THESIS
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A RESEARCH ON THE INVENTORY CONTROL PROBLEMS OF SÜMERBANK WOOLEN FABRICS

By

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CHAPTER I

INTRODUCTION

Sümerbank is an Economic State Enterprise which was founded in 1933 with an initial capital of T.L. 20,000,000. At that time, the total number of production units under Sümerbank were only four, namely:

Feshane Woolen Textile plant,

Hereke Woolen Textile plant,

Bakırköy Cotton Textile plant, and

Beykoz Leather and Shoe factory.

Between 1933 and 1967, rapid expansion was realized and now there are twenty plants specialized in the fields of textiles and chemicals and a Purchases and Sales Institution within the Sümerbank mechanism. The total capital reached T.L. 100,000,000 by 1939, T.L. 150,000,000 by 1942, T.L. 200,000,000 by 1946, and T.L. 500,000,000 by 1955.

Let us briefly review the Sümerbank institutions and their capital positions:

1. Sümerbank Purchases and Sales Institution
   Capital = T.L. 150,000,000

2. Sümerbank Cotton Textile Institutions:

   a) Bakırköy Cotton Textile plant
      Capital = T.L. 20,000,000

b) Ereğli Cotton Textile plant
Capital = T.L. 14,000,000

c) Kayseri Cotton Textile plant
Capital = T.L. 18,000,000

d) Malatya Cotton Textile plant
Capital = T.L. 30,000,000

e) İzmir Cotton Textile plant
Capital = T.L. 40,000,000

f) Nazilli Plant Capital = T.L. 26,000,000

g) Çırçır Plant Capital = T.L. 20,000,000

3. Sümerbank Woolen Textile Institutions:

a) Merinos Woolen Textile plant
Capital = T.L. 40,000,000

b) Sümerbank Woolen Textile Institution
Capital = T.L. 43,000,000

i. Bünyan plant

ii. Defterdar plant (Former Feshane)

iii. Diyarbakır plant

iv. Hereke plant

v. Isparta plant

4. Sümerbank Chemical Industries:

a) Beykoz Leather and Shoe factory
Capital = T.L. 12,000,000

b) Gemlik Viscose Products plant
Capital = T.L. 10,000,000

c) Filyos Fire Brick plant
Capital = T.L. 11,000,000

d) Kütahya Ceramics plant
Capital = T.L. 2,500,000

e) Sıvas Cement Industry
Capital = T.L. 17,000,000

f) Yıldız Porcelain Industry
Capital = T.L. 8,000,000

g) Taşköprü Hemp Industry
Capital = T.L. 7,000,000

Besides these, there are 16 new projects included in the five-year plan, which will further the expansion of Sümerbank. Some of the projects have already been partially completed. The total cost associated with these is forecast to be T.L. 584,000,000 by the time all projects are finished.

This brief discussion shows that Sümerbank stands as one of the largest and most-known of Economic State Enterprises in Turkey. One of its basic characteristics is its involvement in many different kinds of production activities such as:

Cotton and Woolen Textile production,

Cotton and Woolen Yarn manufacturing,

Sewing Thread manufacturing,

Leather and Shoe manufacturing,

Chemical Industries, etc.

In selecting the area of research, such a large-scale enterprise was deliberately chosen so that it could be a representative of the problems encountered by many of the public and private sector firms.

The title of this thesis indicates that the second aspect of the research is to investigate inventory control problems, the first aspect being the Sümerbank itself. Inventory control is among the major problem areas in Turkish industries. Many industrial enterprises are faced with the problems of large amounts of money tied up in raw materials, in process and finished good inventories and in spare parts and supplies. The problem becomes more significant when costs of carrying inventories and the high cost of detaining capital in Turkey are considered. It costs approximately T.L. 20 to keep a T.L. 100 worth article in stock for a year.[1] Although in some cases inventory pile-ups are caused by the quota system in Turkey, in many others an efficient inventory control system can free much precious capital from being tied up in the warehouses.

The third aspect of this research is that it has been concentrated on the woolen fabrics of Sümerbank. The purpose in covering the inventory control problems pertaining only to woolen fabrics is to permit analysist of a specialized area in depth rather than conducting a general but superficial analysist. The three aspects of this research are explicit in the title given to it:

"A Research on the Inventory Control Problems of
Sümerbank Woolen Fabrics"

Throughout the thesis, the inventory control problems will be considered as being interrelated with the internal mechanism of Sümerbank. Fo[r] that reason, a systems analysis approach will be used by defining and analyzin[g]

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[1] Ahmet N. Koç and Metin Göker, "Current Problems of Turkish Industry in Production Management and Marketing." Submitted to Turkish Management Association 1966. Unpublished.

the different components of the Sümerbank mechanism and finding the relationships between these and the inventory control function. The analysis will be directed towards the control of aggregate inventory rather than considering each woolen fabric type individually.

Now, let us summarize the planning and organization of the thesis. The introductory chapter is followed by a discussion of the system analysis approach to the inventory control problems and basic principles of the inventory theory are illustrated to prepare the reader for the coming chapters. In a general sense, Chapter II is simply a continuation of the introductory nature of the first one. The basic systematic approach to the problems will start with Chapter III and continue with the rest of the thesis such as:

	Chapter III
1. The definition of the system:	Chapter IV
	Chapter V
2. The analysis and improvement	Chapter VI
of the system :	Chapter VII
	Chapter VIII

It is explicit that Chapters III - V will include a description of the Sümerbank mechanism as it stands today. Chapter III contains a discussion of the level of production in woolen fabrics, the planning phase for production, the selling activities, and the level and seasonality of woolen fabric sales. This part of the thesis is in a way an introduction to the Sümerbank system as it integrates in itself the activities pertaining to producing and selling. Chapter

IV includes a description of the distribution channels, flow of finished goods and of the communication network. The stages involved in flow of information, flow of finished goods and the approximate lead times will be illustrated with diagrams to supplement the information presented. Chapter V contains a discussion of sales forecasting techniques and the stock control mechanism. The functioning of a particular department in Sümerbank Purchases and Sales Institution, namely the statistics department is also described because it is considered as being the heart of information flow and act as the first point of reference in forecasting and control. In this way, these three chapters will give the reader an objective definition of how the system works.

Starting with Chapter VI, the relationships between the system and the inventory control problems will be analyzed. At this stage of the discussion, it will be possible to see that those relationships are actually more complicated than expected. Chapters VI and VII contain an analysis of the origin and nature of the inventory control problems and suggested improvements in the system. The choice on using a systems analysis approach in attacking the problems will prove to be a successful one as the relationships are clarified. The number of Sümerbank producing units are constant for the time being and their production are very close to their capacities. This indicates that the over-all profitability of the enterprise can be increased effectively by achieving improvements in the system. More efficient handling of inventory is followed by higher inventory turnover and more effective use of capital.

Throughout the thesis, in defining and analyzing the problems as in suggesting the possible changes and improvements, the statements on evaluating the system will be supported by factual data. Most of the data on production, sales, level of inventories, lead times and costs associated with inventory carrying is collected from the Statistics Department and the archives of Sümerbank. Another substantial portion of the data and information is obtained from the plants and the different departments in Sümerbank Purchases and Sales Institution by interviewing these separately and most of them a number of times. In any research work, complete information is hard to attain and there are certain aspects of every organization which are intentionally or unintentedly kept secret by the members. At instances where only partial information is available, analysis is based on the limited data available and subjective evaluation is avoided as much as possible.

CHAPTER II

SYSTEMS ANALYSIS AND INVENTORY THEORY

Systems Analysis

The process of systems analysis requires three steps:

1. The definition of the system
2. The analysis of the system's properties
3. Improvement or correction of the system.[1]

The main interest in using a systems analysis is the dynamic properties of the system, rather than its improvement for one point in time, or for one special condition. Before getting into an individual description of the steps involved in the analysis, let us briefly review the terms most commonly used.

The term black box is used to indicate a grouping of detail. A set of operations is assumed to be contained within a boundary, which we are either not privileged to penetrate, or which we choose to draw, so that knowledge about what goes on within the boundary is missing or disregarded. In such a case, we know only what goes into and what comes out of the black box, and must work with these imput-output relationships. These black boxes are called the elements of the system.

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[1]Hertz, D.B. and Eddison, R.T., Progress in Operations Research, Vol. II, John Wiley and Sons, Inc., 1964.

The term transformation refers to the relationship which describes in a predicting manner how the inputs to a black box are related to its outputs. The black box transformation may be simple, or complex, depending on the number and kind of operations within the black box boundary.

The terms flow, relationship, transaction, and connection are used to indicate what is known about the structure, or pattern of the system; that is, how the black boxes or elements that make it up are related. Specifically, such terms refer to how the outputs of one black box are coupled to the inputs of the others. The term variable applies to the measure that is made of the inputs and the outputs to the black boxes in the system.

It should be clear that the difficulty in discussing "systems analysis" is that the definition of any system chosen for study is completely arbitrary. Any real physical operation contains an infinite number of possible systems, depending on the viewpoint and level of detail chosen to be included in the analysis.

Systems Definition

In defining the system, search, and learning programs, the design of paperwork and communication systems, and similar applications require a method for organizing the detail as well as the structure of the system. The procedure required to define the system in each case is similar, although the mechanics, level of detail, and exact method of displaying the defined system will differ in each case. The elements chosen for analysis may be groups of workers, banks of machines, departments in a factory, factories in a distribution network, or industries in the economy, depending on the level of the study. The machines of system definition follow:

a) Selection of the elements,

b) Selection of the relevant connections,

c) An assembly of the data into a pattern.

With a system roughly defined, the next step is improving the definition within the boundary. In most cases, this consists of defining more exactly the transformation that each element makes in the flows that pass to and from it. In cases where it is possible to develop formal transformations for each element and connection in the defined system, the objective of writing a transformation for the total defined system can usually be carried out analytically.

Systems Analysis

Methods of systems analysis can be broken down into outside and inside tests.

In the outside tests, the system is viewed as a black box and the relationship between inputs to the box and outputs from it, that is, the system response is sought for a wide range of input conditions.

With the inside tests, the structure of the system is examined for completeness, consistency, and correctness of transformation at each element.

Frequently, inside and outside tests are combined, so that a knowledge of system structure and internal operation can suggest critical response tests or a sequence of input conditions that will isolate defective or malfunctioning elements.

The most general of outside tests is the response test which is performed on a completely unknown black box. In this case, a random series of inputs is as good as any other, and the most that can be learned about the box is what can be gathered from observation of a history of input - output pairs. When system structure is totally or partially known, the response test can be used to check the internal operation of the system, so alterations in element transformations, changes in assumed conditions, and possible changes in structure can be detected.

There is a clear danger in dealing with a system of unknown structure, since knowledge of its operation is limited to what can be learned from past history. In such cases, improvements in the system usually require that the structure of the system or the properties of element transformations be changed. So system improvement and control will ultimately require some inside tests to be made.

Tests for continuity and shorts are the first tests usually made on the internal structure of the system. Thus, if a flow is required between two points A and B and that flow is not present or possible, a correction in the system will be required. Frequently such tests can be made by inspection of the flow diagram or matrix of the system under study. Special checks for compatibility, fidelity of coupling, and correctness of element transformation usually follow continuity and short tests. Two elements are compatible if the output of the first is a suitable input for the second. An incompatible input may be caused by an incorrect transformation at a previous element, an incorrectly designed element, or distorted coupling. In testing the correctness of element transformations, the gain or loss of flow at an element and the lag or time delay of flow is checked against a standard value. This is particularly true in feedback control systems. In testing for element overloads, insufficient supplies, or in general for constraints that are present, an inspection of flow rates and timing to known capabilities and requirements is involved.

Several common strategies of testing are in use and provide a framework into which special tests can be set. The first of these strategies is the probability methods which are often the fastest and most common. These are especially useful if a large number of systems of similar type are to be maintained, for example, automobile, television, radio, hardware, medical diagnosis, standard paperwork flow systems, or standard problem types.

Signal training methods are based on the known response of the system and each of its elements to standard inputs. With these methods, a standard input is applied to the system on either a continuous or a periodic basis, and the transformations through the system are checked against element standards. Signal training methods are common in medical practice.

Isolation methods are a variant on the signal training method, with the additional device of splitting the system into logical parts. Successful application of this technique requires that the blocks isolated for testing are independent.

Stress methods are often used where malfunctioning of the system is erratic or intermittent. In this case, a couplingor element may not be defective at all times, but fails under stress or under a specialized sequence of inputs.

In summary, methods of systems analysis are questioning techniques, and the more that is known about the structure of the system under study, the more efficient this questioning process can be.

Systems Improvement

Improvements in the system require a change in the structure or transformation properties of the system elements. In addition, the type of change required often rests as a starting point on information obtained from an analysis of a presently described system. Methods for defining and analyzing systems were the subject of our previous discussion. At this point, several system improvement strategies will be considered.

In most cases, these strategies are based on the fact that the analyst must approach a new problem with an awareness of the complexity confronting him. His subsequent strategies of improvement usually follow from the initial observation. This is particularly true when dealing with large scale systems. With large scale systems the only method of attack that is usually feasible is to use presently available physical constraints and introduce artificial boundaries to cut the variety in the system to the ability of the controller. Frequently, the most effective strategy is to look for a critical constraint to be introduced or exploited, or to convert a present bothersome constraint into an advantage.

In most cases small scale modifications will have no effect on the overall operations of the system unless the minor modifications made are critical to the system's operation. Thus, if a change is to be made, it either has to be big enough to get above the noise level of the system, or must treat an element or connection that will produce the same effect. The control of the solution is easier when the variety of changes is less. By dealing with classes, rather than more detail, the operation of a system can often be stabilized, control gained and consequent improvement achieved.

In some cases, structure values and goals for use in response to different input conditions will both reduce the amount of variety that must be controlled for a given input condition and at the same time provide additional flexibility for the system to use in countering long-range variety. Similarly by goal and value changes, otherwise separate operations can be integrated, the priority of operations changed, and measures of effectiveness changed without having to deal directly with the total variety of the system.

The systems analyst can obviously use any combination of strategies to improve a given system. So, for work in a specific field, a compilation of specific strategies can be a valuable tool for the systems analyst.

Inventory Theory

This section of the chapter includes topics such as:

Why are inventories needed?

The nature of inventory problems.

Inventory costs, and

The objectives of carrying inventories.

Special emphasis will be put on the discussion of inventory costs. At this point it should be remembered that each specific cost arises in some kinds of inventory problems but generally not all the various costs will be simultaneously relevant to any single inventory problem.

Why Are Inventories Needed?

There is an optimum level of investment for any asset, whether it be cash, physical plant or inventories. For every asset class, then, the optimum investment which, when considered with optimum levels in other asset classes, helps to maximize long-run profits. If production and delivery of goods were instantaneous, there would be no need for inventories except as a hedge against price changes. But the manufacturing and merchandising processes do not function quickly enough to avoid the need for having inventories. Inventories must be maintained so that the customer may be serviced immediately, or at least quickly enough so that he does not turn to another source of supply. In turn, production operations cannot flow smoothly without having inventories of work in process, direct materials, finished parts, and supplies.

Inventories are cushions

a) to absorb planning errors and unforeseen fluctuations in supply and demand;

b) to facilitate smooth production and marketing operations.[1]

Furthermore, inventories help isolate or minimize the interdependence of each part of the organization so that each may work more effectively.

Inventory Problems

After this brief discussion of why inventories are needed, let us turn to the question of what inventory means. The word inventory immediately brings to mind a stock of some kind of physical commodity. Therefore, it follows that inventory theory deals with the determination of optimal procedures for procuring stocks of commotities to meet future demand. It is clear that all inventories do have economic value. Here it is possible to introduce a definition by Fred Hanssman: "An inventory is an idle resource of any kind, provided that such resource has economic value."[2] Inventory theory, then, deals with the determination of the optimal level of such an idle resource. The element of futurity is implicit in the definition since an idle resource resulting

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[1]Horngren T. Charles, Cost Accounting, New Jersey: Prentice Hall, Inc., 1962.

[2]Fred Hanssman, Progress in Operations Research, New York: John Wiley and Sons, Inc., 1961.

from a past decision represents a sunk cost for future decisions.

This definition calls attention to two aspects of the inventory problem:

1. Procurement of the commodity in question;

2. The future demand.

The differences among inventory problems can be illustrated in a number of ways:

First is the knowledge of demand. Actually, in very few business cases the future demand may be known exactly. This very rare case of knowing the future demand exactly is considered as a problem under certainty. On the other extreme, management may be entirely ignorant of the likelihood of various levels of future demand. Total ignorance is probably just as rare as complete certainty. In a great majority of actual business problems, only partial information is available. Such information is likely to be available if the item in question is one for which records of past demand are available. Still another aspect of future demand is that demand level may be fixed over time or it may vary. If the demand distribution varies with time, then it becomes much more difficult to obtain readily usable results.

Secondly, there is some time lag between the time when an order is placed and the time when the commodity in question is actually received in inventory. For some kinds of inventory problems this time lag is constant and for others it varies. This distinction has important consequences in the analysis of the problem. The second difference results from the fact that som companies order the commodity in question from an outside supplier while other companies produce the commodity themselves. If the commodity is self-supplied, the usual situation is that one part of the company orders the commodity from another part of the company. The problem of a self-supplying company is likely to be considerably more complex than that of the company which is supplied from the outside.

The third difference between various inventory problems arises because some inventory decisions are essentially made only once whereas other inventory decisions are simply steps in a continuing process of such decisions. In the continuing process the outcome of one decision has an immediate effect on the subsequent decisions and it is necessary to take this effect into account. This case of a repetitive decision process is called a dynamic problem.[1]

Inventory Costs

In any inventory problem, there exists opposing costs, and the first step of the analysis is to determine what the costs are and then, if possible, to measure them. The usual objective will be the minimization of the total costs involved, not simply a minimization of one or the other of the opposing costs. The total costs include all of the relevant costs. Here, we come to the question of what relevant costs are.

The first major class of costs is the procurement costs. The procurement costs are distinguished as ordering cost when outside suppliers are

[1] M. K. Starr and D. W. Miller, Inventory Control, New Jersey: Prentice-Hall Inc., 1962.

involved, and set-up cost when the commodity is self-supplied. The ordering costs include all those cost components which result from the processing of an order.

The self-suppliers procurement costs are called set-up costs. Set-up cost refers to the cost of changing over the production process to produce the ordered item. This entails time lost for the production process and involves an associated cost which can usually be determined directly from cost accounting records. Set-up cost includes all of the cost components associated with one order for the given item. If the company has a continuous production line then costs result from varying the production level – the cost of hiring and firing, training, and so forth.

The second major class of costs are called the stockage costs which include the costs of carrying and of not carrying inventory. The costs of carrying include a number of components such as:

1. The cost of the money tied up in the inventory. The amount of money invested in the inventory could be utilized elsewhere to earn some kind of return. Since it is tied up in inventory, it is not available and this fact requires that a cost be assigned to reflect lost earning power. Cost of capital invested in inventory is the product of factors such as:

   a) The capital value of a unit in inventory;

   b) the time a unit of product is in inventory; and

   c) the imputed interest rate placed against each unit of invested cash.

2. Storage costs. The space required to store the inventory of the given item usually has a cost associated with it. This kind of cost also depends on whether there is an alternative use for the space in question or not.

3. Deterioration costs. Many kinds of commodities and items deteriorate in value during storage. Inventory obsolescence and spoilage costs arise from:

   a) Outright spoilage after more or less a fixed period;

   b) risk that a particular product will become technologically unsalable or go out of style or simply spoil.

   Therefore, loss in value of the inventory represents a cost which must be assigned to carrying inventory.

4. Insurance costs. Since many inventories require insurance, it is necessary to include this cost in the cost of carrying inventory. This is equally true whether outside insurance is carried or the inventories are self-insured.

One common feature of all carrying costs is that they increase as the amount stored increases.

A second kind of cost associated with carrying inventory results when there is stock left on hand after the demand for the item has terminated. This is called the overstock cost which is one of the major headaches of the management concerning inventory control. Overstock costs deserve special attention when:

Production is leveled and the demand is limited to a certain period of the year.

Demand is leveled but production is limited to a certain period of the year because of the unavailability of raw materials and spare parts at other times of the year.

The cost of not carrying inventory is called the out-of-stock cost. There are two variants of this cost, depending on the reaction of the prospc-tive customer to the out-of-stock situation. If the company is out of stock when an order is received it will institute an unergency expediting procedure to get some stock. This situation is called a back-order. The sale to the customer will not be lost, only a delay of a few days in shipment. But, as a result of out of stock situation, there will be additional costs, such as:

Special handling costs

Special purchasing and shipping costs

The cost of expediting

The other kind of case occurs when the sales is lost. The customer simply goes to a competitive supplier which has the item in stock. This is considered to result in a cost; the loss of customer goodwill. An important objective in most production planning and inventory control systems is the maintenance of reasonable customer service which may lead to loss of customers and their sales, if not considered seriously. Investment in in-ventories is not riskless but so is loss of cutomer goodwill and sales. Profi-tability of the enterprise increases upon the achievement and maintenance of an effective control system which balances and minimizes the total relevant opposing costs.

In practice, some of these relevant costs may be adequately determined directly from cost accounting records. In other cases, one has to rely on executive opinion. If nothing better is available, although the estimate may not be correct, it at least has the merit that the resulting inventory decisions would be in accord with the opinions of the executive. The typical inventory analysis is not overly sensitive to reasonable errors in the measurement of costs. Nonetheless, it is precisely in those areas where cost accounting information is most readily available that inventory theory has been most successfully applied.

SUMMARY OF COSTS

- RELEVANT COSTS
  - Procurement Costs
    - Ordering Cost
    - Set-Up Cost
  - Stockage Costs
    - Cost of Carrying
      - Cost of Money Tied Up in the Inventory
      - Storage Costs
      - Deterioration Costs
      - Insurance Costs
      - Overstock Costs
    - Cost of not Carrying Enough Inventory
      - Back Order Cost
      - Loss of Customer Goodwill

The Objectives of Carrying Inventory

What are the major purposes which the inventories serve? Kenneth Arrow classifies the purposes into three kinds, suggested by Keynes as the motives for holding stocks of cash:[1]

1. transaction;
2. precautionary, and
3. speculative motives.

The transaction motive results from the fact that it is not generally possible even in the case of certainty to synchronize perfectly the inflow and outflow of the commodity in question. Inventories are therefore held in order to compensate for the lack of synchronization. The precautionary motive results from the usual inability to predict demand exactly, and the consequent need to maintain some kind of a safety allowance. This motive will only operate as a result of the inability to obtain instantaneous delivery of commodities, at least without extra costs. The speculative motive results when prices are rising or when there are expected changes in costs. Under these circumstances profits may be made by holding inventories at the lower price until the higher price is obtained.

Actual inventory on hand is the sum of amount carried to meet average demand and the amount carried as anticipation and fluctuation stocks.

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[1]Arrow, Karlin, Scarf, Studies in the Mathematical Theory of Inventory and Production, California: Stanford University Press, 1958.

Anticipation stocks are most commonly needed when sales are highly seasonal. Management must balance the risks of not having enough stock to meet demand, and lose profit against the risks of having too much on hand and consequently incurring obsolescence loss or storage expense until the next selling season. Fluctuation stocks are held to cushion the shocks arising basically from unpredictable fluctuations in consumer demand. The concept of anticipation and fluctuation stocks may very well lead the way to excess amount of inventories that result from forecasting errors. This is purely related to the internal factors such as false assumptions that lead to an overestimation of consumer demand and inefficient communication system and information flow within the management area. Communications is bound to have an important impact upon inventory problems.

Inventory Control Problem in Sümerbank and the Application of Systems Analysis

Three factors complicate the management of woolen fabric inventories in Sümerbank:

1. Woolen fabrics are characterized by rapid product obsolescence
2. Seasonality
3. Lead times involved

Seasonality and obsolescence characterize particularly those product lines which serve the garment industry. In the more expensive, so-called fancy lines, colors and patterns are dominant factors and furthermore are introduced early in the manufacturing process. If the colors and patterns selected for inventory anticipation are improperly chosen, and a sizable amount of goods is left unsold after the end of the normal selling season, these must be disposed of through distress sale, often at an out of pocket cost.

> "The woolen fabrics remaining unsold at the end of the normal selling season will be disposed of through distress sale before undergoing spoilage or obsolescence and before having increased costs due to the rate of interest on the capital tied up."[1]

The costs involved in carrying inventory at the end of the normal selling season are the ones which have been discussed under carrying costs, namely:

1. Cost of money tied up in the inventory;
2. storage costs;
3. deterioration costs;
4. insurance costs, and
5. overstock costs.

All of these costs have been discussed in the earlier section, and it is worth repeating that they increase as the amount stored and the length of time they are in storage increase. An increase of this kind in the carrying costs simply has the effect of wiping out to some extent the season's profit on the sale of woolen fabrics. Since any overstock of the fashion items typically undergo a drastic devalutation after the normal selling season, the objective

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[1] Minute 4(e) from İzmir Term Meeting of Sümerbank, September 14-17, 1964.

of the system should be to control the total rate of production of the key facilities and to indicate the proper allocation of available capacity in plants to different fabrics, patterns, and colors during the production period. It should be clear that the main problem is with those types that are on their way to losing their marketability and sales potential. Therefore, this aspect of the problem is directly related with the degree of flexibility in the plants and the extent to which adjustments can be made in the production schedule during the year.

The second aspect of the problem is associated with the seasonal inventory anticipation. Any deviation between the forecast sales and the actual demand is absorbed in inventory. In any industry with a seasonal sales pattern, forecasts should include adjustments based on past and current experience. One thing that has been noticed in Sümerbank is the lack of a model which will automate such adjustments. Sales forecasts should enable management to evaluate the necessity for cutting back on existing production rates when no additional production can be scheduled without its resulting in any inventory with negative net expected profit. Conversely, certain classes of fabrics may be taken out of the line when more profitable sales are predicted on others in sufficient quantities to make it unnecessary to continue the less profitable items. It has also been noticed in Sümerbank that the stocks of woolen fabrics are equivalent to about five months' sales averaged through the year. Inventory turnover ratios for the years 1964 and 1965 were found to be 2.26 and 2.49 respectively.[1] Part of these stocks are due to the

[1] These figures are to be developed at the end of Chapter V.

perfectly seasonal nature of sales, but the rest to the obsolescence of certain types. It is believed that by developing reasonably accurate sales forecasts and by specifying the manner in which current production should be allocated to individual patterns and colors, it will be possible to maintain the same level of sales through a lower investment in the finished goods inventories. Large inventories drain off cash which could be used to make a profit and inventory investment gets non-liquid and risky especially for those types that are fashion items and have higher chance of getting obsolete. Therefore, the problem of Sümerbank can be defined as:

1. Risks associated with inventory obsolescence
2. Price declines that result from 1.
3. Tying up capital in hard to move inventories that restrict the turnover

So far nothing has been said about the third factor that complicate the management of woolen fabric inventories, namely, the lead times involved. In actual business situations, movement inventory is a factor of the average sales rate and the transit time to move goods from the plant to the individual retail outlets. The amount of movement inventory needed is given by the simple equation

$$I = S \times T \quad \text{where}$$

I = Movement inventory needed

S = Average sales rate

T = Transit time to move materials from the plants to the retail outlets.

The amount of movement stock changes only when sales or the time in transit is changed. Time in transit is largely a result of the methods of:

a) Communication, and

b) transportation.

It is observed that in Sümerbank, the lead time (time that elapses between realizing the need for inventories and their actual reception) is characterized by its length. Assuming the average sales rate remains constant, any increase in the lead or the transit time results in a rise in the quantity of movement inventory needed. It is explicit that one way of keeping the level of stocks low is to shorten the lead time and the correct way of attacking the problem is to improve the methods and systems of communication and transportation.

Now, let us consider the structure of the inventory problem of Sümerbank and let us consider demand first. Obviously, some specific level of demand will eventuate at any given point in time. But at the time the inventory decision must be reached the important question is what do we know about the level of future demand. Knowing exactly what the future demand will be is not a very frequent case. For Sümerbank woolen fabrics, entire ignorance of the likelyhood of various levels of future demand is equally unlikely. The problem, therefore, is that of one under risk.

Secondly, the goods are not supplied from an outside supplier but they are produced and sold by the Sümerbank enterprise itself. This has a major effect on the analysis of the inventory problem because the self-supplying company must consider the effect of its ordering policies not only on the inventory situation but also on the production process.

Finally, it can be summarized briefly that the problem is that of a dynamic one where any inventory decision can be conceptualized as one in a series of similar decisions. The demand distribution varies over time in a seasonal fashion. The inventory problems can be differentiated as to mutiple retail outlets with and without central ordering and the Sümerbank mechanism is one with central ordering. Multiple-items of woolen goods are ordered from a coordinator inside the mechanism, which will be subject to discussion in the coming chapters.

The nature of inventory control problems in Sümerbank and their dependence on the three factors mentioned earlier in the section leads us to consider several aspects of the system in relation to better management of inventories. Different parts of the entire Sümerbank mechanism cannot be visualized as being independent of each other. For this reason, a systems analysis approach is used and the connections among production processes, forecasting methods, communication and transportation systems and the inventory control mechanism are analyzed to reach ~~at~~ a feasible solution to the problem. Systems analysis provides a means for investigating whole systems and integrated procedures, and this is what is actually needed in our special case. It is fair to say that the rapid growth in the use of this approach for inventory studies can be attributed to the advantages of designing inventory procedures which could be handled by a computer. However, the importance of systems theory to inventory analysis should not be predicted on the use of a computer. The benefits which can be derived even when electronic data processing (EDP) is not involved are substantial. The method will begin at first with overall system view and then it will be possible to move into finer detail. The approach in systems analysis can best be defined by the word systematic.

There are problems in which the entire system must be viewed as a whole in order to proceed meaningfully with the analysis. Inventory control problems of Sümerbank are of this type. However, it should be kept in mind that rationality operates within the framework of a simplified model of a real situation. Intuition and judgement can help to eliminate some details which would be a waste of time and in the long-run no solution is free from premises and assumptions.

SECTION I

CHAPTER III

SÜMERBANK AS A PRODUCING AND SELLING UNIT

Sümerbank is an Economic State Enterprise which integrates in itself the activities pertaining to programming production, executing production, marketing, distributing, and selling the finished goods and the controlling function that follows. As a consequence of the above mechanism, the problems that come up during the course of the mentioned activities are numerous, varied and interrelated. In this chapter, our main concern will be the production and selling activities of Sümerbank and this will be in a way an introduction to the Sümerbank mechanism as a producing and selling unit. The analysis, to be consistent with the rest of the research, is concentrated on the woolen textile finished goods.

Sümerbank Production

Sümerbank textile production can be classified into the following main groups of activities:

1. Cotton thread production
2. Cotton cloth production
3. Woolen stuff production
4. Woolen yarn production

5. Artificial silk production

6. Sewing thread production

Here our main concern will be the woolen cloth production.

Both cotton and woolen cloth are produced in Sümerbank plants which are scattered over different districts of Turkey. The plants are called by the city names in which they are located. The total of Sümerbank producing units in textile industry is 16 where some of the plants produce cotton textiles and some produce woolen textiles. Cotton textile production is done in the following plants:

Adana

Bakırköy

Ereğli

Kayseri

Malatya

Nazilli

İzmir

Erzincan

where Kayseri and İzmir plants produce nearly half of the total cotton textile production of Sümerbank.

Cotton thread production is carried out in:

Bakırköy

Denizli

Erzincan

İzmir

Kayseri

Ereğli

plants and 76 percent of the total cotton thread production of Sümerbank is provided by the Bakırköy and Denizli plants. During 1966, Adana and Malatya plants also started to produce cotton thread and by the end of November, the production of the two factories reached a figure of 156,819 Kgm.

To give a general idea about the capacity of cotton textile producing plants of Sümerbank it is possible to say that the total programmed production for 1966 was:

175,401,200 meters for cotton clothes

5,236,404 Kgr. for cotton thread

Woolen textile production is carried out in the following Sümerbank plants:

Bünyan

Defterdar

Dıyarbakır

Hereke

Merinos

To get an idea of the production capacities of these different producing units of Sümerbank, yearly production program for 1966 will be illustrated in Table I.

TABLE I

WOOLEN CLOTH PRODUCTION PROGRAM FOR 1966

Name of Plant	1966 Production Program
Bünyan	223,000 metres
Defterdar	1,412,000
Diyarbakır	325,000
Hereke	900,000
Merinos (Bursa)	1,308,000
Total	4,168,000

The yearly program for 1966 indicates that two-thirds of the total woolen cloth production of Sümerbank is accomplished by Defterdar and Merinos plants. In addition to the approximate 1,300,000 metres of woolen stuff production, Merinos also produces 50,000 Kgm. of woolen yarn which constitutes the total of Sümerbank woolen yarn production.

Isparta plant was programmed to produce 40,000 m^2 of carpet during 1966 which is followed by Hereke programmed to produce 750 m^2 of carpet, the total programmed production being 40,750 m^2.

The above figures are illustrated to give an idea about the number and locations of Sümerbank textile producing units and their respective production programs and capacities.

Planning for Production

Planning the production program for the coming year is begun in

September through the coordination of individual producing units and the Sümerbank Purchase and Sales Institute. Sümerbank Purchase and Sales Institute, abbreviated in Turkish as "Sümerbank ASM" is an independent unit in staff relationship with the plants. Information from selling and producing units are collected, classified, evaluated and distributed back in the form of production programs, sales forecasts and instructions for the shipment of finished goods from the factory warehouses to the sales outlets. Production, workforce and raw materials purchase planning for the coming year is made between September and December. After the preparation of the production program for the coming year, it is the policy of producing units to follow it as closely as possible. Production during winter months are programmed to be concentrated on textiles that sell during summer months and vice versa. This is mainly a policy to make it possible to supply the customers with summer textiles during early summer months like April and May. For example, Merinos is programmed to produce woolen yarn starting in October, concentrate on the production of summer woolen cloth during early months of the year so that goods will be ready for sale by April.

In planning for next year's production, sales trend for the previous years and finished goods inventory at hand are important considerations. During the course of the year, small changes in the production program are likely to occur as a result of:

1. Special orders from Sümerbank ASM which reflect changes in consumer demand for certain types of textiles.

2. Increasing stocks of certain types both in the factory warehouses and in individual retail outlets. This is an indication of the deterioration in the marketability and a decline in consumer acceptance for those types.

Information on sales and stock levels of woolen textiles, and cotton textiles as well, are collected and evaluated in "Sümerbank ASM" which gives the necessary instructions to the individual producing units on whether to speed up or slow down the production of types that show divergence from the forecasted demand. Individual plants try to avoid a high level of finished goods inventory in their warehouses which cuts down the profitability of the Sümerbank Enterprise as a whole. The dangerous thing here is to have large stocks of finished goods at hand which do not have any sales potential and marketability.

Woolen cloth production is planned to be concentrated on two types of stuff. The first type is produced by Merinos under the commercial name of "Kamgarn" (worsted) in Turkish. The fleece of wool used in the production is 100 percent Merinos and Australian, and the threads are fine. The resultant woolen product is high in quality and expensive compared to the second type.

The second type is called "Woollen" commercially. The threads are not so fine as the first type and domestic wool is used in the production. The fibers are also not as smooth as the Merinos production and naturally this second type is cheaper in price. This type of production is done mainly in Hereke plant.

Defterdar plant produces a mixture of the two fibers and in this way the cost is lowered and the product is made suitable especially for summer and winter overcoats.

In planning for production, first the quantity to be produced of each type is determined and then each type is colored and patterned individually. Quantity to be produced of each type is determined through the coordination of factories with the "Sümerbank ASM" and the resultant production program is submitted to the Head Office in Ankara for approval. Design and coloring of the different types are done by the people in the factory. It is not uncommon practice to send authorized people to fairs to follow the changes and most recent trends in consumer taste. Any kind of special orders from foreign markets does not necessitate the coordination of "ASM" with the plants because orders come directly to the producing units, and it is within the authority of factories to plan for the production of it. This kind of orders from outside markets come usually to Merinos which produces the highest quality woolen cloth.

Leveling the Production

As the over-all production schedule for the coming year is determined, the production is allocated equally to the different months of the year. There is an apparent leveling of production for all Sümerbank textile factories and the situation is more so for plants producing woolen textiles. Changes in production rates among different months and different seasons are avoided in the production program. This will be clearly illustrated in Table II.

TABLE II

PROGRAMMED PRODUCTION IN METERS FOR THE YEAR 1966 IN WOOLEN TEXTILES FOR ALL SÜMERBANK PLANTS

Name of Factory	Annual Production	Monthly Production
Bünyan	223,000	18,583
Defterdary	1,412,000	117,667
Diyarbakır	325,000	27,083
Hereke	900,900	75,075
Merinos	1,308,000	109,000
TOTAL	4,168,900 meters	347,408 meters

As will be noticed in Table II, each month's share is exactly equal to 1/12 of the total programmed production for the year. Let us make a similar comparison in Table III.

TABLE III

PROGRAMMED AND ACTUAL PRODUCTION OF WOOLEN CLOTH DURING THE FIRST 11 MONTHS OF 1966

Name of Factory	(1) Programmed Production[a] for the First 11 Months	(2) Realized Production[a] for the Same Period	(2)/(1)
Bünyan	204,413 meters	206,208 metres	1.01
Defterdar	1,294,337	1,288,717	1.00
Diyarbakır	297,913	308,553	1.04

TABLE III - Continued

Name of Factory	(1) Programmed Production[a] for the First 11 Months	(2) Realized Production[a] for the Same Period	(2)/(1)
Hereke	825,825	818,507	.99
Merinos	1,199,000	1,312,953	1.10
TOTAL	3,821,448	3,934,943	1.03

[a]Since figures on realized production for the year 1966 were not available by the time of analysis, the first 11 months are taken as the basis of comparison.

Table III indicates that 3,821,448 meters of woolen cloth production were programmed for the first 11 months of 1966 and the actual production was 3,934,943 meters, deviating from the production program by 3 percent. This indicates two things:

1. Sümerbank produces to stock by leveling the production.

2. Woolen textile production of individual plants is almost equivalent to the plant capacities so it is not possible to make drastic changes in the program.

For the present, a further discussion on the topic is avoided because there are still a lot of aspects of the Sümerbank mechanism to be considered before starting the analysis.

Sales of Woolen Textiles

Sales of woolen textiles can be classified into the following main groups:

1. Sales by retail
2. Wholesaling
3. Other sales

What percentage of total sales is sales by retail? By wholesale? By other sales? To get an idea about the retailing, wholesaling and other activities of Sümerbank, Table IV will be illustrated which contains the sales figures both in terms of meters and in terms of Turkish Liras.

TABLE IV

TOTAL SALES OF SÜMERBANK WOOLEN GOODS IN YEARS BETWEEN 1958 - 1965

	1958		1959		1960		1961	
	Millions of m.	Millions T.L.	Millions of m.	Millions T.L.	Millions of m.	Millions T.L.	Millions of m.	Millions T.L.
Wholesale	.504	21,725	.887	41,219	.780	37,217	.754	35,447
Retail	1.693	72,345	1.705	88,941	1.559	86,783	1.591	83,435
Others	1.514	53,876	1.711	65,188	2.477	94,175	1.741	74,446
Total	3.712	147,948	4.303	195,349	4.817	218,176	4.086	193,328

TABLE IV - Continued

	1962		1963		1964		1965	
	Millions of m.	Millions T.L.	Millions of m.	Millions T.L.	Millions of m.	Millions T.L.	Millions of m.	Millions T.L.
Wholesale	.802	38,459	.808	38,389	.841	38,272	.786	40,419
Retail	1.432	82,503	1.428	85,668	1.567	99,335	1.636	109,122
Others	1.785	76,648	2.329	91,076	1.744	75,439	1.819	75,716
TOTAL	4.019	197,611	4.565	215,133	4.153	213,047	4.241	225,258

Taking the extreme cases into account, wholesaling constituted 13.5-20.5 percent of the total sales between the year 1958 through 1965. Similarly sales by retail constituted 30 - 45 percent of the total annual sales between the same two years. Table IV illustrates that the major portion of woolen cloth sales is sales by retail and other sales. Analyzing sales to retail and wholesale components reveal Table V.

TABLE V

PERCENTAGE OF TOTAL ANNUAL SALES

Year	Wholesale	Retail	Other Sales
1958	13.5 %	45.7 %	40.8 %
1959	20.6	39.5	39.9
1960	16.2	32.5	51.3
1961	18.4	39.0	42.6
1962	20.0	35.6	44.4
1963	17.5	31.2	51.3

TABLE V - Continued

Year	Wholesale	Retail	Other Sales
1964	20.2 %	37.7 %	42.1 %
1965	18.6	38.5	42.9

In taking the percentage composition of sales, amount of woolen cloth sold is evaluated in terms of meters because T.L. taken as base can be misleading in the sense that the price of woolen textiles show variations from year to year.

Table V shows that the policy on the sale of woolen textiles remained fairly constant throughout the years.

Now, something has to be said of what is meant by other sales. Other sales include Central sales and official sales. Central sales include sales to other private wholesaling firms but these firms should not be mixed up with wholesalers that work for Sümerbank on a commission basis. Official sales are mainly sales to military organizations and other official state organizations.

An interesting feature of woolen cloth is the employment of instalment sales. This is applied to carpets and woolen cloth. Woolen cloth is sold on instalment basis to government officials, bank officials, chambers of commerce and stock Exchanges. The reasons behind the instalment sales are:

1. To promote sales of woolen stuff.

2. To service the government officials better.

Serving government officials is an important consideration because the prices of woolen cloth are much higher when compared to cotton cloth. The terms of instalment selling are:

Sales up to T.L. 500 on 6-month instalment basis.

Carpets are also sold to government officials on instalment basis and the terms are:

Carpets up to T.L. 1250 on a 12-month instalment basis.

Hereke carpets that are up to T.L. 2500 on a 24-month instalment basis.

Application of instalment selling to the cotton textiles had been discussed in the "Sümerbank Izmir Term Meeting" in September 1964 and "Sümerbank ASM" had been authorized to search out for the possibilities and report back by the end of October 1964. Since there is no instalment selling for cotton textiles at the present, it can be concluded that the attempt had not been successful.

The policy of stressing sales by retail is justified by the Woolen Textile Department of Sümerbank ASM on the basis that sales by retail provide a profit margin around 10-15 percent when compared to 2-5 percent profit margin provided by wholesaling. In the next section, seasonality of woolen cloth sales will be discussed.

Seasonality of Woolen Cloth Sales

In Table VI, the dispersion of total woolen cloth sales throughout the year will be illustrated.

TABLE VI

TOTAL WOOLEN CLOTH SALES IN DIFFERENT MONTHS OF THE YEAR IN MILLIONS OF METERS

	1961	1962	1963	1964	1965	5 Year's Total
January	.208	.217	.434	226	.249	1.334
February	.754	.666	.516	.291	.481	2.708
March	.168	.272	.165	.283	.250	1.138
April	.294	.316	.222	.436	.113	1.381
May	.212	.130	.272	.281	.197	1.092
June	.382	.172	.220	.228	.346	1.348
July	.251	.122	.196	.154	.438	1.161
August	.366	.170	.545	.257	.332	2.070
September	.263	.229	.456	.715	.625	2.288
October	.456	.470	.527	.473	.403	2.329
November	.337	.410	.394	.488	.349	1.978
December	.395	.445	.618	.321	.458	2.237
TOTAL	4.086	4.019	4.565	4.153	4.241	21.064

To get a better picture of the dispersion of sales to months of the year, Table VII will show the distribution on a percentage and index number basis, taking the years 1961 through 1965 into consideration. The percentage figures and index numbers are prepared by taking the 5-year total of different months and dividing the sum into the total woolen cloth sales in five years.

TABLE VII

DISPERSION OF TOTAL WOOLEN CLOTH SALES TO MONTHS BETWEEN 1961 - 65

	% of Annual Sales	Index
January	6.36	76.3
February	12.80	153.5
March	5.40	64.9
April	6.56	78.7
May	5.15	61.7
June	6.40	76.8
July	5.50	66.2
August	9.83	118.0
September	10.90	130.9
October	11.10	133.1
November	9.40	112.8
December	10.60	127.1
	100.00 %	1200.0

Seasonality of Sales

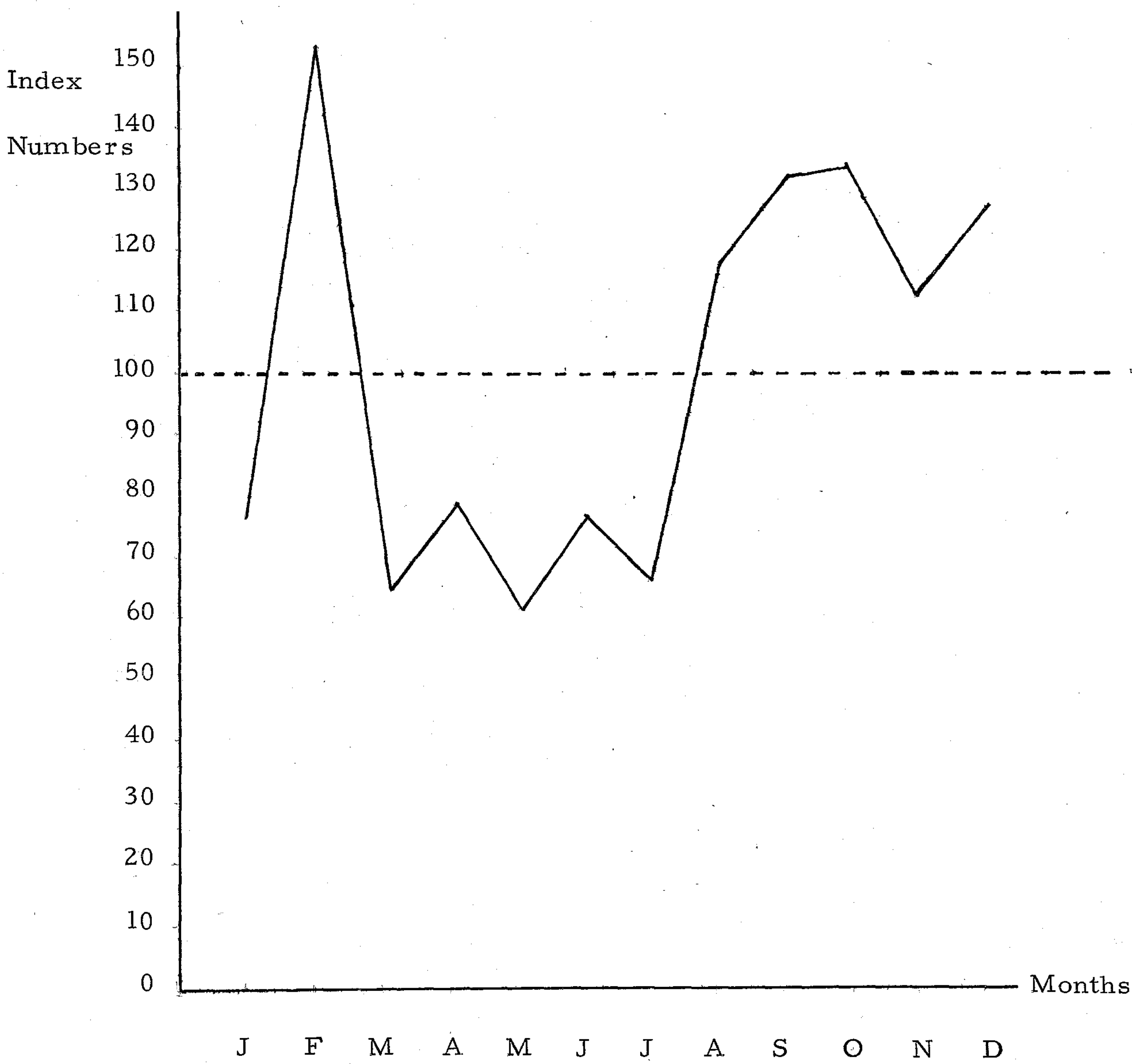


Table VII and the diagram show that sales rise above the monthly average starting in August and continue to do so until January. This is as would be expected for woolen fabrics, however, the one largest peak is in

February. In the years 1961 through 1963, February sales constituted 12-19 percent of the total annual sales.

The leveling of Sümerbank woolen textile production coupled with the seasonality of sales illustrate the problem of inventory pile-ups vividly and this is one of the reasons for the existence of high levels of stocks in the Sümerbank retail outlets and factory warehouses at certain times of the year.

CHAPTER IV

FLOW OF INFORMATION AND GOODS

In this chapter the sales outlets, distribution channels, and the flow of information between the Sümerbank units will be discussed. The reason for including such topics to the research will be more clearly demonstrated as the discussion proceeds. For the present, the argument is that such features of the Sümerbank Enterprise have a direct relationship with the inventory control problems associated with Sümerbank woolen textiles.

Sümerbank Sales Outlets

Sümerbank ASM acts as an advisory and in some cases as an instructive organ in the Sümerbank organization and it has a staff relationship with the individual producing units such as Merinos, Bünyan, Defterdar, etc. There are 165 sales outlets in total under the Sümerbank ASM in line responsibility to it. These 165 outlets are classified in the following way:

Retail Outlet Directorials	3
Main Retail Outlets	22
Inside City Retail Outlets	35
Outside City Retail Outlets	102
Warehouses	3
Total	165

Out of these 165 units, 162 are actually employed in selling activities while the three Retail Outlet Directorials located in Ankara, Izmir and Istanbul are responsible for the management of the rest.

The main Retail Outlets located in 22 different cities have accounting departments and they act as an intermediary between Inside City Retail Outlets and Sümerbank ASM besides being involved in selling activities. In Inside City Retail Outlets, information on sales and stock levels are prepared and sent to the Main Outlet of the city where this information is classified and put into a form presentable to the Sümerbank ASM. Only Outside City Outlets are authorized to get into direct communication with the ASM in Istanbul. The three warehouses are employed only in wholesaling activities.

Main Outlets are responsible for:

1. Determining and securing the needs of the Inside City Retail Outlets
2. Control of function.
3. Collecting and classifying the information on sales and stock levels of these outlets and sending this to the ASM.
4. Acting as sales outlets themselves.

Sümerbank ASM has the authority to contact these individual outlets depending on the importance and urgency of the situation provided that the main outlets are also informed about the case. Any demand made by Inside City Outlets for more finished goods has to pass through the Main Outlet in the city before coming to ASM. This is violated only for exceptional and urgent situations.

Sümerbank ASM is responsible for the establishment of new retail outlets, liquidation of the old ones that prove to be unsatisfactory, finding the necessary buildings to rent, making up the contracts. In opening new outlets, ASM employs local research on:

1. Social environment
2. Geographical environment
3. Population
4. Economical situation
5. Rent and other expenses
6. Daily, monthly, and yearly sales forecasts

In addition to these, local future customers and local businessmen are interviewed.

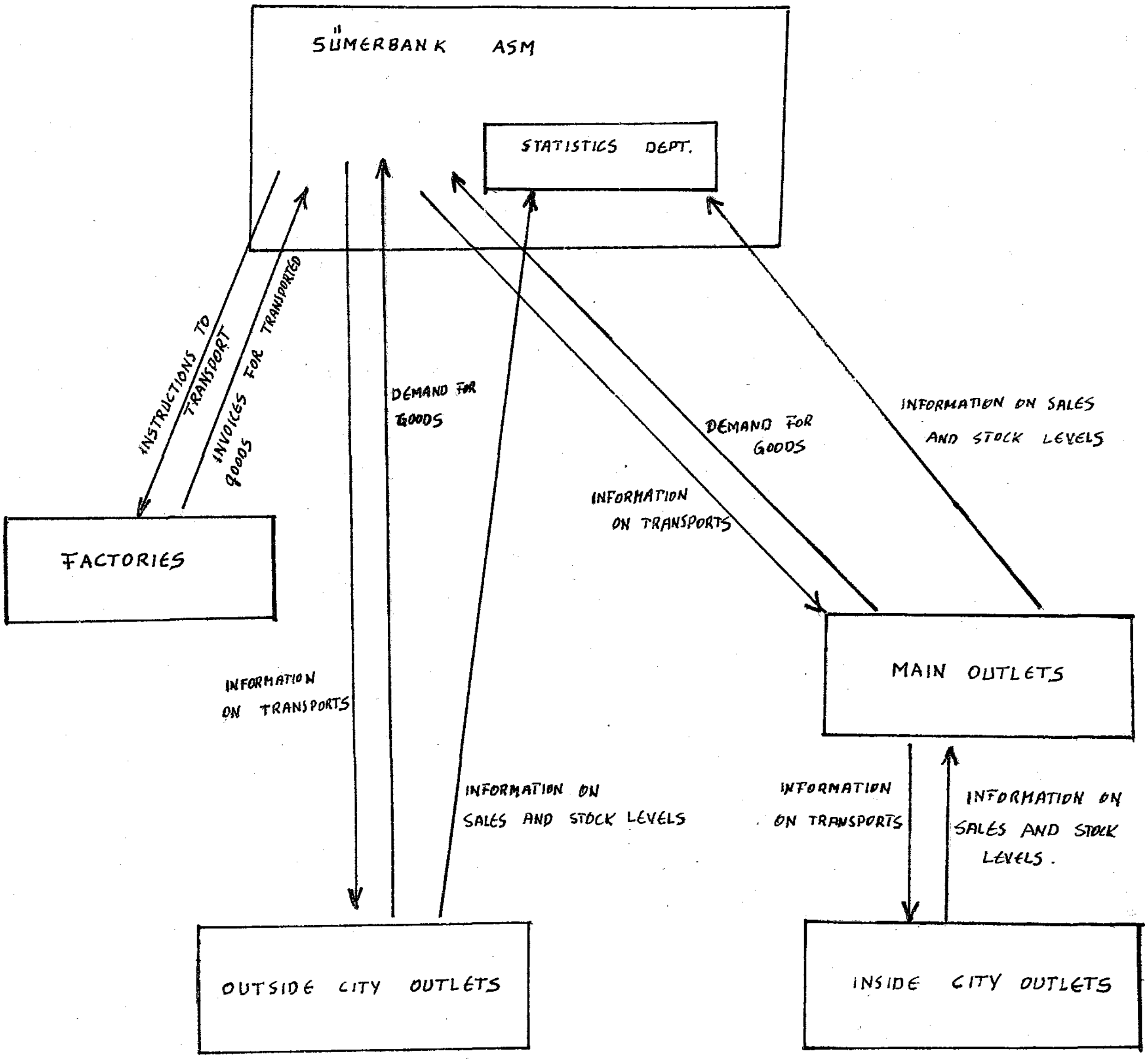
The conclusion reached by ASM people on ~~whether~~ opening a new outlet at a certain location or giving up the project is sent to the Head Office in Ankara. The final decision is always made by the Head Office.

One of the most controversial areas is the liquidation of the old outlets. The main criteria considered by ASM people on deciding such an act is the profitability of the outlet. The Head Office usually acts in favor of keeping the old ones even if they provide little or no profits. The purpose is simply providing better service to the customers. In fact, better customer service is achieved at the expense of foregone profitability. This situation will be discussed further in the coming chapters.

The communication network will be illustrated by a diagram on the next page. The characteristics of the system are indicated as:

CHART I

FLOW OF INFORMATION



1. Outside city outlets, main outlets, and factories can get into direct communication with the Sümerbank ASM in Istanbul.

2. Inside city outlets communicate with the main outlets which act as an intermediary between them and the ASM.

Distribution of Finished Goods

The finished goods are distributed all over Turkey through channels that contain no intermediaries.

Factory Warehouse ⟶ Retail Outlets

The transportation of goods from the factories to the outlets is under the responsibility of "Antalya Nakliyat" which is a well-known Turkish forwarding agency. "Antalya Nakliyat" is committed to handle all the transportation activities between the factories and retail outlets and the contract is usually made for two years. Transportation of finished goods is done mainly by trucks.

The essence of distribution of finished goods to the retail outlets is the following:

Sümerbank ASM gives the necessary instructions to the factories on what type and what quantity to send to each retail outlet. Factories do the necessary preparation and packaging and inform the local agency of "Antalya Nakliyat" that goods are ready for shipment. The trucks take the finished goods from the factory warehouses and transport to retail outlets. Transportation expenses are paid to "Antalya Nakliyat" according to the articles of the contract. The basis of payment is a certain amount of T.L. per Kgm. of finished goods per Km. The number of expeditions done per truck does not affect the payments made by Sümerbank ASM. The price demanded by "Antalya Nakliyat" per Kgm. Km. stays constant throughout the duration of the contract.

Finished woolen goods are distributed to the Sümerbank retail outlets:

1. Upon the demand of individual outlets;
2. upon the instructions given to factories;
3. upon the instructions given personally by authorized people representing the outlets;
4. exceptional transports.

Now, let us describe the mechanism of each of these:

1. Upon the demand of individual retail outlets: Here the outlets send the Woolen Textile Department of ASM a demand paper which contains the following information:

   a) Quantity needed of each type of woolen cloth,

   b) sales realized since the beginning of the calendar year on each type, and

   c) present stock level of each type in the retail outlet.

   This information is evaluated by the Woolen Textile Department of ASM. Every 10 days, people from this department visit the factories and give the necessary instructions to meet the demand of the retail outlets. While giving the instructions, the production schedule and the finished goods inventory at the factory warehouse are also considered. Sometimes it is not possible to satisfy the orders made by outlets, and this problem arises as a result of the production limitations of the factories. If it is not possible to meet the demand of the outlets, the situation is explained, and they are informed that the order had been satisfied only partially. Lead time involved is usually around 20-25 days.

2. Instructions given to the factories by the Woolen Textile Department: These instructions depend on the ten and thirty day reports on sales and stock levels of the retail outlets that are prepared in the Statistics Department of ASM. The Woolen Textile Department evaluates these reports together with the

   a) Production schedule of factories

   b) Finished goods inventory level at the factory warehouses which are reported to the ASM on 7 - 10 day intervals.

This mechanism will be discussed further in Chapter V of this section together with the functioning of the Statistics Department. This is the usual practice of distributing finished goods.

The steps involved are:

i. The Statistics Department receives monthly repords from the retail outlets showing monthly sales and month-end finished goods inventory level of each type.

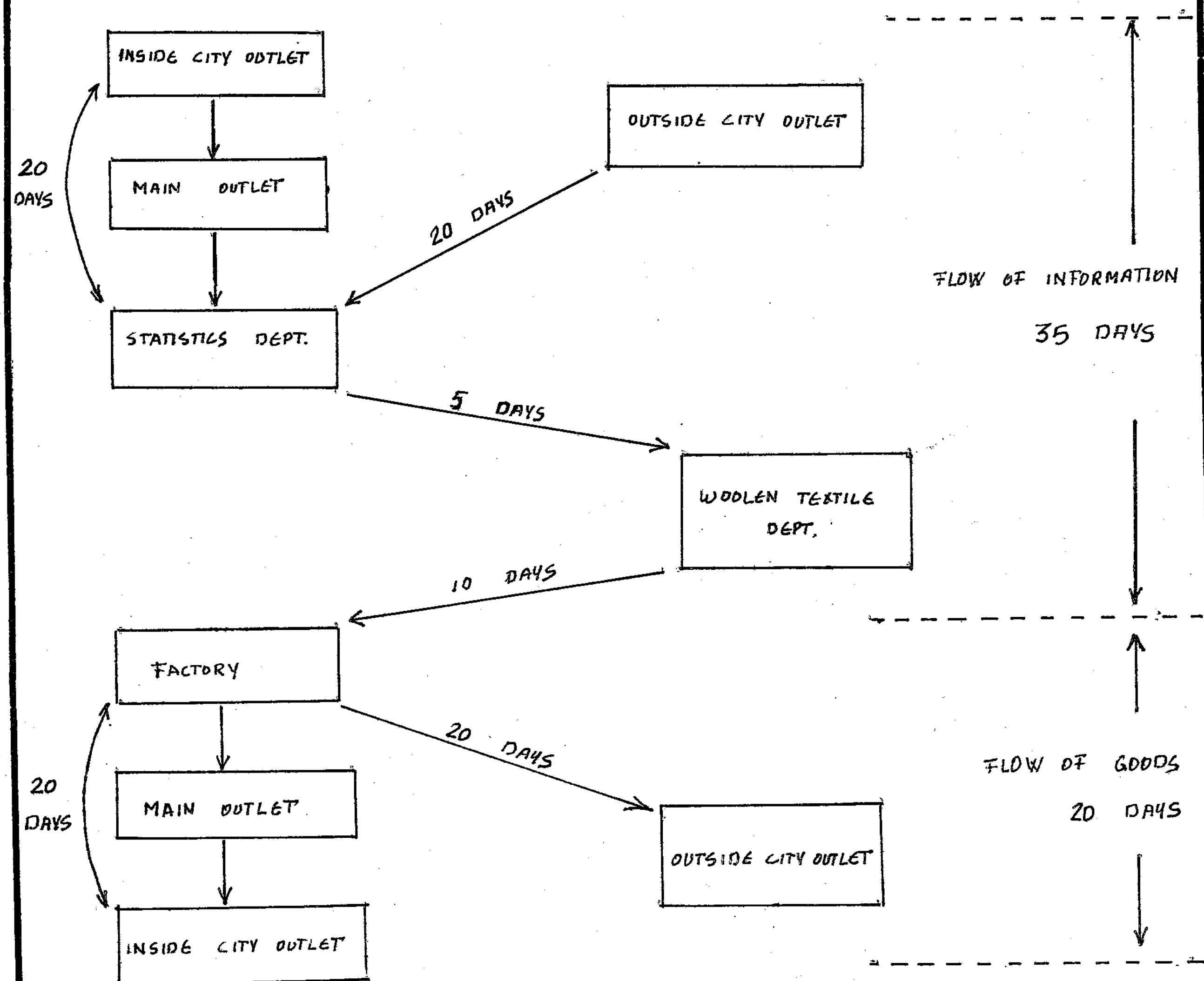
ii. This information is classified and presented to the Woolen Textile Department.

iii. Woolen Textile Department gives the necessary instructions to the factories on the transportation of goods.

iv. Goods are transported from the factory warehouses to the retail outlets.

CHART II

APPROXIMATE LEAD TIME



3. Transport instructions given to the factories by the people from certain retail outlets: According to the circular letter dated 10/22/1962 and numbered as 89/563 the authorized people belonging to retail outlets that can sell in excess of 15000 meters of woolen cloth annually can visit Sümerbank producing plants and order the quantity of each type that they need. Those outlets that sell in excess of 15000 meters can order twice, and those that sell in excess of 20000 meters can order three times a year. Such orders are usually realized in August and September and at the period of religious holidays.

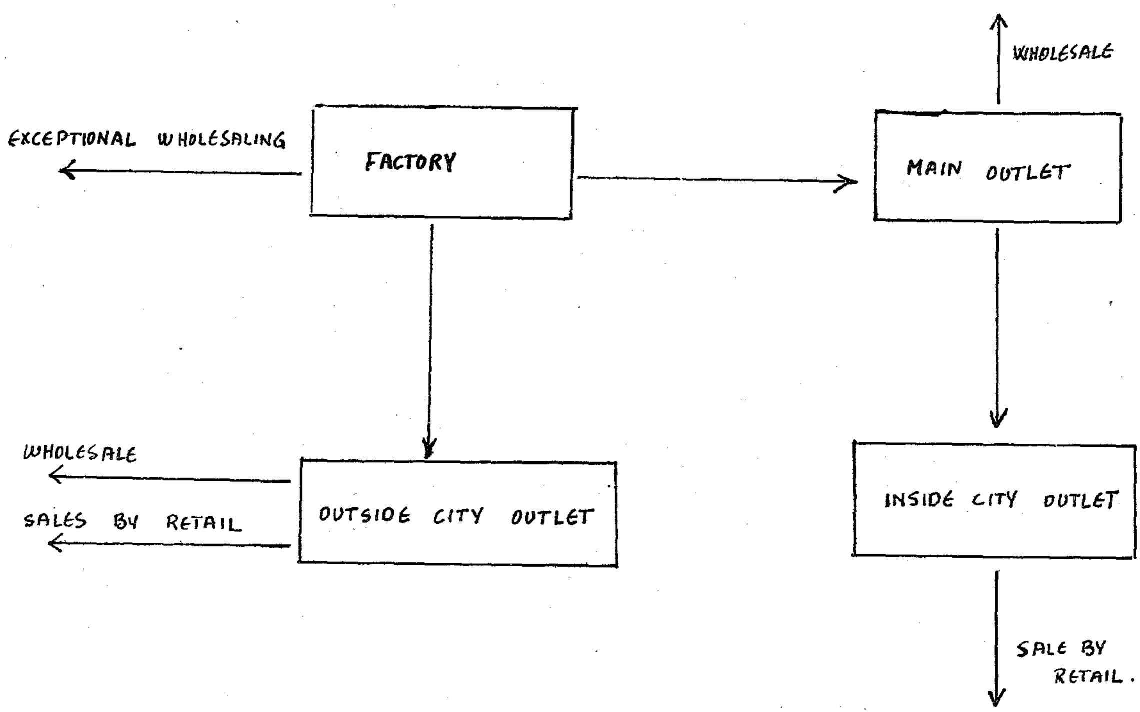
4. Exceptional Transports: Depending on the importance and urgency of the situation some retail outlets can call the Woolen Textile Department and inform it of their immediate needs. The Woolen Textile Department calls the factories and gives the necessary instructions to transport the ordered items. This type of communication is fast but the situation is very exceptional.

In Chart III, the mechanism of flow of finished goods will be shown schematically.

The flow chart shows that finished goods are sold by both wholesaling and by retail at the outside city outlets while inside city retail outlets are employed in sale by retail, leaving wholesaling to the Main Outlet.

CHART III

FLOW OF WOOLEN GOODS



CHAPTER V

SALES FORECASTING AND STOCK CONTROL MECHANISM

This chapter includes a brief discussion of the sales forecasting methods presently employed, the functioning of the Statistics Department of Sümerbank ASM and the nature and level of finished goods inventory in woolen textiles. The reason for including the Statistics Department in the discussion is that it is the heart of the ASM in Istanbul which collects the information from all sales outlets, classifies it, and a great majority of the decisions relevant to sales forecasting and inventory control comes out of this information.

Sales Forecasting

Sales can be forecast for short, medium, and long-term. Among these, short-term sales forecasts of one year is the only projection into the future used in the Sümerbank ASM. In other words, long-range sales forecasts of 5 - 10 years are not favored but demand forecasts for the coming year are considered as being sufficient for the purpose of planning. The Woolen Textile Department prepares sales forecasts for the coming year on performance for September-November of the current year making use of and evaluating the following criteria:

1. Comparison of the forecastst and actually realized sales of the current year.

2. Comparison of the programmed and realized production of Sümerbank plants for the current year.
3. Production capacities of plants that produce woolen cloth.
4. Availability of raw materials and workshop situation in plants which may limit the production.
5. Forecast finished goods inventory at the end of the year to be transferred to the coming year.

It is implicit that the main criteria for evaluating the customer demand in the coming year are:

a) Past experience, and

b) executive opinion.

To get acquainted with the degree of effectiveness of this system, the following information can act as a guide. The table presented compares the total forecast woolen textile sales with the actual.

TABLE I

FORECAST AND ACTUAL WOOLEN TEXTILE SALES BETWEEN 1960 AND 1965

Year	Forecast Sales in Meters (Annual)	Actual Woolen Cloth Sales in Meters (Annual)
1960	6,009,000	4,817,000
1961	4,110,000	4,086,000
1962	4,259,000	4,019,000
1963	3,875,000	4,565,000
1964	4,657,000	4,153,000
1965	4,175,000	4,241,000

Demand forecasts for 1961, 1962 and 1965 are quite comparable with the actual sales, however, the other years show considerable deviations between the forecasts and actuals. The problem is such a delicate one that underestimation of sales results in foregone contribution margins on lost sales and loss of customer goodwill while overestimation paves the way for high levels of inventory and associated carrying costs. In general terms, inadequate forecasting lowers the profitability of the enterprise.

Responsibility of sales forecasting is two dimensional:

1. Forecasting the quantity of each woolen type that is going to be demanded. This is the responsibility of Woolen Textile Department under Sümerbank ASM.
2. Patterning and coloring the different woolen types. This is done by experts in Sümerbank plants who are sent to international fairs from time to time and are well acquainted with the customer taste in Turkey.

The public opinion on the designing and coloring of woolen textiles of Sümerbank can be considered as being quite favorable.

Statistics Department

The functioning of this department, which is located in Sümerbank ASM, goes as far back as 1956. The work consists mainly of collecting numerical data on sales and stock levels from sales outlets scattered all over Turkey, classifying the data and preparing sheets to be submitted to executives of the Cotten and Woolen Textile Department in a presentable form. As is explicit in the definition of its functions, the department does not do any statistical analysis in an academic sense.

Information on sales and inventory levels of the sales outlets flow to the Textile Departments at ASM through the Statistics Department in two forms:

1. 10-day tables
2. Monthly tables

Let us briefly discuss the nature of these tables. The flow of information between the Statistics Department and outside city outlets is direct but inside city retail outlets send this information through the main outlets. Ten-day tables contain information on:

Quantity of finished goods received by each outlet during the 10-day period.

Quantity of finished goods available for sale at the beginning of the period at each outlet.

Sales realized in ten days.

Quantity of finished goods that remain in stock at the end of the 10-day period.

It takes between 11 - 14 days in the Statistics Department to collect, classify, and tabulate this information. In other words, information pertinent to June 1 - 10 period is presented to the Woolen and Cotton Textile Departments between the 20th and 25th of June.

Similar type of written communication is employed between the plants and the Statistics Department which reveals information on the 10-day production and level of finished goods inventory in plant warehouses.

Presentation of this information on the sales of each outlet, production of plants and level of finished goods inventory in the outlets and plant warehouses, to the Cotten and Woolen Textile Departments makes a ready source of reference available and facilitates the mechanism of finished goods inventory control.

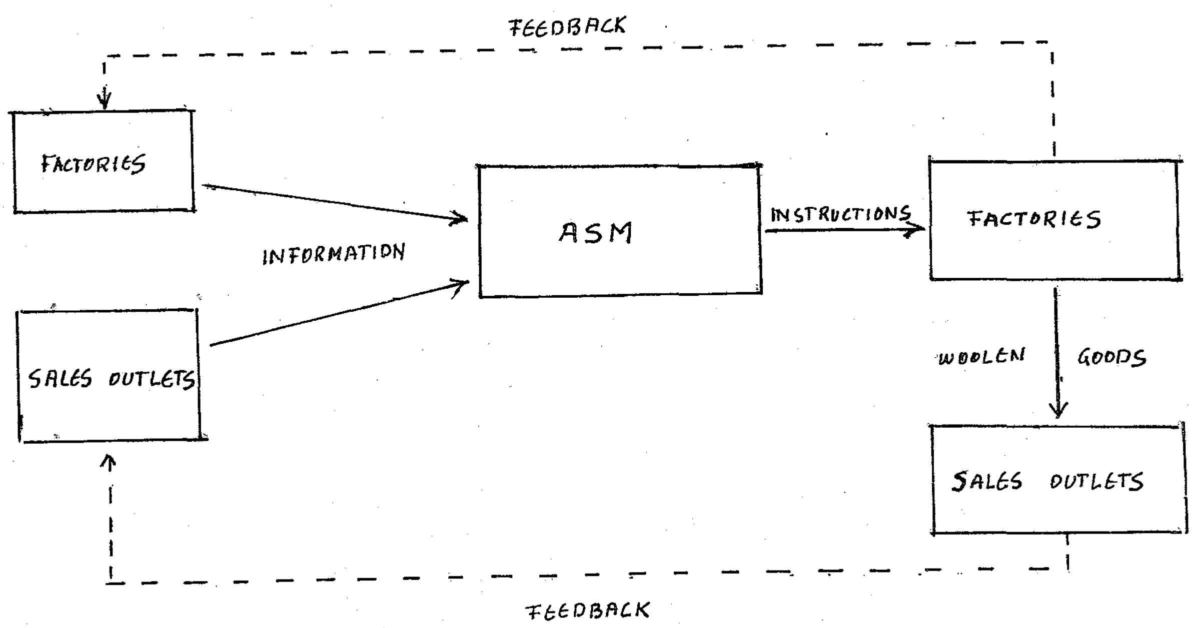
The nature of Monthly Reports is similar to that of 10-Day Reports, only they are:

1. Based on monthly figures
2. Sales figures are cumulative, January 1st of the current year taken as the starting point.
3. Finished goods inventory figures show the month-end level.

As would be expected, collection, classification, tabulation, and presentation of this information to the Woolen and Cotton Textile Departments takes a longer period of time than does the 10-Day Reports. For example, the report of a certain month is received by the Woolen Textile Department towards the end of the following month. This introduces the problem of lead time on the flow of information which will be discussed in the coming chapters.

Level of Finished Goods

The discussion on the functioning of the Statistics Department is in fact a part of the description of the stock control mechanism employed by the Woolen Textile Department. Combining this piece of information with the discussion presented in Chapter IV on flow of goods and flow of information, a complete picture of the inventory control system can be obtained. To be brief and specific, the information that flows from the individual sales outlets and factories to the Woolen Textile Department through Statistics Department, concerning the sales, production and finished goods inventory levels constitute the input to the inventory control system. The output is the instructions given to the plants on the transporting and distributing of the woolen products to the individual sales outlets.



What is the degree of effectiveness of this input-output system? Table II presents a picture of total finished woolen goods inventory in the plant warehouses, retail outlets, and in transport.

F = Quantity in factory warehouses

S and T = Quantity in the sales outlets and in transport

TABLE II

	1964			1965			1966		
	F	S and T	Total	F	S and T	Total	F	S and T	Total
January	0.787	1.089	1.876	1.137	0.690	1.827	0.874	0.687	1.562
February	0.950	1.011	1.961	0.847	1.086	1.934	0.702	0.789	1.492
March	0.905	0.900	1.805	0.992	0.752	1.744	0.921	0.760	1.681
April	0.847	0.924	1.772	1.152	0.776	1.929	0.759	0.759	1.519
May	0.791	0.914	1.706	1.270	0.768	2.038	0.867	0.771	1.638
June	0.920	0.957	1.878	1.254	0.760	2.015	0.923	0.766	1.690
July	1.091	0.986	2.078	1.248	0.692	1.941	0.909	0.820	1.729
August	1.119	1.018	2.138	1.026	0.913	1.940	0.821	0.946	1.767
September	0.910	1.023	1.934	0.861	0.862	1.724	0.561	0.926	1.487
October	0.855	0.967	1.822	0.917	0.754	1.672	0.534	0.874	1.409
November	0.740	0.936	1.677	0.907	0.761	1.668	0.490	0.817	1.349
December	0.940	0.855	1.796	0.858	0.720	1.579	NA	NA	NA

- Finished Woolen Goods Inventory in (000000) meters. -

Table II indicates that:

1. Level of woolen product stocks has a downward trend between the years 1964 and 1966.
2. Finished goods inventory in woolen textiles tend to increase during summer months and decline in winter months. This is largely due to the fact that sales of woolen products are seasonal as indicated in Chapter III of this section. Decline of sales as indicated during hot months of the year causes finished goods inventory levels to rise because production is leveled.
3. Portion of finished goods inventory in the factory warehouses tended to decrease in 1966 while inventory in the sales outlets and in transport began to constitute the greater portion of the total finished inventory.
4. Generally, the level of finished goods inventory is high when compared to annual sales of woolen products. The computation of inventory turnover reveals the following:

$$1964 \text{ Turnover} = \frac{4.153}{\frac{1.876 + 1.796}{2}} = 2.26$$

$$1965 \text{ Turnover} = \frac{4.241}{\frac{1.827 + 1.579}{2}} = 2.49$$

The level of finished goods inventory is explained by:

1. The seasonality of sales
2. Sales characteristics of woolen textiles

3. Coloring and design variability of each type.

4. Priority given to sales by retail.

It is unnecessary to discuss the effects of seasonality of sales on the levels of inventory because the situation is self-explanatory.

It is possible to combine the second and third causes and their effects in the following way: When woolen textile sales are expressed in terms of meters, it is found that woolen products cannot be classified as easy-selling items when compared to other classes of textiles because they are more expensive and their uses are not as general as cotton textiles. Similarly each type is patterned and colored in a great variety of combinations and it is necessary from a marketing point of view that samples of different colors and patterns of each type should be available in the storehouses, ready for consumer demand. These facts contribute to the level of finished goods inventory to be high.

The Woolen Textile Department favors sales by retail and gives priority to it. This may partly be due to the greater profits involved in sales by retail when compared to wholesale and central sales. According to the opinion of Woolen Textile Department, this is another contributing factor to the level of finished goods inventory.

This chapter completes the introduction to the Sümerbank mechanism and the definition of the system. The interrelationships among problem areas and the nature of the inventory control problems will be discussed in Chapters VI through VIII.

SECTION III

ANALYSIS AND IMPROVEMENT OF THE SYSTEM

Up to here, our main concern had been a proper introduction to the Sümerbank mechanism and definition of the system. As have been discussed in Chapter II, the factors that complicated management of finished goods inventories of Sümerbank were given as the obsolescence of woolen fabrics, seasonality of sales and the lead times involved. A better control of the obsolescence factor will be associated with the improvements in the degree of flexibility in the production process and possible adjustments in the plants which will put the emphasis on the fabric types that have greater marketability and consumer acceptance when compared to the others. The subject of seasonality will be treated in relation to more accurate forecasting methods which will automatically take care of the ups and downs in the demand throughout the year. Finally, the problem of lead times will be considered in the final chapter of this section and with the completion of the discussion, the proposed model to improve the effectiveness of control in Sümerbank will be illustrated.

CHAPTER VI

ANALYSIS OF THE PROBLEMS ASSOCIATED WITH THE NATURE OF PRODUCTION

In order to proceed more meaningfully with the analysis and to understand better the pros and cons of the argument, it is assumed to be a necessary step to go over the basic technology involved in converting raw wool into woolen fabrics in Sümerbank plants. It should be remembered that in the case of self-supplying companies such as Sümerbank, inventory situation and ordering policy are affected by the nature of the production process.

Wool

Wool is perhaps the most useful of all fibers. Not only is it attainable in very large quantities but it is a warm handling fiber and is thus particularly suitable for outer clothing and underwear. Wool can vary a great deal in quality. Some types consist of short worse fibers while others are very fine and long. Merinos wool is in general most prized by wool manufacturers. Wool fibers are quite different in form and composition from cotton and linen. Raw wool also contains a high proportion of impurities, mainly of a greasy character, which have to be removed by a scouring process before spinning and weaving operations can be carried out. In its purified condition each wool fiber is composed of the protein known as keratin, a substance which consists of CHONS (carbon, hydrogen, oxygen, nitrogen and sulfur). A general characteristic and defect in fully manufactured wool materials are the property of felting and shrinkage. Wool fibers are unique in having crimp or waviness. The finest fibers have most crimps or waves. A merino wool fiber may have up to 12 crimps per cm, whereas a low quality wool may have only 2-5 crimps per centimeter. This crimp is of importance in the spinning of wool yarns because it favors adhesion between the fibers as these lie in the yarn twisted about each other. Wool fibers vary considerably in length. A merino wool fiber is about 7-12 cm. long but other types may extend to 30-40 cm. The thickness of a fiber varies a great deal too. Generally wool fibers are around $\frac{1}{2500}$ cm. in diameter but they are frequently twice this thickness. When air dry, wool contains about 18 percent of absorbed moisture.

At normal times not enough wool is obtained from sheep to meet the requirements of the wool industry. The deficiency is made up by collecting waste and discarded wool materials such as rags, garments and yarns and then passing these through special machines which scratch up the material into loose fiber.

Allied to wool as obtained from sheep are a few types of fibers which are secured from other animals, particularly goats. The goat fibers include mohair, which is obtained from the angora goat, and cashmere. These goat fibers resemble wool in consisting of keratin. But the scales are more smoothly arranged, and so these goat fibers do not felt so readily as does sheep wool.

Wool is purchased by Sümerbank plants during early summer months, namely, May and June. The policy is to buy raw wool in such quantities that will meet the production requirements of the whole year. Otherwise raw material shortages during the year lead the management to the problems of buying rather low quality wool at higher prices than that of the May - July period. This indicates that the general policy in purchasing raw wool in Turkey is to concentrate it to the early summer months. At other times of the year it is hard to find high quality wool, and even if it is found, it is at much higher prices. The same practice is applied to the purchasing of cotton. Of course, this leads the way to carrying the raw materials supply throughout the year until they are depleted gradually by the next buying season. Lots of money is tied up in the raw materials inventory and carrying costs in the form of spoilage, handling, storage, and insurance costs are incurred. This policy is not characteristic of only Sümerbank but of a heavy majority of the public and private sector firms in Turkey. This seems to be more or less a general practice.

General Principles of Yarn and Fabric Manufacture

The first stage in the production of a fabric from fibers is to clean and mix them thoroughly. The fibers are then generally straightened and those having no twist are next drawn out into the form of sliver. More and repeated drawing and twisting produces a fine roving which is finally twisted into yarn. The yarn is used to produce fabrics by weaving. It will be realized that for the carrying out of these manufacturing processes a wide range of different types of complicated machinery are used.

The first point to notice is that purification of textile fibers is left to that stage at which the fibers are in the form of yarn or fabric. This is because it is more convenient to apply purification treatments with the fibers in a manufactured form. This does not apply, however, to such impurities as sand, dirt and bits of leaf. These impurities are removed before spinning since they would interfere with these early processes. It is the natural fat, wax and simple impurities which can remain until the later stages.

Raw wool is generally so impure that it is necessary to give it a scouring treatment quite early. The scouring of raw wool fiber is carried out continuously in long machines which comprise shallow iron tanks filled with a warm detergent liquor, usually soap solution. Before entering the scouring process, wool fibers are sorted according to their quality and are treated separately. The Defterdar plant can treat approximately 4500 Kgm. of raw wool in a 16-hr. day working on two shifts. It has been estimated that approximately 100 Kgm. of soda-water is used on those two shifts in a work-day. The construction and operation of scouring machines are such that the wool is disturbed as little as possible.

A relatively small proportion of raw wool is purified by extraction with organic solvents such as white spirit. It is claimed that the wool is less harmed than when alkaline soap solutions are used. This practice, however, does not find any application in the Sümerbank plants visited.

The wool industry has to deal with many different types and qualities of wool. These vary widely in fiber length from 5 to 35 cm. and also differ considerably as regards their thickness. Therefore, the manufacture of wool yarns has become divided into two main sections, woollen and worsted.

For the manufacture of worsted yarns it is customary to use the finer qualities of wool, since in these yarns the fibers are arranged parallel to each other and it is generally desirable for these yarns to be strong and fine. Woollen yarns are much less regular, since they are composed of shorter and often coarser fibers. Worsted yarns are employed for making fine clear-cut cloths, while the woollen yarns are useful for making rougher clothes. For the manufacture of worsted yarns the wool fibers have to be combed but this is not necessary for woollen yarn. More operations are involved in the production of worsted yarns.

Woollen yarn manufacture. Wool which has been scoured in the loose form, has to be prepared in the form of roving which can then go forward for spinning into yarn. The wool is processed in a carding machine. The carding machine usually consists of a group of two or three machines of the same type. Once the roving is formed, it is taken straight to the spinning machine.

Worsted yarn manufacture. In this section preparation of the scoured wool is for the purpose of making the wool suitable for passing through the combing treatment which is necessary for making worsted yarn. Carding is an excellent method for straightening fibers but there is another method known as gilling. However, gilling is not satisfactory if the fibers are short. The wool produced may then be washed in its sliver or roving form. It is now ready for combing. The capacity of the wool-combing machines in Defterdar plant is approximately 5000 Kgm. of wool in sliver form in a 16-hour day, work being performed in two shifts.

Combing machines are exceptionally ingenious. The different types are named after their inventors: The Noble, Heilman, Holden, and Lister combs. Of these the Noble is probably the most widely used.[1] When the gilled or carded wool is put through one of these machines, it emerges with the wool fibers alligned to a high degree of parallelism. The next stages are now mainly drawing operations in which the wool in the form of roving is progressively drafted in several stages until it is obtained in the form of a thinner roving ready for spinning. Spinning can be carried out on any of the different forms of spinning machines.

No matter what the type of fiber, the general principles of yarn production are much the same. The fibers have to be freed from impurities such as sand, dirt and stalk. Then they have to be mixed and blended. Processes are then employed to eliminate the very short fibers. Further parallelisation of the fibers is attained by combing and by repeated drawing and drafting. In drawing slivers of fibers, a small degree of twist is introduced, the sliver then becomes known as roving. Finally the uniform fiber is in the form of

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[1]A. J. Hall, The Standard Handbook of Textiles, New York: Chemical Publishing Inc., 1965.

roving and is further drafted and twisted into yarn.

Weaving

All woven fabrics are made up of two sets of threads, the warp and weft. Usually fabric is woven in long lengths. The threads which extend throughout the length of the fabric are termed warp threads, while those which go across are termed weft threads. Since it is generally necessary for the warp threads to be strong in order to withstand the considerable strains to which they are subject in weaving, they are the more important. In order that the fabric may have strength and compactness combined with a fair degree of elasticity, it is necessary that the warp and weft threads be interlaced in the fabric.

Previous to weaving, the warp threads will have been brought together side by side just as they will be in the fabric and wound on a roller. The length of these threads must be approximately that of the fabric which it is intended to weave.

In order that the warp yarns may not break during weaving, they are previously strengthened by coating them with a thin film. The weaving or interlacing of warp and weft threads is accomplished with a machine which is known as a loom. Today in plain looms there is an automatic device which allows differently colored cops of yarn to be used in turn and so produce fabrics having colored patterns.

In the plain loom, the arrangement of the interlacing of the warp and weft threads is settled at the outset of weaving by the manner in which the individual warp threads are threaded through the two sets of heddled. Once these arrangements have been made, they must persist until the whole length of the warp threads is used up. For the production of some patterned fabrics, however, it is desirable to be able to change these arrangements frequently through the weaving. By such changes it becomes possible to make patterns based on variations in the way the warp and weft threads are interlaced. To be able to do elaborate patterns it is necessary to use a Jacquard loom.

Now, let us briefly illustrate the characteristics of the different stages in converting the raw wool into a woollen fabric.

Scouring of loose wool. It has been stated previously that the general practice is to move the wool through a series of long shallow tanks containing warm, slightly alkaline soup solution. A loose wool scouring machine comprises from three to five of these shallow iron tanks or troughs. They are arranged end to end and between each adjacent pair is a mangle. Each tank is filled with the scouring liquor, the composition of which may vary from tank to tank in order to serve special advantages. It is not unusual that the last tank may contain pure running water so as to wash out most of the dirty detergent liquor brought forward by the wool from the previous tanks. The first tank may contain a relatively strong soap liquor. When the wool emerges thoroughly purified at the far end of the last tank, then it is ready for drying. The important idea behind this scouring of wool is to keep it in a soft, free and lofty state completely free from matting.

Carbonisation. When the wool contains a high proportion of vegetable impurities, it is better to subject it to a process of carbonization in order to remove these . For carbonization the wool is saturated with a weak solution of sulphuric acid (H_2SO_4) or sometimes a solution of $AlCl_3$, Aluminium Chloride, and is then hydroextracted to remove all excess liquor. The wool is then led through a drying or haking machine. The acid dried in the wool does not harm this fiber, but by contrast the acid dried into the vegetable impurities disintegrates these.

Purification of fabrics. This is another method used for scouring after the weaving process is completed. Purification is done in machines that have a pair of rollers which press upon each other lightly. The fabric receives a light squeeze as it passes between the nip of the mangle rollers which squeezes out the emulsified oily and fatty matter impurities commonly found in wool fabrics.

Milling of wool materials. Wool fibers readily close up on each other by reason of their unique felting power. This property is frequently used to give wool materials a thicker and more compact character. Woven fabrics are usually milled in a machine where they repeatedly pass through rollers and a compressing device. All milling methods involve squeezing the fibers together and with each squeeze the fibers remain a little closer together and more interlocked than they were before.

Finishing of wool materials. There are several technologies involved at this stage of the production. Many types of wool fabrics, especially worsted materials which must have a sheer surface are sheared. When it is required to produce a smooth surface in wool fabrics it is preferable to subject it to a hot pressing. One of the oldest and most favored methods for achieving this is a hydraulic press. Under this a very pleasing surface is given to the fabric and it is easy to see the difference between the fabric before and after it has been pressed.

A finishing treatment which is frequently applied to woolen fabrics is known as raising or brushing. The object of this treatment is to change the smooth surface of the fabric to a degree of hairiness which makes the fabric very soft to handle and at the same time warmer. This treatment of brushing is applied especially to wool blankets.

Having completed the discussion of the technology involved in woolen textile plants and the description of the different stages, the next step will be to analyze the flexibility of the production system in Sümerbank plants.

Flexibility in Plants

Flexibility in plants has two dimensions:

1. Flexibility in the aggregate capacity to meet the ups and downs in demand for products that have seasonal sales.
2. Flexibility within the production facilities to ensure that certain types of fabrics can be taken out of line when more profitable sales are predicted on others, in sufficient quantities to make it unnecessary to continue the less profitable line.

Before getting into a discussion of the flexibility in Sümerbank plants, it seems to be a necessary step to analyze the characteristic features of Sümerbank production. The common practice is producing to stock which is achieved by leveling the production throughout the year and meeting the demand, which is highly seasonal, from stock at certain times of the year. In theory, this can only be applied to products that do not deteriorate or become obsolete quickly. For products of other kinds, management is apt to face with high costs of obsolescence and spoilage. Big upward swings in inventory, especially during early summer months necessitate large storage facilities, large amounts of working capital and other direct costs besides creating risks such as obsolescence for certain types of woolen fabrics. Clearly, absorption of sales fluctuations by building up or drawing upon inventory has drawbacks of its own. High inventory carrying costs are incurred especially if the cost of obtaining capital is high, and it is an obvious fact that, in Turkey it is so.

The policy of production smoothing in Sümerbank can best be illustrated by giving an actual situation as an example.

The annual woolen cloth requirement of the army which is to be delivered by September is started to be produced during February and the production goes on at a moderate level until September, causing inventory pile-ups in the factory warehouses. The order is met in September and the goods are shipped but at the same time unnecessary carrying costs are incurred between February and September, and capital is tied up in the warehouses.

The alternative course of action will be to start at a much later date and proceed with the production at a faster rate, thus preventing inventory pile-ups. This alternative asks for flexibility in the aggregate production capacity which will be discussed in the coming pages.

This particular example given involved a sale to the order of the government sector of the economy. Government is one of the best customers of Sümerbank goods and sales to institutions like PTT, DDY, army, navy, airforce, and Direction of Public Security are labelled as official sales. These so called official sales constitute about 40 to 50 percent of the total achieved by Sümerbank on woolen fabrics and they have the following properties:

1. The demand is free from wide fluctuations and is predictable with reasonable accuracy.
2. The delivery dates are fixed by the orders from the government which help a lot in scheduling the production.
3. The T.L. value of the sales per meter is lower than those of sales by retail and wholesaling which indicate that they are produced for a particular purpose and leave very little marketability if the government stops the orders on these. This is true and unrealistic at the same time because there is no indication whatsoever that there may be such a possibility. The government turns to Sümerbank as a ready source of supply to meet the requirements of the armed forces, PTT, railroad company and other government institutions.

4. Although these official sales lead to inventory pile-ups at certain periods of the year, there is a sense of security on the part of the textile plants that the fabrics in the warehouses are going to be shipped, and they have a ready market when the date of delivery comes.

Woolen fabrics that are produced to the orders of the government institutions do not stay in the factory warehouses long enough to deteriorate. Secondly, they carry almost no risks and costs of obsolescence explained in Chapter II. The only problem encountered here is the carrying costs associated with the inventory that is built up slowly as production goes on.

The sense of security on the part of the plants do not exist for those types directed towards the consumer market, as it did in producing for government institutions. No accurate guess can be made on the length of time these fabrics may get tied-up in the plant warehouses. This depends solely on the instructions coming from the ASM on the shipment of goods to individual retail outlets.

Now, let us analyze the burden imposed upon the plants in carrying inventories. In Defterdar plant, the finished goods warehouse is insured for 20 million T.L. The cost of stock keeping in this plant will be illustrated by actual figures for the year 1966. These figures simply represent the annual warehouse expenses.

FINISHED GOODS WAREHOUSE EXPENSES FOR THE YEAR 1966 IN DEFTERDAR PLANT

Handling Expenses	52,039 T.L.
Personnel Expenses	118,335
Supplies	180,561
Depreciation of Fixed Assets	4,515
Insurance Expense	50,736
Other Expenses	621
Corporate Office Expenses	38,700
Total	445,507 T.L.

One may be surprised by what is actually meant by Head Office Expenses and the reason for including it here. It is a general practice in the Sümerbank mechanism to distribute the annual expenses of the Corporate Office in Ankara to different Sümerbank units and to the different departments in these units. Therefore the T.L. 38,700 actually represent the share of the finished goods inventory in Defterdar plant warehouse.

Another feature of these expenses is that they remain almost the same throughout the years. Depreciation of fixed assets does not change at all. Similarly personnel and incurance expenses show only slight variations.

During 1966 the total of fabrics that entered the warehouse was 1,987,870 meters and the total that has been shipped was 1,800,738 meters. The cost of stock in the warehouse is calculated by taking the average of these two figures and dividing total warehouse expenses into it.

$$\frac{1987870 - 1800738}{2} = 1894304 \text{ meters}$$

$$\frac{445506 \text{ T.L.}}{1894304 \text{ meters}} = 0.2352 \text{ T.L./meter}$$

The insurance expense in Merinos plant is higher when compared to that of Defterdar. An annual premium of 3.30 per thousand is paid to "Güven Sigorta" by the Merinos plant. In other words, T.L. 3.30 of insurance premium is paid annually per T.L. 1000 worth of finished goods in the warehouse. Following the same kind of analysis,

Total Inventory Expenses Incurred in		
Merinos Plant in 1965	=	T.L. 955 500
Production in 1965	=	1355 000 meters.

$$\frac{955500 \text{ T.L.}}{1355000 \text{ m.}} = 0.705 \text{ T.L./meter.}$$

It can be noticed immediately that the cost of capital and cost of obsolescence are not included in the above analysis. Cost of capital reflects the lost earning power of money. The cost that should be assigned depends on the use to which the money would be put if it were available. A company might be earning a return of 10 percent on its total investment. If money released from inventory could also earn 10 percent then this is the cost of the money tied up in inventory. The interest rate has the following structure in Turkey:

Rate of Interest	10 percent
Taxes	2 "
Total	12 percent

In actual business situations, bank's commission of 2 percent per year compounded quarterly is added to this total, raising the cost of capital to approximately 15 percent. These are alternative ways of measuring the cost of money tied up in inventories. The basic principle involved in obtaining the cost is:

Cost = I x r

where I = Investment in inventories (annual)

r = rate of interest involved in obtaining capital.

Thus, a T.L. 100 investment in inventories result in a T.L. 15 cost at a cost of capital of 15 percent. Put in different words, the annual cost of keeping a T.L. 100 worth inventory in stock is T.L. 15 at a cost of capital of 15 percent. If high costs of obtaining capital in Turkey is considered, it becomes explicit that the main cost involved in carrying inventories is the cost of capital. This increases linearly with the increasing value of the inventory.

Obsolescence cost is not of the type that can adequately be determined directly from cost accounting records. It is based mainly on the executive opinion.

The two figures representing the warehouse expenses of the two Sümerbank plants show a difference of T.L. 0.47 per meter in favor of Defterdar plant. This is considered as being due to the following:

1. Merinos production is based mainly on worsted yarn manufacturing while that of Defterdar is a mixture of woolen and worsted yarns,

majority being woolen. The difference between the two has been discussed at the beginning of this chapter.

2. Merinos manufactures market type fabrics while 75 percent of Defterdar production is based on sales to the government sector.
3. The price and quality of Merinos production easily outbalances those of Defterdar production. This involves higher insurance expenses, higher handling, supplies, and personnel expenses on the part of Merinos.

Assuming that the production of these plants stay at the same level, a higher inventory turnover than the present one will mean that finished goods remain a shorter time in the warehouse and the time interval between completion of the production of a certain batch and its shipment from the factory will be shortened. This will mean a decrease in the warehouse expenses and a decrease in the carrying costs. By the same token, money tied up in the warehouses will also be decreased and it will be possible to put it into other uses.

Flexibility in the Aggregate Capacity

Having completed the analysis of the Sümerbank production and the burden imposed upon the plants in carrying inventories, let us turn to the subject of flexibility in the production system which counts to a large extent for the improvement in the system. It has been stated earlier that sales fluctuations throughout the year are absorbed by letting inventories to fluctuate, keeping the aggregate production rate constant. Let us consider the case from a viewpoint concerned with the flexibility in the aggregate capacity. The alternative ways of responding to such fluctuations to avoid inventory pile-ups at certain months of the year can be given as:

A. Maintenance of constant production rate by hiring and firing work force in precise adjustment with demand fluctuations.

B. Maintenance of a constant work force adjusting production rate to sales by working overtime and regular time accordingly.

A. The first of these alternatives mean that an increase in sales is met by hiring and a decrease in sales is accompanied by lay offs. This procedure is clearly not optimal for the economy as a whole but it can be admissible alternative for an individual enterprize. In Sümerbank plants, the most common practice is to transfer workers from one department to another in bottleneck situations. Particularly in the May - July period which is the time for buying the whole year's supply of raw wool, the mixing and the scouring departments need extra workers to process the incoming wool. In this case, workers from other departments are transferred to the mixing department and work there for a couple of months. They are put back to the departments they belong as soon as the wool to be processed in the mixing department is finished. This kind of interdepartmental transfers does not interrupt the activities of the other departments. Similarly in scouring, additional labor requirements during the early summer months is met by intraplant worker transfers and hiring temporary workers. Hiring workers on a temporary basis takes place in summer months for another logical reason that most of the workers ask for their leave. It should be mentioned, however, that this temporary increase in the work force is not a large-scale operation but provide only a 2 percent variation in the regular payroll. In case skilled or semi-skilled workers are needed by the spinning and weaving departments during this period, no difficulties are encountered in getting them. This temporary expansion in the work-force does not lead to additional training costs because of the availability of semi-skilled and skilled textile workers in Turkey. The number of applicants for a job has always been greater than the number actually needed in spite of the fact that this is only temporary employment. This automatically takes care of the psychological drawback that worker morale can be lost when the work force is contracted.

What will be the reaction of the production facilities to this temporary expansion of the work force? This part of the discussion is concerned with the flexibility in the aggregate capacity in production. The mixing and scouring departments have already been discussed and the types of arrangements made involved transfers from other departments and hiring temporary workers. The wool combing, spinning, and weaving departments in Defterdar plant work on a two-shift, 16-hour basis throughout the year. The productivity of the spinning and weaving departments is dependent on that of wool combing because the latter is an earlier step in the production process and the amount of work to be handled by the last two depends on the production capacity of the combing machines. The combing machines are rather old (Josephy - Polish made) and the normal daily capacity is 4.5 tons. However, this daily capacity can be increased to 5 tons without working overtime or adding another shift. This increase in the capacity of the combing machines can be followed by similar increases in the spinning and weaving departments. This has been practiced from time to time in Defterdar plant, but not on a regular basis. Although no additional costs are involved in this process, it has not been applied much because of the basic policy of smoothing the production and avoiding ups and downs. Now let us finish the discussion of the first alternative (A) by saying that:

1. There is a ready potential of textile workers to be hired on a temporary basis in case there occurs a need.
2. Production rate can be increased by 10 percent and there is this much flexibility in the aggregate capacity.

The same argument holds equally well for Merinos because the maximum capacity is given as 1 666 513 meters of fabrics whereas the normal production varies between 1.3 million meters and 1.4 million meters which indicate a ready production potential 20 percent above the so called normal.

B. The second alternative realizes the ideal work force situation by absorbing fluctuations in sales with corresponding fluctuations in overtime work without changing the size of the work force. However, since there is an upper limit to what a worker can produce by working overtime, the necessity for meeting peak orders governs the size of the work force. When sales fall to lower levels overtime is eliminated. In Sümerbank, the maximum overtime that can be expected of workers is set legally at 3 hours per work day. The overtime premium is an addition of 50 percent of the regular wages. This same rate is applied for work on Sundays.

Now let us carry a simplified analysis of the situation:

Assume that 1 hour of regular work costs 100 units in terms of labor cost. Similarly, 1 hour of overtime has to cost 150 units at an overtime premium of 50 percent. One work-day consists of two shifts and 16 hours of labor.

Total labor cost without overtime = 16 hrs. x 100 units/hr.

= 1600 units

Labor cost with 3 hour of overtime will be given as = 1600 + 3 x 150

= 2050 units.

It follows that:

$\frac{3}{16} \times 100 =$ 18.75 percent increase in the production is followed by

$\frac{2050 - 1600}{1600} \times 100 =$ 28.10 percent increase in the labor cost.

Costs of overtime increase at a higher pace than the rate of production. One thing to be noted is that the above figures give no consideration to the fact that labor productivity may fall during overtime. It should be concluded that overtime has its own merits as well as its drawbacks in responding to fluctuations in sales.

In general, none of the two alternatives discussed prove best under all circumstances, but rather some combination of them. Theoretically sales fluctuations should be absorbed partly by overtime and partly by small-scale hiring and layoffs and the optimum emphasis of these factors will depend upon the costs in any particular factory. But even for a particular factory, the best allocation is not fixed, but will vary with the external and internal factors, such as immediate availability of the temporary work force, level of employment in the economy and industry, amptitude of the coming fluctuation, etc.

In the light of these, let us discuss what can be done in terms of flexibility in the aggregate capacity to absorb sales fluctuations. This will be an alternative to production smoothing.

It has been illustrated in Chapter III that woolen textile sales show two upswings during the year. The first of these start in August and continues through December with minor fluctuations. The second largest peak takes place in February. Similarly, in Chapter V, the table on stock levels indicate that inventories are record high during summer months - May, June, and July. This has been explained as being caused by production smoothing and decline in sales between March and July. In Turkey, as in any other country, employee vacations and leaves are encountered in July and August. On the other hand, summer months are followed by increasing demand in woolen fabrics. It is explicit that July and August should be characterized by a rise in the production level to absorb the upswing in demand from August through December. Since part of the work force is absent from the factories during summer a larger work force will be required than called for by the rule.

The proposal will be an increase in the production rate to absorb the rise in sales between August and December. The amount of increase in the rate is dictated by the flexibility in the aggregate capacities of plants which have been calculated as 10 percent for Defterdar and 15-20 percent by Merinos. It should be noted that this rise will be perfectly temporary and as the sales fall below the yearly average, the emphasis on production will be removed. Instead of smoothing out the production, the practice will be to go above the present level at certain months of the year and go below in others. This will be an exact response to the below-average sales in March - July and above-average sales in the August - December periods. This adjustments in the production will be compensated by hiring additional workers in the July - November period. It is noted that the temporary rise in the work force leads the temporary rise in sales by one month. This one month is the time interval needed to complete the production of a certain item, starting with wool combing and ending with finishing. Of the two alternatives to adjust the production, the first one that is hiring temporary workers is preferred to overtime because sales persist at high levels until December and five months is a very long interval of time to permit the problem to be handled by overtime. Overtime proves to be too costly for such long periods, and it has an adverse effect on the employee morale and productivity. Hiring workers on a temporary basis will also compensate for the ones who are on their vacations and production will not be hampered by employee leaves. This process proves to be successful because no training costs are involved in the temporary employees. The availability of work force has been discussed in detail in the previous pages.

This alternative course of action will have the chief merit of avoiding upward swings in inventory which necessitate large storage facilities, large inventory carrying costs especially in the form of money tied in the warehouses and create risks of obsolescence.

The one largest peak in demand that occurs in February cannot be treated in the same way. The duration of the upswing is short although the amplitude is considerable. This does not justify hiring additional work force for just one single month. Since in February there is no problem of employee leaves, the situation can be handled by overtime and the possibilities of sales backlogs can be eliminated if there exists one.

Total manufacturing costs may change as a result of a decision to change the rate of production. If a firm has been operating at 90 percent normal capacity, on a double-shift operation, an increase of output could be effected without additional costs of overtime or third-shift premiums. However, if the plant has been operating at 100 percent of normal capacity, an increase very likely would involve overtime costs or additional shift premiums. Each output rate has its own cost function by which the cost of increasing or decreasing present capacity is computed.[1] Curves are assymetrical for present

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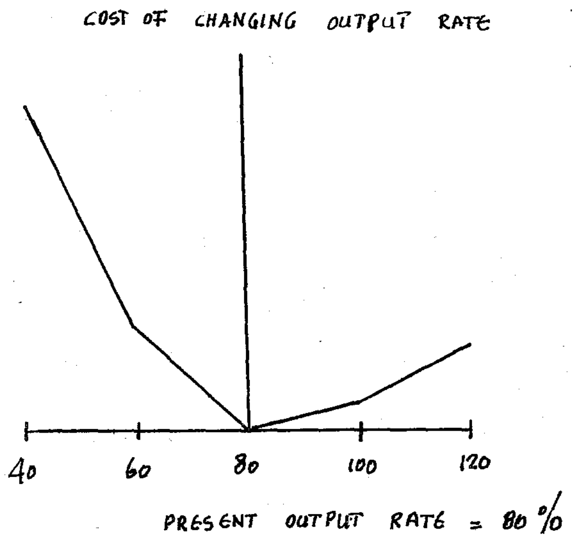
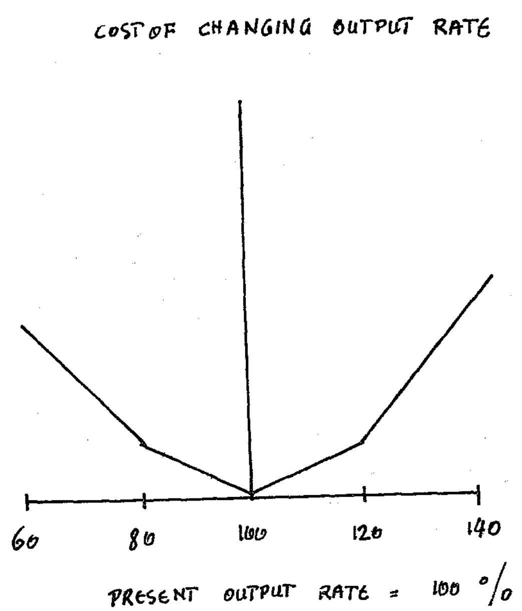
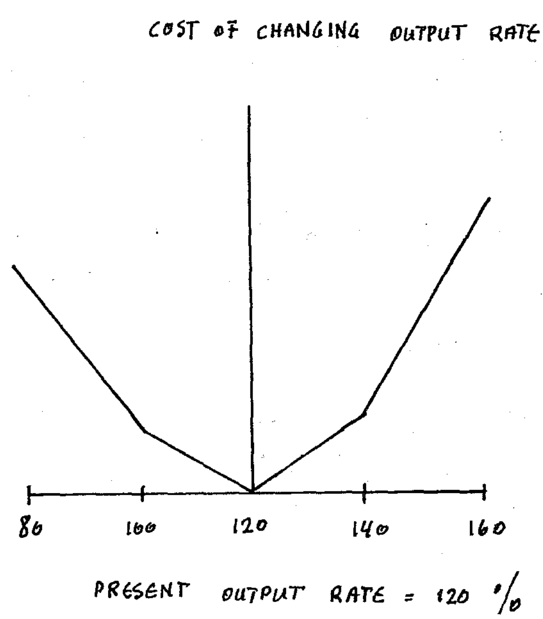
[1]P. H. Thurston, Arch R. Dooley, R. E. McGanah, J. L. McKenney, R. S. Rosenbloom, C. W. Skinner, Casebooks in Production Management, New York: John Wiley Inc., Part IV, 1964.

capacity. In this linear relationship, it is recognized that the costs are discontinuous. Now let us present the linear functions that represent the cost of changing aggregate production output rate.







Since the Sümerbank plants work somewhat below the aggregate capacity, the costs of increasing the production rate to 100 percent of capacity at certain periods of the year and meeting the sales fluctuations by making such adjustments will not hurt the enterprise as much as going beyond the aggregate capacity or working considerably below it.

Flexibility Within Facilities

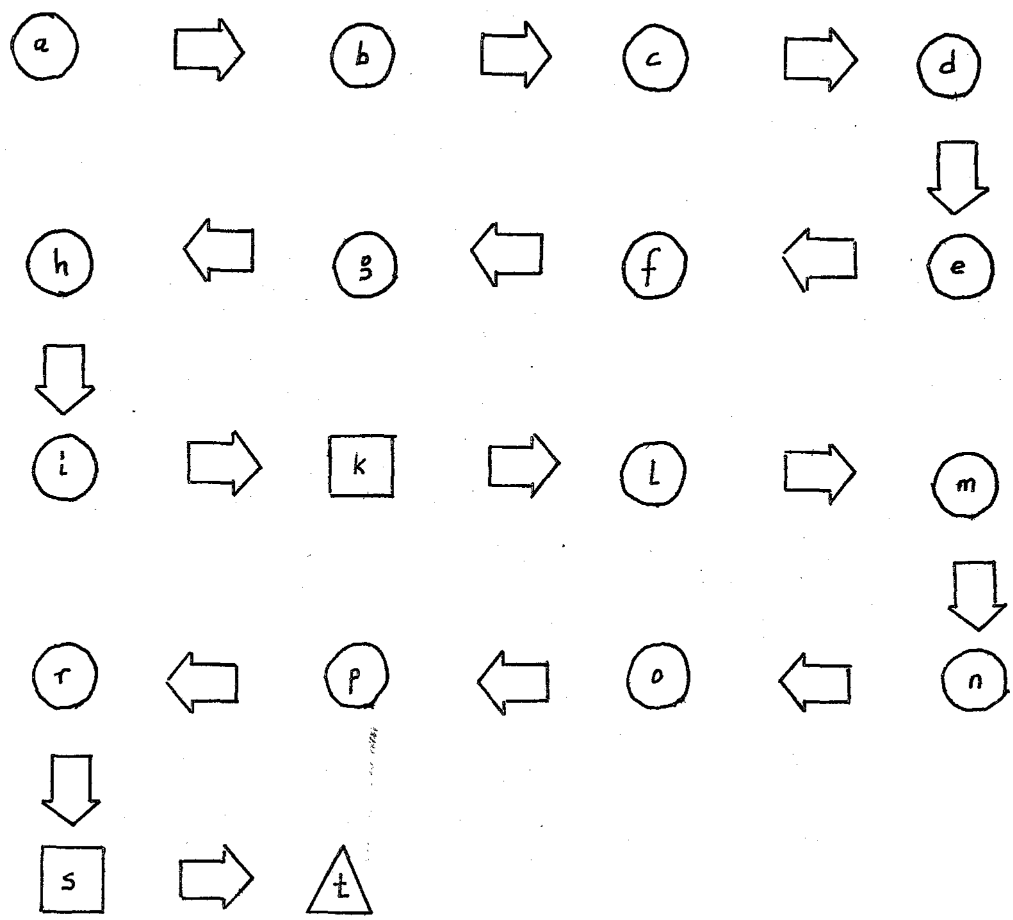
Up to this point, the main concern had been adjustments in the normal production rate in the plants. The second aspect of flexibility to be discussed is the allocation of current production to individual woolen fabric items and to different colors and patterns in these items. The problem is oriented towards those fabrics designed for the market. Production for the government institutions is standardized and carries no costs and risk of obsolescence. For example, the same type, quality, and color of woolen cloth has been produced for years for the army, navy or the PTT. However, in the more expensive market lines the situation is quite different. Some fabric types, patterns and colors enjoy a level of market acceptance beyond the predictions of the producers while others prove to be hard to move inventories. When such a situation is realized at the start of the selling season, production can be concentrated on easy-selling items by shifting some part of the total capacity to those if the facilities permit that much flexibility. The structure of the problem is the following:

Investment in hard to move inventories leads the management to distress sales at the end of the normal selling season when costs of obsolescence and cost of capital tied up in the inventory hamper the profitability of the enterprise. This can be avoided by shifting to more profitable lines and slowing down the production of hard-selling items long before the end of the selling season. This degree of flexibility in facilities can absorb the forecasting and planning errors to some extent.

It has been discussed earlier in the chapter that conversion of wool into cloth involves many different pieces of equipment in succession. Those at the beginning of the process such as scouring equipment operate continuously. On the other hand, spinning and twisting are batch type operations, but the individual batches (spools of yarn) are very small. Weaving assumes a distinctly batch-type character as yarns are aggregated into warps which require considerable set-up effort. Running time on the loom for a single warp may vary greatly, from a matter of days to a matter of weeks. The process flow chart will be illustrated in the following page before getting into the discussion of stages in the production.

The amount of machine capacity required at each stage in the process is determined by the construction of the fabric. There is a close relationship between the flexibility of the facilities and the variety of fabrics to be produced. It is desirable to minimize variety and therefore the number of changeovers at the early stages of production, and stick to a limited number of yarn sizes and types. Substantial variety at relatively little cost can then be provided in weaving and finishing, since these operations are carried out in

PROCESS FLOW CHART



a) Sorting

b) Scouring

c) Carbonization of Raw Wool

d) Drying of Raw Wool

e) Mixing

f) Wool Combing

g) Roving Formation

h) Spinning

i) Weaving

k) Inspection

l) Purification

m) Milling

n) Fabric Carbonization

o) Shearing

p) Brushing

r) Pressing

s) Inspection

t) Storage

batches anyway.

If we take a look at the Sümerbank plants, we see that this is the actual policy involved in production. For example, Merinos is specialized in worsted yarn whereas Defterdar concentrates on woolen yarn and the other plants following the same basic attitude on producing either one. This indicates a potential flexibility on the part of the plants in shifting from one item to another within their product line. This has actually been stated by the production managers that during the year, it is within the capacity of the plants to slow down the production of certain types and switch to others that prove to be more profitable. The only problem is encountered at the weaving phase due to the arrangement of warps on the loom. Now, let us discuss the stages in the production as separate groups:

1. Preliminary Processes
2. Yarn Manufacture
3. Weaving
4. Finishing Processes

Preliminary processes. Preliminary processes include sorting, scouring, carbonization of raw wool, drying, and mixing. Sorting involves the assortment of the incoming raw wool as to origin and quality. Since the usual practice of purchasing wool is to buy the whole year's supply in one large batch in either May or June, this process is rather a large batch type of operation.

Scouring and carbonization of raw wool following its assortment involve the removal of impurities such as sand, dirt or bits of leaf before going into further processing. The scouring of raw wool is carried out continuously in long machines. The same basic treatment applies to all qualities and origins of wool. Similar argument holds for the carbonization of wool except that this process is applied when the wool contains a high proportion of vegetable impurities.

Preliminary processes are more or less general and the same basic treatment is applied to the raw wool without consideration given to the possibilities of different yarn sizes to be produced at the later stages. In case a shift from one fabric type to another is planned for, the only change might occur in the mixing department provided that the shift includes a change between types that have different compositions of different qualities of wool. An example would be shifting the production from serge to "lastikotin" which is a kind of knit cloth where the raw material for the former is a mixture of Australian wool and goat's wool compared to the purely goat's wool nature of the former. Since mixing is a batch-type process, if there happens to be a bottleneck situation, this can be met by transferring a few workers from other departments temporarily. This has been a common practice in the Sümerbank plants and does not lead to changes in the payroll records or personnel records and has no adverse effect on the plant community relations. It neither disrupts the activities of other departments unless the transfer is a large-sized one.

Yarn manufacture. Yarn manufacturing includes combing, roving formation and spinning. Wool combing treatment is employed to attain parallelization of fibres. No matter what the type of fibre, the general principles of yarn production are much the same. The roving formation and spinning are strictly batch-type operations with small individual batches. The wool has to be prepared in the form of roving before going forward for spinning into yarn. The rovings are led forward to be wound on bobbins which are taken to the spinning machine and converted into yarn by drafting and twisting. Since the Sümerbank plants are specialized on certain sizes of yarns, warp and weft threads, the arrangements in the roving formation and spinning can be achieved at no delay and at no additional cost.

Weaving. Previous to weaving, the warp threads are brought together side by side just as they will be in the fabric and wound on a roller. The length of these threads are approximately that of the fabric which it is intended to weave. The weft threads are approximately that of the fabric which it is intended to weave. The weft threads are wound on small tubes to form cops. Since the weft threads have to be moved between the warp threads in weaving, it is not possible to make these cops large, so a great many of these have to be used one after the other in making a long length of fabric. The problem encountered here in shifting from one fabric type to another is the length of the warp threads on the loom. It is not possible to change immediately the arrangements that have already been made because running time on the loom varies considerably. Arrangements in the allocation of looms to different fabrics can only be completed gradually and this is determined by the length of the warp threads that were originally brought together. Therefore, shifting of the emphasis on the production of one type to others requires a preparation stage of around one week by which time the allocation of looms to certain items are gradually changed. This operation in the weaving department does not lead to any additional costs and it has been estimated that fluctuations in the ordering of different items can be met completely within a one month's period.

Finishing Processes. These treatments start with the purification as shown on the flow chart and end with pressing. Some of the finishing processes are general to all woolen fabric items whereas others are applied only to certain types. Purification is of the former type. Similarly milling is used to give wool materials a thicker, more compact character. The fabric is subjected to a process of milling which is essentially repeated compression and relaxation. Woven fabrics are usually milled in a machine where they repeatedly pass through rollers.

Besides these finishing processes that are more or less general to all, shearing, brushing and hot pressing are particular to some. Shearing treatment is applied to largely worsted materials which are supposed to have a sheer surface. Necessity for production of a smooth surface in wool fabric leads to hot pressing. And finally, brushing or raising is applied to wool blankets to change the smooth surface of the fabric to a degree of hairiness. These finishing treatments present no problems as to the allocation of the production facilities to different wool items and treatment of woven fabrics can be handled without forming bottlenecks in the process.

In spite of the fact that there exists such a ready potential for flexibility in plants, this process of switching from one item to another has not been applied much recently except for a couple of exceptional instructions from the corporate office. As had been stated previously, flexibility in production facilities has the chief merit of avoiding the concentration of production on less profitable lines. Utilization of this inherent flexibility provides a rise in the sales rate, increase the turnover of inventories, and add to the profitability of the enterprise.

However, one major area of difficulty centers around the problems of forecasting. The refinements in the production programming make sense only to the degree that reasonably reliable forecasts can be made of future sales. Therefore, further comments on the flexibility of the facilities and refinements in the production program will be avoided until the problems of forecasting in Sümerbank is considered in the next chapter.

CHAPTER VII

PROBLEMS ASSOCIATED WITH SALES FORECASTING

Analysis

The discussion is Chapter V showed that in Sümerbank demand forecasts are made on an annual basis and long-range projections are not practiced. Forecasts for the coming year are based mainly on:

1. Executive opinion, and
2. past experience.

In fact, sales of industrial enterprise is related to a number of internal and external factors such as industrial production, volume of trade, commodity prices, wholesale prices, national income, level of employment, exports, and imports. Some of these factors are external and are beyond the control of management. There are quite a number of sales forecasting techniques to be employed by the executives. Among these, the easiest is to base forecasting decisions on executive opinion. This is a broad guess made by those people in charge of a business. Such forecasts can be made quickly and at little expense, however, the drawback of this method is that it lacks scientific validity.

The second technique is to depend on the estimates by salesmen. Salesmen presumably know more about their own sales districts than anyone else in the organization. This is a body of information that becomes a fairly reliable forecast as it goes through the hands of managers in the central office.

The other techniques can be mentioned as statistical sampling, historical background, and statistical projection. These look for detailed sales records by items and sales territories. Historical data is used to predict both level and pattern of sales. Here, it is possible to use annual sales figures and five or ten year moving averages.

Another statistical technique is regression or correlation analysis. The basic principle is to use information about one activity that leads to another activity in forecasting the sales of the latter, then this is called a multiple correlation. The thing to notice here is not to use production figures for the analysis because production and sales in most cases do not coincide.

The problem of forecasting the quantity is to predict the sales, with some degree of certainty, at some future date. It is possible to distinguish between different types of fluctuations in sales. Primarily, sales may be subject to irregular fluctuation, the causes of which are never completely known. Some such fluctuations are purely temporary, and will be quickly offset by later changes in the opposite direction. Failure to recognize temporary fluctuations as being such leads to forecasts having too much variability. The second type of fluctuations is due to trends. Trends are produced by long term influences on the level of sales. Thirdly, there are seasonal influences on sales. These influences are cyclical, but they may change character with time. Irregular fluctuations and trends complicate the problem of separating out the strictly seasonal parts of such influences. Finally, there are relations between the sales of a company and some other variables in the total economy. The level of activity in the total economy and in the industry will have a direct impact on the sales of any one company.

Erroneous forecasting leads the management into a number of problems. On the other hand, a sales forecast based on a careful analysis of external factors is the foundation for planning all aspects of a company's operations. One way of improving management control is to have reliable sales information. If the sales data is good enough, then the management will be willing to give it much more weight in scheduling production than the actual orders received at the factories. Inventories can be manipulated more efficiently and as a result capital can be used more effectively. Customers can be kept happy by being supplied the products they want as soon as they want them and this, in the long run contributes to the good will of the enterprise.

The inventory turnover ratio for the years 1964 and 1965 was found to be a little above 2.00 for Sümerbank. The discussion in Chapter V and the calculation of turnover ratios indicated that Sümerbank generally carries a finished goods inventory equivalent to about 5 months' sales. An apparent aspect of the problem is that there are inventory pile-ups in the storehouses. The unexpected aspect of the problem is that some of the storehouses do not have the adequate finished goods inventory to meet the demand. Thus, there is a conflicting situation where most of the storehouses carry several months' supply of finished goods while some others are in urgent need for inventories to meet the customers' orders. It has been stated in the previous pages that one way of manipulating inventories more efficiently is to have reliable sales data and to develop accurate sales forecasts.

What are the most up-to-date methods for developing reliable sales forecasts? Here, let us introduce the results of a survey made recently by APICS (American Production and Inventory Control Society).[1] This extensive survey covered 387 plants in the United States, and it was found that the most important factor in planning production is the forecast. In a good many plants, it is done by executive opinion and most of the forecasting is limited to less than four months in advance, while about 40 percent tried to extend it to a year. Less than 20 percent of the companies placed any faith in the estimate of the customers. The number of companies using the statistical methods for forecasting was surprisingly low. The most interesting of all was that 138 out of 387 plants representing a good 35.7 percent, developed sales forecasts by historical averages adjusted by latest sales information.

Forecasts of individual product sales are always needed for the operation of an inventory control system. This is true for Sümerbank as it is true for all industrial enterprises. Forecasts must be made quickly, cheaply and easily. The number of pieces of information required to make a single forecast must be small so that the total amount of information required for all product types will not be expensive to store and to maintain. It should also be possible to introduce current sales information easily.

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[1]James H. Greene, Production Control, Illinois: Richard D. Irwin Inc., 1965.

Now, let us describe the type of forecasting technique most desirable by the Sümerbank ASM. It is a given fact that a good portion of forecasting is based on the past and current data on sales of individual woolen fabric types. This body of information comes from the sales outlets and is collected and classified in the statistics department. Building a model on this data will synchronize and automate the activity of forecasting. The properties of the model should be such that:

1. Forecasts are computed rapidly.
2. Only a limited amount of information is needed namely, the past and current sales data on each of the fabric types.
3. Only a limited amount of information is required to be stored.
4. The forecasting technique should be such that no additional information gathering costs are imposed upon the management.
5. Seasonal effects on sales are handled automatically.
6. Sales forecasts for the coming periods should be corrected for observed error in the preceding forecast.

In the light of these, forecasting sales of products by exponentially weighed moving averages will be discussed.

Exponential Smoothing[1]

This method has been developed by Robert G. Brown of Arthur D.

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[1] Based on Chapter 14 of Holt, Modıgliani, Muth and Simon, Planning Production, Inventories and Workforce, New Jersey: Prentice Hall, Inc., 1960.

Little, Incorporated.[1] Exponential Smoothing does not explain sales changes but simply extrapolate a sales time-series. The only input to the forecasting system is the past history of sales of the item; no direct information concerning the market, the industry, the economy, sales of competing and complementary products, price changes, advertising campaigns, and so on is used. This method has the desirable characteristics that were mentioned in the previous page. For products with stable sales rates, the simple exponential model proves quite satisfactory. In the case of Sümerbank woolen fabrics, however, it is worthwhile to extend the exponential system to take into account seasonal effects since the fabrics have marked seasonality patterns.

The simplest form of the exponential forecast is appropriate to predicting sales of a product with no definite seasonal pattern. The assumption involved in forecasting is that fluctuations in sales are made up of two kinds of random components: one lasting a single period of time, and the other lasting through all subsequent periods. The estimate of the permanent component is changed in each period, as additional sales information becomes available, by an amount proportional to the most recently observed error. The observed error is given in the model as the difference between the estimated sales at a certain period t and the actual sales.

Observed error = Actual sales in t - Estimated sales in t

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[1] Robert G. Brown, Statistical Forecasting for Inventory Control, New York: McGraw-Hill Book Co., Inc., 1959.

Here t can be any time period involved; it can be a month or a year. The choice on t is perfectly arbitrary.

Let actual sales in time period t be denoted by S_t and the estimated sales by $\overline{S}_{t-1}$. The sales forecast for the coming period will be given by the model

$$\overline{S}_t = \overline{S}_{t-1} + w_e (S_t - \overline{S}_{t-1}) \qquad (7.1)$$

The sales estimate for the coming period is equal to the sales estimate for the current period which has been predicted in the previous period plus the observed error in the estimation for the current period multiplied by an exponential factor w_e.

$\overline{S}_t$ = Sales estimate for the coming period

S_t = Actual sales in the current period t

$\overline{S}_{t-1}$ = Sales estimate for the current period which has been done in the previous one.

w_e = exponential factor.

The limitation on w_e is that $0 \leq w_e \leq 1$. The choice on the value of w_e is perfectly arbitrary. If it is preferred to depend the forecast heavily on the recent information, then w_e should be nearly unity so that adjustments are made faster. In the case that recent sales information is thought of to tell little about the future, then it is given a smaller weight than the previous case and the value of w_e approaches zero. The forecasting proceeds smoothly as $\overline{S}_t$, sales estimate for the coming period is compared with the actual sales that take place in the same period, to get the observed error in period $t + 1$. In other words, this time S_{t-1} is compared with $\bar{S}_t$ and the model for two periods hence takes the form:

$$\bar{S}_{t-1} = \bar{S}_t + w_e (S_t - \bar{S}_t)$$

It is obvious that forecasts involve only the coming period and are developed in a stepwise fashion. Assuming we are in period t, it is possible to forecast only for t+1. As period t+1 is reached and the data on sales for t+1 is obtained, then it becomes possible to make predictions for t+2.

On the basis of this simple one, it is possible to develop a forecasting model with a seasonal effect. Let the actual sales in period t be denoted by S_t, and the estimate of the seasonally adjusted sales rate in period t by $\bar{S}_t$. The periodicity of the seasonal effect is L; with an annual seasonal, L would be 12 months. The model is then

$$\bar{S}_t = w_e \frac{S_t}{F_{t-L}} + (1-w_e)\bar{S}_{t-1} \qquad (7.2)$$

where $0 \leq w_e \leq 1$, for the estimate of the expected seasonally-adjusted sales rate in period t, and

$$F_t = w_F \frac{S_t}{\bar{S}_t} + (1 - w_F) F_{t-L} \qquad (7.3)$$

where $0 \leq w_F \leq 1$, for the current estimate of the seasonal factor for period t. In equation (7.2), $\bar{S}_t$ is a weighted sum of the current estimate obtained by removing the seasonal effect in current sales S_t, and last period's estimate, $\bar{S}_{t-1}$, of the seasonally adjusted sales rate for the series. In obtaining the current estimate of $\overline{S}_t$, from S_t/F_{t-L}, the most recent estimate of the seasonal effect for periods in this place in the cycle has been used. This corresponds to using the seasonal factor computed for May of last year to adjust this year's May data. The value of $\overline{S}_t$ calculated from Equation (7.2) is then used in forming a new estimate of the seasonal factor corresponding to the current month in Equation (7.3). This new estimate, F_t, is again a weighted sum of the current estimate, $S_t/\overline{S}_t$, and the previous estimate, F_{t-L}, for periods in this position in the cycle.

A forecast of the expected sales in the next period would then be made with:

$$S_{t,1} = \overline{S}_t F_{t-L+1} \tag{7.4}$$

where $S_{t,1}$ is the forecast made at the end of the current, or t'th period, for the following period. More generally, a forecast of the expected sales T periods into the future has the form

$$S_{t,T} = \overline{S}_t F_{t-L+T} \tag{7.5}$$

where $T \leq L$, for any period not more than one cycle away.

It can be seen that $\overline{S}_t$ is revised every period, but the F's are revised only once per season. Now, let us consider the problem of selecting initial values of $\overline{S}$ and the F's. For the initial estimate of $\overline{S}$, the general practice is to use the average sales for the first year. It is assumed that month is chosen as the period. To get the initial values of F, the average sales per month for each year is computed. Secondly, seasonal factors are computed for each month, $t = 1$ to $t = 12$. Seasonal factors for corresponding months in each of the initial years are averaged to obtain one seasonal factor for each month in a year. For example, the F's are averaged for all the Januaries to get a single January seasonal factor. Finally, the seasonals are normalized so that they add to L; for 12 periods to a year, the summation is supposed to equal 12. This step is made to insure that over a cycle the seasonal factors make only seasonal adjustments, and do not increase or decrease the average level of sales.

It is possible to extend the technique further by including the trend factor into the estimates. However, this last step will be of very little use to the estimates because as it was pointed out in Chapter II, sales of woolen fabrics do not have a linear trend. For that reason, it is assumed that forecasting both with ratio seasonals and linear trend will simply increase the quantity of computations to be made without any appreciable effect on the accuracy.

The studies on this method lead to the conclusion that exponentially weighted forecasts perform rather well. The forecasts automatically adjust to changes in sales characteristics, without responding very much to random fluctuations. The formulas are easy to use and may be adapted to different product types.

Another version of Exponential Smoothing is given by James H. Greene.[1] Here the basic model is:

[1]James H. Greene, Production Control, Illinois: Richard D. Irwin, Inc., 1965.

$$E_2 = E_1 + \alpha (D_1 - E_1) \qquad (7.6)$$

where E_2 = New estimate

E_1 = Last estimate

D_1 = Current demand

α = Smoothing constant

This is same as (7.1). The greater the difference between the estimate made for the last period and the actual demand this period $(D_1 - E_1)$, the greater will be the adjustment for the next period. If the value of the smoothing constant is small, the response will be slow and gradual. A value such as 0.5 will cause a quick response. In the United States, companies have found 0.1 is a satisfactory smoothing constant.

Let us convert equation (6.6) into the form

$$E_2 = \alpha D_1 + (1 - \alpha) E_1 \qquad (7.7)$$

New estimate = α (Current Demand) + $(1 - \alpha)$ (Last Estimate)

If the new estimates are accumulated over a number of estimating periods, the last estimate of the above equation could be replaced by the new estimate of the period before. This will include a last estimate again, which can be replaced by the appropriate new estimate and this procedure can be carried on indefinitely. Last estimate in (6.7) can be replaced by,

Last Estimate E_1 = α (Last Demand) + $(1 - \alpha)$(Previous Last Estimate)

and Equation (7.7) takes the form,

New Estimate = $\alpha D_o + (1 - \alpha)(\alpha D_1 + (1 - \alpha)$(Previous Last Estimate) where D_o = Latest demand

D_1 = Demand one month ago

D_k = Demand k months ago

P.L.E.= Previous last estimate

Let us extend the subscripts back in time one more period,

$$\text{New Estimate} = \alpha D_o + \alpha(1-\alpha) D_1 + (1-\alpha)^2 \left[\alpha D_2 + (1-\alpha)\ \text{PLE}\right]$$

Extending the subscripts further back in time gives:

$$\text{New Estimate} = \alpha D_o + \alpha(1-\alpha) D_1 + \alpha(1-\alpha)^2 D_2 + \dots + \alpha(1-\alpha)^{k-1} D_{k-1} + (1-\alpha)^k \text{ estimate made k months ago}$$

This process is to be continued long enough so that the factors $(1-\alpha)^k$ become smaller, and the early information has no appreciable effect on the present estimate.

The only drawback of this method in the case of its application in Sümerbank is that this version of smoothing responds to random changes. If there is a consistent seasonality in sales, the estimates will be biased and will fall below the demand at certain months of the year and rise above it at others.

By using the moving average forecast method a few minutes of arithmetic applied to available data will produce sales forecasts for Sümerbank woolen fabrics. After judgemental review and revision, these forecasts can be used for manipulating inventories and planning production. Any decision settling the production schedule is a good or a poor decision depending upon what sales are realized after the decision was made. A decision is not good or bad in itself, but is relative to what happens during the time in which the influence of the decision is being felt. At the time a decision has to be made, the probable outcomes of each of the alternatives is uncertain, since each depends partly on the unknown future.

Now let us link the concept of forecasting and of inventory control together. The inventory control function deals with problems associated with storing something to meet future demand. There are costs associated with storing and with not storing as have been discussed in Chapter II. This suggests that the decision problem of how much to store can be formulated in terms of the minimization of the sum of these two kinds of costs, which can be called the total costs. The costs associated with storing like insurance, handling, storage, and cost of capital increase as the amount stored increases. The costs associated with not storing decrease as the amount stored increases. The total costs are a function of the amount stored and the problem is to determine that amount to be stored which minimizes these total costs. Costs associated with storing tend to increase in the presence of the excess amount of inventory that has resulted from forecasting errors. Similarly, costs associated with not storing such as back-order costs discussed in Chapter II tend to increase due to forecasting errors, usually are underestimation of demand. Forecasting errors, therefore, that are minimized through models applied to the usual inventory decision problems can result in very significant savings. The most accurate forecast method, however, is not always the best, since the cost of obtaining the forecasts may exceed their value in improving the quality of decisions. On the basis of this, an Exponential Model had been suggested in this chapter, labeled as 7.2, 7.3, 7.4, and 7.5.

This exponentially weighted moving average forecast method based on past sales will yield better results on both the forecasts of the aggregate woolen fabric sales and that of the sales of individual types when compared to indefinite judgemental methods. Such forecasts are proposed to be applied at the ASM level rather than in individual retail outlets since the former is assumed to be the coordinator of the Sümerbank mechanism and has a broader view of the system in its entirety. The forecasts rely on information that is readily available, and it is very easy to compute. There would seem therefore to be little excuse for tolerating forecasts poorer than those obtained by this simple method.

The essence of the moving average forecast method was this. Seasonal influences are observed once a year, and hence several years' sales data are needed to get reasonable estimates of the magnitudes of recurring seasonal influences. In the simple method that is proposed, the January sales of several years are added together, February sales similarly, and so on. Dividing the total sales in any month by the total annual sales gives an index of the percentage of the annual sales that usually falls in that month. This is exactly the same method that was used in Chapter III to obtain the seasonality index of the aggregate woolen fabric sales. Applying the index to the moving average of sales gives a forecast for a future month.

It has been mentioned previously that data on the sales of woolen fabric types is collected, classified and evaluated each month in the Statistics Department. Since different versions of Exponential Smoothing require limited amount of information, namely, the sales date of each item, the application of this technique will not lead to additional costs of information gathering. The only additional work will be the computation phase of the forecasting which is to be handled by the 11 members of the Statistics Department.

Introduction of this forecasting model coupled with the possibilities of making refinements in the production program discussed in Chapter VI will improve two of the main problem areas encountered in inventory management. However, it is not possible to design the entire control system without considering the third problem area, namely, the lead times involved which is the subject of the coming chapter.

Illustration of the Method

In this section, the application of the method will be illustrated by giving an actual example from the Sümerbank enterprise. The illustration will be based on data given in Chapter III on total woolen textile sales in different months of the years 1961 through 1965. The 5 years' sales data is needed to get reasonable estimates of the magnitudes of seasonal influences. The January sales of several years are added together; other months' sales similarly. The total sales in any month is divided by the total annual sales giving an index of the percentage of the annual sales that usually falls in that month.

On the basis of this, the following indexes are obtained:

Month	Index	Month	Index
January	76.3	July	66.2
February	153.5	August	118.0
March	64.9	September	130.9
April	78.7	October	133.1
May	61.7	November	112.8
June	76.8	December	127.1

The total of the index numbers add up to 1200. For the sake of simplicity, the index numbers are used by shifting the decimal point two places to the left such as January factor 0.763, February factor 1.535, etc. Now let us assume that we have collected this data in five years and will start using it by the January of 1966 to forecast sales. A forecast of the expected sales in January 1966 will be made by

$$S_{t_1 1} = \overline{S}_t F_{t-L+1} \quad \text{where}$$

$$\overline{S}_t = w_e \frac{S_t}{F_{t-L}} + (1 - w_e)\,\overline{S}_{t-1} \quad \text{and}$$

F_{t-L+1} = seasonality factor for January which is 0.763.

It is assumed that presently we are at the end of December 1965. Then t is the period December 1965, t-1 is the November of 1965 and F_{t-L} is the seasonality factor for December 1965. To start with the forecasting procedure it is necessary to choose a base which is $\bar{S}_{t-1}$, namely, the sales forecast for the present period December 1965. Since we did not have a forecast for that period, we start the analysis by assuming that the sales forecast for period t had been made by averaging the 5 years' sales in Decembers.

$$= \frac{0.395 + 0.445 + 0.618 + 0.321 + 0.458}{5}$$

$$= 0.447 \text{ million meters of woolen cloth.}$$

This figure represents the base to start the forecasting. It is indicated that 447,000 meters of woolen fabrics was the forecasted sales for December. This is a perfectly assumed figure. Now let us start the forecast for January 1965.

$$\bar{S}_t = w_e \frac{S_t}{F_{t-L}} + (1 - w_e)\, \bar{S}_{t-1}$$

where S_t = Actual sales in December 1965 which is 0.458 million meters.

F_{t-L} = Seasonality factor for December which is 1.271.

$\bar{S}_{t-1}$ = Expected sales in December which is the base, 0.447 million meters.

w_e = 0.1

This choice of w_e is perfectly arbitrary and it is assumed that we have chosen 0.1 because we do not want random variations in sales effect the forecast.

$$\bar{S}_t = 0.1\,\frac{0.458}{1.271} + 0.9\,(0.447) = 0.4383$$

The sales forecast for January 1966 will be

$S_{t_1 1} = (0.4383)(0.763) = 0.334$ million meters of woolen fabrics.

At the same time, we have to make adjustments in the seasonality factor for December according to

$$F_t = w_F \frac{S_t}{\bar{S}_t} + (1 - w_F) F_{t-L}$$

where w_F is chosen as 0.1.

$$F_t = 0.1 \frac{0.458}{0.4383} + 0.9\,(1.271) = 1.248$$

Now, we have found two things. The first is the sales forecast for January 1966 and the second is the new seasonality factor for December, to be used in December of 1966. From this point on, 1.271 is forgotten and the new factor of 1.248 will be used to forecast in December of 1966.

The actual woolen fabric sales realized in January 1966 was given by Sümerbank as 312 817 meters. It is realized that the forecast and the actual deviate by

$0.334 - 0.313 = 0.021$ millions of meters, which is equivalent to

$$\frac{0.334 - 0.313}{0.313} \times 100 = 6.7 \text{ percent deviation.}$$

Now, let us try to forecast the February sales assuming the January of 1966 has ended. The actual sales in January was 0.313 million meters compared to the forecast of 0.334.

$$\bar{S}_t = 0.1 \frac{0.312}{0.763} + 0.9\,(0.334) = 0.3416$$

$$S_{t_1 1} = (0.3416)(1.535) = 0.524 \text{ million meters.}$$

Here, 1.535 is the seasonality factor for February, 0.763 the seasonality factor for January and 524000 meters is the forecast for February 1966.

Similarly,

$$F_t = 0.1 \frac{0.312}{0.3416} + 0.9\,(0.763) = 0.778 \text{ is}$$

the new seasonality factor for January to be used 12 months from now. Actual sales in February 1966 is given by Sümerbank as 466283 meters of woolen cloth. This corresponds to a deviation of

$$\frac{0.524 - 0.466}{0.466} \times 100 = 12.4$$ percent between the forecasted and actual sales in February 1966.

Now let us extend the forecasts, a couple of periods ahead. Assume that based on the February data, we want to forecast September sales. This is a forecast of expected sales 7 periods or months into the future.

$$S_{t_1 7} = \bar{S}_t F_{t-L+T} = \bar{S}_t F_{t-12+7}$$

$$= \bar{S}_t F_{t-5} \quad \text{where}$$

F_{t-5} = seasonality factor for September 1966.

$$\bar{S}_t = 0.1 \frac{0.466}{1.535} + 0.9\,(0.524) = 0.5020$$

$$S_{t_1 7} = (0.5020)(1.309) = 0.648 \text{ million meters.}$$

Actual sales in September 1966 is given as 632866 meters of woolen fabrics. The deviation between the actual and the forecasted is

$$\frac{0.648 - 0.632}{0.632} \times 100 = 2.52 \text{ percent.}$$

These examples on the application of the method are given to provide a rough idea on what the technique is capable of doing. Exponential Smoothing does not respond quickly to random ups and downs in sales. At this point, it is proposed to apply this method solely to sales by retail rather than the aggregate sales. This is because aggregate sales include also the official sales which are to government orders and involve periodic and large batches of shipments. Including a big party of official sales in any of the month's sales figures introduces a bias and threatens the reliability of the forecasts.

CHAPTER VIII

PROBLEMS ASSOCIATED WITH LEAD TIMES

It had been discussed in Chapter VI that Sümerbank factories maintain an inventory of the products and ship from stock on hand. This situation has two dimensions:

1. A stockout condition at the factory, especially if it is of considerable duration, increases the probability of stockouts at the retail outlets. The probability that a factory stockout will in fact cause stockouts at the retail outlets also increases with increasing lead time.
2. Duration of the lead time has a direct impact on the inventory levels given by the equation $I = S \times T$, and therefore a direct impact on the inventory holding costs. In this equation,

   I = Movement or trigger inventory. When the inventory of the products at the retail outlets decline to a certain level called the movement or trigger level, an order has to be placed with the plants for the shipment of goods to those retail outlets. The level is determined by S and T where,

   S = sales rate in meters of product per day,

   T = lead time in units of day.

An increase in the duration of lead times has a direct effect on the level of inventory at the retail outlets and therefore on the level of inventory holding costs. Let us visualize the situation by giving an example:

The sales rate of a certain retail outlet is 10 units of product per day. The lead time involved in obtaining the product is 10 days. In this situation,

$$I = S \times T = 10 \frac{\text{units}}{\text{day}} \times 10 \text{ days} = 100 \text{ units}$$

that is, the plants should be informed that a shipment to the retail outlet is required as soon as the level of inventory in the outlet is depleted to 100 units. In this way, the lot will be received by the retail outlet as soon as the stock at the outlet reaches the point of zero units and no actual stockouts will occur.

The same equation indicates that a shortening of 20 percent in the lead time is followed by a 20 percent decrease in the movement inventory level and therefore a decline in the inventory holding costs is achieved. Following the same line of logic, a shortening of the lead time within the entire distribution system decreases the level of movement inventory and the probability of stockouts in the distribution channels. Probability of stockouts is decreased because a decline in the movement inventory ensures a better distribution of goods to the retail outlets.

The average lead time in the system has been given as 55 days in Chapter IV where 35 days involve the flow of information to the plants and the remaining 20 days the transportation of goods from the plants to the sales outlets.

Analysis

Let us start the analysis by giving a complete list of the Sümerbank sales outlets:

1. ADANA
2. Kumköprü
3. Abidinpaşa
4. Ceyhan
5. Tarsus
6. Osmaniye
7. Kadirli
8. İskenderun
9. ADAPAZARI
10. Düzce
11. Bolu
12. AMASYA
13. Merzifon
14. ANKARA
15. Ulus
16. Yenidoğan
17. Yenimahalle
18. Hamamönü
19. Yenişehir
20. Gülveren
21. Bahçelievler
22. Cebeci
23. Kırıkkale
24. Polatlı
25. Çubuk
26. Nallıhan
27. Haymana
28. Aksaray
29. KIRŞEHİR
30. NİGDE
31. ÇANKIRI
32. ÇORUM
33. YOZGAT
34. ANTAKYA
35. ANTALYA
36. ARTVİN
37. AYDIN
38. Söke

39. Nazilli
40. BALIKESİR
41. Bandırma
42. Gönen
43. Edremit
44. BURDUR
45. BURSA
46. İnegöl
47. M. Kemalpaşa
48. ÇANAKKALE
49. Biga
50. DENİZLİ
51. DİYARBAKIR
52. Silvan
53. BİTLİS
54. MARDİN
55. SİİRT
56. BATMAN
57. EDİRNE
58. Uzunköprü
59. ELAZIG
60. BİNGÖL
61. MUŞ
62. ERZİNCAN
63. ERZURUM
64. Karaköse
65. Bayburt
66. ESKİŞEHİR
67. İkieylül
68. AFYON
69. BİLECİK
70. KÜTAHYA
71. GAZİANTEP
72. Kilis
73. Nizip
74. Islahiye
75. ADIYAMAN
76. MARAŞ
77. GİRESUN
78. Görele
79. Tirebolu
80. ISTANBUL
81. Bahçekapı
82. Beyoğlu

83.		Kasımpaşa	106.		Ödemiş
84.		Üsküdar	107.		Tire
85.		Harbiye	108.		Bergama
86.		Aksaray	109.		Menemen
87.		Beşiktaş	110.		Turgutlu
88.		Eyüp	111.		Alaşehir
89.		Kadıköy	112.	ISPARTA	
90.		Fatih	113.	KARS	
91.		Gedikpaşa	114.		Sarıkamış
92.		Bakırköy	115.	KASTAMONU	
93.		Beykoz	116.		İnebolu
94.		Pendik	117.		Tosya
95.		Zeytinburnu	118.	KAYSERİ	
96.		G. Osmanpaşa	119.		Develi
97.		Harbiye	120.	NEVŞEHİR	
98.		Yalova	121.	KIRKLARELİ	
99.	İZMİT		122.		Babaeski
100.	İZMİR		123.	KONYA	
101.		Kemeraltı	124.		Samanpazarı
102.		Karşıyaka	125.		Ereğli
103.		Basmahane	126.		Karaman
104.		Eşrefpaşa	127.		Akşehir
105.		Tepecik	128.	MALATYA	

129. MANISA
130. Salihli
131. Akhisar
132. MERSİN
133. Silifke
134. MUGLA
135. Milas
136. ORDU
137. SAMSUN
138. Bafra
139. Çarşamba
140. SİNOP
141. SIVAS
142. Zile
143. TOKAT
144. TEKİRDAG
145. Çorlu
146. TRABZON
147. Vakfıbekir
148. GÜMÜŞHANE
149. RİZE
150. URFA
151. Siverek
152. UŞAK
153. VAN
154. HAKKARİ
155. ZONGULDAK
156. Soğuksu
157. Bartın
158. Karabük
159. Ereğli

The complete list of 165 sales outlets given in Chapter IV can be reached by adding to these the three sales outlet directorials in Ankara, İzmir and Istanbul and the three warehouses. The 65 names written in capital letters indicate that Sümerbank has expanded its sales outlets to 65 cities in Turkey. The other 94 names indicate the localities of the outlets in terms of towns. The present situation in the system is given by the list of the Sümerbank plants in Chapter I and this recent list as:

1. Sümerbank factories are widely distributed over Turkey rather than being concentrated in a so-called "industrial region."
2. Sümerbank sales outlets are similarly widely dispersed practically all over Turkey following the basic policy of providing optimal customer-service.

If the effects of 1 and 2 are coupled, the result comes out as an extremely complex communication and transportation network. Let us discuss the effects of the present communication and transportation networks separately in the coming pages.

A. <u>The communication system.</u> The organizational operations concerned with the communication network can be analyzed into:

1. Reception of information
2. Processing of information
3. Transmission of information.

In the Sümerbank system, all sales outlets feed the Statistics Department of ASM with the information on their monthly sales of all textile fabric items, and their month-end stock levels. This is the reception of information by the ASM which has a duration of 20 days as have been illustrated in Chapter IV. This information is collected, classified in the Statistics Department and presented to the Textile Department executives in the ASM. This step is the processing of information in the ASM and has a duration of 5 days. Evaluation is done in the Textile Department in terms of:

1. Speeding up the flow of goods to those outlets that sell reasonably well and need more inventories.
2. Slowing down the flow of goods to those that seem to have inventory pile-ups.

This analysis is followed by an instruction to the plants on what types and quantities of fabrics to send to each sales outlet. This is the transmission of information and has an average duration of 10 days, thus the total duration of the information flow adds up to 35 days. The basic characteristic of this flow is that it is dominantly in written form and actually very little oral communication is practiced.

The defects in this network can be summarized as:

a) Information collected and processed too slowly;

b) channels of communication overloaded;

c) Conflicting value judgements of the ASM and the retail outlets.

Let us start with the delays in the collection and processing of information. All sales outlets are supposed to turn in a monthly report on their sales and month-end stock levels. In practice, some retail outlets send this report in immediately at the beginning of the following month whereas a majority of them do it at a delay of 10 or even 15 days. Since the Statistics Department cannot process the information until all reports are in, a considerable amount of time is lost in the collection and classification of information. It has been found out that the main reason for this delay is the lack of capable personnel in most of the retail outlets. Almost all of the daily business operations in the outlets is done by a chief-in-charge and those outlets that cause delays in sending in the monthly reports are the ones that do not have additional qualified personnel besides the chief-in-charge.

ASM exerts a centralized control over the management of inventories by collecting, processing, and transmitting information and this causes an overload in the channels of communication that connect ASM with the individual sales outlets and plants. Now, let us consider the effects of this overload together with those of conflicts of opinion within the system. The essence of the conflict in the value system is this: The individual sales outlets are usually dissatisfied with the shipments they receive from the plants and press the ASM every now and then to increase the shipments. This is mainly due to the fact that each outlet evaluates the situation from its point of view without taking the entire system into account. They claim that they can sell more if they have more. However, ASM is in a situation to feed each sales outlet in proportion with its sales potential rather than causing the concentration of goods in a few. This automatically eliminates the possibility of decentralizing the control and permitting all outlets to place their orders directly with the plants without passing through the one single coordinator in the system, namely, the ASM. The situation has been experimented in the past and it has been found out that total of the orders from the outlets exceeded the production capacities of plants by a considerable amount. In business practice, faster order handling is often suggested as a quick and easy step toward better management control. There are mainly two types of orders in an actual business situation:

1. Orders which directly reflect sales;
2. Orders that adjust inventories with changes in business volume. This involves a gradual upward and downward movement in inventories as the rate of sales increases or decreases.

The orders in process are proportional to the level of business activity and to the length of time required to fill an order. Both an increased sales volume and an increased delivery lead time result in increased total orders in the supply pipeline. The ordering rate also depends on some presumption about future sales. Due to the length of the lead time and presumptions about future sales, Sümerbank retail outlets increased both the number of orders and the quantity involved in each order. As factory deliveries became slower, outlets began to order further in advance of their needs and still more orders were put into the system. As a result of the seasonality of sales and hopeful expectations of the outlets during those months when the demand rose, orders to the factories exceeded their capacities. Therefore, the possibility of decreasing the load of certain communication channels by putting in new ones was eliminated due to the conflicting view points in the system on evaluating the current information. The authority to have a direct channel connecting the outlet with the plants, by-passing ASM, is currently delegated to only a few outlets that have sales figures above a specified level.

B. The transportation system. In the case of a single plant supplying its products nationally, it has to ship to each of the retail outlets carrying the products. The single plant is the only source of supply. The situation in the Sümerbank system is quite different where there are several origins of the goods to be transported and a large number of possible destinations. Theoretically, as the number of sales outlets and factories increases, the total number of possible different ways of transporting the required amounts to the various retail outlets increases with such rapidity that it becomes impossible to manage it in an optimal way. This is called the many location effect in operations research and accounts for the need to consider the whole inventory system as an integrated entity.

Practically no industrial enterprise in Turkey distributes its goods by using its own transportation facilities. The common practice employed by a great majority of the firms is to make a contract by one of the transportation companies on an annual basis. Similarly, Sümerbank invites a number of transportation companies to bid for contracts. Each company interested in obtaining a contract submits a closed bid and the one submitting the lowest bid gets the contract. The chief merit in working with the transportation companies on annual contracts has its roots in the nature of transportation business in Turkey.

The current situation is that prices for transporting goods between any two points show considerable fluctuations among different seasons of the year. Especially during the September-November period, prices go up by 70 - 80 percent. This is mainly due to the cotton and beat production in the southern Turkey which attracts carriers in that direction by providing profitable business. An annual contract by one of the big transportation companies protects the managements against such fluctuations in price and releases them from the fear of not being able to find enough carriers to provide for the distribution of their products to the sales outlets.

Theoretically, in estimating the costs of alternative shipping carriers, one should not overlook the cost of having valuable inventory tied up while the vehicle is in transit. Usually this cost is not large but if it is taken into account, the costs of using faster rather than slow shipment procedures will be systematically lowered. Another economy associated with fast shipments is the fact that time in transit is one component of the lead time. It has been shown in Chapter IV that the interval of time elapsing between the point of time at which the instruction on the shipment of goods is received by the plants and the point of time at which goods reach the sales outlets averages around 20 days. It was found out that this is mainly due to the fact that goods to be shipped wait sometimes up to 15 days in the plant warehouses after the proper notification of the transportation company. It is assumed that the discussion on fast and slow shipments include not only the speed of the carrier but an additional delay such as this in the process of transportation. Before getting into the discussion of possible refinements in the system, it is worth mentioning again that shortening the lead time allows a reduction in the aggregate inventory level and in the associated costs.

Refinements in the System

In 1949 sales of Sümerbank goods were carried out in only 14 outlets whereas by 1967, this figure increased rapidly and reached 165. It has been found that 70 percent of the total textile fabric sales of Sümerbank is realized currently in the largest 17 outlets in the system. This means that less than 10 percent of the total sales outlets is capable of distributing 70 percent of the Sümerbank textile goods to the market. This implies intensive distribution that is maximum exposure to sale rather than a policy of selective distribution. This type of a situation is assumed to be more prevalent for consumer goods and "With the increase in number and variety of products offered for sale, proprietors find that their investment in inventory is gaining faster than their sales."[1] An investigation on the sales of 123 retail outlets of Sümerbank indicated that 55 had sales below 20 meters of woolen-cloth per day and only 26 had a sales potential above 50 meters of fabrics. This finds justification in the basic policy of Economic State Enterprises which is that of offering products for sale in as many as possible of the outlets where potential customers would expect to find it.

Number of Outlets	Average Daily Woolen Fabric Sales
19	4 - 10 meters
36	11 - 20 "
16	21 - 30 "
18	31 - 40 "
8	41 - 50 "

[1] Phillips, A.F., Duncan D.J., Marketing, Principles and Methods, Richard D. Unwin Inc., Illinois, 1960.

Number of Outlets (Cont'd)	Average Daily Woolen Fabric Sales
17	50 - 100 meters
9	Above 100 meters.

Existence of Sümerbank sales outlets at those places with very limited sales potential add very small increments to total sales. Therefore the basic policy of Sümerbank should be to expand the sales of the existing outlets rather than adding new retail stores, and channelizing goods to those that might otherwise be directed towards the existing ones. Freezing the number of sales outlets at the present level will also contribute to faster order handling by:

a) Leveling the load of the communication channels;

b) Keeping the number of lines in the transportation network constant.

Assuming no additional load is put into the communication channels and into the transportation network by increasing the number of possible destinations, let us discuss what can be done in terms of shortening the lead time.

Critically, the duration of the information collection phase had been given as 20 days. This was found out to be caused by the fact that in most of the outlets, the chief-in-charge is the person who does the computations, preparation and editing involved in the construction of the month-end reports. This is one of the responsibilities of the chief-in-charge among many others. Any problems encountered in the other activities pertinent to the retail outlet easily causes a delay in the preparation of this monthly report by the chief-in-charge. This delay is realized especially in those rather small enough to construct the report other than the chief-in-charge. The proposed solution to this situation will be:

1. Placing a clerk capable of performing the simple arithmetic involved in constructing the month-end report, into those outlets that do not have one. He will also be carrying the other clerical jobs of the outlet, but will concentrate on the construction of the report starting the first day of the successing month. It has been found out that someone good in arithmetic manipulations can easily finish the report in 2 days. The month-end reports will be edited by the chief-in-charge and mailed at the end of the third day.

2. The ASM will be placing a dead-line on the reports that they are to be mailed not later than the fourth-day of the month. Construction of the report by a clerk will prevent the chief-in-charge from treating it as an additional, take-home job. Including any delay that might occur in the postal-service, all of the reports will be in by the seventh day of the month.

Considering that information collecting had a duration of 20 days under the present system, the improvement corresponds to a shortening of two weeks in the lead time. This represents valuable time-saving and is the first step towards better management control.

The phases of information processing and transmission were given to have an average duration of 15 days. It is extremely difficult to make an objective analysis to reach at a conclusion of by how much this time interval can be reduced. Faster information processing and transmission can only be achieved at the ASM by reducing the clerical and data-processing delays to a minimum. An estimation of the average duration involved in the evaluation of data which connects processing and transmission phases is bound to be subjective. It can be a matter of hours, days or even weeks. The proposed refinement at this point had been the introduction of "Exponential Smoothing" that will synchronize the process of evaluating the data and developing forecasts that will act as an input to the instructions that are transmitted to the plants on the shipment of goods. The benefits may not be realized in the form of reduction of the time involved in transmitting the information but in a form that develops more solid forecasts based on current data and shipping instructions based on more solid grounds.

It has been mentioned earlier that time in transit is one component of the lead time, and it has been given as 20 days in the Sümerbank system. Since Sümerbank products are distributed to the retail outlets by means of a written contract made by one of the transportation companies on an annual or two-year basis, speeding the shipments up is a matter to be included among the articles of the contract. It is proposed that in preparing the articles, special emphasis should be put on the criteria of time in transit and it should be required of those transportation companies that present a closed bid to standardize the process of taking the goods from the warehouse and delivering them to the individual sales outlets. Promptness in the delivery of items is assumed to be as important as the costs involved in transporting. If the plants notify the transportation company as soon as they receive shipment instructions from ASM, a standard procedure that puts the company under the responsibility of delivering the goods to the specified locations in 10-days after the receival of the notification, will imply reduce the time in transit into half. In case the transportation company fails to do so, there will always be legal procedures provided by the articles of the contract.

It is concluded that by standardizing the processes of flow of information and goods, it is possible to shorten the lead time down to 30 days. Now let us see, what effects will this have on the entire system that has been analyzed in Chapters VI, VII and the present one.

1. Sümerbank has a periodic system of placing orders, which has the monthly reports from the sales outlets as its input and instructions on the shipment of goods as the output. Sales outlets stand in the distribution system between the factories and final customers. On the sales side the outlets face a demand from customers that is subject to seasonal fluctuations. On the supply side, the outlets face a significant lead time for receiving shipments of products. The lead time T is required to obtain the shipment; the order for, say the June period must be initiated 55 days in advance so that goods be received by the beginning of June. Since,

   $I = S \times T$ where

   I is the trigger or movement level of inventory, which indicates the point of time at which an order must be placed, any shortening in the lead time lowers the level of aggregate inventory at the retail outlets. This reduction in the inventory level is in direct proportion with the reduction in the lead time. As have been illustrated, a reduction in the lead time to 30 days in the case of Sümerbank lowers the aggregate inventory in the distribution system by

$$I = 25\ S \quad \text{where}$$

S = Average daily sales rate.

Similarly, since inventory holding costs are assumed to increase linearly with the level of inventory, this means a proportionate decrease in the associated carrying costs in the distribution system. A decrease in the aggregate level of inventory in the system, assuming the sales remains constant, increases the turnover ratio by the same proportion.

2. A shortening of the lead time and achievement of faster information collection and processing by the ASM provides for the application of refined methods of forecasting, namely, the "Exponential Smoothing," at the management level. Exponential method of forecasting can both be applied to the aggregate and individual inventory items by the same effectiveness if up-to-date sales data is available. In this way, the process of evaluation of the current data and its transmittance is synchronized rather than depending solely on executive judgement. This is a method of producing forecasts inexpensively through the use of simple forecast formulas. Seasonal variations are taken into account by performing a few

additions and multiplications with a minimum of data.

3. It was found out that sales in the August - February period constitute 70 - 72 percent of the total annual sales of Sümerbank.[1] This indicates that there is a normal selling season for Sümerbank woolen fabrics that start late in summer. The colors and patterns are usually introduced to the market at the start of this selling season. It has been mentioned earlier that if fabric types, patterns and colors selected for inventory anticipation are improperly chosen, a sizable amount of goods is left unsold after the end of the normal selling season. To prevent costs and risks of obsolescence and to avoid disposal through distress sales which result in an out of pocket cost, let us propose the following on the basis of the discussion on forecasting methods and lead times:

The selection of types, colors and patterns anticipated for the selling season is introduced early in August. The ASM waits for the month-end reports coming from the sales outlets. The sales data is collected and processed by ASM early in September and forecasts are developed on the basis of exponentially weighted moving averages. These forecasts serve mainly two purposes:

a) Regulating the shipment of goods to the sales outlets.

b) Regulating inventories by correcting for observed error in the preceding forecast and removing the emphasis on hard to move inventories.

Evaluation of the August sales data and resulting instructions will be received by the plants before the end of September. If the situation dictates a change in the allocation of the production capacity to various items, this will gradually be performed by the plants. It has been discussed in Chapter VI that shifting the production from certain types of fabrics to others can be fulfilled in one month including the different arrangements to be made within the facilities. This means that before the end of October, production will be fully adjusted to the consumer demand and the remaining part of the selling season until February will be held under control. It is also possible to make further adjustments in the production capacity based on the September and October sales data. However they are considered as being minor variations that can be fulfilled at a time period less than 30 days. At this point, it is worth mentioning once more that the only problem encountered in making changes in the allocation of capacity is the nature of looms in the weaving department, which has been discussed in Chapter VI.

The described alternative has the chief merit of preventing the deviations between the initial forecasts and the actual demand be absorbed in inventories for certain items and sales backlogs for others. The planning process starts with a forecast for the season of price and volume by consturction. As the reason gets under way, if actual sales deviate from the original forecast to a point where a new allocation in the production capacity is needed, the management will be able to handle this before the middle of the normal selling season is reached.

This discussion is purely related to the production and selling of customer-type woolen fabrics of Sümerbank. The other part of Sümerbank production, that is, production to government orders has a specified construction and delivery date and carry practically no risks of obsolescence as have been discussed in Chapter VI.

CHAPTER IX

SUMMARY

In this particular case of Sümerbank, one of the largest industrial enterprises of Turkey, it is extremely hard to design a unique method of solving the inventory control problems. The complexity of the problem is mentioned with the hope that no false expectations will be placed in a particular technique that will immediately improve the effectiveness of the entire system. The potential gain involved in a successful attack to the problem is the production of peripheral benefits by searching for a solution which contribute to a better understanding of the system and the problems themselves.

Inventory control function is involved with the management of stock levels. The methodology used throughout this thesis was to follow the lines of a systems analysis approach. Therefore, the management of stock levels is discussed not only as an input to the production control system, but also as a system in itself, for the information from the inventory system is an input to the forecasting and communication systems, as well as to the production system. The inventory function is also a system with inputs from the production, forecasting and communication functions.

The current practice employed in the Sümerbank system is maintaining a constant production rate and allowing inventories to fluctuate. The factories

maintain an inventory of the products and ship from stock on hand, shipments adjusted to the sales. Sales are subject to seasonal influences which are cyclical in nature. This immediately leads the analyst to the conclusion that seasonality of the sales is followed by cyclical influences on the shipment of goods to the sales outlets. An increase in the sales rate causes a similar increase in the quantity of shipments from the factories. When sales decline to moderate levels in the March - July period, this results in an upward swing in inventory which necessitate working capital and create risks such as obsolescence. The problem is serious because in Turkey the cost of obtaining capital is high and woolen fabrics are subject to rapid product obsolescence. The enterprize maintains an investment in the form of inventory and capital is tied up in finished goods. If the capital were free, it would be possible to find alternative uses for it. By holding inventory the enterprise foregoes investing their capital in alternative ways and this represents an opportunity cost. Similarly, risks of product obsolescence point to the possibility that a sizable amount of goods may remain unsold after the end of the normal selling season. The solution to these problems is found in making gradual adjustments both in the aggregate capacity of the plants and in the allocation of production facilities to different woolen items that are to be achieved through the inherent flexibility in plants. It is found that this does not lead to additional costs of production except for the hiring of temporary workers during certain months of the year to compensate for the employees on leave. The stock levels in different periods of the year act as an input to the production system by leading to gradual adjustments in the aggregate capacity and the allocation of the facilities to different items. Similarly, the production system has its output in the form of finished goods which is an input to the inventory system. However, optimality of this input-output relationship between the production and inventory systems depends also on other functions of the organization such as forecasting and communication.

Refinements in the production planning and inventory control functions depends to a large degree on the reliability of the forecasts for future sales. The current practice in Sümerbank is to base these forecasts on past experiences and executive opinions. Subjective forecasts are entirely permissible when no data on sales can be obtained. This is true of many new products. When historical information is available, the forecasting problem takes on some different aspects. In the presence of reliable sales information, the possibilities of improving management control for company success increase. Sümerbank system actually has this detailed sales data and the problem is automatically reduced to one of prediction of sales of each woolen item in the near future. It is desirable that forecasts be made quickly, cheaply and easily. On the basis of this, the method of exponentially weighted moving averages is proposed for Sümerbank. Here, the sales and stock levels throughout the year constitute the inputs to the forecasting system and the resultant output, namely, the forecasts themselves are fed into the inventory system as inputs.

Analysis of the lead time within the Sümerbank system as a separate topic finds justification in the fact that any shortening in the lead time results in a decrease in the aggregate inventory in the system. Lead time actually has two components. First is the flow of information from the distribution system to the management area, and the second, flow of goods from the plants to the individual sales outlets which is referred to as the time in transit. In both flow of information and flow of goods, refinements are proposed that will eliminate unnecessary delays and contribute to the effectiveness of the communication and transportation systems. In fact, information coming from the sales outlets on sales of woolen items in an input to the forecasting system and elimination of unnecessary delays has a direct impact upon the speed at which the forecasting function can be performed.

At this point, it is possible to reach the conclusion that improvements realized in a certain system within the organization have impacts on others following a chain reaction process. Efficiency gained by faster communication of sales data leads to the application of Exponential Smoothing in the forecasting system at the ASM level. Development of reliable forecasts in the forecasting system contributes to the improvements in the planning and scheduling of production in the production system. Finally, adjustments in the production capacity and facilities coupled with the shortening of lead time improves management control of inventories, thus increasing the effectiveness of the entire Sümerbank system.

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