a. Cusson's shipments of IL Family 200G to the Middle East market.

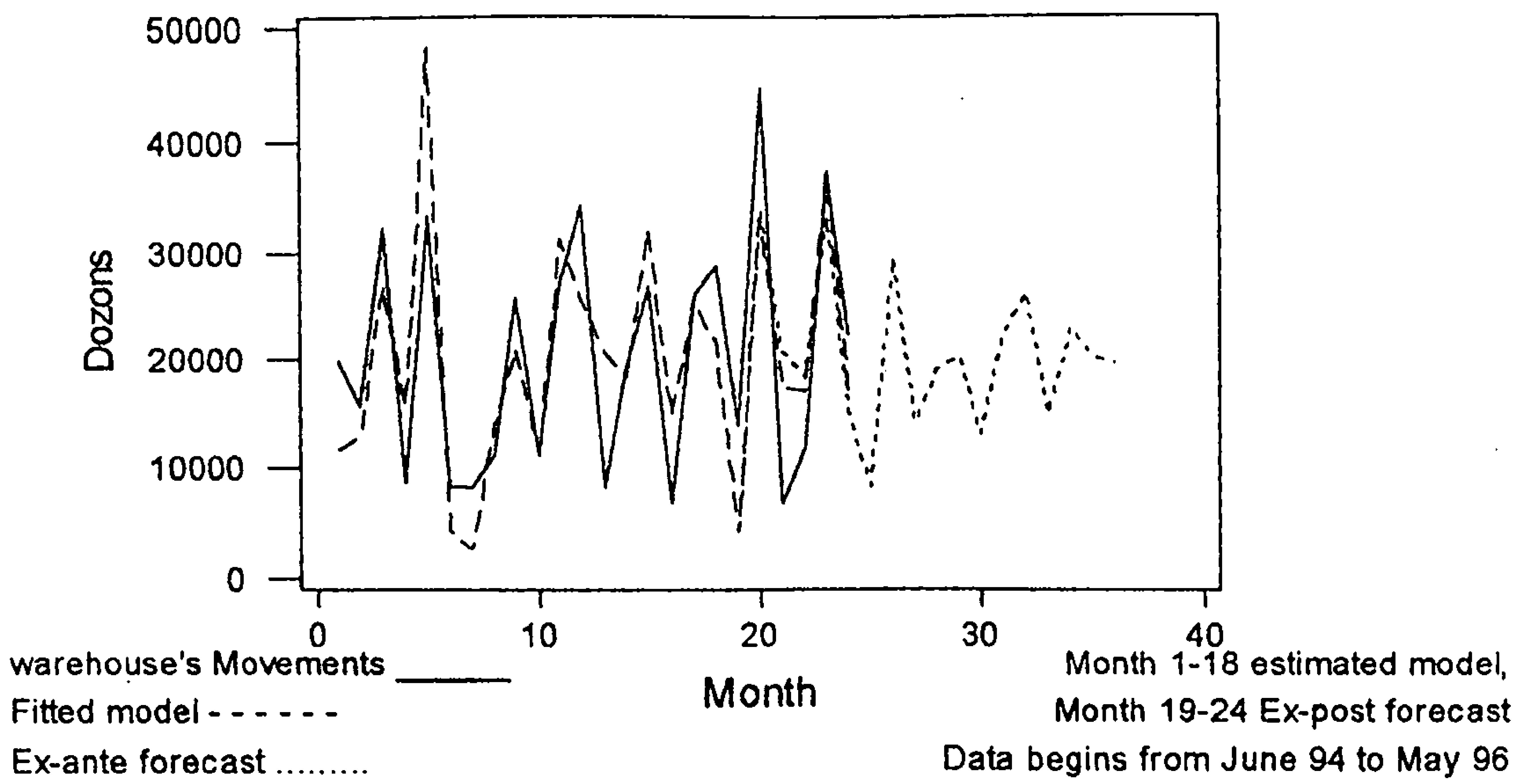


Figure 6.3b. Warehouse's movements of Cussons IL Family 200G in the Middle East market.

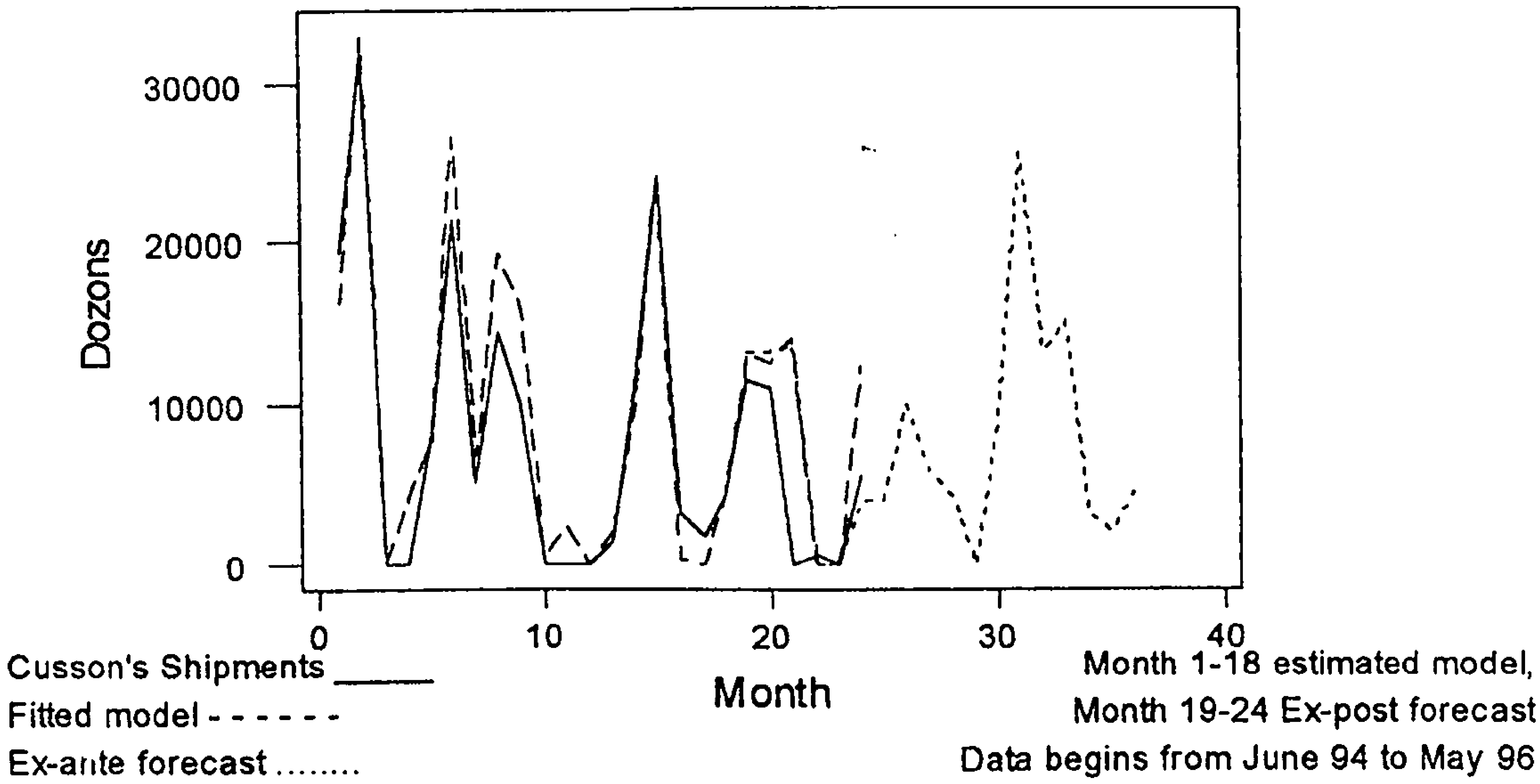


Figure 6.4a. Cusson's shipments of IL Mild 125G to the Middle East market.

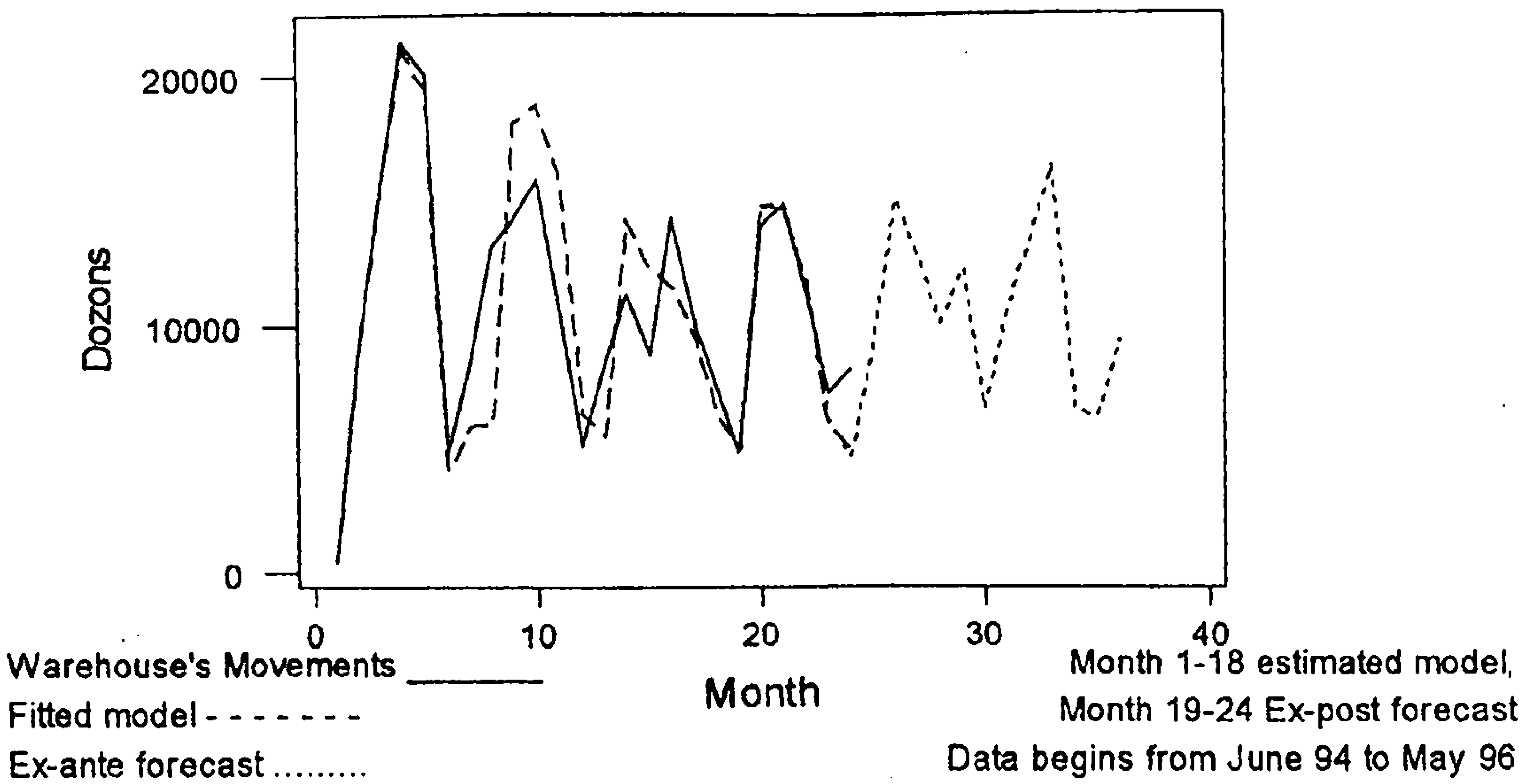


Figure 6.4b. Warehouse's movements of Cussons IL Mild 125G in the Middle East market.

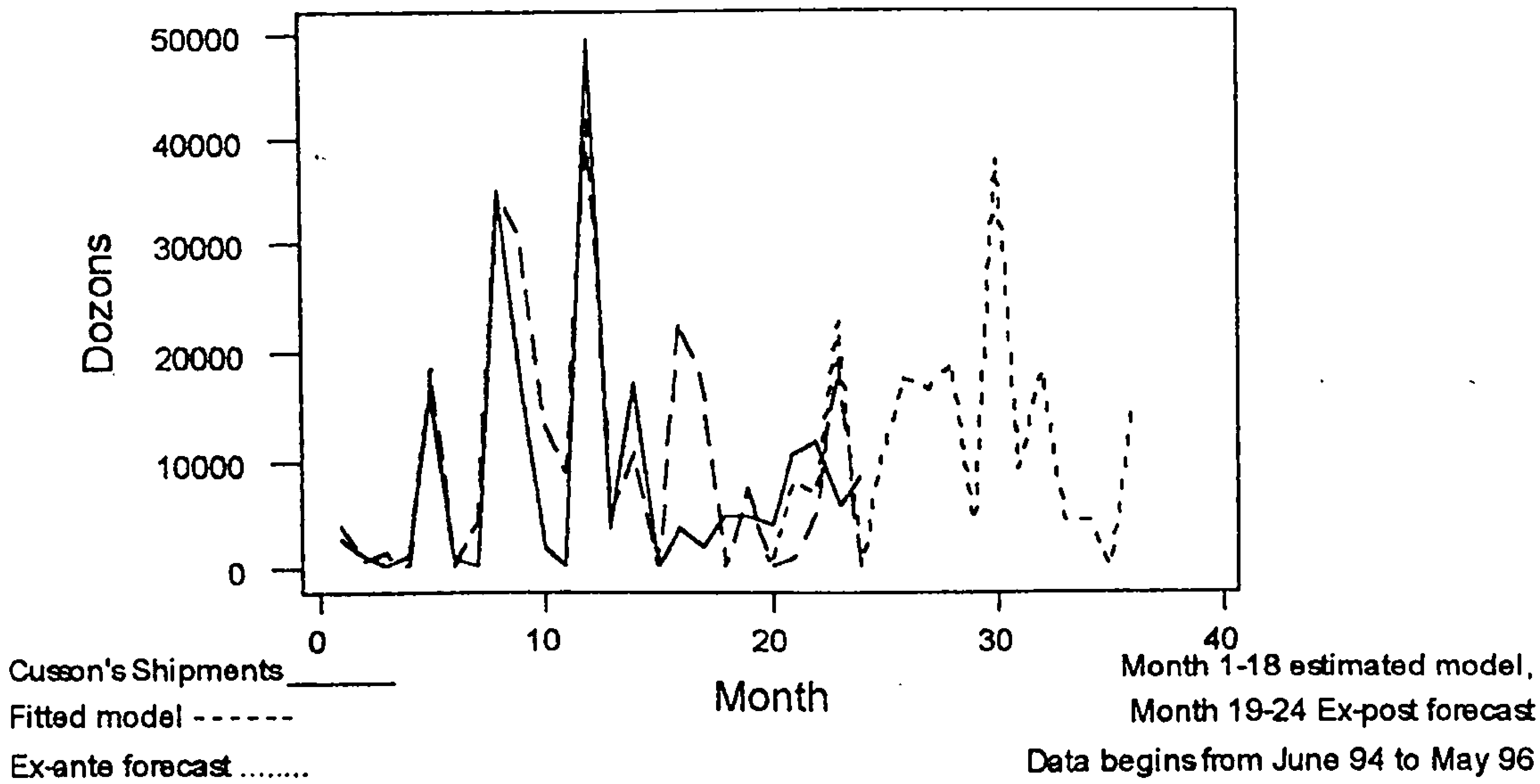


Figure 6.5a. Cusson's shipments of IL Toilet 75G to the Middle East market.

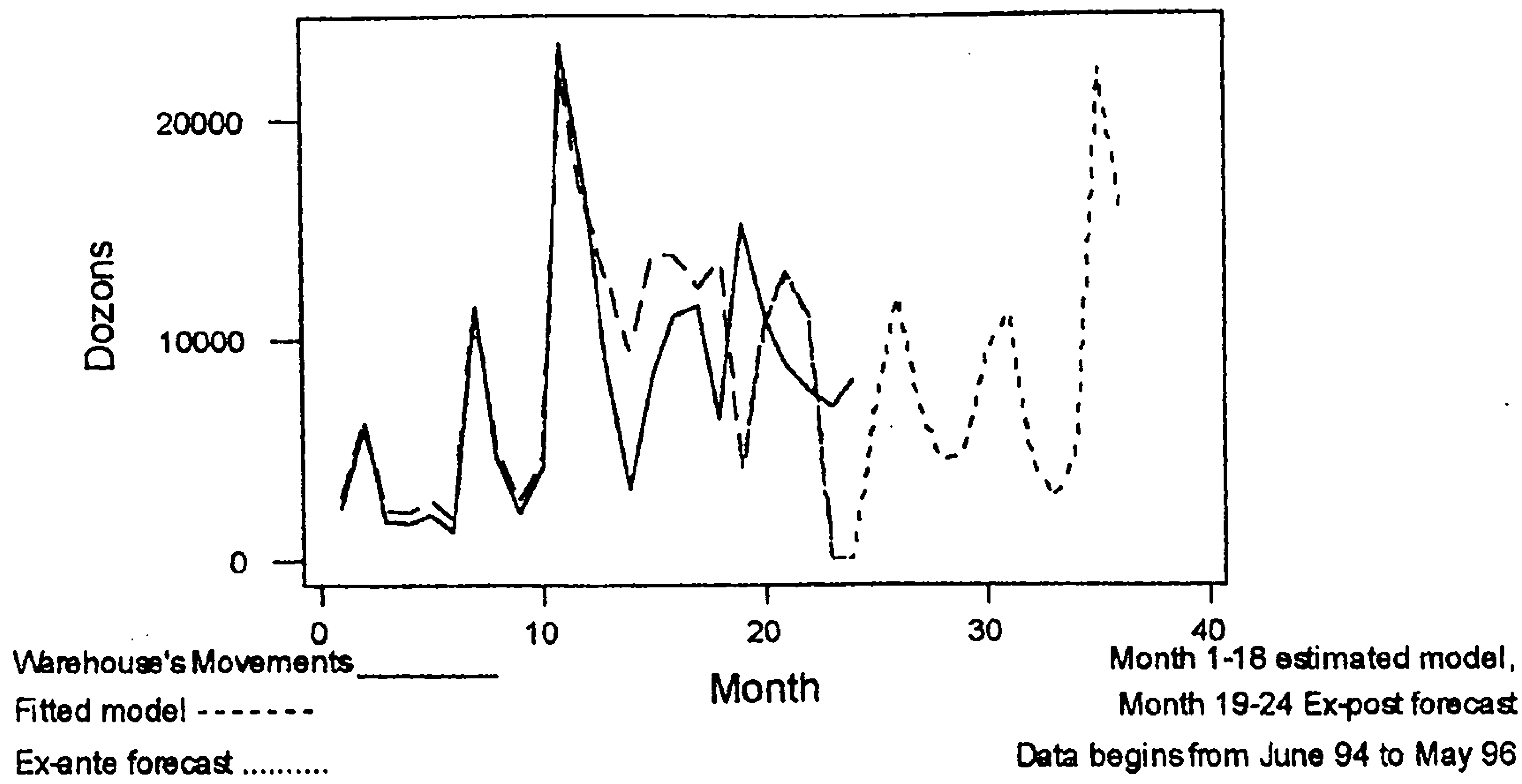


Figure 6.5b. Warehouse's movements of Cussons IL Toilet 75G in the Middle East market.

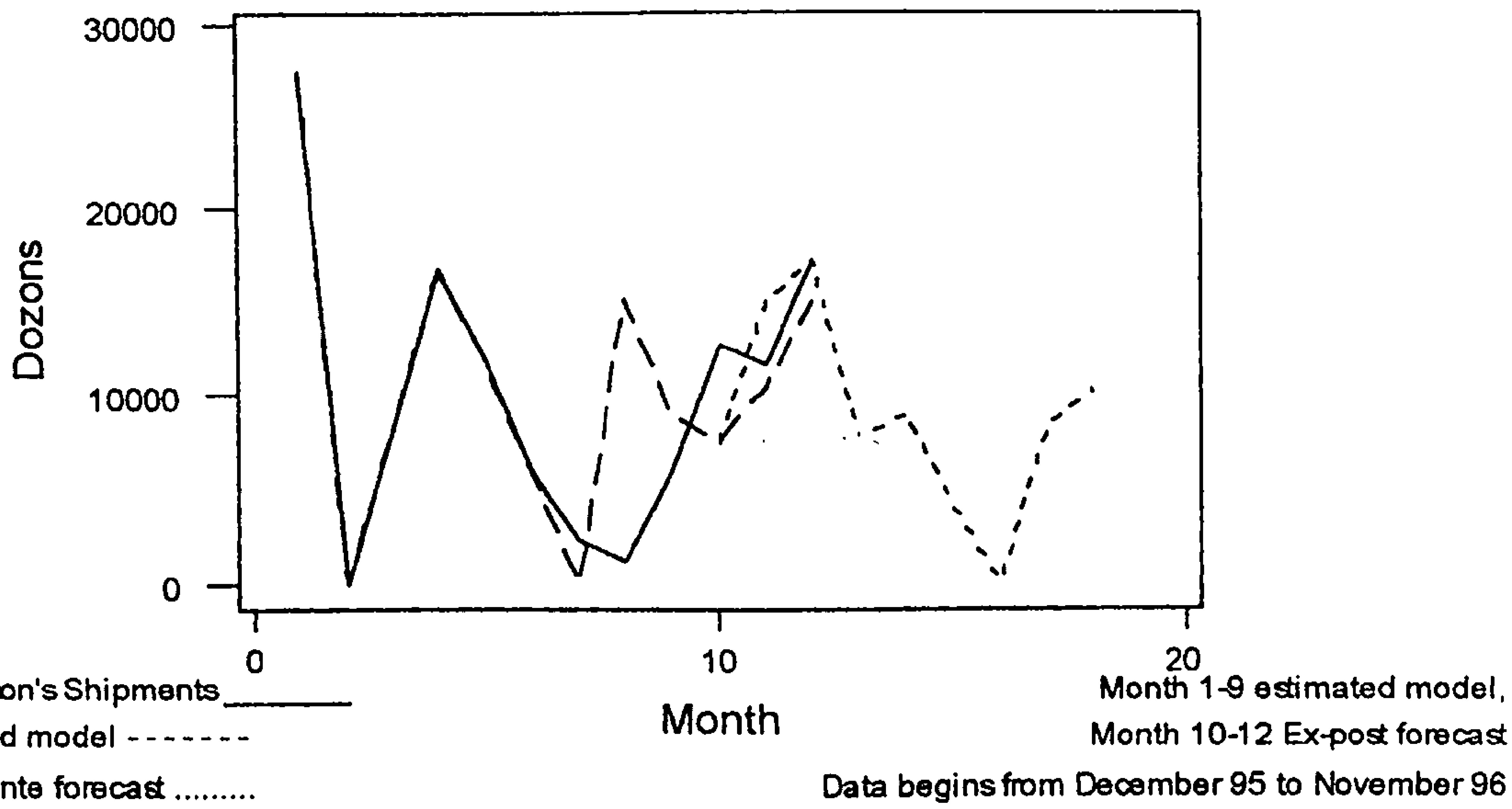


Figure 6.6a. Cusson's shipments of IL Gold 200G to the Middle East market.

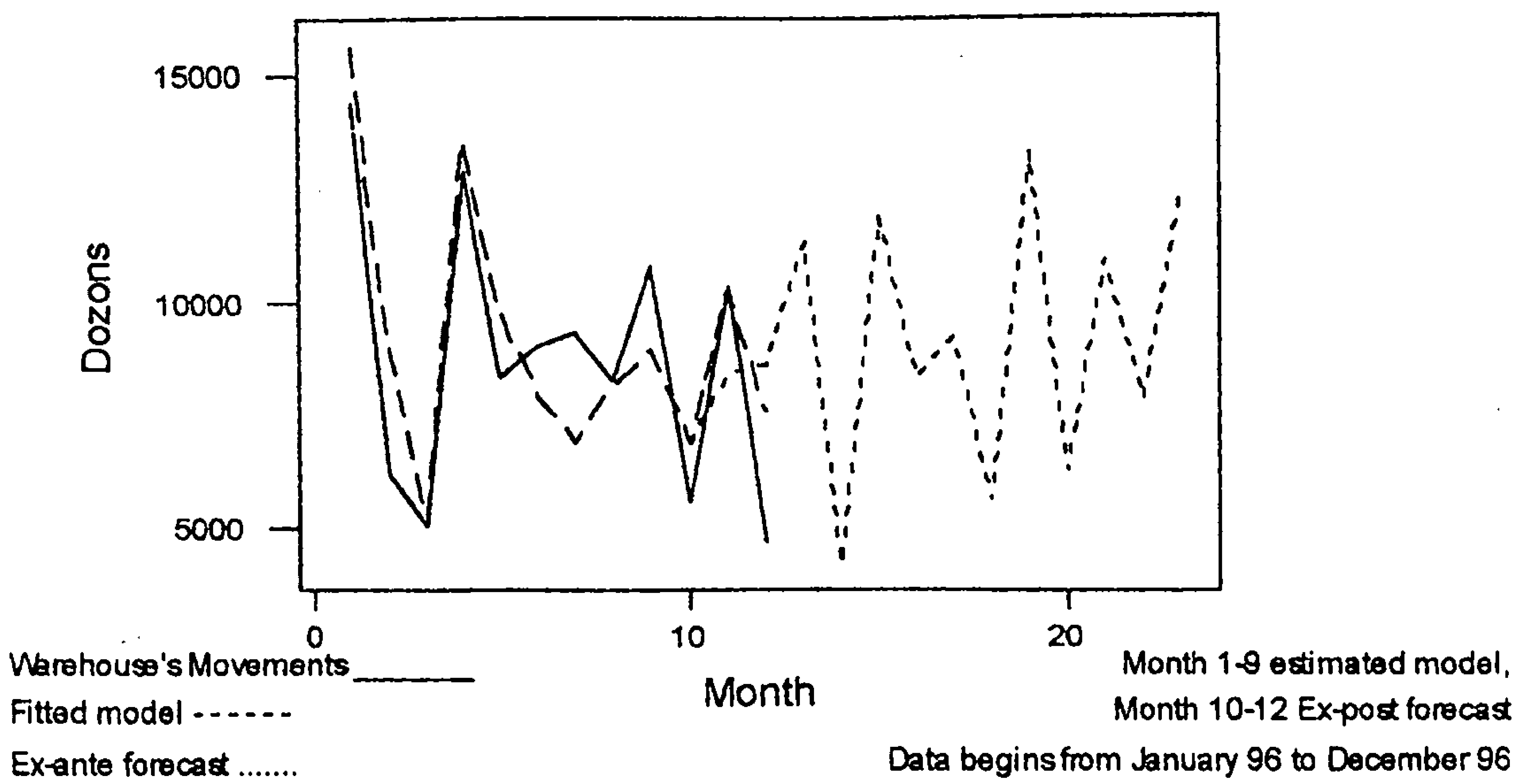


Figure 6.6b. Warehouse's movements of Cussons IL Gold 200G in the Middle East market.

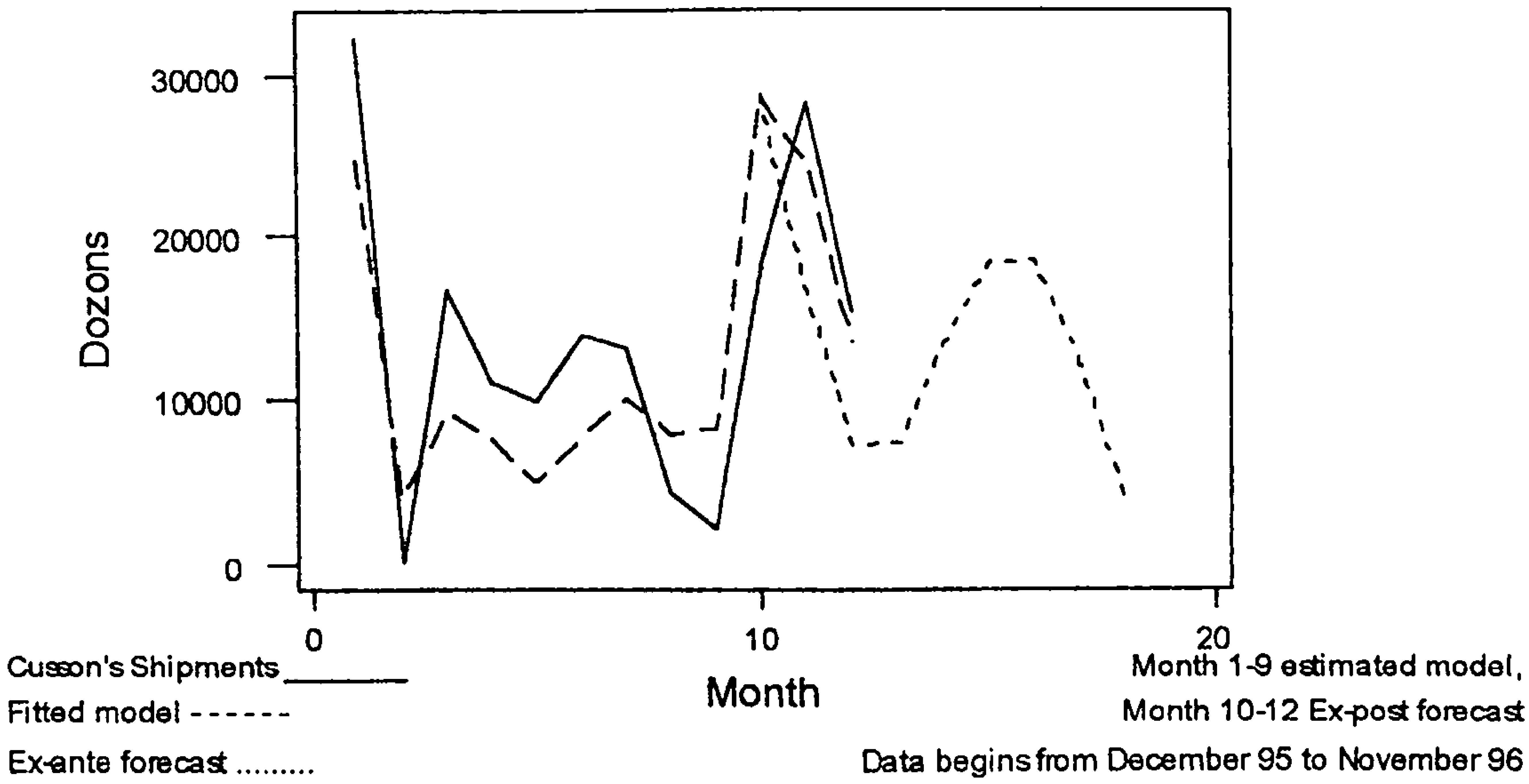


Figure 6.7a. Cusson's shipments of IL Gold 125G to the Middle East market.

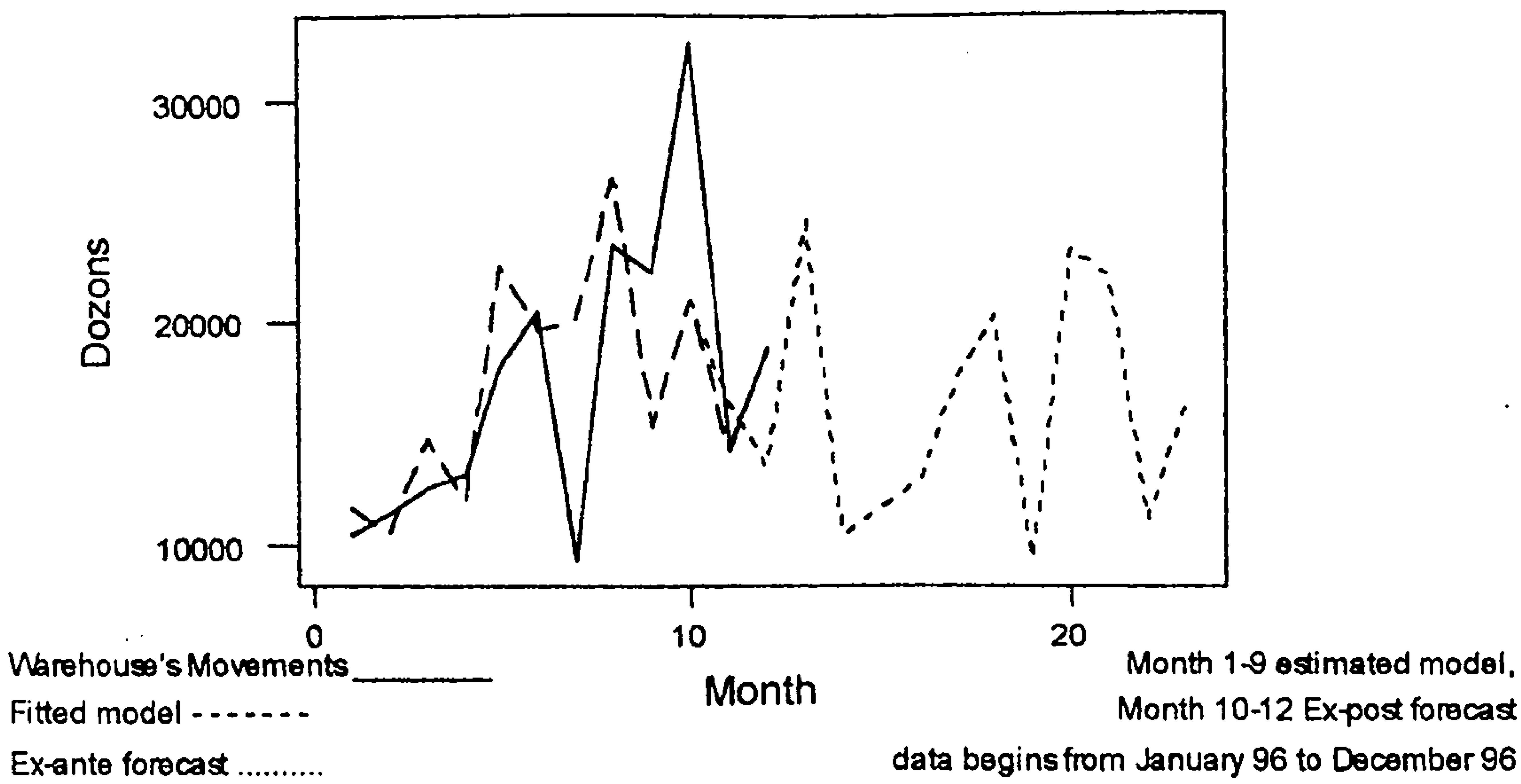


Figure 6.7b. Warehouse's movements of Cussons IL Gold 125G in the Middle East market.

When Figures 6.2a-6.7a are compared with Figures 6.2b-6.7b it shows that the warehouse movements have a much smaller variance than the order data. For instance the maximum change in figure 6.2a in the order data from one time period to the next is about 58,000 units in one SKU, whereas with the warehouse movement data of same SKU, this is about 34,000 units. The maximum change in figure 6.3a in the order data from one time period to the next is 39,000 units, whereas with the warehouse movement data of the same SKU, this is about 30,000 units. Comparison of figure 6.4a with 6.4b also shows similar pattern, the maximum change in figure 6.4a is about 23,000 units, whereas in figure 6.4b this is about 20,000 units. Similarly the maximum change in figures 6.5a, 6.6a and 6.7a is around 50,000, 28,000, and 32,000 units, whereas, in figures 6.5b, 6.6b, and 6.7b, this is about 18,000, 8,000, and 20,000 units respectively. Given certain assumptions, a direct relationships exists between variance in demand, safety stock held and service level. By aiming to meet the demand based on warehouse movements rather than the more variable order pattern a significant reduction in inventory can be expected. This implies that Cussons examine how they can meet demand using warehouse movement data. This is the same conclusion that Cussons came to when analysing demand for their products on the home market (Betts et al, 1994).

The forecasting models, which have been developed, are based on one, and two years monthly data. The two years data is for 1994-95 and 1995-96, whereas one year data is for 1995-96 of Cussons' calendar years. The forecasting models are based on warehouse movement data and Cussons' shipments for all the Imperial Leather Soap products marketed in the Middle East market. The models used for warehouse movements are based on collective data for each product and the same is true for Cussons' shipments. June is the first period of Cussons' calendar year so data depicted in figures start from June and finish in May of each year for two years data, whereas, for one year data the products were launched in 7th month of 1995 of the Cusson's calendar, so data of Cusson's shipment depicted in the figures start from December 1995 to November 1996 and data of warehouse movement depicted in figures start from January 1996 to December 1996, because the sales started one month later in the market. Each observation within the time series used occurs in a particular period of time. The length of the time series and the length of the time horizon is defined as a number of periods. In fitting models depicted in the figures, the initial part of the time series has been used at first. The models have then been used to "forecast" recent history, a process known as "ex-post" forecasting. Comparisons were then made on how the models forecasted most recent sales and warehouse movements, with what actually occurred. If the model performs well in ex-post forecasting then the most recent data is included with those initially used and the model re-estimated. It is then used to forecast the genuine future, a process known as "ex-ante" forecasting. Further details of this approach are described in Pindyck et al (1991). An illustration may help. In figures 6.2a-6.7a and 6.2b-6.7b, for instance there are 24 and 12 data points. Initially the first 18 periods in both time series were used to fit the models for two years data whereas, for one year data first 9 periods were used. Ex-post forecasts were made for periods 19-24 for two years data and 9-12 were the Ex-post forecasts for one year data. These were seen to work well at the Ex-post forecast level and so the last six and three data points in the time series in both cases were merged and both models re-estimated.

From period 25 onwards the graphs show the ex-ante forecasts, whereas, for one year data the Ex-ante forecasts are from period 13 onwards, which are the actual forecasts by the models estimated using two years data.

6.4 Comparison of forecasting with most recent sales

After developing forecasting models for all the SKU's marketed by Cussons in the Middle East, the next step was to collect and compare the most recent sales with the periods for which the forecasting is made to test the accuracy of the models. Although all the models were tested by different accuracy measuring methods to demonstrate the validity of the models. In the case study it is important for the forecaster to develop best workable models, if applied, can solve the company's problems. All the forecasting models based on warehouse movements of six different SKU's of Cusson's Imperial Leather soap were compared with new sales data. In all cases both monthly warehouse despatches against the same periods of forecasting were superimposed on each other. This is shown in figures 6.8 - 6.13.

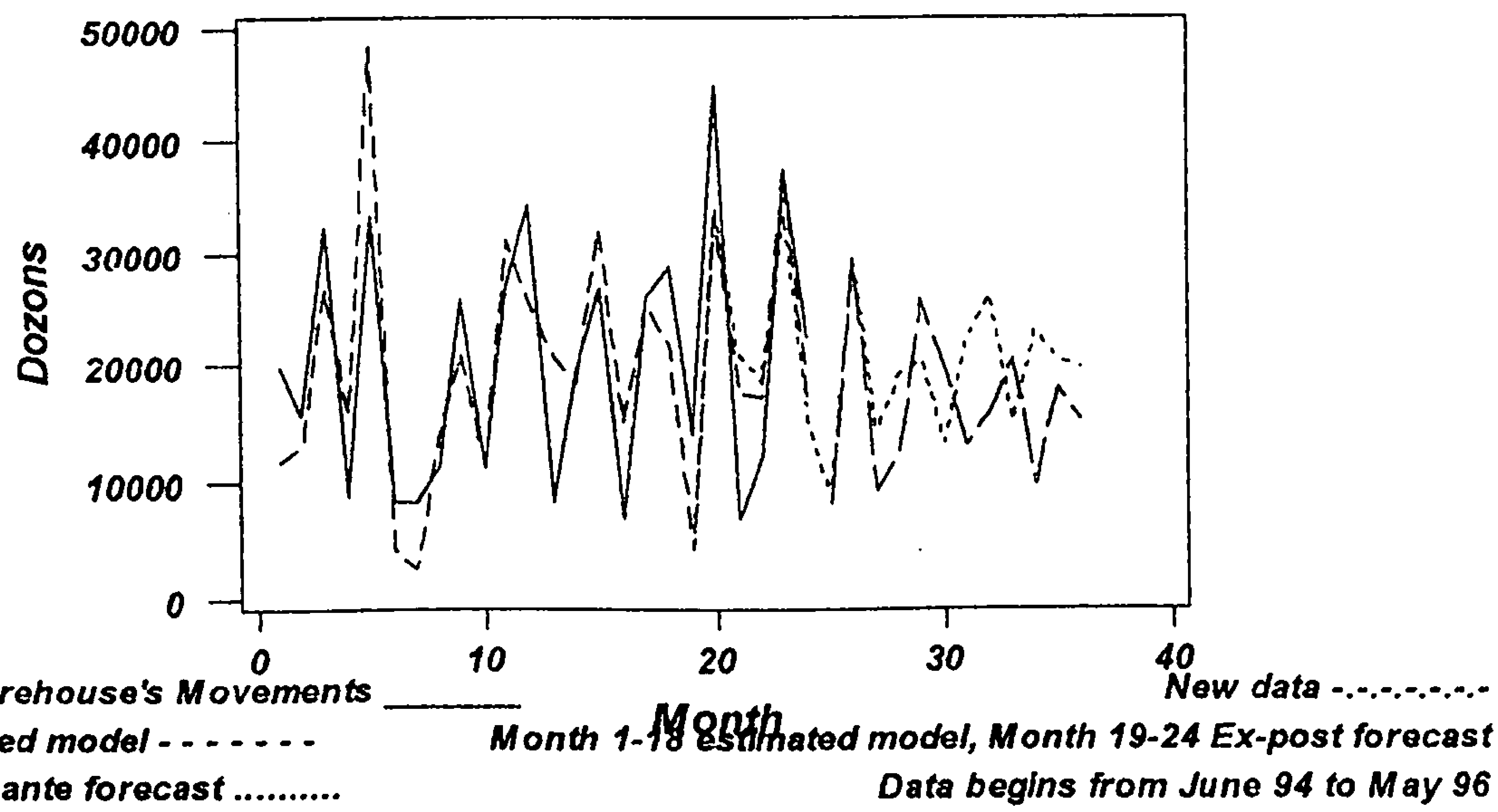


Figure 6.8. Comparison of forecasting model of IL Family 200G with most recent sales.

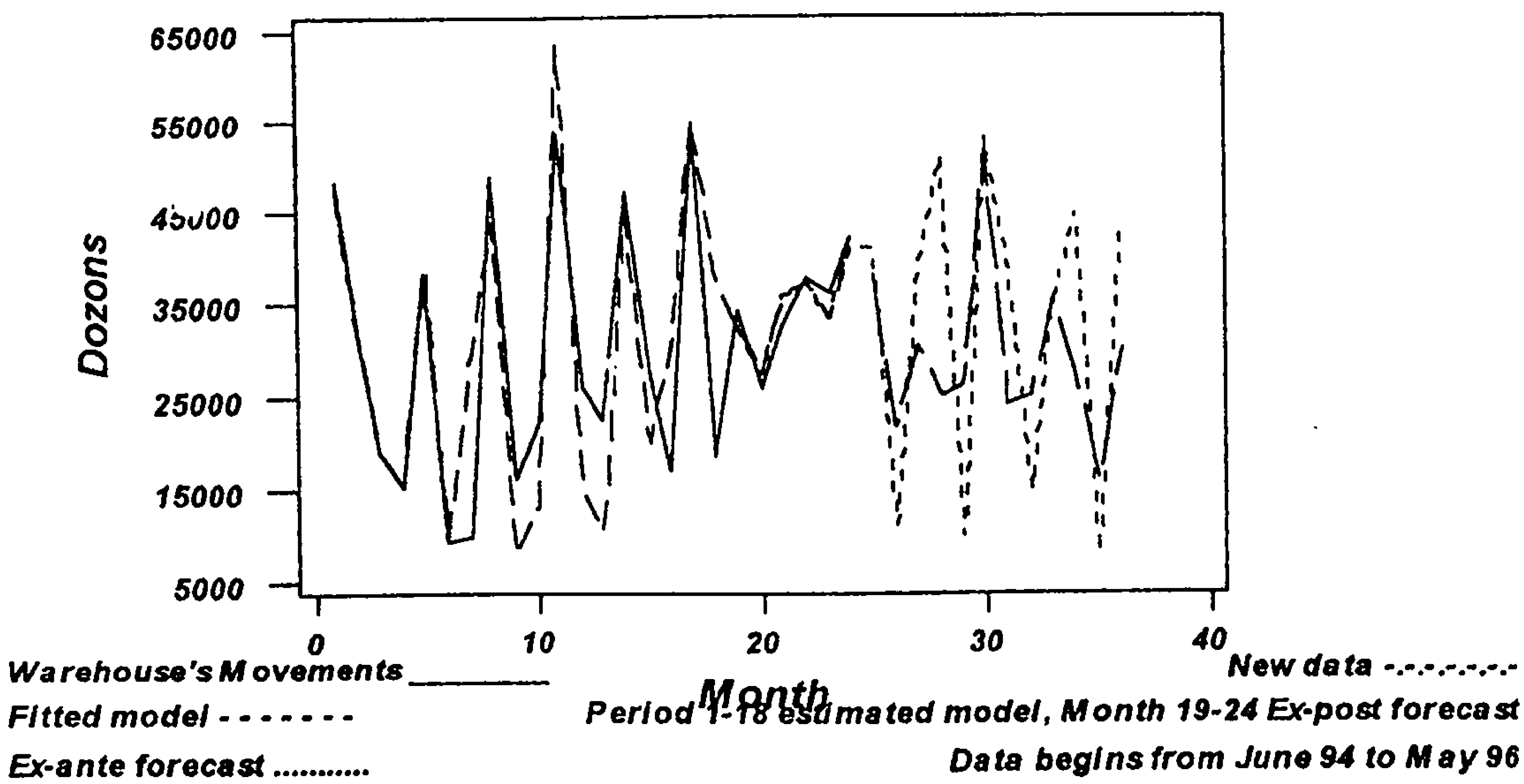


Figure 6.9. Comparison of forecasting model of IL Bath 125G with most recent sales.

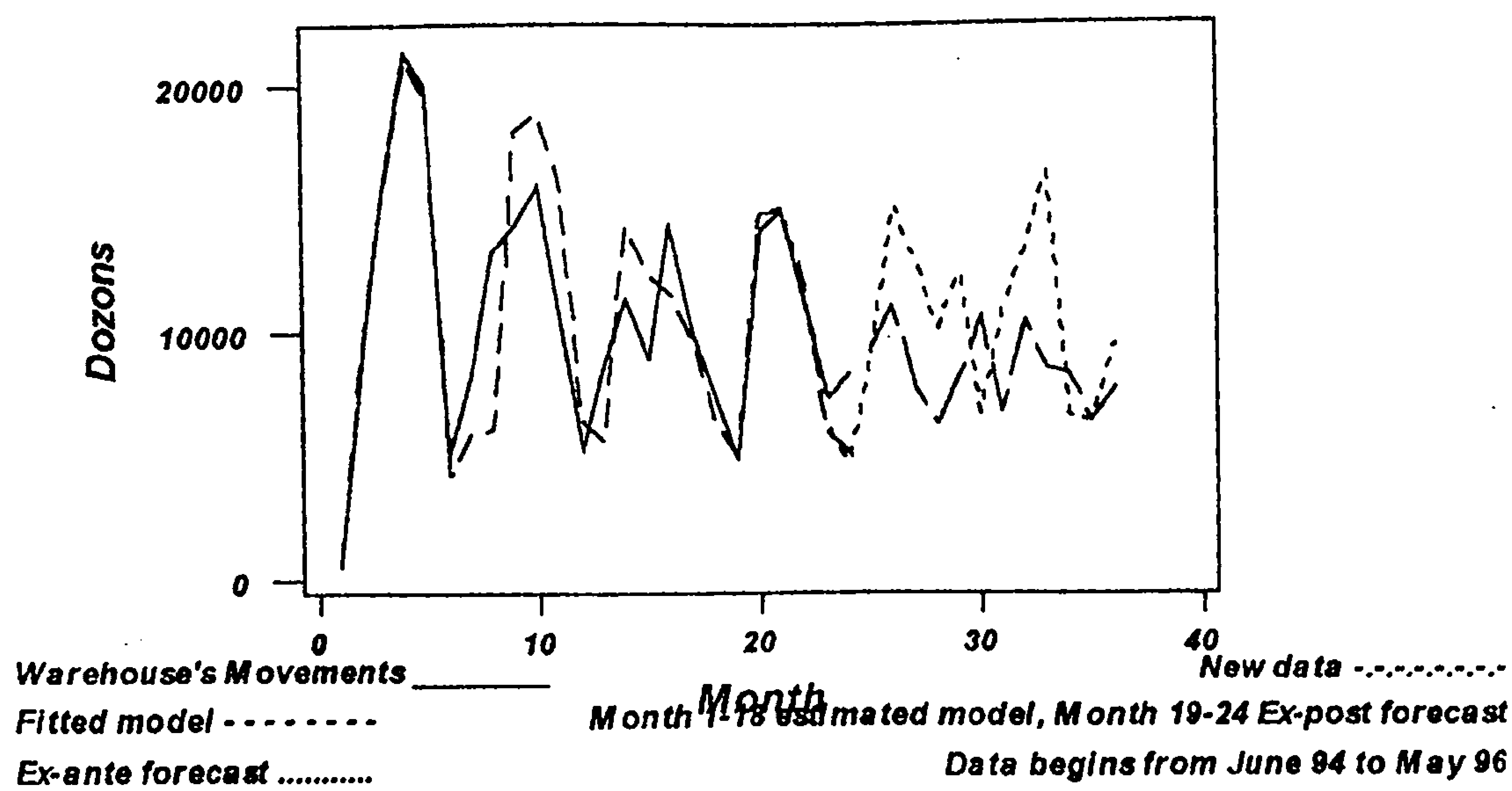


Figure 6.10. Comparison of forecasting model of IL Mild 125G with most recent sales.

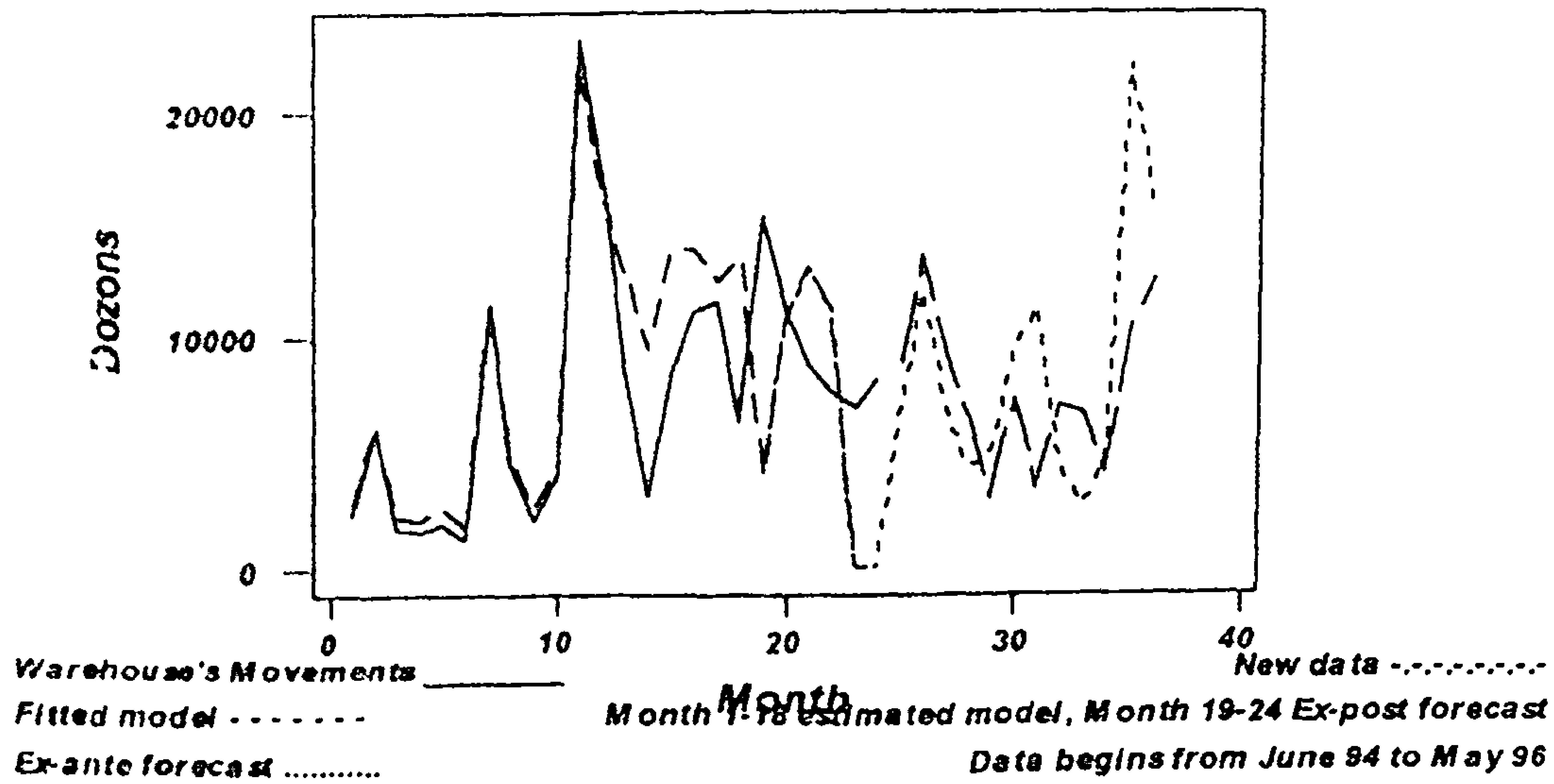


Figure 6.11. Comparison of forecasting model of IL Toilet 75G with most recent sales.

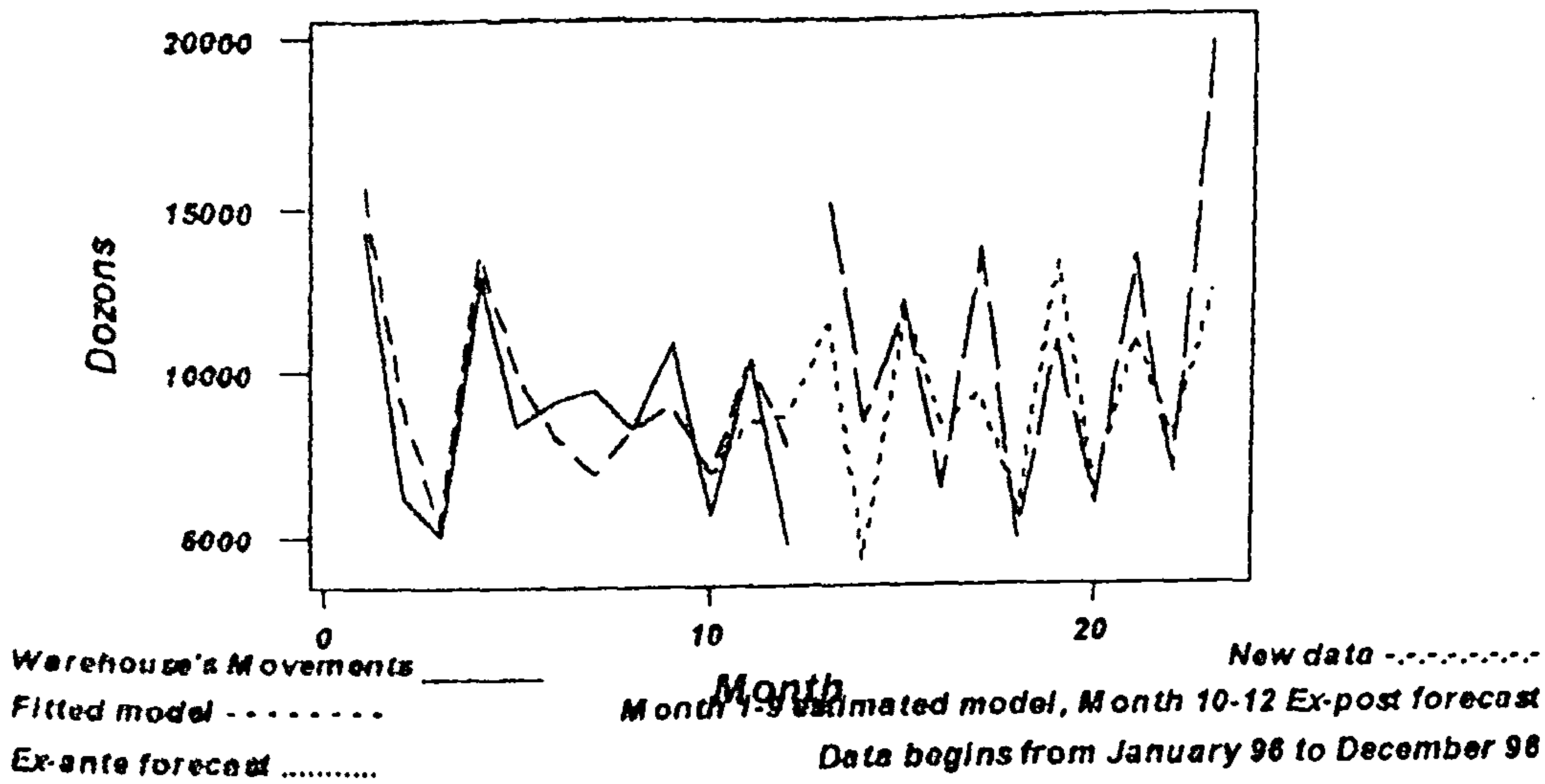


Figure 6.12. Comparison of forecasting model of IL Gold 200G with most recent sales.

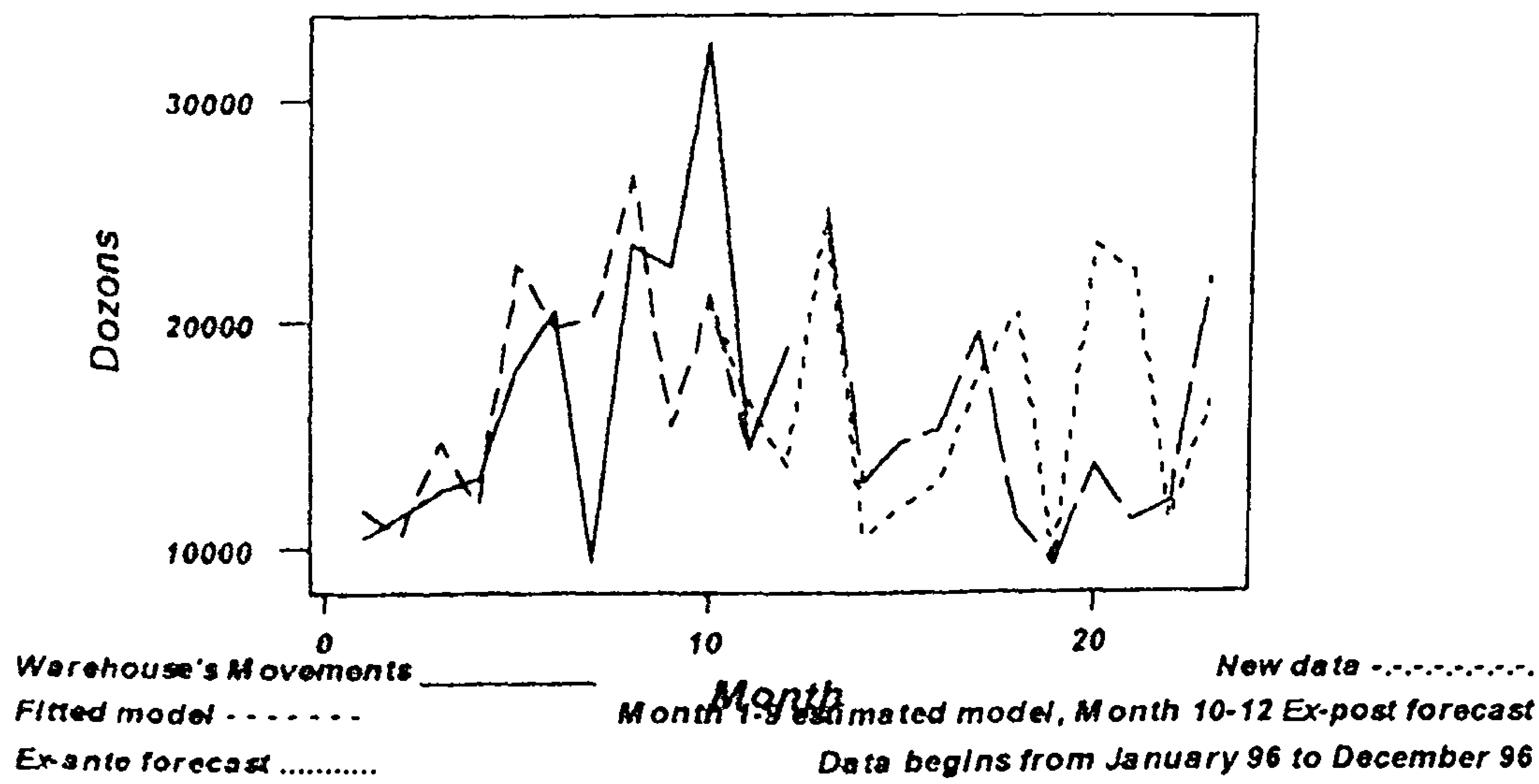


Figure 6.13. Comparison of forecasting model of IL Gold 125G with most recent sales.

When both the data were compared in figure 6.8, it clearly shows that both the series correlate with each other. For instance, the maximum change in forecasting from one period to the next is about 22,000 units, whereas, with the new sales data this is about 23,000 units. This pattern varies from one SKU to another. There are many reasons for these variations, which will be discussed later on. It is important to mention here that one of the possible reasons of these variations is the demand behaviour of the individual markets within the Middle East. For instance, Saudi Arabia is generally considered a big market for Cusson's products. In this market Cusson's sell around 60

- 65% of the products sold in the Middle East market, whereas, in the Libya and some other countries this is around 5%. Also in the Saudi market, the demand varies from one product to another product. In this market the demand for some products is very high and for some products it is low. The same is the case with other countries in the Middle East market.

Due to large variances in the market demand by Cusson's customers and keeping in view, Cusson's lead-time for the Middle East market and a service level of around 98%, which Cussons uses on its home market, to achieve this service level target a safety stock has been proposed. The safety stock is also necessary to protect against uncertainties of supply and demand. Safety stock has two effects on a company's cost, it decreases the cost of stockouts but it increases the holding costs. For the Middle East market Cusson's lead-time is high, so Cussons needs safety stock for each SKU. Safety stock for each SKU has been calculated and presented in this chapter. All the values are in dozons and are reported in Table 6.3 and 6.4 respectively.

Table 6.3. Safety stock for Cusson's shipments of various products to the Middle East market.

Product description	Safety stock
IL Bath 125G	68937 dozons
IL Family 200G	41415 dozons
IL Mild 125G	31707 dozons
IL Toilet 75G	42470 dozons
IL Gold 125G	34420 dozons
IL Gold 200G	27787 dozons

Table 6.4. Safety stock for warehouse movements data of various Cussons' products.

Product description	Safety Stock
IL Bath 125G	48300 dozon
IL Family 200G	39597 dozon
IL Mild 125G	17522 dozon
IL Toilet 75G	19656 dozon
IL Gold 125G	24187 dozon
IL Gold 200G	10886 dozon

6.5 Critique of distributor's forecasting approach in the Middle East

In the competitive business environment, it is important for the upstream channel commonly known as the supplier to have accurate information from the downstream channel for the demand planning of their products. This information is generally referred to as products demand. These figures can be collected from many sources namely marketing personnel or representatives of the company such as distributor for a particular market. If the downstream channel deliberately provides the wrong picture of customer demand to the upstream channel, this can be a cause of poor planning resulting in unsatisfactory customer service.

In the Middle East market, Cussons sells their products through the distributor, which services the market from Dubai. He is responsible for the whole market for the sales so he makes the estimates of future demand for all Cusson's products marketed in the Middle East Market.

Currently he has adopted a very inappropriate forecasting approach, which will further complicate the inventory situation in the Middle East. His approach will not help to reduce inventories, which presently Cussons has on hand, but possibly will further aggravate the inventory situation there. He has made the following recommendation to Cussons for improving accuracy of forecasting the demand in the Middle East market.

- The monthly sales rate (MSR) is calculated as an average of the previous six months sales. If sales go up or down, the MSR will therefore be affected accordingly and this way, sales trends are automatically taken into account. The average control is needed to smooth out seasonality trends, so that only the underlying sales trend is reflected.

In a situation, where the demand is not uniform and fluctuating rapidly, for instance summer sales are very high but in the winter this trend is totally reversed so in this situation, if he takes the average of six summer months for forecasting the demand it will create many problems for the company such as inventory will be too much stockpiled throughout the supply chain. Contrary to this , if he takes the average of six winter months, it is possible that the market may witness a stockout. Due to this behaviour of the market, two years monthly average in even not sufficient to forecast the future demand with any accuracy.

The overall situation requires the distributor to adopt a rational approach for forecasting demand. It would be better if he investigate the market behaviour thoroughly before making any concrete suggestion for the improvement of forecasting accuracy. The best way is to monitor monthly sales figures of all Cussons' products and in a case of any abnormality in sales, the matter should be investigated from the marketing personnel or from the retailers. It will present the true picture of customer's demand and will also help in making solid proposals for future demand forecasting. Without analysing the market response and making such type of suggestions regarding forecasting demand shows a lack of interest on the part of distributor to solve the company's problems.

6.6 Development of hypotheses

Hypotheses are propositions that can be made by certain observations on the occurred events and are subject to test mathematically or theoretically to prove their validity.

Both data sets presented in the graphs of this chapter and the information about market behaviour discussed in chapter 1 coupled with literature review presented in chapters 2 and 3, provided a basis for the development of these hypotheses. Although the forecasting problems for Cusson's products in the Middle East were so unique, which needed an in-depth study of the market. All the required information was collected to analyse the situation and find out factors which create forecasting problems for Cusson's products in the market.

The market study revealed that there is influence of certain factors such as Islamic festivals and seasonality on the demand of Cusson's products. When both data sets were analysed and validated the influence of certain factors can be seen from the graphs of both series. On the basis of these assumptions the hypotheses were developed, which are included in chapter 4 and will be discussed thoroughly in the following chapter.

Chapter Seven

Discussion of the results

7.1 Introduction

The objective of the present chapter is to discuss the factors, which were found to be significant for improving the forecasting accuracy of Cusson's products in the Middle East market.

This chapter starts with the consistency tests of all the forecasting models developed for the market. Only the results of two accuracy measuring methods are presented and discussed here namely Pearson correlation coefficient test and the Chi-square test.

This chapter also continues with a discussion on the problems associated with the demand of Cusson's products in the Middle East. A forecasting strategy to overcome these problems has been suggested, which will enable Cussons to improve the forecasting for the market by taking various factors into account and to reduce the inventories throughout the supply chain and subsequently improve the service level.

7.2 Consistency tests

Consistency tests are an essential stage of mathematically developed models. The analysis of these tests reveals the presence of good or poor fit. There are many methods of conducting these tests namely correlation coefficient, chi-square test and t-test, etc. The first two tests were conducted for the analysis of all the forecasting models developed for the Middle East market.

7.2.1 Correlation coefficient

It often occurs that two variables are related to each other, even though it might be incorrect to say that the value of one of the variables depends upon, or is caused by the changes in the value of another variable. In any event, computing the correlation between two variables can state a relationship. The coefficient of correlation r, is a relative measure of the linear association between these two variables. The value of correlation coefficient can be found by using the following formulas.

The correlation between two variables X and Y is designated r_{xy} and for a paired observations (X_i, Y_i), where i = 1, 2, ..., n. The following formulas can be used.

Mean of X

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

Mean of Y

$$\overline{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$$

Covariance between X and Y

$$COV_{xy} = \frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})$$

Variance of X

$$Cov_{xx} = Var_x = \frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X})^2 = \delta^2 x$$

Variance of Y

$$Cov_{yy} = Var_y = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \overline{Y})^2 = \delta^2 y$$

Correlation between X and Y

$$r_{xy} = \frac{Cov_{xy}}{\sqrt{Cov_{xx}Cov_{yy}}}$$

$$r_{xy} = \frac{Cov_{xy}}{\delta_x \delta_y}$$

Where

$\delta_x = \sqrt{Cov_{xx}}$ $\delta_y = \sqrt{Cov_{yy}}$

Both are the standard deviations of X and Y respectively.

All the developed forecasting models were tested by different accuracy measuring methods, one of which is correlation coefficient. The value of correlation coefficient can be anything between 0 and 1. The closer the value to 1, the more closely the model fits the actual series. The closer the value to 0, the worse the fit and the model cannot be used for effective forecasting. The correlation value for both the series depicted in figures 6.2a – 6.7a and 6.2b – 6.7b were around .9. Generally the correlation coefficient for all models were between .8 and .9. It means that correlation between the actual series and the fitted models was between 80-90%. It shows that both the models and the series are highly correlated. All the results of this test are presented separately and are reported in Appendix B. All the forecasting models for both the series were tested by another accuracy measuring method, namely Chi-square goodness of fit test.

7.2.2 Chi-Square goodness of fit test

In 1970, Box and Pierce developed the modified version of this test. The chi-squared test is a statistical test used to determine whether the mean value of the autocorrelation is significantly different from zero. If the computed value of the chi-squared test is smaller than the corresponding value from a table of chi-squared values, then the data are concluded to be random. It means that the autocorrelations used to calculate the test are not significantly different from zero. If the computed chi-squared commonly known as Q-statistic is larger than the value from the table, the autocorrelations are significantly different from zero, indicating the existence of some pattern. However, the chi-square test becomes unreliable when the numbers in the cells are small. It is also sensitive to sample size. A small sample may indicate no relationship between the variables at a given level of probability whereas a larger sample from the same data might show a relationship. Generally the Q-statistic is computed from the following formula.

$$\chi^2_{(df)} = n\sum_{k=1}^{m} r^2_{(k)}$$

Where

χ^2 = Chi -Square distribution,

n = the number of observations,

m = the largest time lag considered,

r (k) = the autocorrelation for time lag k

df = degrees of freedom = m - p - q

p = the number of parameters

q = the number of parameters

The chi-square test can be applied as a first approximation in determining the extent of randomness in the autocorrelations and subsequently in the data. This test also holds true when applied to the autocorrelations of residual errors. If the computed value of the chi-square of the residuals is smaller than the value from the chi-square table for the given degrees of freedom (df), the hypothesis that the autocorrelations are not significantly different fron zero is supported, indicating that the residuals are randomly distributed and the model used is a good one, since only the random errors remain. This test was applied to all the forecasting models developed for Middle East market. The results of these tests established the presence of good fit between the models and the data and are reported in Appendix C.

7.3 Discussion of hypothesis one

The analysis of both the series coupled with market information provided sufficient ground for the development of a hypotheses for this piece of research. The hypotheses is divided into four key points. Hypothesis one associate the market demand with the Islamic festivals, which is quite visible in the forecasting models of both the series presented in chapter 6.

An analysis of the two series shows one thing in common and that is large sales in few months. The Middle East is mostly populated by Muslims. When both the series were compared with the Islamic Calendar, it can be seen that the Islamic Calendar has a strong influence over Cussons' sales. For instance, the peaks that occur during periods 8 and 20 coincide with Ramadan of 1994 and 1995. The peaks that occur during periods 11 and 23 coincide with Zil'Hajj for the same years. As the Christians celebrate Christmas every year by decorating their homes and purchasing many new things, in the same way Muslims celebrate their Islamic holy festivals twice a year, which are Ramadan and Zil'Hajj occurring in the 9th and 12th months of the Islamic calendar. Once a year, in the 12th month of the Islamic calendar millions of Muslims from all around the world perform the Hajj in Saudi Arabia, many stay more than one month there. Anticipating the demand during these months local retailers build up inventories before to meet the increased demand generated by the pilgrims. Furthermore the Islamic calendar is ten days shorter than the Christian calendar and so Islamic festivals appear to move backwards in relation to the Christian calendar. Western companies tend to collect data on a monthly basis based on the western calendar and so peak demand in Muslim markets will appear to move back to a previous month every three years, leading analysts unfamiliar with the Muslim calendar to believe that the peak demand is not as predictable as in fact it could be if for instance the data was collected and analysed on the basis of the Muslim calendar.

However there are difficulties associated with translating demand under the Muslim calendar back into equivalent months in the Christian calendar.

In 1994 Ramadan started on 30th of January which is the 8th month of Cussons' 1994-95 calendar year and finished at the end of the 9th month of the same year. So Ramadan covered two months namely the 8th and 9th months of the Cussons' 1994-95 calendar. In 1995-96 Ramadan started in the third week of the 8th month and in 1996-97, Ramadan started early in the 2nd week of the same month, so it is expected that in these years most probably the demand will follow the same pattern. As the Islamic calendar is 10 days short compared with the Christian calendar, the demand in the year 1997-98 will be shifted one month backward from 8th and 9th month to the 7th and 8th month. Another Islamic festival Zil'Hajj, which in the year 1994-95 came at the end of the 11th month of Cussons' calendar year and that festival covered the 11th and 12th month of Cussons' calendar. In 1995-96 this remained the case but in the year of 1996-97 the demand shifted one month backwards into the 10th and 11th months of Cussons' calendar year.

Cussons in the Middle East market uses aggregated time-series data for demand forecasting provided by Cusson's distributor for the same market. It is one of the reasons that makes Cusson's decision makers and demand planners unfamiliar with the events occurring in the individual markets. Generally in the Middle East, there are three or four big markets for Cussons products and others are very smaller markets. Among these big markets, Saudi Arabia is one of the biggest market in the Middle East. In this market, Cussons sells around 65% of their products which distributed in the Middle East market. During the timings of Islamic events, instead of concentrating on the whole market, it would be appropriate for Cussons to get the information of expected increased demand from three or four big markets. It can help Cussons to make accurate estimates of customer's demand during the periods of high demand. In this way, Cussons can manage sufficient inventories during these periods to cope with the demand created by these Islamic events.

With regard to demand in the Middle East for Cusson's products, the company concluded that forecasting using time series data was not appropriate. This conclusion was possibly due to the complications generated by the effects on demand for FMCG's due to Muslim religious festivals and the fact that the Islamic Calendar has ten less days than the Christian Calendar. Both the series coupled with a knowledge of the Muslim calendar and when Muslim festivals occur can be used to forecast future demand.

7.4 Discussion of hypothesis two

This hypothesis concerns the seasonality factor which is associated with the demand of Cusson's products in the Middle East Market. Many companies also experience seasonal demand for their products or services. Seasonal patterns are regularly repeating upward or downward movements in the demand, which is measured in periods of less than one year, namely days, weeks, months, or quarters. In this context, quarters are generally referred to as seasons.

The monthly observations of Cusson's shipments and warehouse movements were compared with each other, in a view to trace any commonality between the two series. The comparison of both the series shows that in addition to the effect on Cusson's sales due to Muslim religious festivals, there is an increase in demand for Cusson's products during summer months and it is quite visible in the models containing two years data. As mentioned earlier, June is the first month of Cusson's calendar, so the large sales in the first quarter of the year and fourth quarter of the same year coincide with summer months of the year 94 and 95. The sales in the second and third quarter of the same year coincide with winter months of the year 94 and 95. One year data models also showing this trend but it is not very clear in the figures. The possible reason is that these products were launched in the 7th month of Cusson's calendar so the first observation depicted in the figures contain one years data of Cusson's shipment starting from December instead of June. The sales in the market started one month later so the models for warehouse movements contain one year data starting from January and ending in the December of the same year.

For instance, the average sales in summer months for one product are around 30,000 dozens, whereas, in winter months this is around 12,000 dozens. This variation indicates the seasonal behaviour of the market and this variation is common in all the SKU's marketed by Cusson's in the Middle East market.

This seasonal behaviour of the market is at large because of the Islamic festivals which are occurring during summer months, particularly the 'Hajj' occurs in the fourth quarter of the year, which has tremendous impact on the sales, due to the importance of Saudi Arabia market.

All the constructed forecasting models for the market follow this seasonal pattern and can be used in a same way until the demand shifts from one month to the previous month due to Muslim religious festivals. This pattern of market demand will be changed significantly in winter months when Muslim festivals will occur in these months. It is expected that the market demand will increase during these months and will significantly reduce the seasonality effect from the demand.

7.5 Discussion of hypothesis three

The discussion of this hypothesis is based on the fact that the warehouse movements data is more reliable for demand forecasting than the order data. The mechanism by which order data is generated is that the retailers will make the orders with the wholesalers in the various countries that make up the Middle East market. The orders are consolidated in Dubai by Cusson's employees and passed on to the UK, which then ships the products to the Middle East.

The main difference between the two data series is that the warehouse movements data represents the actual sales in the market, which reflects the true market demand patterns, whereas, the order data represents the customer's information which are not based on actual sales and hence cannot reflect the true market demand. Nowadays it is important for the FMCG manufacturers to have market information which is based on actual sales that reflects the true demand in the market. In other words, companies need accurate information not distorted information. The customer orders are changeable according to market situations so this data cannot be considered as very reliable for demand forecasting, whereas, the warehouse movements data is describing the real demand in the market and is more reliable and suitable for demand forecasting for the market.

It is also shown in the graphs of both series presented earlier that the order data is behaving very erratically as compared to warehouse movements data. It can be seen from the tables 6.1 and 6.2, where the mean and standard deviations of both the series are presented. In these tables, mean and standard deviations of both the series verify the claim that order data behaves very erratically as compared to warehouse movements data. In some cases, the standard deviation values of order data are more than the mean values. Comparisons of the standard deviation values of both the series reveal that the standard deviation values of order data are greater than the standard deviation values of warehouse movements data for all the SKU's. In some cases, the standard deviations ratio of order data is almost double the standard deviation ratio of warehouse movements data. In this situation, it is important for Cussons to use the less erratic data for forecasting demand which is based on actual sales and practically it is more reliable for forecasting the demand than the order data. Similarly it will also help Cussons to improve their business forecasting for the market.

Furthermore, forecasting is an integral part of demand planning. The MPS and the whole business is also planned on the basis of forecasting demand and subsequently the material orders are placed with the suppliers for the supply of raw materials. If the forecasting is of poor quality, it will significantly effect the whole decision process and the results will not likely be desirable. The most desirable results for a particular market can only be achieved by the use of reliable data for demand forecasting, which will result in significant improvements in forecasting and also improvements in overall business performance which is very important strategic element of today's volatile business environment. In this situation, it is of the value for Cussons to formulate comprehensive business strategy for this market to improve their demand forecasting process and to reduce inventories significantly. This target can possibly be acheived by using most reliable warehouse movements data.

7.6 Discussion of hypothesis four

This hypothesis presents the most important aspect of the Middle East market and discusses how Cussons can reduce the inventories throughout the supply chain by using the warehouse movements data for the demand forecasting.

The analysis of both the series and discussions presented in hypothesis three reveals that the warehouse movements data is far less erratic as compared to order data. In this situation it is in Cussons interest to use warehouse movements data for their demand planning instead of more unreliable order pattern data.

By using the models based on warehouse movements data it ought to be possible to considerably reduce inventories in the Middle East supply chain of Cusson's products. The analysis of the two series also reveals that within the same lead-time using warehouse movements data a significant reduction in inventory can be achieved.

In this connection, the separate safety stock for each stock keeping unit is calculated and presented in tables 6.3 and 6.4 respectively. Table 6.3 contains the safety stock values of order data, whereas, table 6.4 contains the safety stock values for warehouse movements data. Comparison of both the table values reveal that safety stock values of warehouse movements data are approximately 65% of the safety stock values of order data. These safety stock figures of both the series show that by using warehouse movements data Cussons can reduce 35% of the inventories as compared to order data. Further reduction in inventories can be expected by using information about Islamic festivals. Information about the occurrence of Muslim festivals can be used in the same way as market intelligence is used to "tweak" forecasted demand using time series analysis in the western situation.

A selection of appropriate corporate strategy is imperative, if the company has to succeed in their decision making process of achieving desirable results by solving their complicated problems in the area of demand forecasting and inventories planning.

A strategy presented here by which Cussons will probably improve their market demand patterns in the Middle East by reducing the inventories significantly. The results of reducing the inventories by a sufficient amount can result in more accurate time series which could be used in future to build more accurate forecasting models.

Chapter Eight

Conclusions and recommendations

8.1 Conclusions

Forecasting and demand are two inter-related and inter-dependent terms. Demand created by the markets is a basic source of information for most of the companies to make solid estimates for the future to fulfil that demand.

A detailed case study has been undertaken of the Middle East market that creates forecasting problems for Cusson's (UK) Limited company. These forecasting problems have compelled Cussons to hold huge inventories in the Middle East market to satisfy the demand of their customers at required service level. The following conclusions can be drawn from the study:

The research was concluded through collection of data from Cussons' data base that is order pattern data, the way customers placed orders on Cussons and warehouse movements data from Cussons' distributor in the Middle East market, and a series of un-structured interviews with key members of the staff and with Cussons' distributor in the Middle East market. The initial approach in this research was to compare both the data sets with each other to find which data can be used for better forecasting that can help to reduce the inventories in the Middle East market. Comparison of both the data sets showed that the warehouse movements data is far less erratic than the order data. The analysis of both the data sets and the information from different sources revealed that the demand in the Middle East was influenced by many factors such as Islamic festivals, seasonality etc. On the basis of these findings, four hypotheses were developed. These hypotheses truly represented forecasting problems which were the main cause of forecasting failure. Due to the complex nature of forecasting problems a strategy has been developed for improving the forecasting and reducing the inventories throughout the supply chain in the Middle East market.

It was realised that the demand in the market will be significantly increased at the time of Islamic festivals because of Muslim population in the Middle East market but some difficulties were associated with forecasting the demand by conventional statistical forecasting methods due to the difference of ten days between the Islamic calendar and the Christian calendar. In this situation, it is important for Cussons to use the market intelligence approach when the demand shifts from one to a previous month. It would appear that demand for Cussons' products in the Middle East can be reasonably forecasted, especially when the increased demand due to Muslim festivals is treated in the same way as market intelligence.

It was also identified that in addition to the effect on product sales in the Middle East market due to Muslim religious festivals there was an additional increase in demand for Cussons' products during the summer months. Due to the difference between the Islamic calendar and the Christian calendar, the demand after every three years will shift one month back to a previous month. It was obvious that the demand in winter months was very low, whereas, the demand in summer months is high. It is expected that this demand pattern will be changed in winter months when Islamic festivals will occur in these months. At this stage the market will be supportive but the seasonal effects during summer months will not shift in any systematic way. It is also expected that sales in summer months will be slightly reduced which are presently very high due to Islamic festivals.

To smooth out demand further it is in Cussons' interest to collect downstream data for forecasting because it is based on the actual sales, although the Middle East is populated mostly with smaller customers, and smaller customers probably will not automatically capture sales data because they are not computerised. In this situation, Cussons can collect the warehouse movement data from the distributors for forecasting. The variation of these movements over time is less erratic than the order data. By using warehouse movement data, it is expected that Cussons can reduce 35% inventory throughout the supply chain in the Middle East market.

Due to changeable demand pattern of the market it is of value for Cussons to use short term forecasting. Furthermore, information about the time of Islamic events should be used to help Cussons to reduce inventory by significant amounts and to manage the inventory at the time of high demand.

Companies of a similar size to Cussons can currently afford both the computing hardware and software used in the most sophisticated aspect of forecasting and production planning. Progressive medium sized companies are beginning to be numerate in their approach to forecasting when markets appear to be behaving totally erratically, instead of resorting to judgmental forecasting the market ought to be studied in further depth, and could turn out to be more predictable than initially realised.

8.2 Recommendations for future research

The present research has thoroughly investigated the behaviour of Middle East market and on the basis of findings, the following recommendations for the future research have been made to further improve Cusson's demand forecasting process within the Middle East market that will further help to reduce the inventories to desired levels.

1. In the present research the forecasting models were constructed on the basis of collective data for the whole Middle East market. It is recommended that the

future research should focus on individual countries within the Middle East market to find its impact on overall demand planning.

2. The forecasting models for all the SKU's should be constructed for each country within the Middle East market and efforts should be made to analyse the behaviour of individual countries within the Middle East market. This process will further help to identify the most difficult markets and by controlling those markets the forecasting can significantly be improved.

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Appendix A

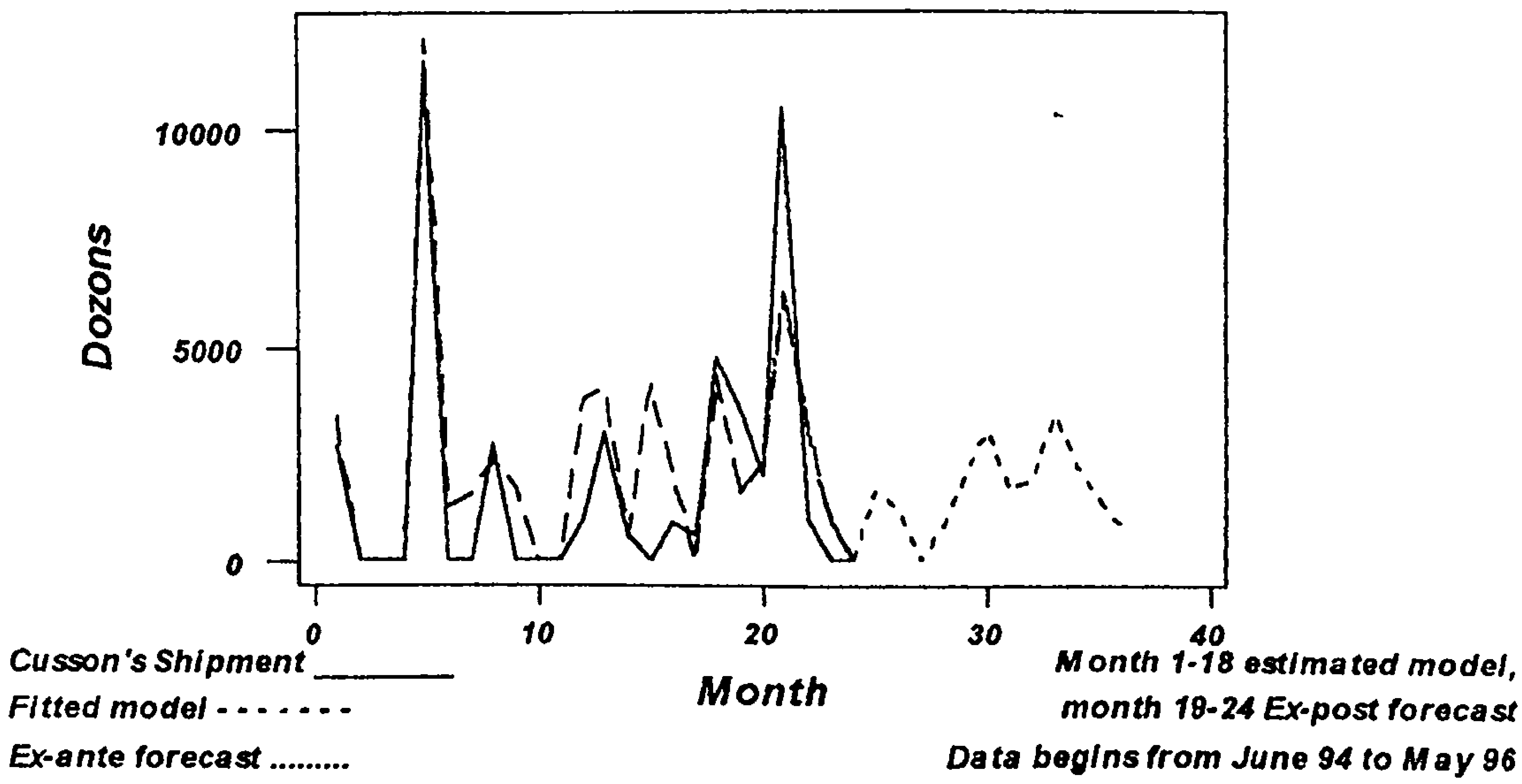

Figure A.1. Cusson's shipments of IL Soap 75G Arabic 4 Pack to the Middle East market.

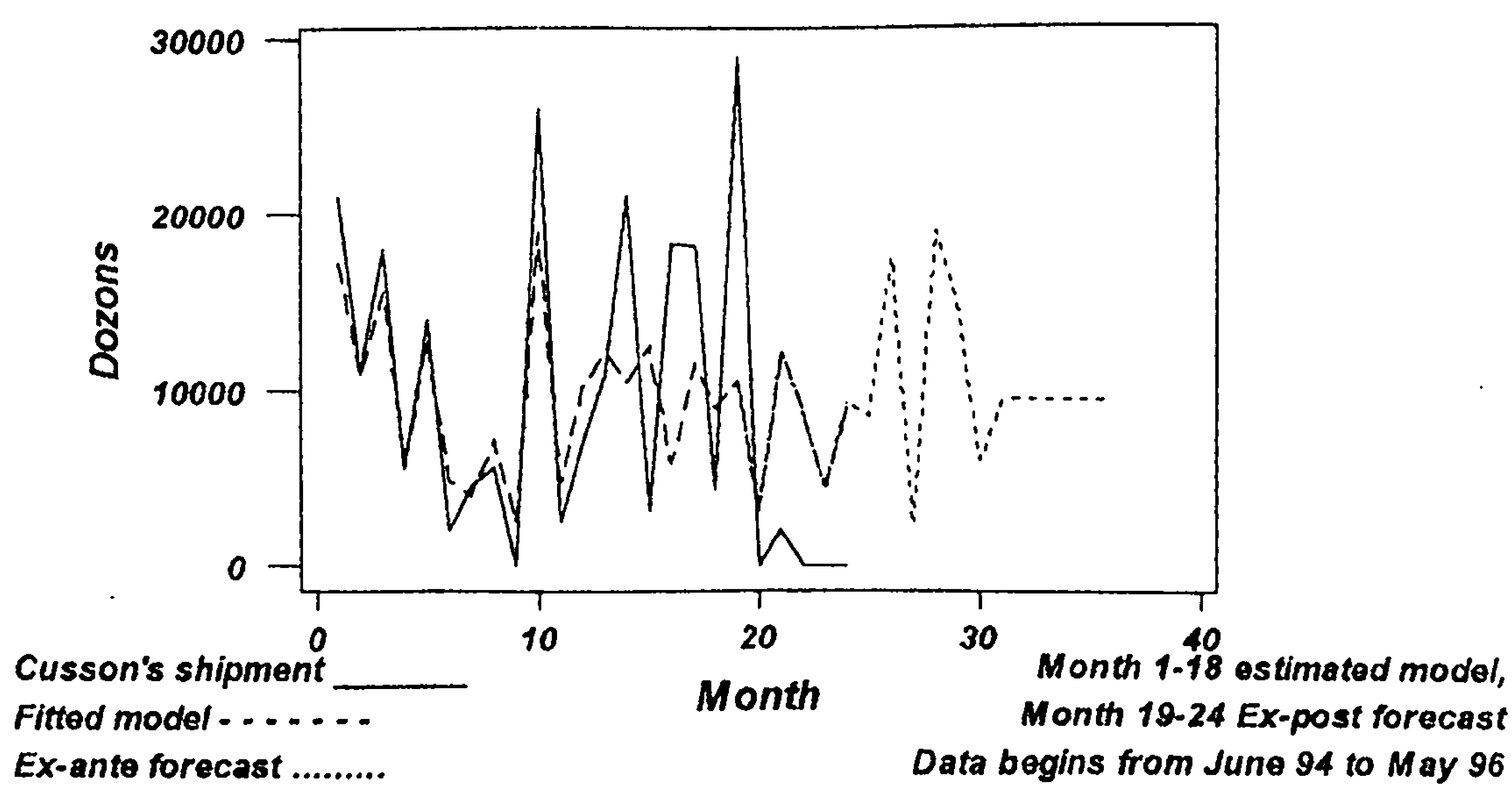

Figure A.2. Cusson's shipments of IL Family Arabic 4's to the Middle East market.

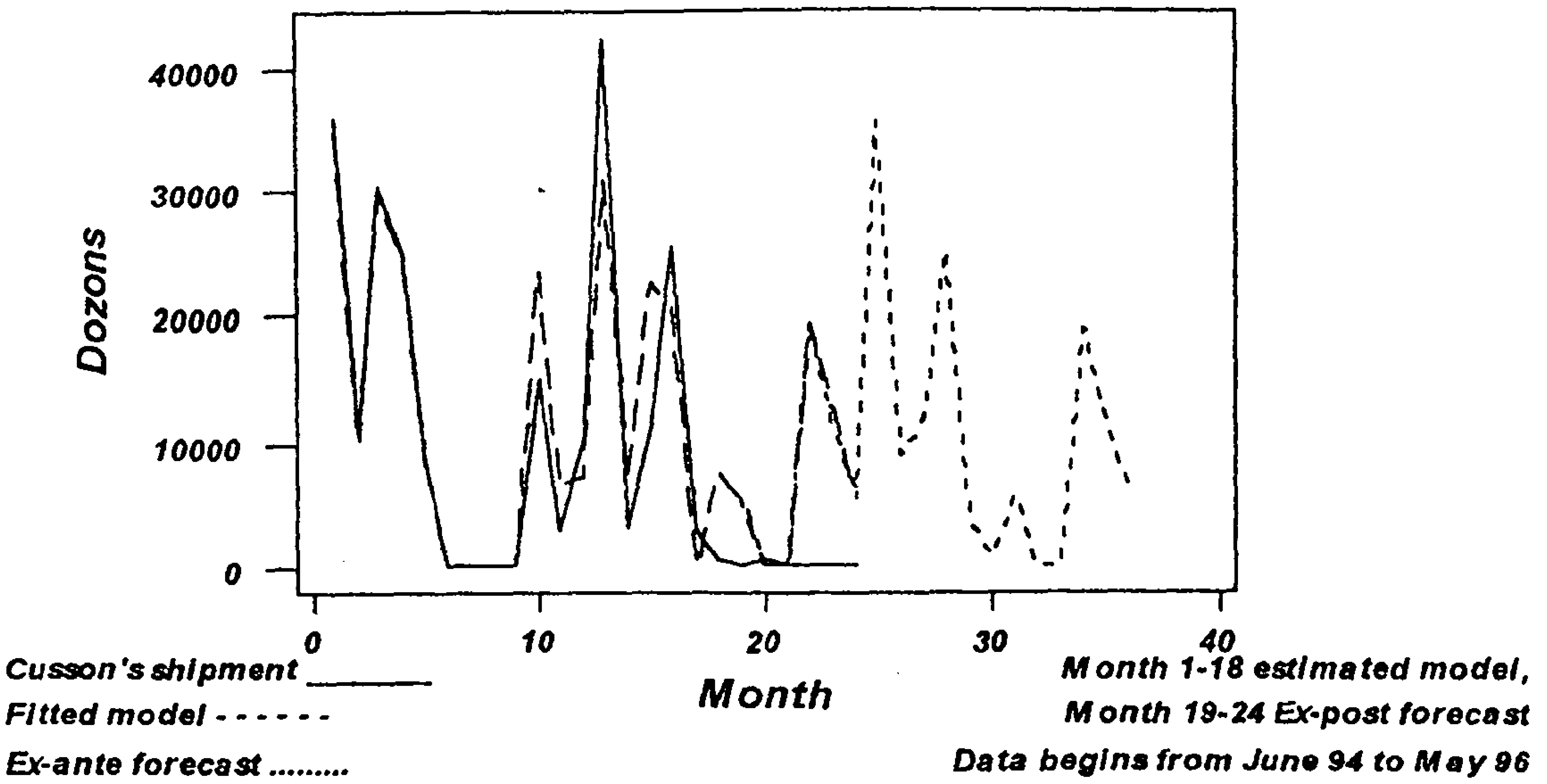

Figure A.3. Cusson's shipments of IL Bath Arabic 6's to the Middle East market.

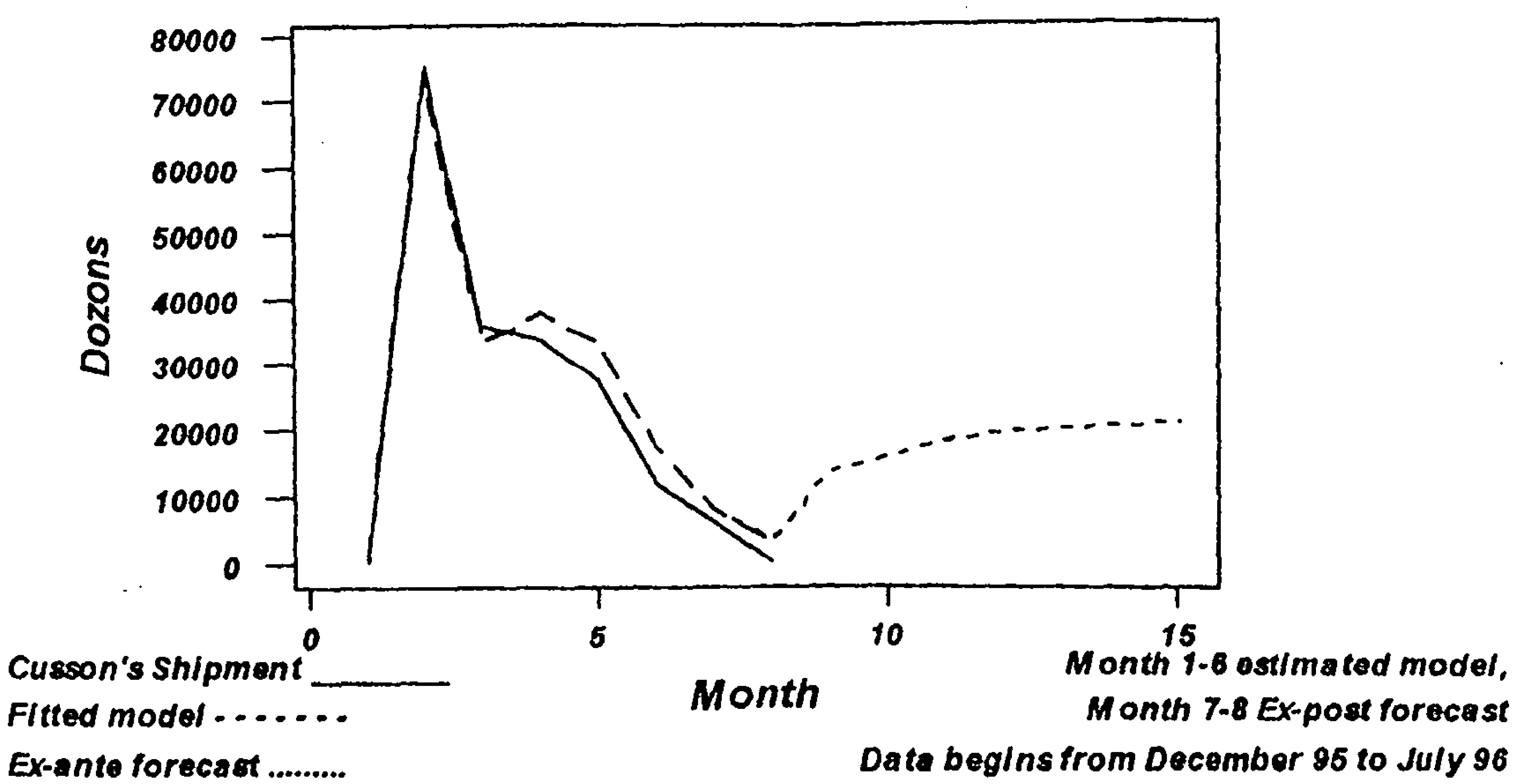

Figure A.4. Cusson's shipments of IL Classic 125G Exp to the Middle East market.

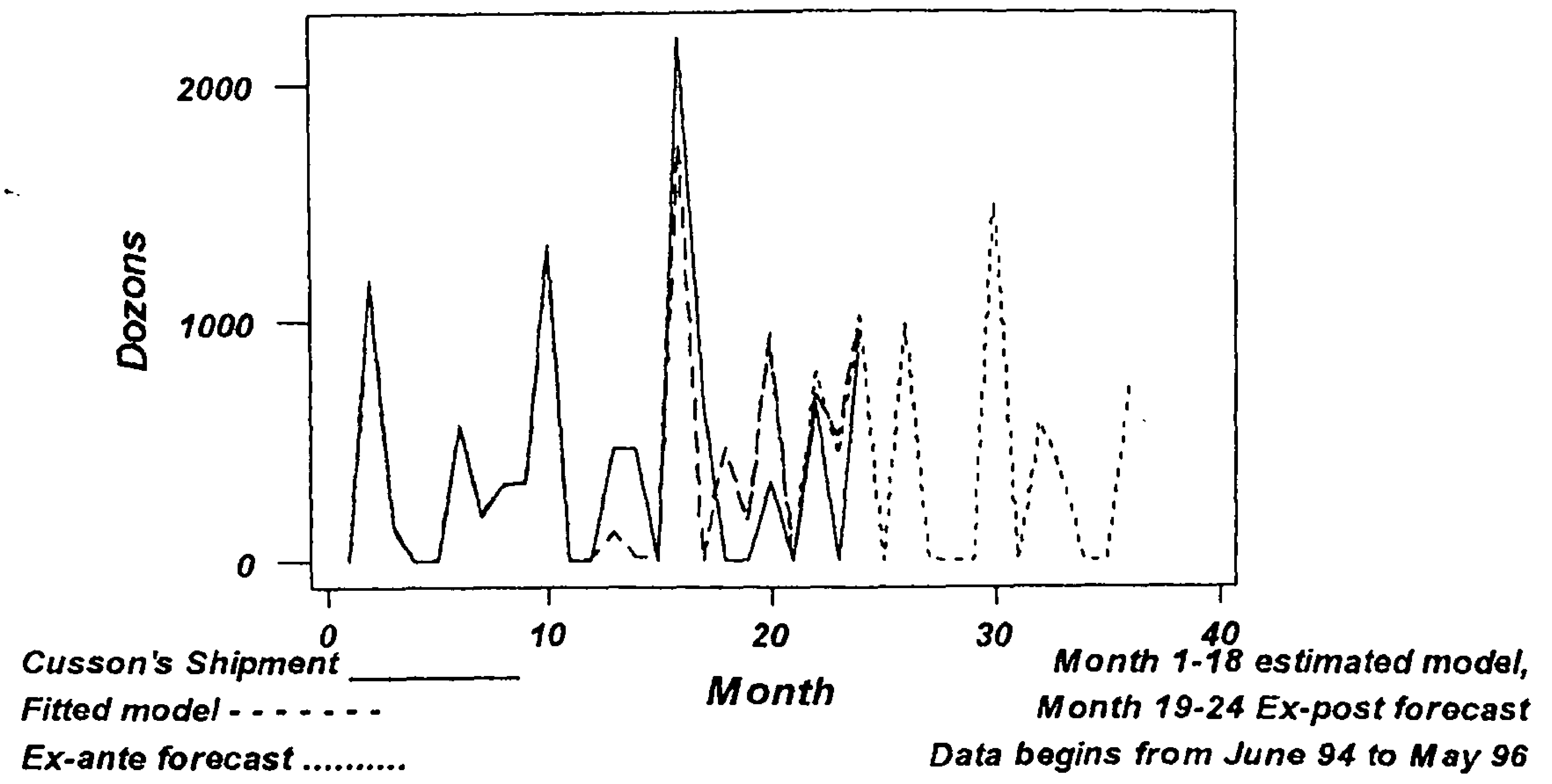

Figure A.5. Cusson's shipments of IL Toilet 2's in trays to the Middle East market.

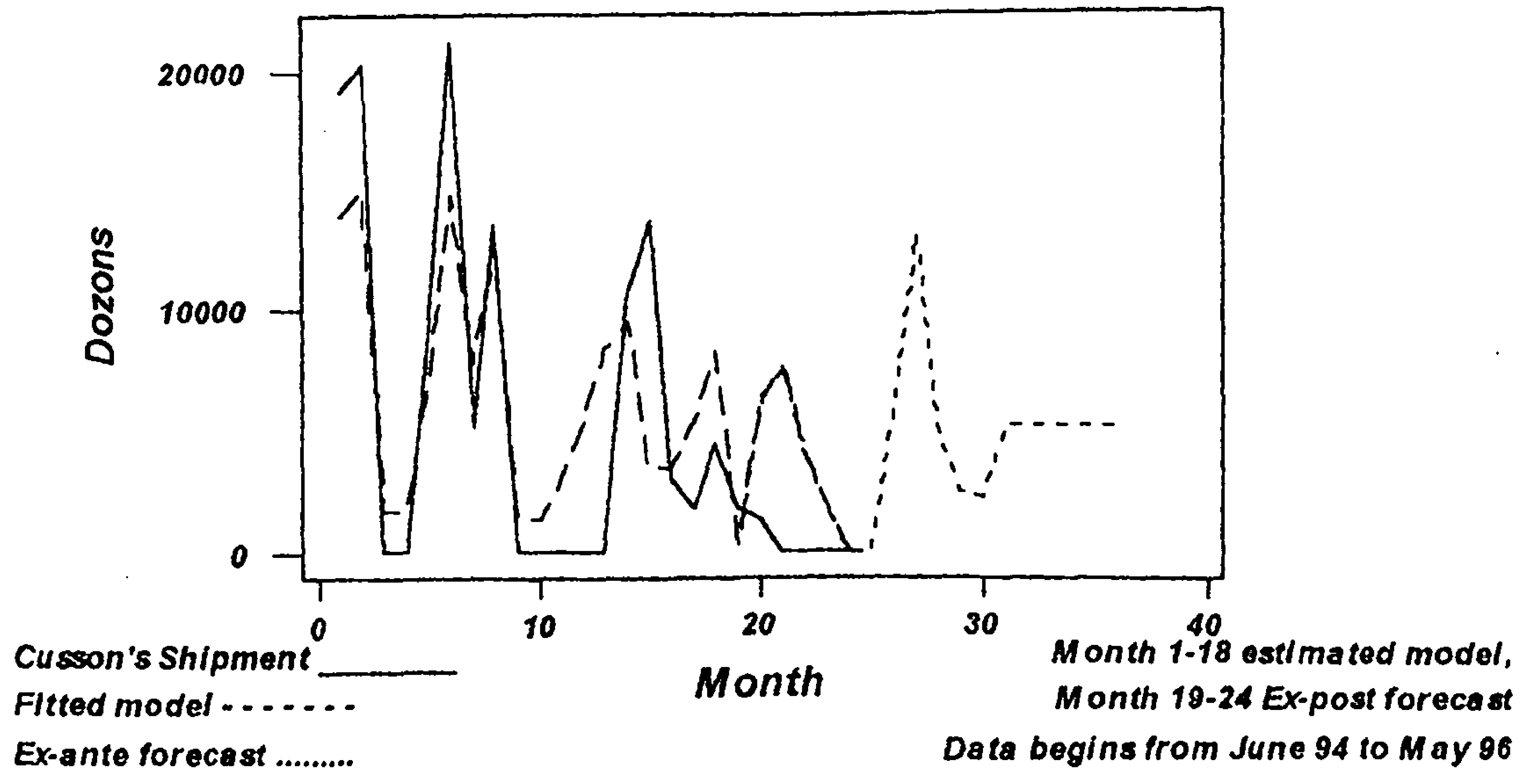

Figure A.6. Cusson's shipments of IL Mild 6 for 5 Arabic to the Middle East market.

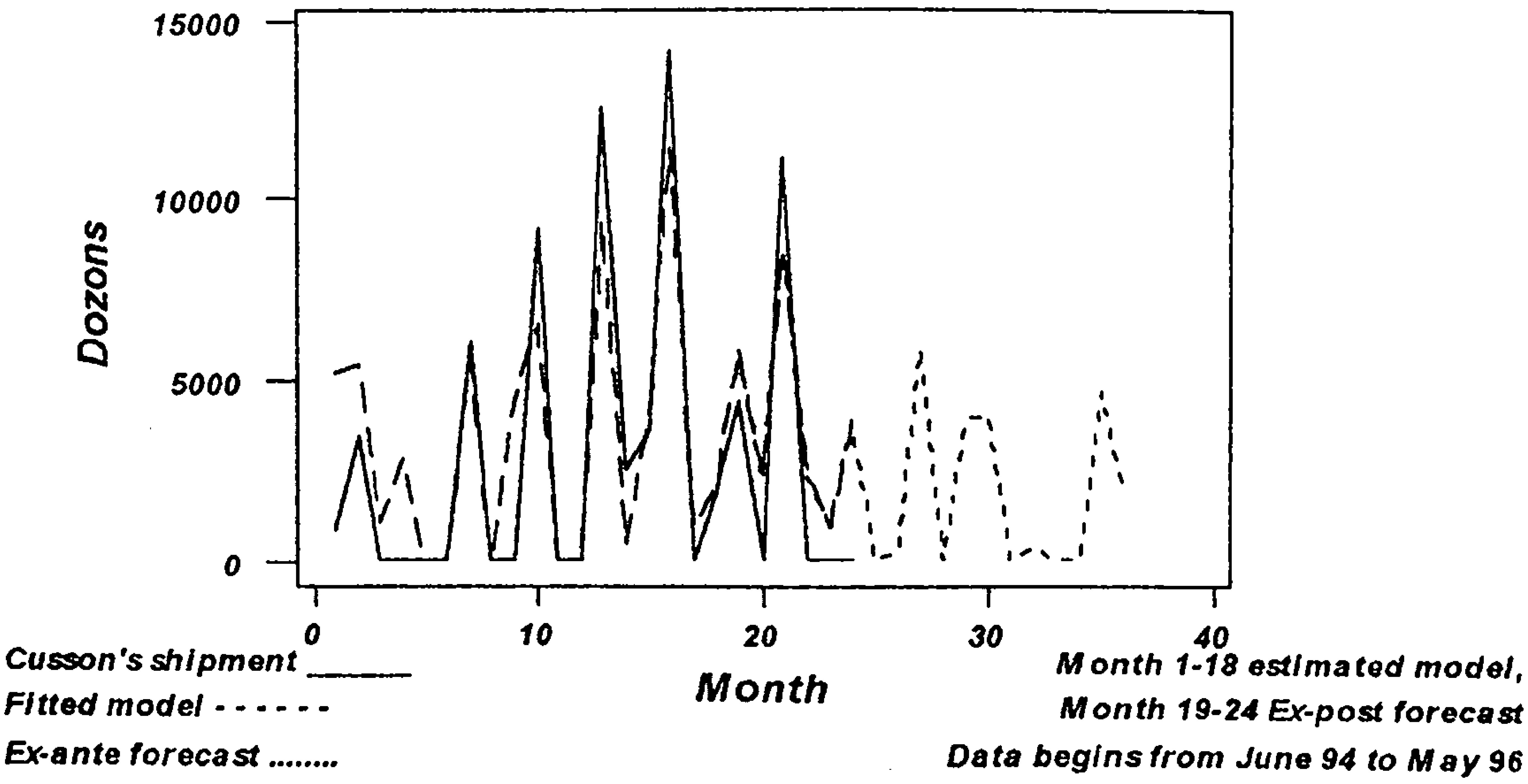

Figure A.7. Cusson's shipments of IL Soap 125G Twin Cyprus to the Middle East market.

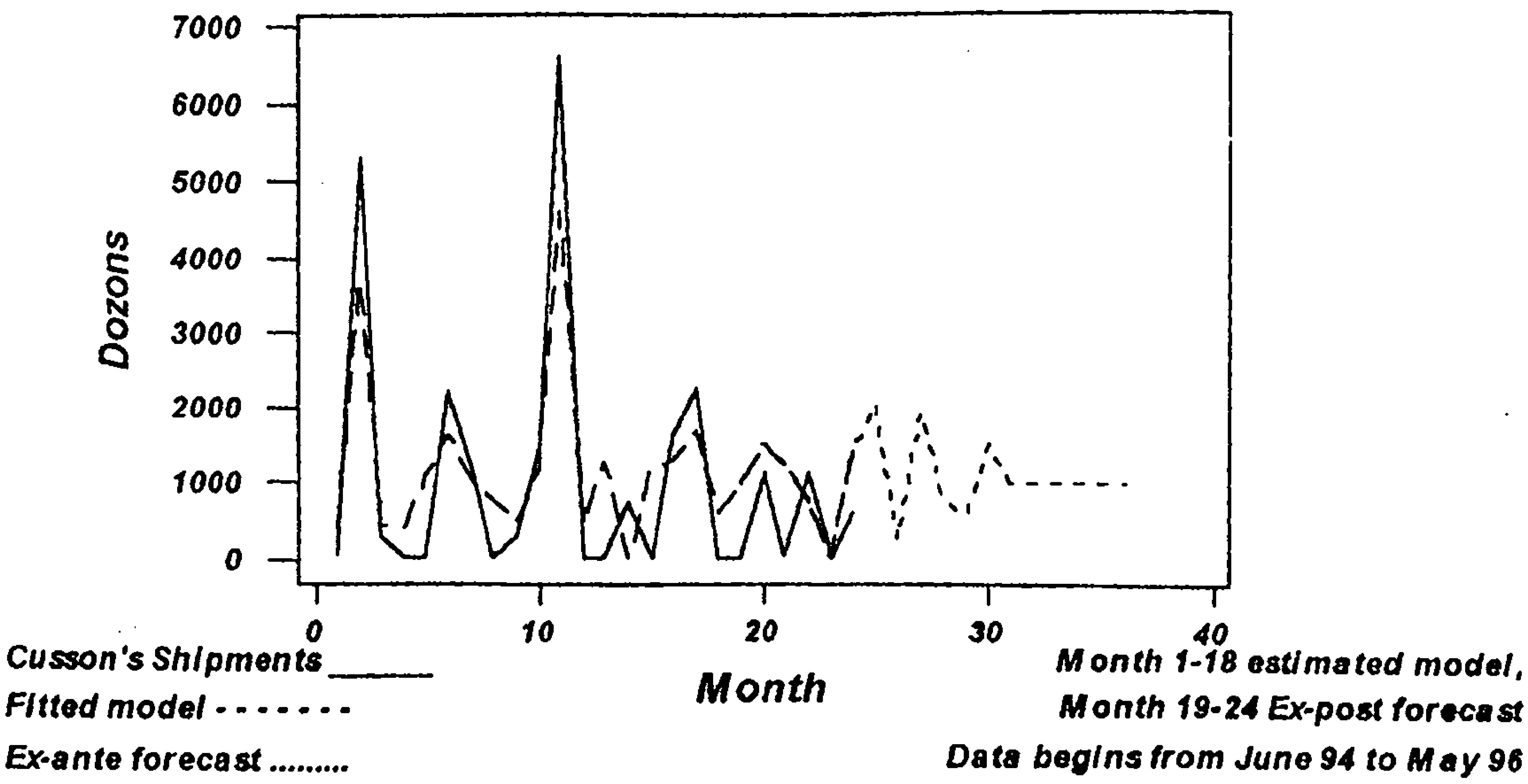

Figure A.8. Cusson's shipments of IL Family H/T 2's to the Middle East market.

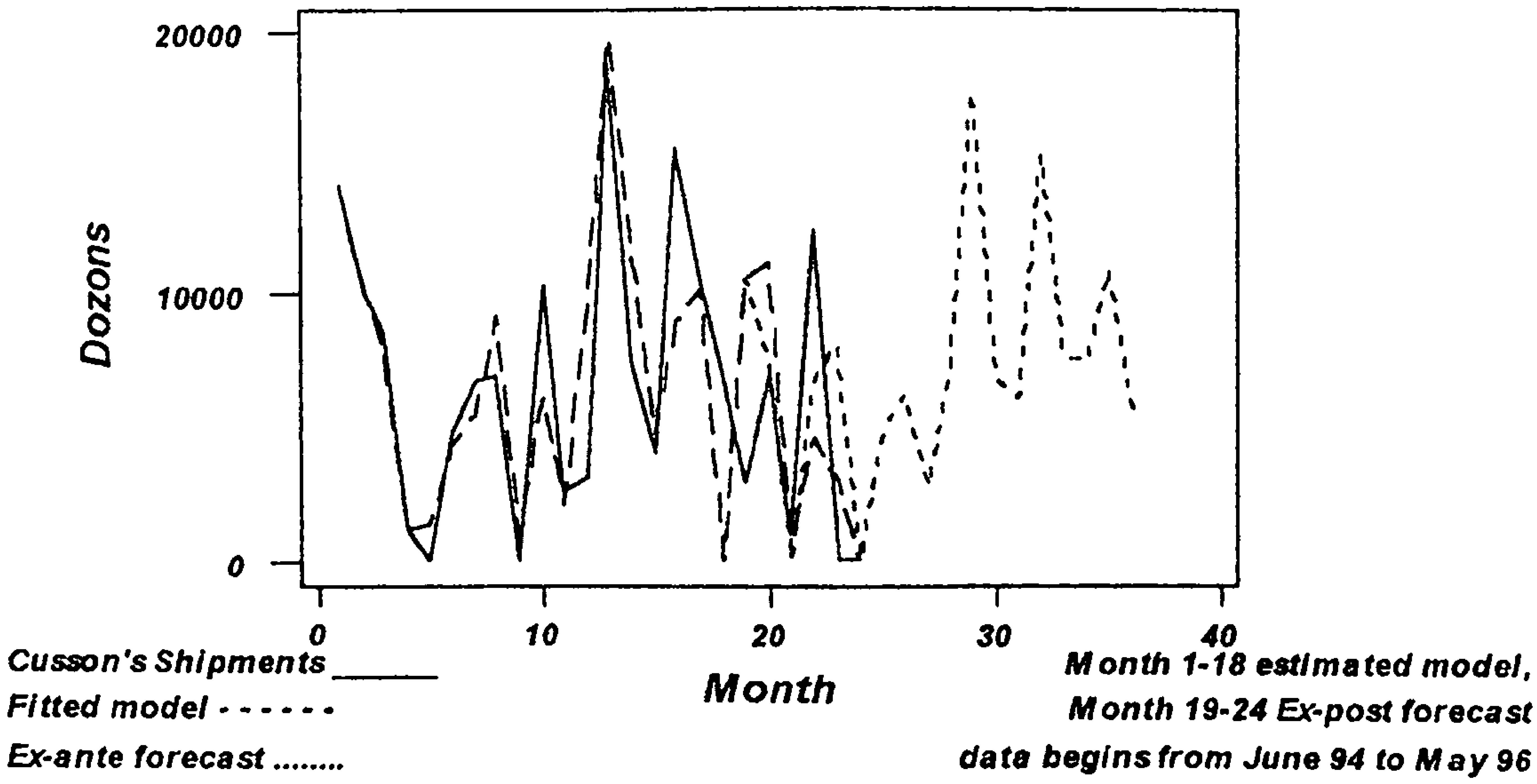

Figure A.9. Cusson's shipments of IL Family Arabic 2's to the Middle East market.

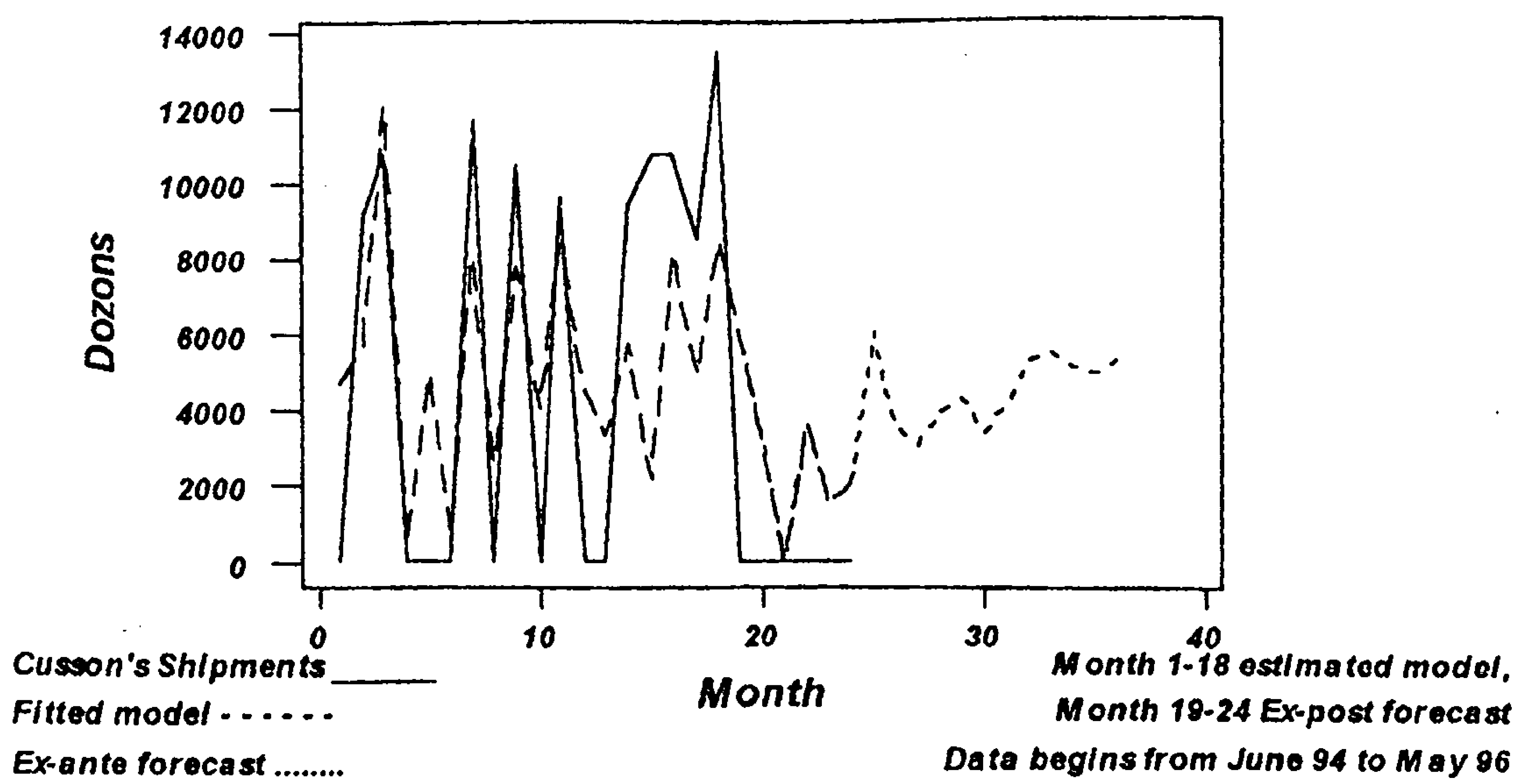

Figure A.10. Cusson's shipments of IL Bath H/T 6 for 5 C& Carry to the Middle East market.

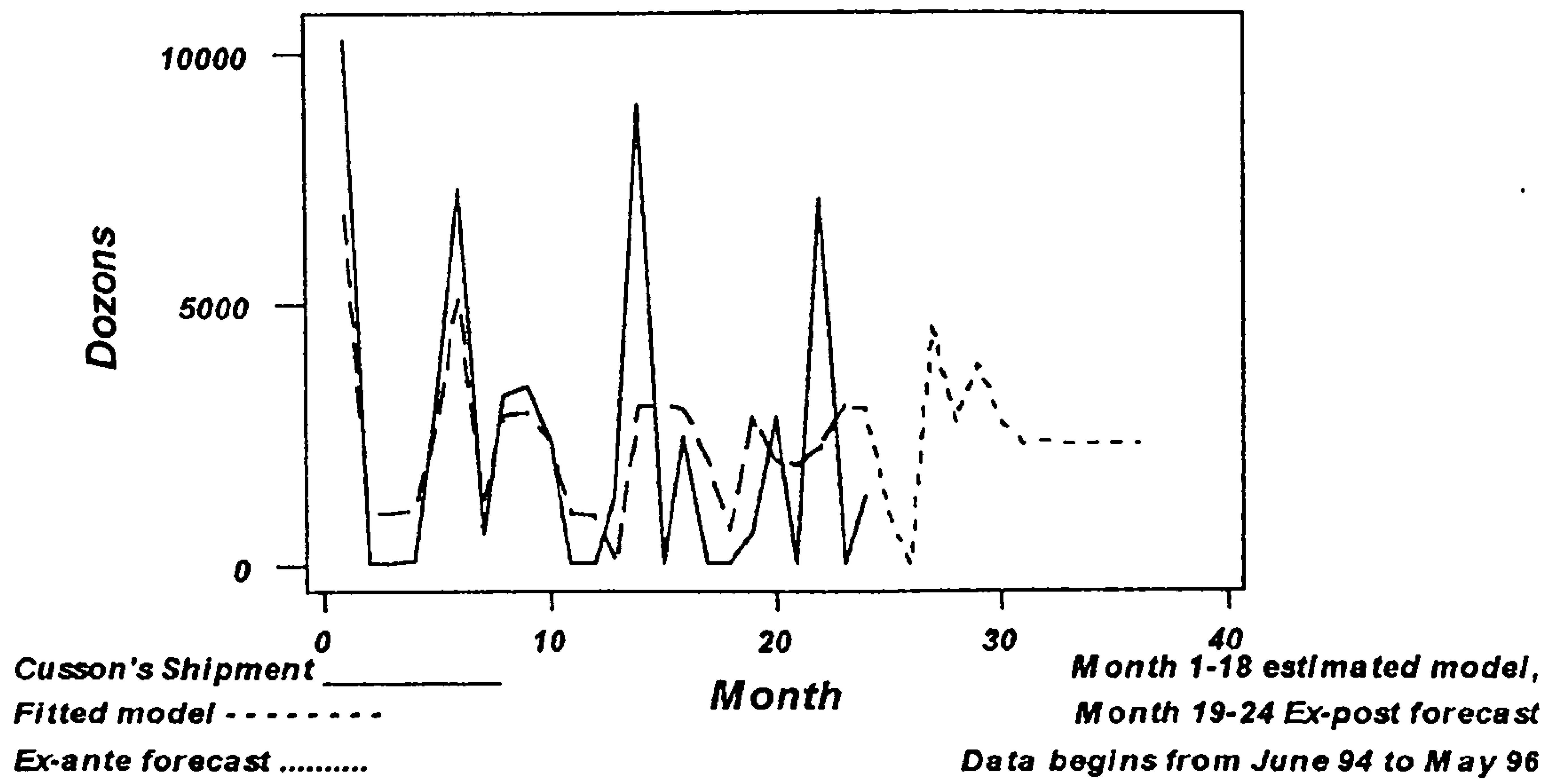

Figure A.11. Cusson's shipments of IL Bath H/T 6's C& Carry to the Middle East market.

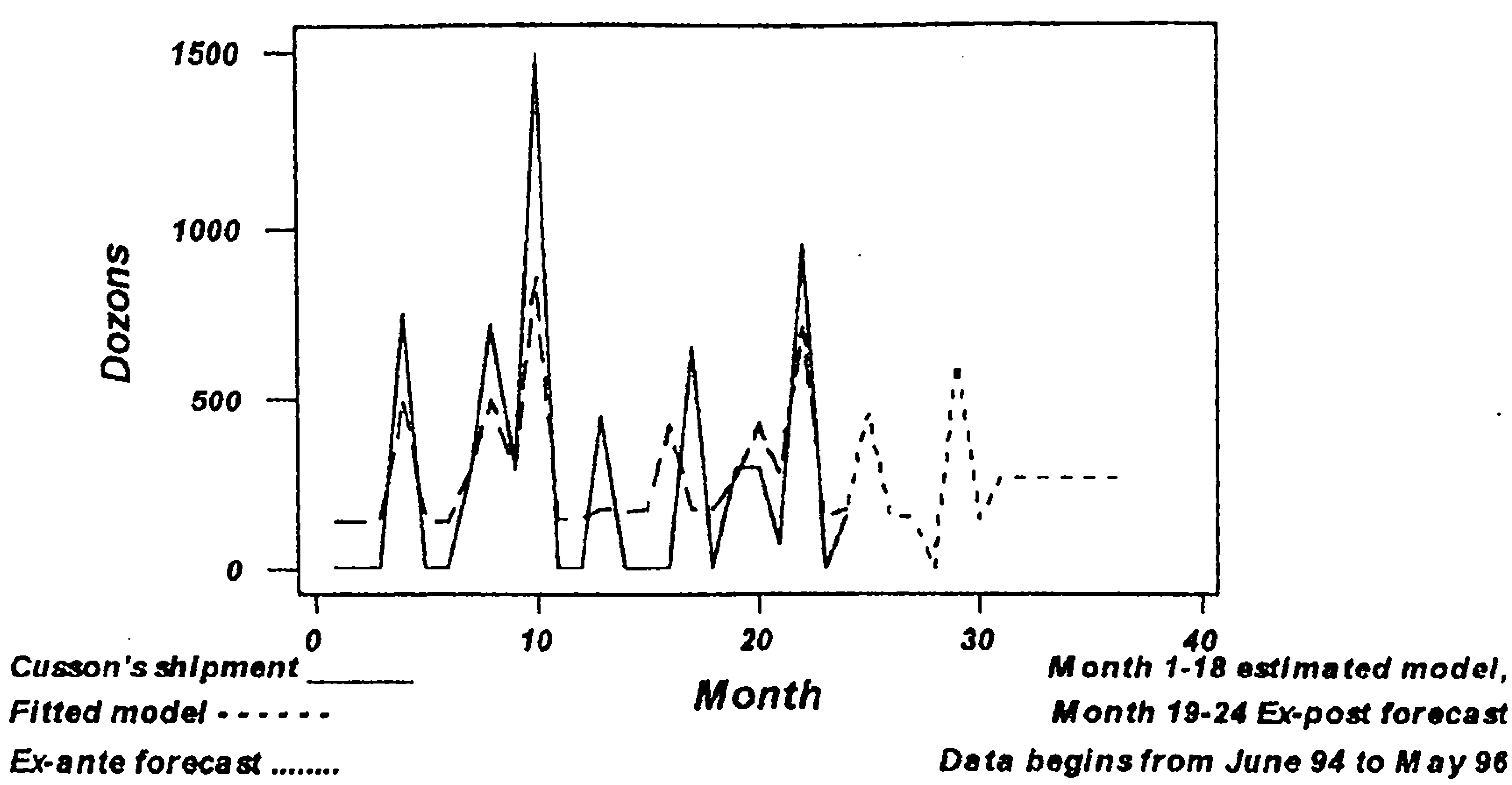

Figure A.12. Cusson's shipments of IL Family H/T 6's C& Carry to the Middle East market.

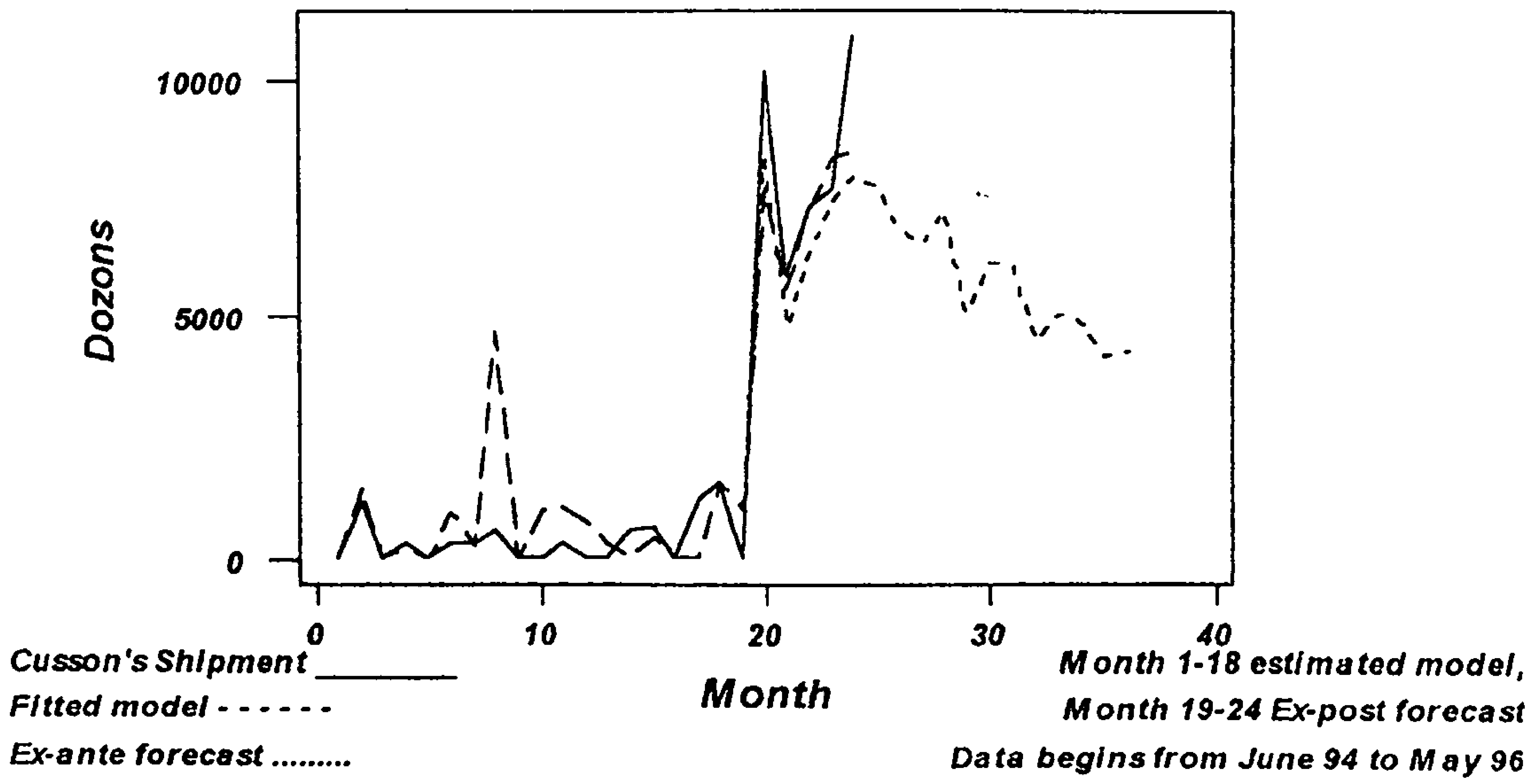

Figure A.13. Cusson's shipments of IL Toilet H/T 6's C& Carry to the Middle East market.

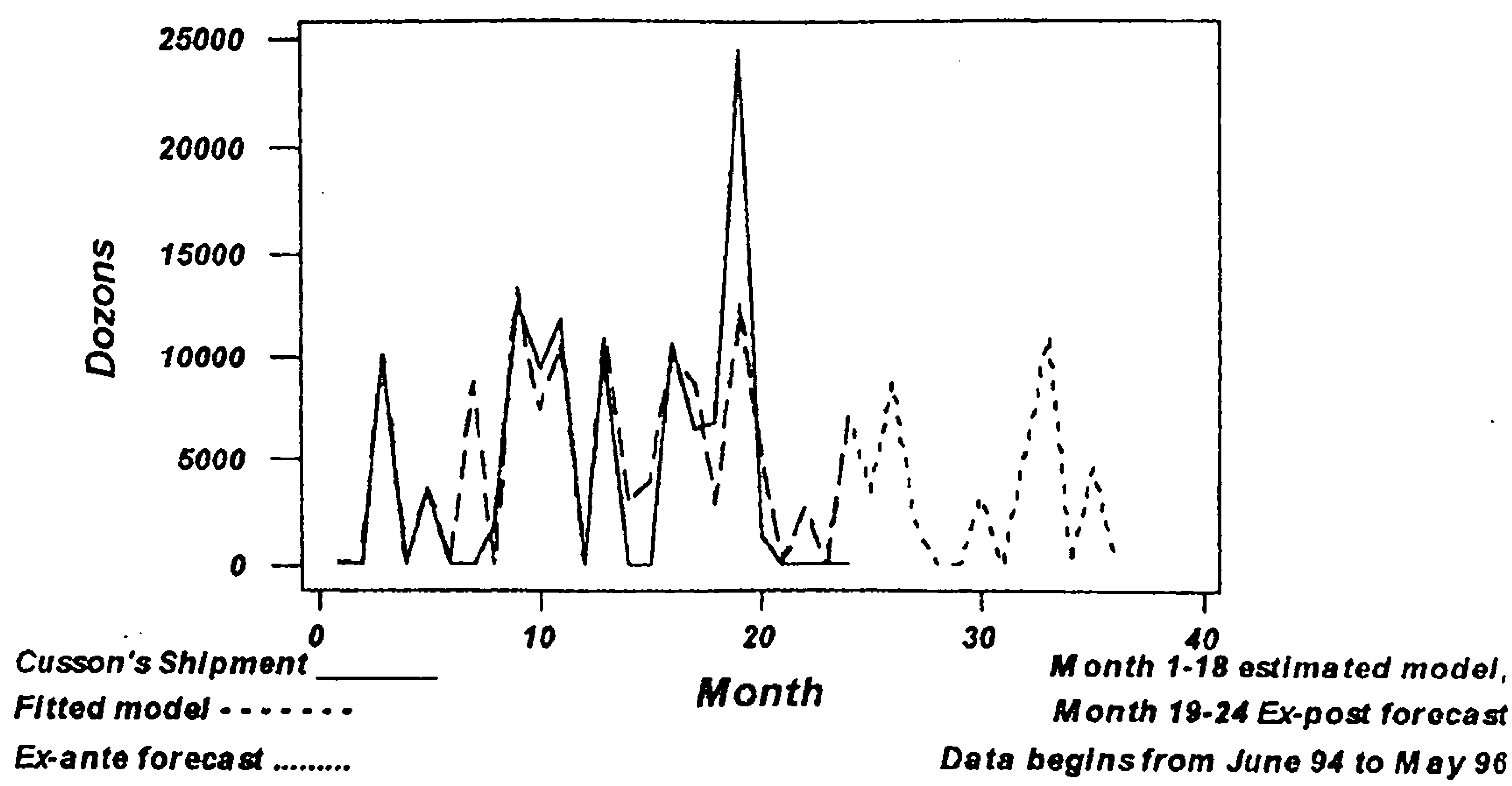

Figure A.14. Cusson's shipments of IL Bath 6 for 5 (UK) to the Middle East market.

Appendix B

Correlations (Pearson)

Warehouse's Movements of Cusson's IL 75G Toilet Soap in the Middle East Market

Correlation of Sales and FITS = 0.720

Correlations (Pearson)

Warehouse's Movements of Cusson's IL Bath 125G Soap in the Middle East Market

Correlation of Sales and FITS = 0.803

Correlations (Pearson)

Warehouse's movements of Cusson's IL Family 200G in the Middle East Market

Correlation of SALES and FITS = 0.824

Correlations (Pearson)

Warehouse's Movements of Cusson's IL Mild 125G in the Middle East Market

Correlation of SALES and FITS = 0.799

Correlations (Pearson)

Warehouse's Movements of Cusson's IL Gold 200G Arabic in the Middle East Market

Correlation of Sales and FITS = 0.897

Correlations (Pearson)

Warehouse's Movements of Cusson's IL Gold 125G Arabic in the Middle East Market

Correlation of Sales and FITS = 0.888

Correlations (Pearson)

Cusson's Shipments of IL Toilet 75G to the Middle East Market

Correlation of Sales and FITS = 0.781

Correlations (Pearson)

Cusson's Shipments of IL Bath 125G to the Middle East Market

Correlation of Sales and FITS = 0.951

Correlations (Pearson)

Cusson's Shipments of IL Mild 125G to the Middle East Market

Correlation of Sales and FITS = 0.921

Correlations (Pearson)

Cusson's Shipments of IL Family 200G to the Middle East Market

Correlation of Sales and FITS = 0.882

Correlations (Pearson)

Cusson's Shipments of IL Gold 125G Arabic to the Middle East Market

Correlation of Sales and FITS = 0.805

Correlations (Pearson)

Cusson's Shipments of IL Gold 200G Arabic to the Middle East Market

Correlation of Sales and FITS = 0.821

Correlations (Pearson)

Cusson's Shipments of IL Soap 75G Arabic 4 Pack to the Middle East Market

Correlation of Sales and FITS = 0.862

Correlations (Pearson)

Cusson's Shipments of IL Family Arabic 4's to the Middle East Market

Correlation of Sales and FITS = 0.644

Correlations (Pearson)

Cusson's Shipments of IL Bath Arabic 6's to the Middle East Market

Correlation of Sales and FITS = 0.873

Correlations (Pearson)

Cusson's Shipments of IL Classic 125G Exp to the Middle East Market

Correlation of Sales and FITS = 0.993

Correlations (Pearson)

Cusson's Shipments of IL Toilet H/T 2's in trays to the Middle East Market

Correlation of Sales and FITS = 0.856

Correlations (Pearson)

Cusson's Shipments of IL Mild 6/5 Arabic to the Middle East Market

Correlation of Sales and FITS = 0.811

Correlations (Pearson)

Cusson's Shipments of IL Soap 125G Twin Cyprus to the Middle East Market

Correlation of Sales and FITS = 0.883

Correlations (Pearson)

Cusson's Shipments of IL Family H/T 2's to the Middle East Market

Correlation of Sales and FITS = 0.912

Correlations (Pearson)

Cusson's Shipments of IL Family Arabic 2's to the Middle East Market

Correlation of Sales and FITS = 0.741

Correlations (Pearson)

Cusson's Shipments of IL Bath H/T 6 for 5 C&Carry to the Middle East Market

Correlation of Sales and FITS = 0.725

Correlations (Pearson)

Cusson's Shipments of IL Bath H/T 6's C&Carry to the Middle East Market

Correlation of Sales and FITS = 0.723

Correlations (Pearson)

Cusson's Shipments of IL Family H/T 6's C&Carry to the Middle East Market

Correlation of Sales and FITS = 0.859

Correlations (Pearson)

Cusson's Shipments of IL Toilet H/T 6's C&Carry to the Middle East Market

Correlation of Sales and FITS = 0.940

Correlations (Pearson)

Cusson's Shipments of IL Bath 6 for 5 (UK) to the Middle East Market

Correlation of Sales and FITS = 0.794

Appendix C

Warehouse's movements of Cusson's IL Toilet 75G in the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 20.5(DF= 17)

Warehouse's movements of Cusson's IL Bath 125G in the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 8.7(DF= 6)

Warehouse's movements of Cusson's IL Family 200G in the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 10.3(DF= 6)

Warehouse's Movements of Cusson's IL Mild 125G in the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 6.7(DF= 6)

Warehouse's Movements of Cusson's IL Gold 200G Arabic in the Middle East Market

Number of observations: 12

Chi-Square statistic

Chi-Square 24.06(DF= 11)

Warehouse's Movements of Cusson's IL 125G Arabic in the Middle East Market

Number of observations: 12

Chi-Square statistic

Chi-Square 18.05(DF= 11)

Cusson's Shipments of IL Toilet 75G to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 13.3(DF= 7)

Cusson's Shipments of IL Bath 125G to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 16.8(DF= 8)

Cusson's Shipments of IL Mild 125G to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 5.1(DF= 6)

Cusson's Shipments of IL Family 200G to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 12.6(DF= 7)

Cusson's Shipments of IL Soap 75G Arabic 4 Pack to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 15.5(DF=10)

Cusson's Shipments of IL Family Arabic 4's to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 13.0(DF=10)

Cusson's Shipments of IL Bath Arabic 6's to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 16.2(DF= 9)

Cusson's Shipments of IL Classic 125G Exp to the Middle East Market

Number of observations: 8

Chi-Square statistic

Chi-Square 8.6(DF= 7)

Cusson's Shipments of IL Toilet H/T 2's in trays to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 8.6(DF= 7)

Cusson's Shipments of IL Mild 6/5 Arabic to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 16.9(DF=10)

Cusson's Shipments of IL Soap 125G Twin Cyprus to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 22.7(DF= 7)

Cusson's Shipments of IL Family H/T 2's to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 8.4(DF=10)

Cusson's Shipments of IL Family Arabic 2's to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 8.8(DF= 8)

Cusson's Shipments of IL Bath H/T 6 for 5 C&Carry to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 5.8(DF= 9)

Cusson's Shipments of IL Bath H/T 6's C&Carry to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 16.8(DF= 9)

Cusson's Shipments of IL Family H/T 6's C&Carry to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 11.0(DF=10)

Cusson's Shipments of IL Toilet H/T 6's C&Carry to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 10.2(DF= 6)

Cusson's Shipments of IL Bath 6 for 5 (UK) to the Middle East Market

Number of observations: 24

Chi-Square statistic

Chi-Square 18.5(DF= 9)

Appendix D

```
Worksheet size: 100000 cells


Retrieving worksheet from file: A:\ILT75gwm.MTW
Worksheet was saved on  6/ 9/1999
```

ARIMA Model

```
ARIMA model for Dozons

Estimates at each iteration
Iteration         SSE      Parameters
     0       735050467     0.100     0.100     0.100     0.100
0.100 5592.942
     1       616848542     0.189     0.119    -0.050     0.010
0.050 5725.948
     2       601778000     0.092     0.269    -0.080    -0.123
0.192 5579.880
     3       589732904     0.059     0.419    -0.115    -0.192
0.335 4949.199
     4       576558734     0.096     0.569    -0.169    -0.201
0.474 4082.043
     5       562753662     0.175     0.719    -0.260    -0.170
0.605 3338.342
     6       551566336     0.156     0.804    -0.338    -0.178
0.685 3352.145
     7       538003180     0.184     0.856    -0.406    -0.131
0.749 3313.804
     8       522384594     0.145     0.887    -0.463    -0.162
0.810 3612.779
     9       508670239     0.184     0.889    -0.509    -0.103
0.845 3690.187
    10       499316819     0.149     0.880    -0.541    -0.134
0.866 4117.058
    11       493771590     0.175     0.869    -0.565    -0.092
0.875 4249.606
    12       490538890     0.156     0.860    -0.586    -0.111
0.878 4567.487
    13       488594082     0.174     0.854    -0.603    -0.085
0.879 4653.716
    14       487395963     0.164     0.849    -0.618    -0.096
0.878 4852.961
    15       486631803     0.176     0.846    -0.630    -0.079
0.877 4900.478
    16       486136059     0.171     0.844    -0.641    -0.086
0.875 5027.519
```

```
   17        485807518    0.180     0.842     -0.650    -0.074
0.874 5052.958
   18        485587381    0.176     0.841     -0.657    -0.079
0.873 5137.661
   19        485437892    0.182     0.840     -0.663    -0.071
0.872 5150.840
   20        485335540    0.179     0.840     -0.668    -0.074
0.871 5209.720
   21        485264844    0.184     0.839     -0.673    -0.069
0.870 5215.942
   22        485215677    0.182     0.839     -0.676    -0.071
0.869 5258.270
   23        485181298    0.185     0.838     -0.679    -0.067
0.869 5260.465
   24        485157111    0.184     0.838     -0.682    -0.069
0.868 5291.701
   25        485140054    0.186     0.838     -0.684    -0.066
0.868 5291.555
** Convergence criterion not met after 25 iterations

* WARNING * Back forecasts not dying out rapidly

Back forecasts (after differencing)
Lag  -88 -   -83
7689.4177477.6667483.4437539.8687770.0028074.450
Lag  -82 -   -77
7442.2247462.3217426.3738011.7518158.9317693.915
Lag  -76 -   -71
7710.0927583.5317964.2617699.3898054.1458044.577
Lag  -70 -   -65
7942.0707552.5457012.7648127.4728092.0938151.568
Lag  -64 -   -59
7117.5156843.4557690.5367661.1767883.9547186.546
Lag  -58 -   -53
7640.0937047.9217063.6857249.6827907.3018863.813
Lag  -52 -   -47
6899.4806961.7296863.8518689.5039198.2747657.328
Lag  -46 -   -41
7710.5517318.6258593.9357818.5718803.0038777.186
Lag  -40 -   -35
8440.0887332.9735638.9039098.5598989.0959149.184
Lag  -34 -   -29
5927.6584985.7627785.3157688.9418378.0606049.697
Lag  -28 -   -23
7372.9285743.9745785.9626396.2378254.3141.13E+04
Lag  -22 -   -17
5163.1385355.5215095.5551.08E+041.25E+047436.617
Lag  -16 -   -11
7610.9446399.9611.06E+048390.5201.11E+041.10E+04
```

```
Lag  -10 -   -5
9900.3326792.6431487.1911.22E+041.19E+041.23E+04
Lag   -4 -    0   2266.864-
937.7718269.3097954.2341.01E+04
Back forecast residuals
Lag  -88 -  -83     76.699-127.815 -75.349 -68.809
106.194 249.347
Lag  -82 -  -77   -236.234-109.018-144.508 267.097
325.247-171.449
Lag  -76 -  -71    -37.891-128.681 290.854 148.343
75.586 100.413
Lag  -70 -  -65      8.316  68.951-194.543 291.448
167.529 159.028
Lag  -64 -  -59   -251.326-369.114 201.548  48.959
148.557-331.095
Lag  -58 -  -53    -92.988-218.323-193.221 -80.156
29.255 490.751
Lag  -52 -  -47   -596.162-315.488-341.172 578.536
793.635-440.646
Lag  -46 -  -41   -110.204-323.136 716.877 303.677
306.337 320.950
Lag  -40 -  -35     83.612  76.429-746.061 997.578
549.758 558.189
Lag  -34 -  -29   -916.448-1.3E+03 755.132 200.231
547.101-1.2E+03
Lag  -28 -  -23   -496.196-550.243-562.113-158.561-
103.2531352.138
Lag  -22 -  -17   -1.8E+03-984.621-
1.0E+031655.5262406.467-1.4E+03
Lag  -16 -  -11   -387.097-1.0E+032201.212 992.230
889.677 963.265
Lag  -10 -   -5    224.941 295.006-
2.3E+033135.0951744.3811744.694
Lag   -4 -    0   -2.8E+03-4.2E+032532.202
726.9611802.217

Final Estimates of Parameters
Type            Coef         StDev          T
AR    1        0.1863        1.0431       0.18

SAR   5        0.8379        0.2033       4.12
SAR  10       -0.6838        0.2138      -3.20
MA    1       -0.0658        1.0547      -0.06
SMA   5        0.8678        0.3142       2.76
Constant       5291.6         159.7      33.13
Mean           7687.6         232.0

Number of observations:  24
Residuals:      SS =  389311963
                MS =   21628442
```

```
Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Chi-Square   11.5(DF= 7)
```

ARIMA Model

```
ARIMA model for Dozons

Estimates at each iteration
Iteration          SSE       Parameters
    0        485140054     0.186      0.838     -0.684     -0.066
0.868 5291.555
    1        485127957     0.185      0.838     -0.686     -0.068
0.867 5315.002
    2        485119376     0.187      0.838     -0.687     -0.065
0.867 5313.654
    3        485113253     0.186      0.837     -0.688     -0.067
0.867 5331.538
    4        485108904     0.187      0.837     -0.690     -0.064
0.867 5*329.454
    5        485105788     0.186      0.837     -0.690     -0.066
0.866 5343.311
    6        485103578     0.188      0.837     -0.691     -0.064
0.866 5340.881
    7        485101992     0.187      0.837     -0.692     -0.065
0.866 5351.731
    8        485100873     0.188      0.837     -0.692     -0.064
0.866 5349.198
    9        485100070     0.187      0.837     -0.693     -0.065
0.866 5357.769
   10        485099509     0.188      0.837     -0.693     -0.064
0.866 5355.283
   11        485099106     0.188      0.837     -0.694     -0.064
0.866 5362.103
   12        485098831     0.188      0.837     -0.694     -0.063
0.866 5359.753
   13        485098634     0.188      0.837     -0.694     -0.064
0.866 5365.216
   14        485098504     0.188      0.837     -0.694     -0.063
0.865 5363.047
   15        485098411     0.188      0.837     -0.695     -0.064
0.865 5367.448
   16        485098353     0.188      0.837     -0.695     -0.063
0.865 5365.484
   17        485098312     0.188      0.837     -0.695     -0.064
0.865 5369.046
   18        485098290     0.189      0.837     -0.695     -0.063
0.865 5367.291
```

```
   19        485098274    0.188     0.837    -0.695    -0.064
0.865 5370.188
   20        485098269    0.189     0.837    -0.695    -0.063
0.865 5368.635
   21        485098265    0.188     0.837    -0.695    -0.064
0.865 5371.000
   22        485098259    0.188     0.837    -0.695    -0.063
0.865 5370.401
Unable to reduce sum of squares any further

Back forecasts (after differencing)
Lag  -88 -  -83
7661.5207475.3927480.2977554.4217770.6728124.354
Lag  -82 -  -77
7404.4667425.0957398.4898068.2038272.1177673.751
Lag  -76 -  -71
7691.5147552.9108047.5967784.2838099.7028091.404
Lag  -70 -  -65
7962.9247594.9326984.9178224.8708189.3448234.104
Lag  -64 -  -59
7080.0066724.8177762.8977732.0907970.7037111.512
Lag  -58 -  -53
7561.4697027.1347041.1637263.8497889.9238942.019
Lag  -52 -  -47
6806.3606867.5406792.2878781.0519399.6587598.856
Lag  -46 -  -41
7652.2807241.5108733.6687964.8578869.7288846.017
Lag  -40 -  -35
8460.0757395.1485580.6509258.9279153.5739280.004
Lag  -34 -  -29
5853.0344775.7877899.5167806.8738513.9875922.757
Lag  -28 -  -23
7236.2195704.4275744.4846413.3338224.3261.14E+04
Lag  -22 -  -17
5018.6585200.0764987.8191.09E+041.28E+047350.393
Lag  -16 -  -11
7511.0366293.8271.08E+048549.6231.11E+041.11E+04
Lag  -10 -   -5
9914.9806835.9481439.3551.23E+041.20E+041.24E+04
Lag   -4 -    0   2218.364-
1.0E+038350.1428071.5371.02E+04
Back forecast residuals
Lag  -88 -  -83     70.190-138.895 -85.812 -72.383
107.679 265.669
Lag  -82 -  -77   -272.803-133.664-162.358 292.925
371.025-219.630
Lag  -76 -  -71    -63.742-156.364 338.917 196.129
49.193  92.738
Lag  -70 -  -65    -10.986 108.801-183.544 306.753
183.504 162.879
```

```
Lag  -64 -   -59   -250.653-404.148 239.207  70.322
169.544-366.412
Lag  -58 -   -53   -136.832-204.485-194.066 -66.785  -
1.086 490.493
Lag  -52 -   -47   -634.229-347.374-355.758 594.201
850.794-507.192
Lag  -46 -   -41   -149.870-359.277 775.729 373.478
268.801 309.688
Lag  -40 -   -35     55.738 130.044-726.3361024.100
579.804 563.255
Lag  -34 -   -29   -914.693-1.4E+03 820.650 244.989
579.735-1.2E+03
Lag  -28 -   -23   -567.089-506.945-545.282-127.907-
153.8431318.196
Lag  -22 -   -17   -1.8E+03-1.0E+03-
1.0E+031639.8162428.166-1.5E+03
Lag  -16 -   -11   -439.924-1.0E+032218.8621048.660
827.254 924.479
Lag  -10 -    -5    188.390 332.672-
2.2E+033086.7831741.3321701.513
Lag   -4 -     0   -2.8E+03-4.1E+032513.353
762.2761768.157
```

Final Estimates of Parameters

Type	Coef	StDev	T
AR 1	0.1884	1.0457	0.18
SAR 5	0.8365	0.2017	4.15
SAR 10	-0.6954	0.2120	-3.28
MA 1	-0.0634	1.0570	-0.06
SMA 5	0.8653	0.3140	2.76
Constant	5370.4	162.0	33.16
Mean	7705.1	232.4	

```
Number of observations:  24
Residuals:      SS =  389852091
                MS =   21658449
Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Chi-Square   11.8(DF= 7)
```

Appendix E

Product description: Warehouse movements of IL Toilet 75G

Month	Dozons
June 94	2352
2	6174
3	1735
4	1560
5	2034
6	1195
7	11579
8	4695
9	2137
10	4198
11	23409
12	17042
June 95	8901
2	3168
3	8579
4	11186
5	11674
6	6430
7	15375
8	11083
9	8976
10	7788
11	6990
12	8169

Product description: Warehouse movements of IL Bath 125G

Month	Dozons
June 94	48242
2	30577
3	19277
4	15253
5	38288
6	9356
7	10086
8	49036
9	16320
10	22248
11	53556
12	26175
June 95	22511
2	47198
3	27325
4	17086
5	54358
6	18665
7	34127
8	25709
9	32268
10	37514
11	35840
12	42183

Product description: Warehouse movements of IL Family 200G

Month	Dozons
June 94	19810
2	15650
3	32262
4	8762
5	33346
6	8509
7	8219
8	11245
9	25768
10	11168
11	27296
12	34316
June 95	8259
2	19501
3	26916
4	6776
5	26215
6	28887
7	14038
8	44846
9	6828
10	12028
11	37302
12	22539

Product description: Cusson's shipments of IL Toilet 75G

Month	Dozons
June 94	2700
2	1167
3	140
4	1167
5	16440
6	767
7	187
8	34947
9	16827
10	1907
11	0
12	49656
June 95	3791
2	17267
3	0
4	3693
5	1913
6	4728
7	4800
8	3843
9	10500
10	11807
11	5850
12	8283

Product description: Cusson's shipments of IL Bath 125G

Month	Dozons
June 94	47280
2	22860
3	62382
4	28437
5	26100
6	10320
7	18700
8	8280
9	40020
10	36328
11	34820
12	10200
June 95	67446
2	24180
3	26094
4	65104
5	24024
6	22830
7	29502
8	80154
9	46770
10	52830
11	27780
12	18570

Product description: Cusson's shipments of IL Family 200G

Month	Dozons
June 94	35232
2	26412
3	29880
4	7550
5	14056
6	8999
7	14490
8	13400
9	2010
10	41781
11	11851
12	9928
June 95	30290
2	30878
3	7300
4	35830
5	33248
6	11484
7	32304
8	17680
9	13963
10	32420
11	7200
12	16434