DESIGN OF COMPUTER AIDED MANAGERIAL DECISION SUPPORT SYSTEM FOR AN INTEGRATED TEXTILE PLANT BASED ON CAPACITY ANALYSIS

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İZMİR

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We certify that we have read the thesis, entitled **"DESIGN OF COMPUTER AIDED MANAGERIAL DECISION SUPPORT SYSTEM FOR AN INTEGRATED TEXTILE PLANT BASED ON CAPACITY ANALYSIS"** completed by **Sabri ERDEM** under supervision of **Prof Dr Güngör BAŞER** and **Doç Dr. Alp KUT** and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

In this study, a managerial decision support system based on capacity analysis has been developed. This study has been achieved by installing an imaginary integrated textile plant in computer medium. Capacity of the textile plant mentioned has been simulated under the different conditions that include varying product distributions, and also considering worker absenteeism and assumption of reserve workers for certain machine groups, using the software developed. Finally the results obtained from the simulation runs have been evaluated and the real capacity of the plant, which is determined in respect to the bottlenecks arising, expressed in finished fabric length in meters, has been computed for each simulation process by developing relevant database.

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CHAPTER 1

1 INTRODUCTION

1.1 General Information on Textile Production

Textile industry supplies a variety of textile products, which belongs to the category of basic human needs and consumer goods. Textile products used as clothing are made up articles produced by giving shape to fabrics which may have been produced by the method of weaving or knitting from yarns. Whereas the made up textile goods or garments are piece goods, a fabric or a yarn is a product which has a long or infinite length-as in the case of yarns, therefore fabric and yarn production which are essential textile processes are continuous processes different from those in assembly productions encountered with in the production of the majority of consumer goods such as cars, machines, home appliances etc.

Although there are different production plant structures to manufacture different types of textile products as dress fabrics, furnishing fabrics, carpets or as different types of yarns like wool yarn, cotton yarn or like weaving yarn, knitting yarn. All these product types have varieties having different properties but which may be manufactured in the same production plant by the same or similar machines. The product range and the technology applied will together lead to a certain plant organization and structure.

However, if we consider the production of fabrics starting from fiber to the finished cloth the following sequence of the main stages in textile processing will generally apply:

- Yarn manufacturing
- Weaving or knitting of fabrics
- Finishing of fabrics

The manufacture of yarns starts with the preparation of the raw material which is a mass of fibres to be converted into a cylidrical form of a certain thickness and infinite length called as a "sliver". For this the fibres are, first, opened and cleaned either by mechanical processes called "blowing" as in the case of cotton or by a washing process called "scouring" as in the case of wool. The next step is to further open and parallelizes the fibres by the "carding" process, which also achieves further mechanical cleaning and the conversion of fibres into a sliver form. The processes following carding have an objective to obtain a "roving" from this sliver which will be the final form of fibres before spinning the yarn, which has sufficiently small thickness and good regularity. This is achieved by a series of "drawing" operations. It may, however, be necessary to remove the very short fibres from the sliver to obtain a roving to spin a very fine and regular yarn. This necessitates the process called "combing" which may be employed both for wool or cotton processing. The spinning machine reduces the thickness of roving to the required degree by further drawing and twists the fibres together to give strength to the produced yarn. This single yarn is later wound as a package called the "bobbin" in a winding machine. Sometimes to get a stronger and thicker yarn two single yarns are "doubled" and "twisted" together to get a "double" or "two fold" yarn. These yarn manufacturing processes may include "loose fibre dyeing" or "sliver dyeing" as in the case of wool only and "yarn dyeing".

For the manufacture of cloth the yarns forming the fabric must be prepared first in a suitable form for fabric formation. In weaving the yarns are prepared as two components, the "warp" yarns being those running along the length of the cloth and the "weft" yarns along the width. The warp yarns will be prepared as a number of parallel yarns wound on to a cylinder called the "warp beam" and may be treated to give them strength by a process called "sizing" which is the application of a certain sticky substance in solution later dried. The weft yarn is directly used from the bobbins in modern "shuttless" weaving. The cloth obtained from the weaving looms are called the "grey cloth" since they are not suitable for immediate use.

The purpose of finishing processes is to clean and relax the cloth first and then give it certain structural and surface properties to make it attractive and suitable for use either as a dress material or as home textile. These finishing processes will be processes like washing, bleaching, boiling, dyeing, drying, ironing, topmaking and may include processes to give special surface effects to the cloth like raising to obtain a hairy surface, cutting to obtain a clean smooth surface or processes to give special structural effects like sanforizing to give shrink resistance, calendering, embossing etc.

1.2 The Structure of Textile Plants

A textile plant manufacturing fabrics from fiber which is the basic raw material to finished product will have main sections producing yarn, grey fabric which is the semi-finished fabric and final finished fabric, namely as yarn spinning, weaving (or knitting) and finishing sections. These sections in turn have departments and in some cases sub-departments or job shops which are smaller production units, each producing a semi-finished product in the whole processing sequence until the finished fabric is dispatched to be stored or sold.

The yarn spinning section will in general include departments like blending, carding, roving preparation, spinning, twisting. The weaving section will have departments weaving preparation and weaving. The finishing section will have departments like wet finishing, dyeing and printing and dry finishing. The actual process flow and machine layout as well as the general organizational structure as formed by sections, departments and sub departments will depend on the type of product range and the technology applied. A general diagram showing the organization of the textile processing according to various alternative textile technologies is given in Figure 1.

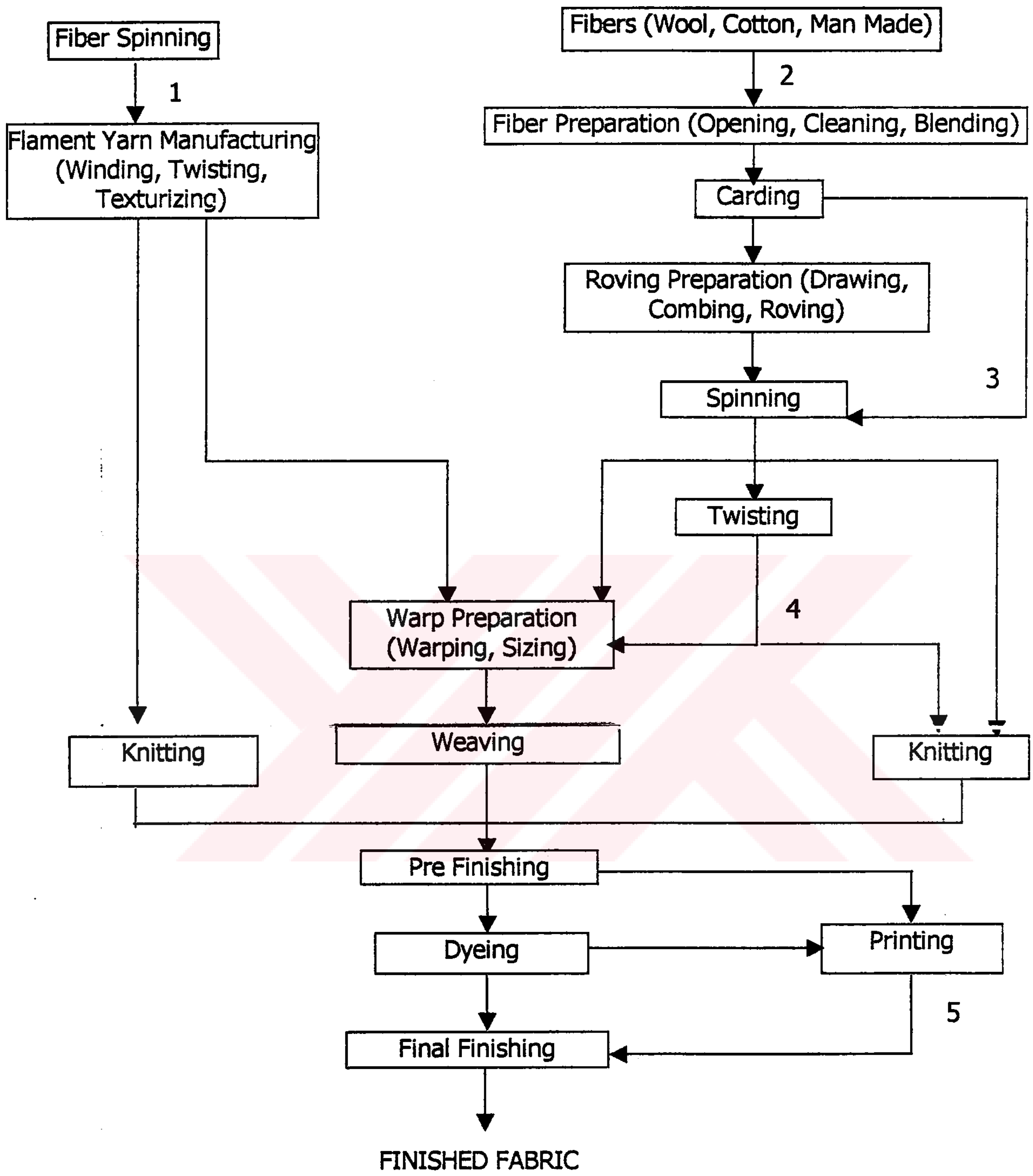

Figure 1 General Organization of Textile Processing (Notes: 1: Continuous Filament Fiber, 2: Staple Fiber, 3: Woollen Yarn, 4: Two Fold Yarn, 5: Printed Clothe)

Thus the textile plants have quite complicated organizational structures formed by many units related to each other in many ways. As textile processes are continuous processes the raw material, which is the fiber mass at the beginning, will go through certain changes in shape and position, which is a transformation from fiber state to the finished fabric state.

1.3 Capacity Analysis as a Tool for a Managerial Decision System

High competition in the global world market condition requires the use of all resources efficiently for the firms. Textile plants like all the other plants in different industrial sectors have to use their resources in the most effective way. Plant capacity, that involves machinery and labor, can be considered as the most important resources. Managers who make decisions for the future have to attain at knowledge about their plants resources for making efficient decisions. Capacity based information provides the decision makers with more flexible plans for the resource allocation for the present and future situations. Nevertheless, handling information about capacity based resources are very difficult because of the complexity of the product-machine relationships and the complexity of textile processes, difficulties about evaluating the obtained data or, sometimes, lack of data or of evaluation methods and algorithms, etc. Thus for such problems methods or techniques like simulation provide powerful tools to cope with them. These situations also arise and the same difficulties are valid for changing the starting parameters of resource allocation or future plans. As an illustration to this type of problems, changes in product distribution can be given. In this case the capacities of all sections and consequently the plant capacity will change due to changing machine-product relationship leading to bottlenecks. Thus these problems increase the computing difficulty of an integrated textile plants' capacity if a comprehensive method of calculation or algorithm supported by the computer is not in hand.

1.4 Description of Production Capacities in Textile Plants

The capacity of a textile plant producing fabrics may be expressed in terms of total length of fabric in meters per year. This capacity will be a reflection of the production capacities of each production unit producing a semi-finished good that has a different form, name the amount of which may be express in a different unit from those of the fabric. Thus the production capacities of each sub department, department or section will be express in terms of the quantities, which may not be comparable with each other. Furthermore the same machine in any production unit producing a different type of product within the general product range may be run at a different speed or with different production efficiencies and therefore the production capacities - as expressed in terms of production per unit time - of machines or of production units, and of the plant in consequence, will vary with the types of products being manufactured together in the same plant.

1.5 Aim of the Study

The determination of production capacities is very important in textile plants for the purpose of long and short term production planning, preparation of modernization projects, sales planning, strategic planning. It is however quite a time consuming task to study the production capacities in detail in textile factories because of the complicated nature of the problem as has been tried to be explained above to some extent.

The textile industry is however, well used to technological change and to taking full advantage rapidly of all relevant modern technology. This brings the changes in product range, technology and in sales planning quite often and the capacity studies will thus be vital in trying to keep up with these changing situations. At this point the advances in computers are potentially of even greater importance and will bring certain advantages to us more than any of the previous technological advances.

The aim of this study is to develop a software to study the production capacity of any textile plant having different organizational structure, process flow and machine layout, in the changing situations of production composition in terms of product types and their respective amounts, of labor force and also in other situations that may arise in the course of business. This will provide us with a tool to study the current situation to throw light to certain managerial decisions concerning production management, investment planning, sales planning, etc.

1.6 Previous Studies

Some studies were made in the past on this topic in our country based on tabulated calculations, but because of lack of using the computer technology they could not be widely applied. One such study was due to G.Başer (1972) and dealt an integrated wool fabric manufacturing plant and was applied once to a woollen plant of SUMERBANK in İstanbul. The algorithm he developed is not in a form suitable for in computer medium because it was developed for calculations to set up a series of tables for capacity analysis. These tables are given in Figures 2-7.

MACHINERY				MACHINE PRODUCTIVITY (x/hour)								PRODUCTIVITY (%)																			
GROUP NAME	MACHINE NAME	Productive Machine	Number of Machines	PRODUCT TYPES								PRODUCT TYPES																			
				1		*2*		*3*		*Average*		*1*					*2*					*3*					*Average*				
				Theoretical	Standard	Theoretical	Standard	Theoretical	Standard	Theoretical	Standard	Mechanical	Technlological	Machine	Labor	Standard	Mechanical	Technlological	Machine	Labor	Standard	Mechanical	Technlological	Machine	Labor	Standard	Mechanical	Technlological	Machine	Labor	Standard
A																															
		V																													
B																															
		V																													
X																															
		V																													
TOTAL (1)			1	2	2	2	2	2	2	2	2																				
TOTAL (2)																															
TOTAL (3)																															
TOTAL (4)																															
OVER/UNDER CAPACITY																															

Figure 2 Capacity Analysis of a Integrated Textile Plant by Tableau Method

NOMINAL AND REAL MACHINE CAPACITY ACCORDING TO PRODUCT TYPES (x/year)												REAL MACHINE CAPACITY ACCORDING TO PRODUCTION PROGRAM (x/year)										NORM PRODUCTIVE LABOR STAFF		
PRODUCT TYPES												PRODUCT TYPES									Total Relative # of Machine	Plant Norm Staff	Norm Staff According to Machine	
1			2			3			Average			1			2			3						
Theoretical	Standard	Relative Mac.	Theoretical	Standard	Relative Mac	Theoretical	Standard	Relative Mac	Theoretical	Standard	Relative Mac	Theoretical	Standard	Relative Mac	Theoretical	Standard	Relative Mac	Theoretical	Standard	Relative Mac			Avg.	Pr.
														6			6			6	10			
														6			6			6	10			
														7			7			7	10			
														7			7			7	10			
														8			8			8	10			
3	3	5	3	3	5	3	3	5	3	3	5	9	9		9	9		9	9		11	1		
																						3		
4	4		4	4		4	4		4	4			29			29			29					
												12				12							14	14
																							17	17
																31								
													30			30			30					

Figure 3 Continued from Figure 2

Program Productive Labor	Real Productive Labor	PRODUCTIVE LABOUR ACCORDING TO PORDUCTIVE MACHINERY		C		CAPACITY ACCORDING TO REAL PRODUCTIVE LABOR (x/year) PRODUCT TYPES								k	Productive Labor fo Programmed Year	Productive labor Requirements for Programmed Year	BALANCED MACHINERY				OVER/ UNDER LABOR FOR BALANCED MACHINERY	
						1		2		3		Average					Productive Machinery		Excess Machinery			
		Avg.	Pr.	Avg	Pr.	Theoretical	Standard	Theoretical	Standard	Theoretical	Standard	Theoretical	Standard				Avg.	Pr.	Avg	Pr.	Avg	Pr.
16	15					19	19	19	19	19	19	19	19									
							32		32		32											
		16	16			20			20						23	23	25	25	26	26	27	27
		17	17	18	18									21	24	24					28	28
														22								
									34													
							33		33		33											

Figure 4 Continued from Figure 3, Workforce Analysis

Program Productive Labor	Real Productive Labor	PRODUCTIVE LABOR ACCORDING TO PRODUCTIVE		C		CAPACITY ACCORDING TO REAL PRODUCTIVE LABOR (x/year) PRODUCT TYPES								k	Productive Labor for Program Year	Productive Labor Requirements in the Programmed Year	BALANCED MACHINERY				OVER/ UNDER LABOR FOR BALANCED MACHINERY	
						1		2		3		Average					Productive Machinery		Excess Machinery			
		Avg	Pr.	Avg	Pr	Theoretical	Standard	Theoretical	Standard	Theoretical	Standard	Theoretical	Standard				Avg	Pr.	Avg	Pr.	Avg	Pr.
16	15					19	19	19	19	19	19	19	19									
							32		32		32											
		16	16			20			20						23	23	25	25	26	26	27	27
		17	17	18	18									21	24	24					28	28
														22								
									34													
							33		33		33											

Figure 5 Continued from Figure 4, Number of Machine Analysis

SECTIONS			# OF MACHINES			Productive Labor for Productive Machinery		CAPACITY ACCORDING TO MACHINERY (x/year)																	
								THECRETICAL CAPACITY						REAL CAPACITY						İDEAL CAPACITY					
				Balanced Machinery				According to Average Type		Relative # of Mac.	According to Program		Relative # of Mac. Ad.	According to Average Type		Relative # of Mac.	According to Program		Relative # of Mac.	According to Average Type		Relative # of Mac.	According to Program		Relative # of Makc.
GROUP NAME	SECTION NAME	Productive Section	Current	Avg	Pr.	Avg	Pr.	Teo	Std.		Teo.	Std		Teo	Std		Teo	Std		Teo	Std		Teo	Std	
A																									
		V																							
B																									
		V																							
X																									
		V																							
TOTAL			1	2	2	3	3	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5
AIMED IN THE PROGRAM																		21							
UNDER/OVER CAPACITY																		22							

Figure 6 Continued from Figure 5, Machine Capacity Analysis

NUMBER OF MACHINES ACCORDING TO BALANCED MACHINERY				NORM PRODUCTIVE LABOR			Program Productive Labor	Real Productive Labor	PRODUCTIVE LABOR FOR BALANCED MACHINERY				C		CAPACITY ACCORDING TO REAL LABOR (x/year)				k	Real Labor for Programmed Year	Productive Labor for Programmed Year	OVER/ UNDER NUMER OF MACHINE FOR BALANCED MACHINERY		OVER/ UNDER LABOR FOR BALANCED MACHINERY			
Real Capacity		Ideal Capacity		Plant Norm Labor	Capacity According to Machinery				For Real Capacity		For Ideal Capacity				According to Average		According to Program							For Real Capacity		For Ideal Capacity	
Avg.	Pr.	Avg.	Pr.		Avg.	Pr.			Avg.	Pr.	Avg.	Pr.	Avg.	Pr.	Teo.	Std.	Teo.	Std.				For Real Capacity	For Real Capacity	Avg.	Pr.	Avg.	Pr.
6	6	6	6	7	8	8	9	10	11	11	11	11			13	13	13	13		15	16	17	18	19	19	20	20
													12	12				23	14								
																		24									

Figure 7 Continued from Figure 6, Workforce Analysis

SECTION NAME	NUMBER OF MACHINES			Productive Labor for Productive Machinery		CAPACITY ACCORDING TO MACHINERY (x/year)																	
	Mevcut	BALANCED MACHINERY				NOMINAL CAPACITY						REAL CAPACITY						IDEAL CAPACITY					
						According to Average		# of Relative Mac.	According to Program		# of Relative Mac.	According to Average		# of Relative Mac.	According to Program		# of Relative Mac.	According to Average		# of Relative Mac.	According to Program		# of Relative Mac.
		Avg	Pr.	Avg	Pr.	Teo.	Std.		Teo.	Std.		Teo.	Std.		Teo.	Std.		Teo.	Std.		Teo.	Std.	
YARN																							
WEAVING																							
FINISHING																							
TOTAL																							
PROGRAM																							
UNDER/OVER CAPACITY																							

Figure 8 Continued from Figure 7, Capacity Analysis Based on Sections

This work was later taken up again and applied in a more detail way to a cotton printing plant of SUMERBANK in İzmir and was reported by G.Başer and U.Kahyaoğlu (1987), with a new algorithm more suited to computer processing. A computer program was actually developed for only the finishing section of a cotton textile plant.

Various works have been reported on capacity analysis and planning in the context of "Aggregate Production Planning" in Product Management Literature, T. Bihun and J.Musolf (1988), H.Noori and R.Radford (1995), T.Chang, R.Wysk (1988), H.Demir, Ş.Gümüşoğlu (1998), M.Groover (1987), H.Harms, D.Kroon (1992).

CHAPTER 2

2 MATERIAL AND METHOD

2.1 Material

2.1.1 Integrated Textile Plant

An integrated cotton textile plant manufacturing dyed and printed cotton fabrics which is to be created in the computer medium has been taken as a material for study. Although this presents certain constraints for the most general textile plant structure it has been taken as a starting point or a basic structure to develop the software having the necessary flexibility of application a possibility of further development.

Such a textile plant is considered as a combination of job shops, namely blow room, carding, drawing, combing, spinning, winding, twisting, warping, sizing, weaving, wet finishing, dry finishing, dyeing and printing. These job shops are further organized as main production sections as mentioned in the previous part, namely spinning, weaving and finishing sections or plants.

2.1.2 Product Structure

As a product structure some of the fabric types are produced in large amounts in SUMERBANK IZMIR Basma Sanayi İşletmesi have been chosen. The names of these fabrics are

1. Furnishing
2. Bed linen
3. Printed flannel
4. Ladies dress fabric
5. Trousering
6. Fine shirting
7. Heavy shirting

The fabric specifications are giving in Table 1.

Table 1Product Specifications

Fabric Type	WEFT Count (Nm)	WEFT Unit Weight (g/m2)	WEFT Weft Sett	WARP Count (Nm)	WARP Unit Weight (g/m2)	WARP Warp Sett (per cm)	Fabric Unit Weight (g/m2)	Fabric Width (cm)
Bed Linen	18/1	206	23	20/1	176	24	382	240
Printed Flannel	10/1	130	17	20/1	88	34	218	90
Furnishing	8/1	230	16	20/1	187	24	417	180
Ladies Dress Fabric	10/1	156	17	32/2	119	22	275	140
Fine Shirting	30/1	81	26	40/1	73	34	154	140
Heavy Shirting	20/1	109	24	30/1	84	29	193	140
Trousering	40/2	147	32	50/2	123	36	270	140

2.1.3 Computer Databases Employed

Relational database has been used in the thesis for computing and data processing. Microsoft Access 2000 is selected as a database design tool. There are several reasons for selecting Microsoft Access 2000. One of them is that it allows rapid generation of prototypes; another is that most of the database features are included in this tool. A third reason is that Microsoft Access has programming features supported by Microsoft Visual Basic. These features also allow the object-based programming facilities for Microsoft Access. Some of the capacity assignment problems have been solved making use of this feature.

2.2 Method

2.2.1 Installation of an Imaginary Integrated Textile Plant in Computer Medium

An imaginary integrated textile plant to manufacture above mentioned fabric types has been installed in the computer medium by specifying the name and number of machines in each job shop together with varying speed and production efficiency of each machine according to product types. These job shops have in turn been arranged and aligned according to process flow in larger production units as departments and main sections as given in Figures 9-11

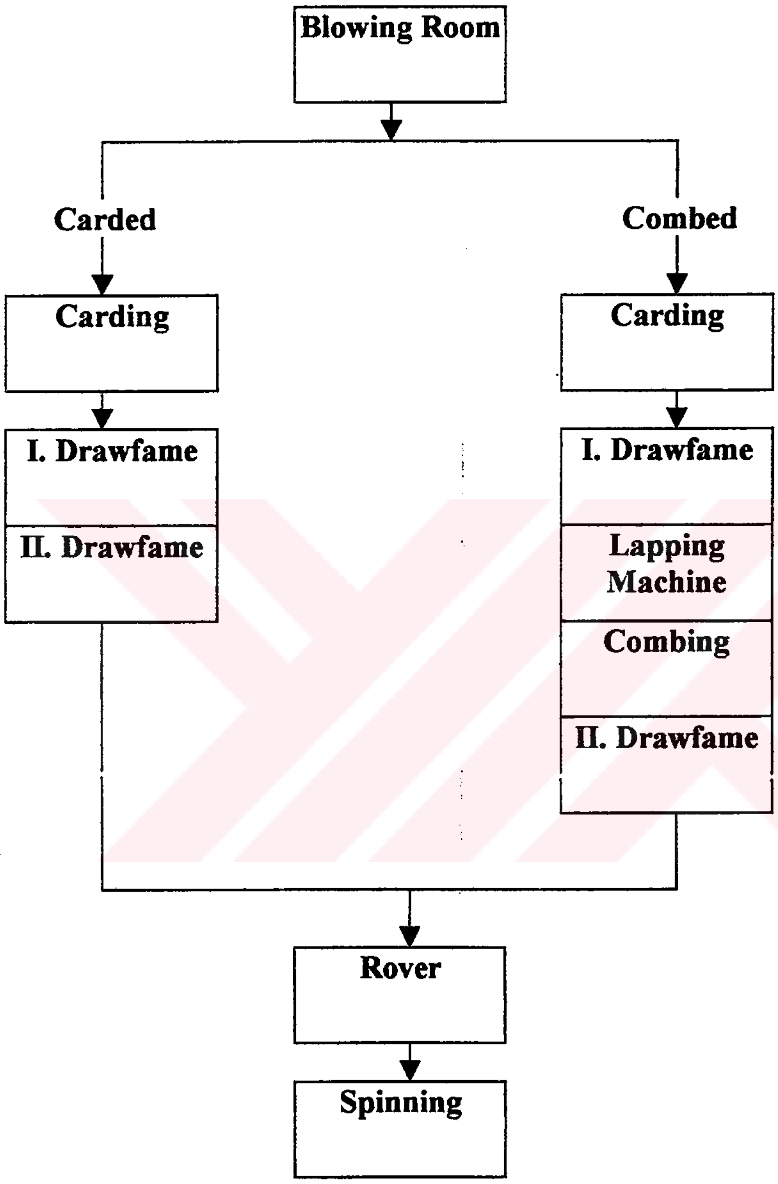

Figure 9 Organization and Process Flow of Yarn Spinning Section

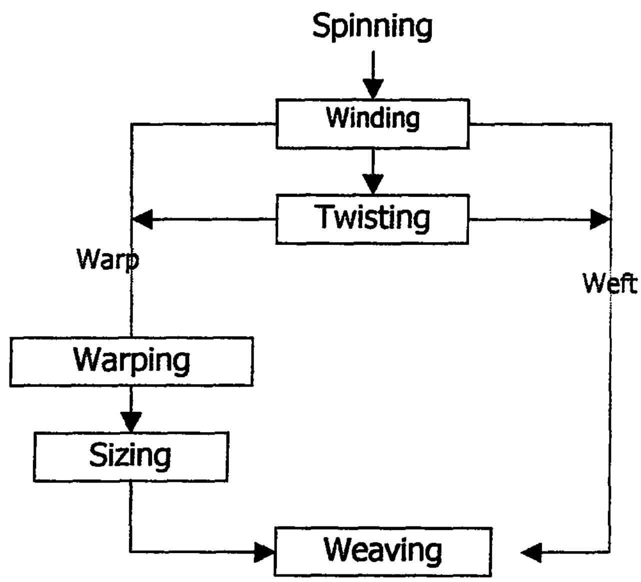

Figure 10 Organization and Process Flow of Weaving Section

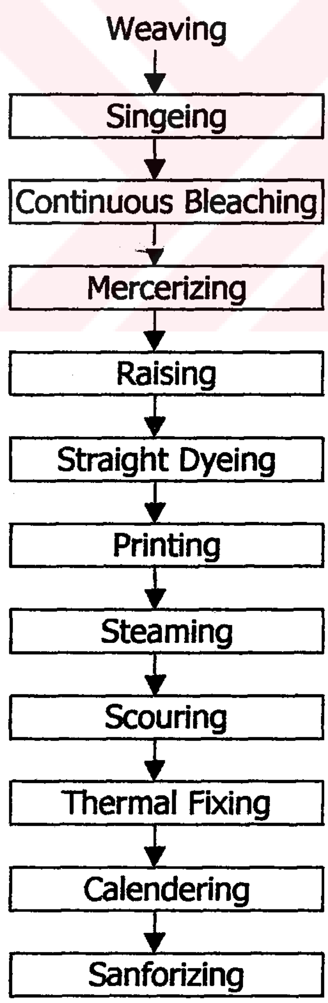

Figure 11 Organization and Process Flow of Finishing Section

The organizational structure of the imaginary integrated textile plant has been defined in the computer medium by coding each machine, job shop, department and main sections.

2.2.1.1 Selection of the Production Machinery

Selection of the production machinery has been based on modern technology paying due attention to the available machines in the Turkish textile sector with reasonable production speeds. Machine characteristics such as constructional features and running speeds have been selected according to the product specifications. For example the loom widths, which affect the running speeds, have been selected as based on cloth widths.

The production capacity of the integrated plant has been based on the production capacity of two blowrooms, as in cotton plants the blowroom capacity is very high and determines to some extent the plant size. Two blowrooms will usually give rise to a medium size cotton fabric manufacturing plant. The types and numbers of the individual machines have been specified as based on the blowroom capacity and on the organizational structure of the plant, which has in turn been based on production types. The names of the machines and their numbers are given in Table 2 together with their codes and the section they belongs.

Table 2 Production Machinery

Section	MacCode	Group Name	Number of Machines
Finishing	BUHAR	BUHARLAMA	2
Finishing	BASKI	BASKI	1
Finishing	YIKAMA	YIKAMA	2
Finishing	RAMOZ	RAMÖZ	2
Finishing	KASAR	KONTİNÜ KASAR	1
Finishing	DBOYA	DÜZ BOYA	1

Section	MacCode	Group Name	Number of Machines
Finishing	KALANDIR	KALANDIR	1
Finishing	MERSERIZE	MERSERİZE	1
Finishing	SANFOR	SANFOR	1
Finishing	SARDON	ŞARDON	1
Finishing	YAKMA	YAKMA	1
Spinning	BUKUM	BUKUM	12
Spinning	YARN1	1. Grup	17
Spinning	BOBIN	BOBIN	10
Spinning	YARN2	2. Grup	9
Spinning	CER2KAR	CER2	3
Spinning	HARHAL	HARMAN HALLAÇ	2
Spinning	FITIL	FITIL	8
Spinning	CER2PEN	CER2	3
Spinning	CER1PEN	CER1	3
Spinning	CER1KAR	CER1	3
Spinning	YARN3	3. Grup	7
Spinning	PENYE	PENYE	8
Spinning	TARKAR	TARAK	9

Section	MacCode	Group Name	Number of Machines
Spinning	TARPEN	TARAK	11
Spinning	VATKA	VATKA	2
Spinning	YARN4	4. Grup	2
Warping	HASIL	HAŞIL	1
Warping	COZGU	ÇÖZGÜ	1
Weaving	SP7150IG	Sulzer P 7150 Projectile	57
Weaving	SP7150PAN	Sulzer P 7150 Projectile	38
Weaving	SP7150KG	Sulzer P 7150 Projectile	34
Weaving	PO6R190DOS	Picard Omni 6-R-190 Hava Jetli	7
Weaving	SG6100DIV	Sulzer G. 6100 Rapier	24
Weaving	SG6300CA	Sulzer G. 6300 Rapier	24
Weaving	SP7150EL	Sulzer P 7150 Projectile	13

The speeds production efficiencies according to product types and other particular about the machines are given in the Appendix. 3

2.2.1.2 Organizational Structure of an Integrated Textile Plant

As both fine and medium weight cotton fabrics appear in production types, the spinning section of the plant has been organized to produce both carded and combed cotton yarns. The carded yarns being in coarse and fine counts. Thus after carding, the production line is branched into two, the one being carded yarn drawing department, the other being the combing department. In calculating the number of machines in the drawing and spinning departments, equal production amounts have been assumed for each type of yarn required as warp and weft taken separately for each fabric type. However, this scheme of breaking up of yarn production to yarn types has been done independently for the carded and combed yarns as two production lines.

Since some of the yarns to be produced are two fold or doubled yarns as seen in Table 3, two-for-one twisting machines have also been included in the winding department.

Table 3 Yarn Specifications

Code	TypeName	RovingNo	YarnNo	Notes
K1	KarÇar	0,8	18/1	Carded Bed Linen
K2	KarKalGöm	0,8	20/1	Carded Heavy Shirting
K3	KarKalGöm	0,8	30/1	Carded Heavy Shirting
K4	KarDöş	0,6	8/1	Carded Furnishing
K5	KarDiv	0,6	10/1	Carded Divitin
K6	KarDiv	0,8	20/1	Carded Divitin
K7	KarPamElb	0,6	10/1	Carded Ladies Dress Fabric
K8	KarDös	0,8	20/1	Carded Furnishing
K9	KarÇar	0,8	20/1	Carded Bed Linen
P1	PenElb	0,9	32/2	Combed Ladies Dress Fabric
P2	PenPan	0,9	40/2	Combed Trousering
P3	PenPan	1,2	50/2	Combed Trousering
P4	PenInceGöm	1,2	30/1	Combed Fine Shirting
P5	PenInceGöm	1,2	40/1	Combed Fine Shirting

Since the imaginary plant is a plant manufacturing dyed and printed cotton fabrics, the sizing process is a necessary step in the process flow. Therefore sizing process has also been included in the weaving preparation department.

The looms in the weaving department have been specified as mainly based on fabric widths. In doing this, the emphasis has been put on high production speeds. The determination of the numbers of the looms have been based on the amounts of yarns that could be supplied from the spinning section for each type of fabric according to the unit weights of warp and weft required for one meter of finished fabric. Thus the production plan has in some ways been determined as based on the machine composition of the spinning section, which in turn has determined that of the weaving section.

The machinery to be included in the finishing department have been selected according to the production plan developed in the way as explained above taking care of finishing process routines suitable for each type of fabric.

2.2.1.3 Determination of The Work Force

The workforce for the imaginary plant has been build up according to machine speeds and working conditions according to product types taking into account the common practice in the textile factories in Turkey. Some reserve workers have been allocated as an alternative working policy for certain machines which directly effect the production capacities such as spinning machines, winding machines, twisting machines and weaving looms.

The number of productive workers as determined according to above mentioned conditions are shown in Table 4.

Table 4 Work Force

MacCode	Code	StdLabor
YARN3	K9	0,33
YARN3	K1	0,33
YARN3	K8	0,33
YARN4	K4	0,25
YARN1	P3	1,00
YARN1	P2	1,00

MacCode	Code	StdLabor
YARN2	K3	0,50
YARN3	K2	0,33
YARN1	P5	1,00
YARN2	P4	0,50
YARN2	P1	0,50
YARN4	K7	0,25
YARN3	K6	0,33
YARN4	K5	0,25
BOBIN	K9	0,50
BOBIN	K1	0,50
BOBIN	K8	0,50
BOBIN	K4	0,50
BOBIN	P3	1,00
BOBIN	P2	1,00
BOBIN	K3	1.00
BOBIN	K2	0,50
BOBIN	P5	1,00
BOBIN	P4	1,00
BOBIN	P1	1,00
BOBIN	K7	0,50
BOBIN	K6	0,50
BOBIN	K5	0,50
SG6300CA	Carsaf	0,08
SG6100DIV	Divitin	0,13
PO6R190DOS	Doseme	0,14
SP7150EL	Elbise	0,17
SP7150IG	InGomlek	0,17
SP7150KG	KalGomlek	0,13

MacCode	Code	StdLabor
SP7150PAN	Pantolon	0,17
HARHAL		2,00
TARKAR		1,00
TARPEN		1,00
CER1KAR		0,33
CER2KAR		0,33
CER1PEN		0,33
CER2PEN		0,33
PENYE		0,25
FITIL		1,00
BUKUM		2,00
COZGU		2,00
HASIL		2,00
KASAR		1,00
BUHAR		1,00
DBOYA		1,00
BASKI		2,00
KALANDIR		1,00
YIKAMA		1,00
MERSERIZE		1,00
RAMOZ		1,00
SANFOR		1,00
SARDON		1,00
YAKMA		1,00
VATKA		0,50

2.2.2 Quantitative Distribution of The Product Types

As mentioned in Section 2.2.1.2 the production plan has been determined as based on the production capacity of the spinning section. In setting up the quantitative distribution of product types has been arranged in a way to produce equal amounts of yarn of each type but keeping the combing and drawing line separately. The lengths of fabrics of each product type have been calculated to consume the yarns produced; but when the amounts of weft and warp yarns are not in the right proportions to make a certain type of fabric the smaller weight of either warp or weft yarn is taken for the calculation of fabric length. The quantitative distribution of product types as expressed in finished lengths of fabric in meters is shown on Table 5.

Table 5 Quantitative Distributions of Product Types

Fabric_Code	FabricQuant (X1000 m)
Bed Linnen	525,00
Printed Flannel	830,00
Furnishing	470,00
Ladies Dress Fabric	690,00
Fine Shirting	1950,00
Heavy Shirting	1250,00
Trousering	1050,00

2.2.3 Mathematical Modeling of An Integrated Textile Plant

In mathematical modeling of the integrated textile plant the following principles have been set and the database has been prepared in accordance to these principles.

1. For each product type the processes have been specified and put in a sequential order. If a process is repeated it has been put in the process line as a separate process though the same machine may execute it.
2. The material losses, length changes and the unit conversions between input and output for each process have been fixed and integrated into the algorithm.
3. The constraints and priorities for the assignment of machines for a particular product have been determined as been based on product type, machine characteristics and on industrial practice. The constraints are such that a particular product type can only be processed on a particular machine doing the

same job (or parallel machine). The priorities are such that a particular product will be processed preferably on a particular machine and if the capacity of that machine is not sufficient to finish the required amount of production another machine of the same group (in parallel) may be used and etc.

An example is given in Table 6 for the spinning machines group.

Table 6 Machine Priorities Table

ProductCode	Preferable MachineCode	Alternative Machine Code
P5	YARN1	YARN3
P3	YARN1	YARN3
P2	YARN1	YARN3
K3	YARN2	YARN3
K6	YARN3	YARN2
K9	YARN3	YARN2
K8	YARN3	YARN2
K1	YARN3	YARN2
K2	YARN3	YARN2

2.2.4 Database and Computer Program Developed

In this study a computer database and software have been developed for simulating an imaginary textile plant or building up a model of a real plant in the computer medium. This software has been devised in such a way to also implement the calculations necessary for capacity analyses. Microsoft Access 2000 and Microsoft Visual Basic for Applications, which is a Programming Language built in Microsoft Access 2000, have been selected as tools for designing database application and software development respectively.

2.2.4.1 Initial Status of Imaginary Textile Plant as Database

Firstly a relational database that contains master records of the imaginary plant is created. These master records are separated into machine master records table, products master tables, process routine table, constrained machine assignment table, work force master table and weight loss /fabric shrinkage table etc. These tables are given in Appendix 3.

These tables have thus specified the initial working status of the imaginary textile plant. There are a number of answers to the following problems concerning the initial status:

- Current machinery status in detail in-group basis and generally by job shops, departments and sections.
- Machine speeds according to each product or semi product types called as sliver, yarn, grey cloth, finished cloth etc.
- Current worker status that involves the following:
  - Absence rate,
  - Reserve work force (for certain jobs),
  - Number of workers for each machine by each job.
- Information for various conversions:
  - Conversion factors to calculate yarn requirements in terms of grams per meter of finished product. This may be called as simple BOM (Bill of Material) information.
  - Conversion factors from finished product amounts to length of grey cloth.
  - Weight losses/ fabric shrinkage factors from each process to the following process.
- Production plan expressed as the amounts of production for each product type which the setting up of the imaginary textile plant has been based upon.
- Process routine information given in sequential order.

Structure of database application is given on Appendix 1 in detail.

2.2.4.2 Developing Software

Having designed a database the next task is to develop a computer program that simulates the real workings of the plant in computer medium in the manner of capacity requirements.

The software developed to analyze capacity requirements in changing conditions with a view to bring out the true capacities obtainable in the constrained conditions can be separated into several parts and sub programs. The software developed can be considered as a system and each sub program or function can be considered as a sub system that inputs a certain fixed data from the database built-in and convert it into desired outputs. This conversion can be considered as the most important stage in the working of the software because of the complexity of textile processing.

These sub systems may be classified with respect to their main functions from the point of view of the execution of the analysis and in the order of executions as:

- Input Stage
  - Setting recordset objects
  - Initializing objects
  - Deleting old simulation records
  - Setting the initial working policy for the integrated imaginary textile plant
- Conversion (or processing data) Stage
  - Arranging the queue in front of each machine as placed before in the routine file as specified according to the product type until the last machine is reached. This sub system is also made up of several sub programs as follows:
    - Add queue
    - Exist queue
    - Edit queue
    - Delete queue
  - Processing the products on each machine as routed before
  - Creating a preliminary finished product record set (i.e., table)
  - Querying the preliminary finished product record set
  - Finding bottleneck or candidate bottleneck machinery in each section, or bottleneck department/section in the imaginary integrated textile plant
  - Finding the corrected capacity of the textile plant in terms of bottleneck section's capacity and finished fabrics in meters
  - Rearranging the capacity of sections in terms of equivalent meters of finished fabric
- Output Stage
  - Querying the results of both preliminary finished and corrected capacity records
  - Reporting the results of the simulation process

- Reporting the real (corrected) capacity results on the basis of sections and plant
- Reporting the machine working times and work loads expressed in percentages for each machine.

These stages have been performed for each working policy including product type composition and working status and policy etc.

Input stage is responsible for setting recordsets that enable the computer program to use the master records mentioned before. Input stage is also responsible for initializing the start up objects used in program. Thus every data in those tables can be processed into output data as desired. Besides, the working policy of the imaginary textile plant is decided at this stage. All these operations set up the input stage.

Once an input state of the program is fixed, and then creating the first queue in front of the first machine as in the routine file starts the second stage. Here is the queuing system that is similar to FIFO (first in first out) in that first product or semi product arrived at the next machine group is the first processed product or semi product. The only difference from FIFO is that the product or semi product that is second in the queue may not have the second order in being processed in this machine group. If a product or semi product arrives at that machine group in the third order but is the same product or semi product as the first one, then the amount of the third order product to be produced is added on the first one. This operation has been named as queue editing and there is a sub program for this process.

On the other hand queue editing sub program or sub system has another function, that is, if the machine capacity is not enough for processing the whole amount of a product or semi product, this sub system edits the queue by computing the amount of product remained.

Queue delete sub system deletes a product data from a machine's queue that is processed completely on that machine.

After that, the following step is to find the next machine, number and speed of that machine for the next queue. Finding the machine process is achieved by a function, which uses the process routine file. Besides finding machine speed and number of available machines is also managed by that function but uses the machine master record.

While adding the processed product or semi product to next machine's queue, at the same time, data about processed product or semi product in the previous machine is recorded as finished operations on related recordset (i.e., table).

As mentioned above, there exists a simple BOM (Bill of Material) that has two levels. There exists a pair of yarns being joined to make a certain fabric in the second level of the BOM. In the first level of the BOM there are fabrics that are composed of two types of second level yarns. Executing the special process named as convert sub system enables the system to move around the BOM.

After producing the entire amounts of products, the next step is evaluating the finished operations' records by querying both master records and records created by the program that exist during the next run. The data handled from this evaluating step is the basis for the next process named as capacity correction.

Reporting phase of the computed and processed data is the final stage. Finished processes information file is queried before reporting the final results because of the necessity that the final data, handled by the previous sub systems, must be composed and summarized by joining the record sets. There are a number of queries that help reporting stage and that contain make-table queries, append and select queries. Whereas MS Access 2000 has rapid prototyping capabilities, it has problems with complex SQL queries. Therefore these problems cause a number of queries instead of a few ones.

Reporting phase can be divided into two categories. The first one is reporting the bottleneck capacity of sections of the plant, real (corrected) capacity of the plant and real capacity of the plan in terms of finished fabric in meter. The other one is the work loading capacity of the plant and of its sections in a given time period such as a year, which is, here, used.

Simulation process is composed of running the program with various combinations of the working policy of the product distribution and worker status.

The flowchart of the software developed is given in Figure 12. Table definitions of the database relationships between the database tables are given in Appendix 1 and Appendix 2.

The data related to the imaginary integrated textile plant setup in the computer medium together with the master production plan are given plan are given Appendix 3.

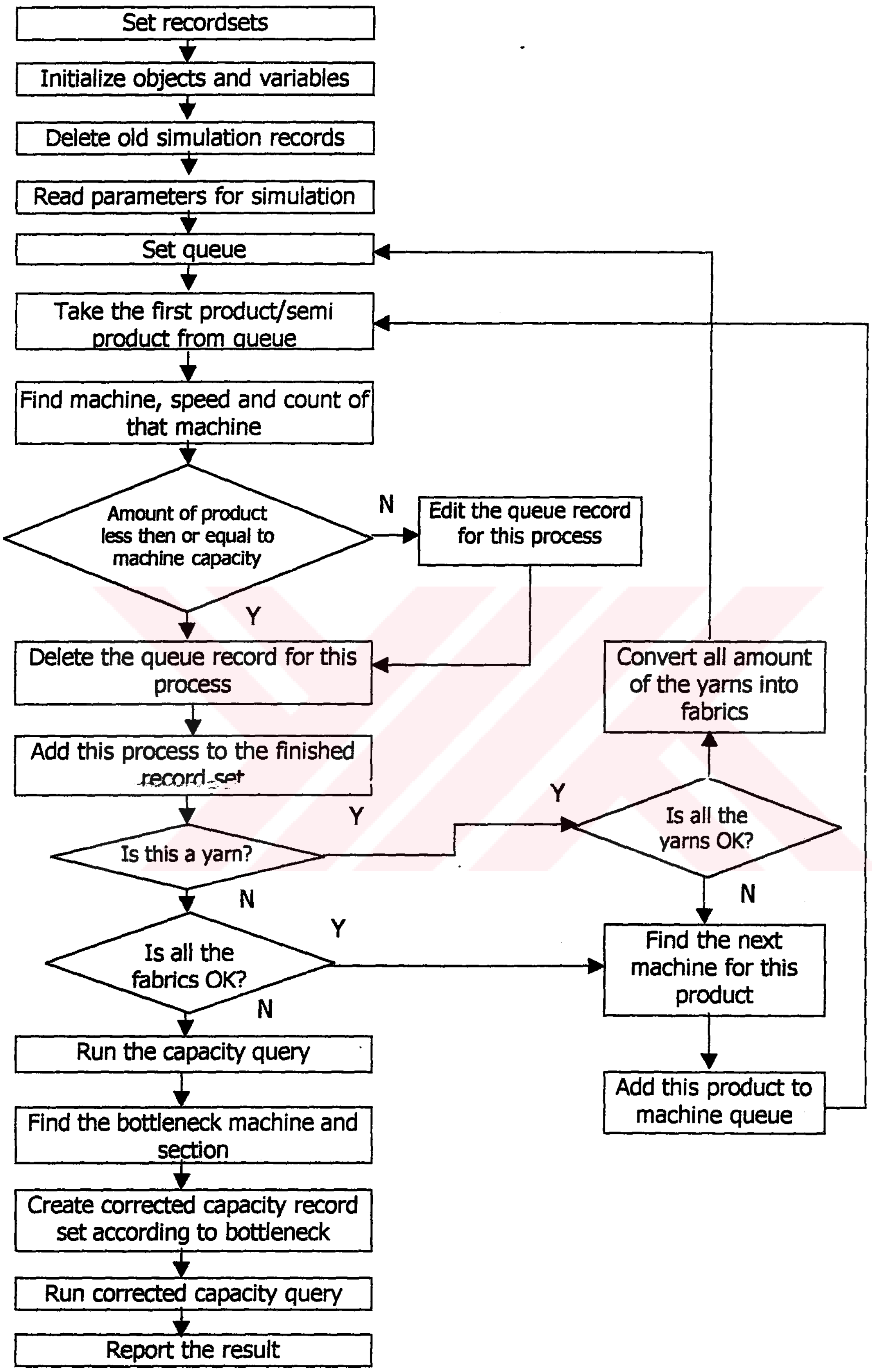

Figure 12 Flowchart of the System Developed

2.2.5 Implementation

2.2.5.1 A Sample Implementation for The Case Study of Initial Product Composition

In order to test the working efficiency and capabilities of the software developed in this study simulation runs have been made for changing production plans and working status. Figure 13 explains the run of the simulation under the normal condition of the imaginary textile plant. Table 7 gives the result of a computer run with the production plan which has initially been worked for the imaginary textile plant with an approach usually made in project planning.

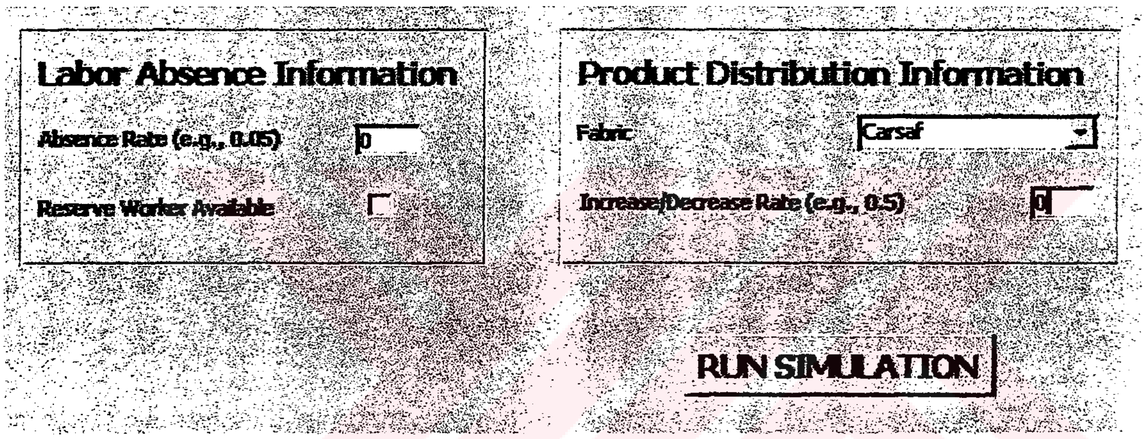

Figure 13 Setting the Initial Parameters of Simulation Run under the Normal Conditions

Table 7 Simulation of Initial Product Composition

Section1	Capacity (1000kg)	Section2	Capacity (1000m)	Section3	Capacity (1000m)	Bottleneck	Plant Capacity	Plant Finished Fabric Capacity
Spinning	1607,45	Weaving	6939,13	Finishing	6766,18	Weaving	6807,52	6637,67

2.2.5.2 Simulation of Varying Product Distribution

For the simulation runs of the varying product distributions the production amount of each product type was first reduced by 50% (set increase /decrease rate = - 0.5 as in the Figure 14) and the resulting idle capacity was distributed equally to other product types, secondly increased by 50% (set increase /decrease rate=0.5 as in the Figure 14) for each type and adjustments were made by decreasing the production amounts of the others. The results are given in Table 8.

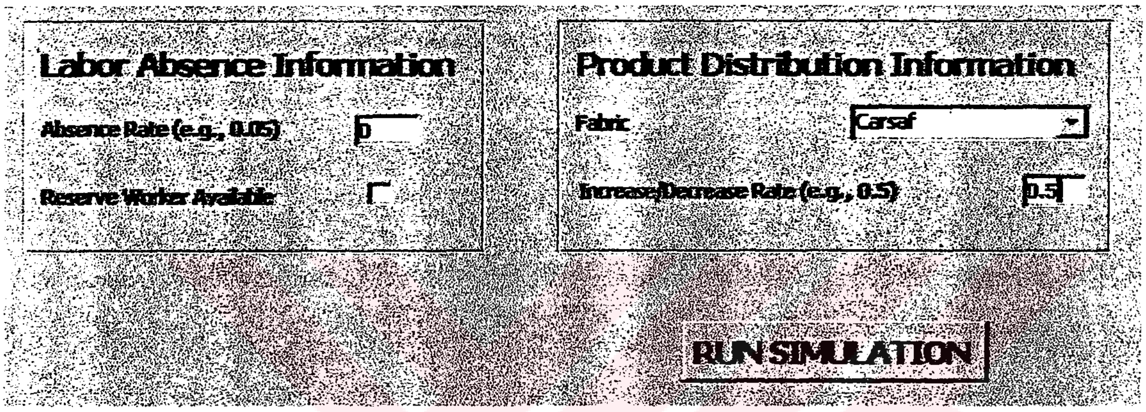

Figure 14 Simulation of Varying Product Distribution

Table 8 Simulation of Varying Product Distribution

Section1	Capacity (1000kg)	Section2	Capacity (1000m)	Section3	Capacity (1000m)	Bottleneck	Plant Capacity	Plant Finished Fabric Capacity	+%50
Spinning	1642,88	Weaving	6939,33	Finishing	6766,34	Weaving	6642,72	6477,16	Bed Linen
Spinning	1581,79	Weaving	6939,45	Finishing	6765,99	Weaving	6527,34	6364,57	Printed Flannel
Spinning	1610,05	Weaving	6938,82	Finishing	6765,36	Weaving	6569,31	6405,43	Ladies Dr Fabric
Spinning	1379,64	Weaving	5387,58	Finishing	5248,30	Spinning	1347,85	4970,92	Trouserin
Spinning	1649,02	Weaving	6939,31	Finishing	6766,07	Weaving	6650,34	6484,54	Furnishin
Spinning	1300,32	Weaving	6938,48	Finishing	6764,38	Weaving	5867,50	5721,17	Fine Shirt
Spinning	1532,91	Weaving	6939,61	Finishing	6765,65	Weaving	6318,26	6160,62	Heavy Shirting

Section1	Capacity (1000kg)	Section2	Capacity (1000m)	Section3	Capacity (1000m)	Bottleneck	Plant Capacity	Plant Finished Fabric Capacity	-%5
Spinning	1572,03	Weaving	6938,93	Finishing	6766,01	Weaving	6572,19	6408,19	Bed Line
Spinning	1633,12	Weaving	6938,81	Finishing	6766,36	Weaving	6404,01	6244,62	Printed Flannel
Spinning	1604,86	Weaving	6939,55	Finishing	6766,99	Weaving	6493,94	6332,21	Ladies D Fabric
Spinning	1607,26	Weaving	6939,76	Finishing	6763,39	Weaving	6353,69	6192,45	Trouserin
Spinning	1565,88	Weaving	6938,95	Finishing	6766,28	Weaving	6611,61	6446,83	Furnishin
Spinning	1742,58	Weaving	6939,78	Finishing	6767,97	Weaving	5915,57	5768,84	Fine Shirt
Spinning	1682,00	Weaving	6938,65	Finishing	6766,70	Weaving	6182,11	6028,69	Heavy Shirting

2.2.5.3 Simulation of Work Force Alternatives

Simulation runs for changing working status were made first with 5% labor absentees without reserve labor as in the Figure 15, secondly with 5% labor absentees with reserve labor at the specified machines which affect the production in the highest degree as in the Figure 16. The results are given in Table 9.

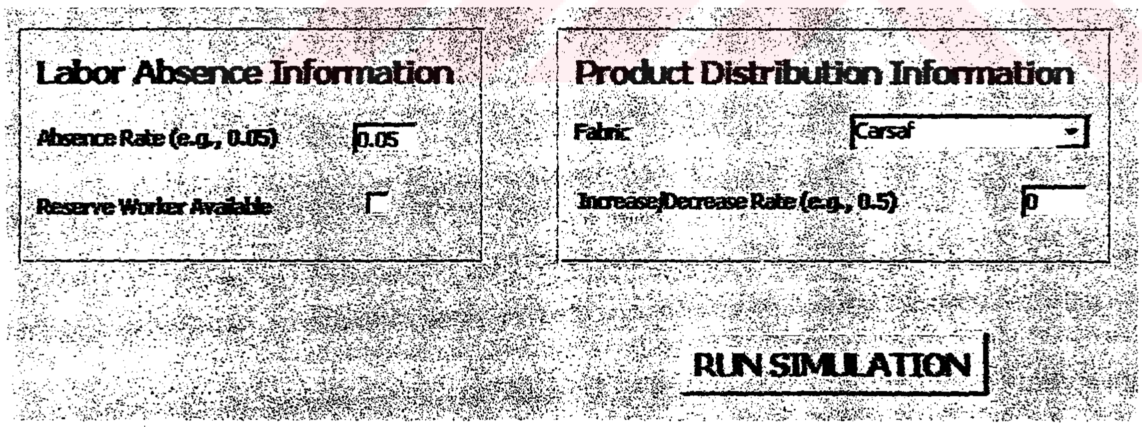

Figure 15 Simulation of Work Force Alternative

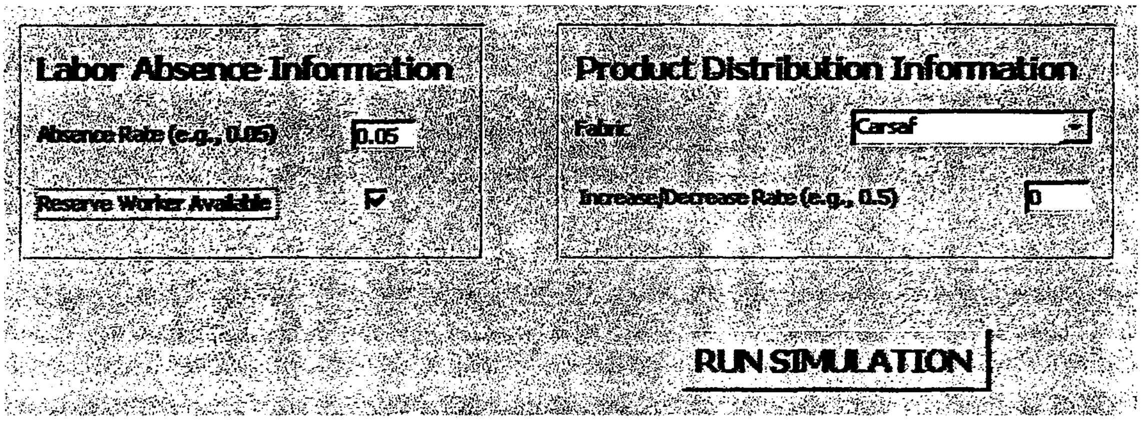

Figure 16 Simulation of Work Force Alternative with Reserve Worker

Table 9 Simulations of Work Force Alternatives

Section1	Capacity (1000kg)	Section2	Capacity (1000m)	Section3	Capacity (1000m)	Bottleneck	Plant Capacity	Plant Finished Fabric Capacity	Working Status
Spinning	1607,45	Weaving	6939,13	Finishing	6766,18	Weaving	6518,02	6355,36	%5 Absence
Spinning	1607,45	Weaving	6939,13	Finishing	6766,18	Weaving	6583,61	6419,34	%5 Absence and Reserved
Spinning	1607,45	Weaving	6939,13	Finishing	6766,18	Weaving	6807,52	6637,67	Normal Conditions

CHAPTER 3

3 DISCUSSION AND CONCLUSIONS

3.1 Discussion of the Results of the Simulation Studies

Simulation runs show that as expected the highest capacity is obtained with the production plant on which the setting up of the imaginary textile plant has been based. The next highest capacities were obtained with 50% reduction in bed linen and furnishing and the same with 50% increase. The lowest capacities were obtained with heavy and fine shirting at 50% increase and with trousering and fine shirting at 50% decrease.

In simulation runs with 5% labor absentees the capacity was reduced to 6355, which was a little increased by reserve workers to a level of 6419, which did not result in substantial improvement.

From the simulation runs it can be seen that the bottleneck arises generally at the Weaving Section as expected because there is less possibility of swapping the production types between machine groups since there are more looms suitable for weaving fine shirting than other fabric types and there are restrictions as to the fabric widths.

The yarn section does not usually present a bottleneck because there is more flexibility in this section. The finishing section on the other hand is not expected to cause a bottleneck because of the high capacities of almost all the machines relative to the planned plant capacity. An excess capacity in finishing departments is a common state of affairs in integrated textile plants.

Since the usage rate of capacity is calculated at each processing stage and each machine a complete picture of the production status may be obtained at any simulation run.

3.2 Conclusions

The results of the simulation runs show that the software developed calculates the production capacities of the main sections of the plant as well as the overall plant capacity based on the bottleneck section.

It can be seen that by evaluating the simulation results in the light of plant structure and fabric characteristics certain managerial decisions can be made and useful policies in respect to sales planning and the organization projects may be developed (See Appendix 4).

3.3 Suggestions

Further work is necessary to generalize the textile plant created in computer medium for this work because more complicated plant structures are encountered with in the textile sector especially in worsted fabric manufacturing. The necessary tools and extensions have been built in the present software to achieve this. A second follow up to this work may be to incorporate in the present software subroutines necessary for production planning and modernization project planning.

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APPENDIX 1 TABLE DEFINITIONS OF THE DATABASE

Table: finished

Columns

Name	Type	Size
Section	Text	10
Code	Text	50
MacCode	Text	50
Sm	Integer	2
Quant	Double	8
ProdTime	Single	4
OrderNo	Long Integer	4
ProdOrdNo	Single	4

Table Indexes

Name	Number of Fields
Code	1
Fields:	Ascending
PrimaryKey	1
Fields:	Ascending
OrderNo	1
Fields:	Ascending
ProdOrdNo	1
Fields:	Ascending

Table: LossWeight

Columns

Name	Type	Size
MacCode	Text	50
Quant	Single	4
Length	Single	4

Relationships

MachineLossWeight

Machine	LossWeight
Section	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: Indeterminate

Table Indexes

Name	Number of Fields
LossWeightMacCode	1
Fields:	Ascending

Table: Yarn_priority

Columns

Name	Type	Size
Code	Text	50
MacCode	Text	50
substitute	Text	50

Relationships

MachineYarn_priority	
Machine	**Yarn_prior**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

MachineYarn_Priority	
Machine	**Yarn_prior**
MacCode	Substitute

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsYarn Priority	
YarnSpecs	**Yarn_prior**
Code	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	Number of Fields
Code	1
Fields:	Ascending
MacCode	1
Fields:	Ascending
PrimaryKey	2
Fields:	Ascending
Ascending	

Table: LABOR

Columns

Name	Type	Size
MacCode	Text	50
Code	Text	50
StdLabor	Single	4
CurrLabor	Single	4

Relationships

MachineLABOR	
Machine	**LABOR**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsLABOR	
YarnSpecs	LABOR
Code	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	Number of Fields
LABORCode	1
Fields:	Ascending
LABORMacCode	1
Fields:	Ascending

Table: FabricYarn

Columns

Name	Type	Size
Fabric_Code	Text	50
FabricQuant	Double	8
SimQuant	Double	8
YarnCode1	Text	50
Quant1	Long Integer	4
YarnCode2	Text	50
Quant2	Long Integer	4

Relationships

FabricYarnWEAVING	
FabricYarn	**WEAVING**
Fabric_Code	Fabric_Code

Attributes: Not Enforced

RelationshipType: One-To-Many

YarnSpecsFabricYarn	
YarnSpecs	**FabricYarn**
Code	YarnCode1

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsFabricYarn	
YarnSpecs	**FabricYarn**
Code	YarnCode2

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	Number of Fields
YarnCode1	1
Fields:	Ascending
Code	1
Fields:	Ascending
Fabric_Code	1
Fields:	Ascending

Table: Queue

Columns

Name	Type	Size
Code	Text	50
MacCode	Text	50
Quant	Double	8
Sm	Integer	2

Table: Machine

Columns

Name	Type	Size
Section	Text	50
MacCode	Text	50
GroupName	Text	50
CurrMac#	Integer	2
Labor#	Single	4
SimLabor#	Single	4
ReservedLabor#	Single	4
Mac#	Single	4
DolMac#	Double	8
GerMac#	Double	8

Relationships

MachineWEAVING	
Machine	**WEAVING**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

MachineLossWeight	
Machine	**LossWeight**
Section	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: Indeterminate

MachineLABOR	
Machine	**LABOR**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

MachineYarn_priority	
Machine	**Yarn_prior**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

MachineYarn_priority	
Machine	**Yarn_prior**
MacCode	Substitute

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

MachineWorkbench	
Machine	**Workbench**
MacCode	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

MachineYarn	
Machine	**Yarn**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	Number of Fields
PrimaryKey	1
Fields:	Ascending

Table: Workbench

Columns

Name	Type	Size
Code	Text	50
MacCode	Text	50
Sm	Long Integer	4

Relationships

MachineWorkbench	
Machine	**Workbench**
MacCode	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsWorkbench	
YarnSpecs	**Workbench**
Code	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	**Number of Fields**
Code	1
Fields:	Ascending
MacCode	1
Fields:	Ascending
PrimaryKey	2
Fields:	Ascending
Ascending	

Table: Production Prog

Columns

Name	Type	Size
Code	Text	50
UreMik	Double	8

Relationships

YarnSpecsProduction Prog	
YarnSpecs	**Production Prog**
Code	1
Code	

Attributes: Unique, Enforced, Cascade Updates, Cascade Deletes, Left Join

RelationshipType: One-To-One

Table Indexes

Name	Number of Fields
PrimaryKey	1
Fields:	Ascending
YarnSpecsProduction Prog	1
Fields:	Ascending

Table: Yarn

Columns

Name	Type	Size
Code	Text	50
MacCode	Text	50
Speed	Double	8

Relationships

MachineYarn	
Machine	**Yarn**
MacCode	MacCode

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsYarn	
YarnSpecs	**Yarn**
Code	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	**Number of Fields**
Code	1
Fields:	Ascending
MacCode	1
Fields:	Ascending
PrimaryKey	2
Fields:	Ascending

Table: YarnProduction

Columns

Name	**Type**	**Size**
PR1	Text	50
PR2	Text	50
PR3	Text	50
PR4	Text	50

Table: YarnSpecs

Columns

Name	Type	Size
Code	Text	50
TipAd	Text	50
RovingNo	Text	50
YarnNo	Text	50

Relationships

YarnSpecsLABOR	
YarnSpecs	**LABOR**
Code	Code

Attributes: Not Enforced, Left Join
RelationshipType: One-To-Many

YarnSpecsYarn_priority	
YarnSpecs	**Yarn_prior**
Code	Code

Attributes: Not Enforced, Left Join
RelationshipType: One-To-Many

YarnSpecsFabricYarn	
YarnSpecs	**FabricYarn**
Code	YarnCode1

Attributes: Not Enforced, Left Join
RelationshipType: One-To-Many

YarnSpecsFabricYarn	
YarnSpecs	**FabricYarn**
Code	YarnCode2

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsWorkbench	
YarnSpecs	**Workbench**
Code	Code

Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

YarnSpecsProduction Prog	
YarnSpecs	**Production Prog**
Code	1
Code	

Attributes: Unique, Enforced, Cascade Updates, Cascade Deletes, Left Join

RelationshipType: One-To-One

YarnSpecsYarn	
YarnSpecs	**Yarn**
Code	Code

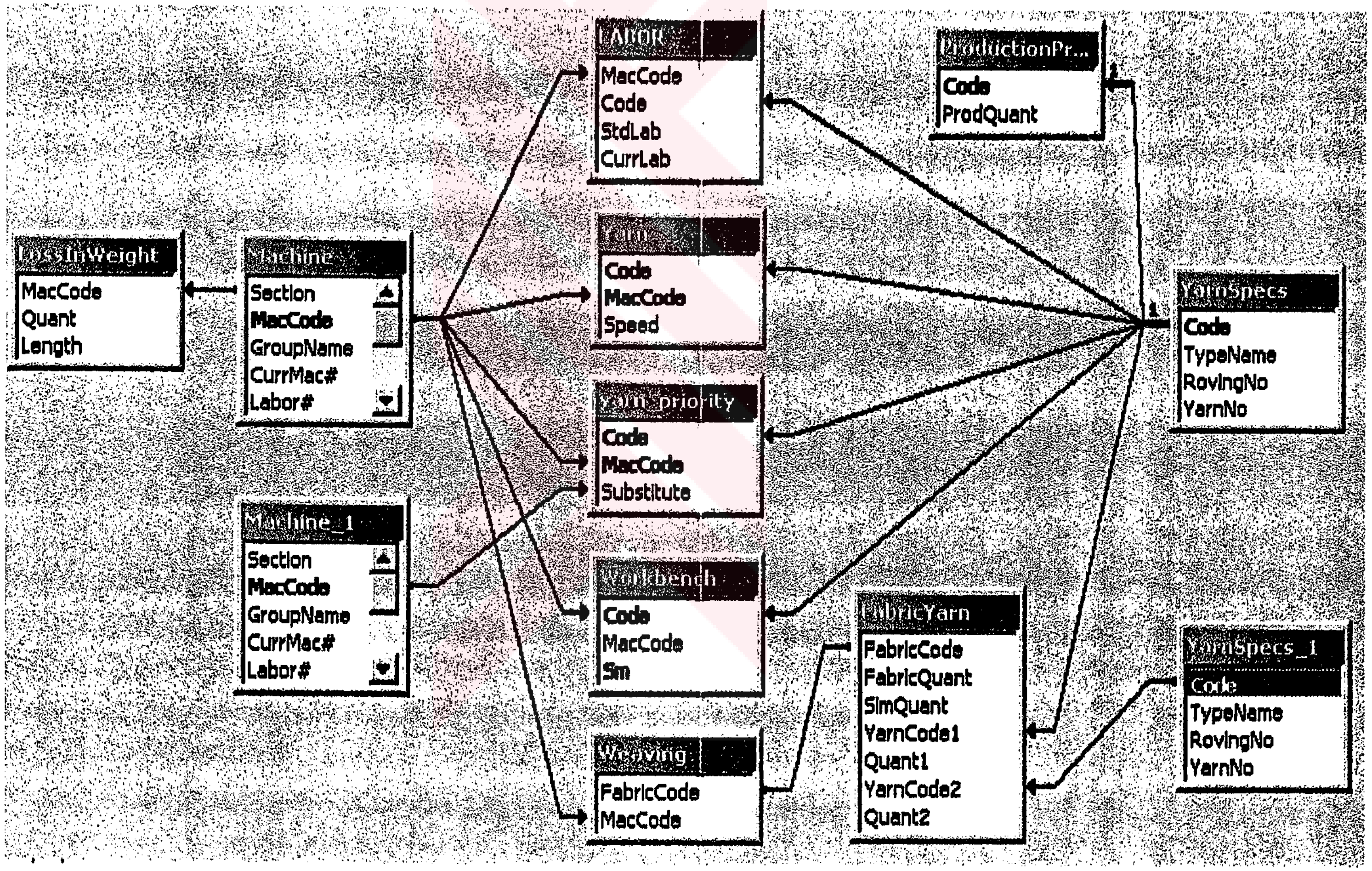
Attributes: Not Enforced, Left Join

RelationshipType: One-To-Many

Table Indexes

Name	**Number of Fields**
Code	1
Fields:	Ascending
PrimaryKey	1
Fields:	Ascending
TipAd	1
Fields:	Ascending

APPENDIX 2 RELATIONSHIPS BETWEEN DATABASE TABLES



APPENDIX 3 IMAGINARY INTEGRATED TEXTILE PLANT DATA

Machine

Section	MacCode	GroupName	CurrMac#	Labor#
Spinning	BUKUM	BUKUM	12,00	24,00
Spinning	YARN1	1. Grup	17,00	17,00
Weaving	SP7150IG	Sulzer P 7150 Projectile	57,00	9,52
Weaving	SP7150PAN	Sulzer P 7150 Projectile	38,00	6,35
Spinning	BOBIN	BOBIN	10,00	5,00
Spinning	YARN2	2. Grup	9,00	4,50
Weaving	SP7150KG	Sulzer P 7150 Projectile	34,00	4,25
Finishing	BUHAR	BUHARLAMA	2,00	2,00
Finishing	BASKI	BASKI	1,00	2,00
Finishing	YIKAMA	YIKAMA	2,00	2,00
Finishing	RAMOZ	RAMÖZ	2,00	2,00
Finishing	KASAR	KONTİNÜ KASAR	1,00	1,00
Finishing	DBOYA	DÜZ BOYA	1,00	1,00
Spinning	CER2KAR	CER2	3,00	1,00
Warping	HASIL	HAŞIL	1,00	2,00
Spinning	HARHAL	HARMAN HALLAÇ	2,00	4,00
Spinning	FITIL	FITIL	8,00	8,00
Spinning	CER2PEN	CER2	3,00	1,00
Spinning	CER1PEN	CER1	3,00	1,00
Spinning	CER1KAR	CER1	3,00	1,00
Warping	COZGU	ÇÖZGÜ	1,00	2,00
Spinning	YARN3	3. Grup	7,00	2,33
Finishing	KALANDIR	KALANDIR	1,00	1,00
Finishing	MERSERIZE	MERSERİZE	1,00	1,00
Spinning	PENYE	PENYE	8,00	2,00
Weaving	PO6R190DOS	Picard Omni 6-R-190 Hava Jetli	7,00	0,99
Finishing	SANFOR	SANFOR	1,00	1,00
Finishing	SARDON	ŞARDON	1,00	1,00

Section	MacCode	GroupName	CurrMac#	Labor#
Weaving	SG6100DIV	Sulzer G. 6100 Rapier	24,00	3,00
Weaving	SG6300CA	Sulzer G. 6300 Rapier	24,00	1,99
Weaving	SP7150EL	Sulzer P 7150 Projectile	13,00	2,17
Spinning	TARKAR	TARAK	9,00	9,00
Spinning	TARPEN	TARAK	11,00	11,00
Spinning	VATKA	VATKA	2,00	1,00
Finishing	YAKMA	YAKMA	1,00	1,00
Spinning	YARN4	4. Grup	2,00	0,50

Process Routine

Code	MacCode	Sm
Carsaf	SG6300CA	1
Carsaf	YAKMA	2
Carsaf	KASAR	3
Carsaf	BASKI	4
Carsaf	BUHAR	5
Carsaf	RAMOZ	6
Carsaf	KALANDIR	7
Divitin	SG6100DIV	1
Divitin	KASAR	2
Divitin	MERSERIZE	3
Divitin	SARDON	4
Divitin	BASKI	5
Divitin	YIKAMA	6
Divitin	BUHAR	7
Divitin	YIKAMA	8
Divitin	RAMOZ	9
Doseme	PO6R190DOS	1
Doseme	YAKMA	2
Doseme	KASAR	3
Doseme	MERSERIZE	4

Code	MacCode	Sm
Doseme	BASKI	5
Doseme	BUHAR	6
Doseme	YIKAMA	7
Doseme	RAMOZ	8
Doseme	KALANDIR	9
Elbise	SP7150EL	1
Elbise	KASAR	2
Elbise	YAKMA	3
Elbise	MERSERIZE	4
Elbise	BASKI	5
Elbise	BUHAR	6
Elbise	YIKAMA	7
Elbise	RAMOZ	8
Elbise	SANFOR	9
InGomlek	SP7150IG	1
InGomlek	YAKMA	2
InGomlek	KASAR	3
InGomlek	MERSERIZE	4
InGomlek	DBOYA	5
InGomlek	BUHAR	6

Code	MacCode	Sm
InGomlek	YIKAMA	7
InGomlek	RAMOZ	8
InGomlek	SANFOR	9
K1	HARHAL	1
K1	TARKAR	2
K1	CER1KAR	3
K1	CER2KAR	4
K1	FITIL	5
K1	YARN3	6
K1	BOBIN	7
K2	HARHAL	1
K2	TARKAR	2
K2	CER1KAR	3
K2	CER2KAR	4
K2	FITIL	5
K2	YARN3	6
K2	BOBIN	7
K3	HARHAL	1
K3	TARKAR	2
K3	CER1KAR	3
K3	CER2KAR	4
K3	FITIL	5
K3	YARN2	6
K3	BOBIN	7
K3	COZGU	8
K3	HASIL	9
K4	HARHAL	1
K4	TARKAR	2
K4	CER1KAR	3
K4	CER2KAR	4
K4	FITIL	5
K4	YARN4	6

Code.	MacCode	Sm
K4	BOBIN	7
K5	HARHAL	1
K5	TARKAR	2
K5	CER1KAR	3
K5	CER2KAR	4
K5	FITIL	5
K5	YARN4	6
K5	BOBIN	7
K6	HARHAL	1
K6	TARKAR	2
K6	CER1KAR	3
K6	CER2KAR	4
K6	FITIL	5
K6	YARN3	6
K6	BOBIN	7
K6	COZGU	8
K6	HASIL	9
K7	HARHAL	1
K7	TARKAR	2
K7	CER1KAR	3
K7	CER2KAR	4
K7	FITIL	5
K7	YARN4	6
K7	BOBIN	7
K8	HARHAL	1
K8	TARKAR	2
K8	CER1KAR	3
K8	CER2KAR	4
K8	FITIL	5
K8	YARN3	6
K8	BOBIN	7
K8	COZGU	8

Code	MacCode	Sm
K8	HASIL	9
K9	HARHAL	1
K9	TARKAR	2
K9	CER1KAR	3
K9	CER2KAR	4
K9	FITIL	5
K9	YARN3	6
K9	BOBIN	7
K9	COZGU	8
K9	HASIL	9
KalGomlek	SP7150KG	1
KalGomlek	KASAR	2
KalGomlek	MERSERIZE	3
KalGomlek	SARDON	4
KalGomlek	YIKAMA	5
KalGomlek	BASKI	6
KalGomlek	BUHAR	7
KalGomlek	YIKAMA	8
KalGomlek	RAMOZ	9
KalGomlek	SANFOR	10
P1	HARHAL	1
P1	TARPEN	2
P1	CER1PEN	3
P1	VATKA	4
P1	PENYE	5
P1	CER2PEN	6
P1	FITIL	7
P1	YARN2	8
P1	BOBIN	9
P1	BUKUM	10
P1	COZGU	11
P1	HASIL	12

Code	MacCode	Sm
P2	HARHAL	1
P2	TARPEN	2
P2	CER1PEN	3
P2	VATKA	4
P2	PENYE	5
P2	CER2PEN	6
P2	FITIL	7
P2	YARN1	8
P2	BOBIN	9
P2	BUKUM	10
P3	HARHAL	1
P3	TARPEN	2
P3	CER1PEN	3
P3	VATKA	4
P3	PENYE	5
P3	CER2PEN	6
P3	FITIL	7
P3	YARN1	8
P3	BOBIN	9
P3	BUKUM	10
P3	COZGU	11
P3	HASIL	12
P4	HARHAL	1
P4	TARPEN	2
P4	CER1PEN	3
P4	VATKA	4
P4	PENYE	5
P4	CER2PEN	6
P4	FITIL	7
P4	YARN2	8
P4	BOBIN	9
P5	HARHAL	1

Code	MacCode	Sm
P5	TARPEN	2
P5	CER1PEN	3
P5	VATKA	4
P5	PENYE	5
P5	CER2PEN	6
P5	FITIL	7
P5	YARN1	8
P5	BOBIN	9
P5	COZGU	10
P5	HASIL	11
Pantolon	SP7150PAN	1
Pantolon	YAKMA	2
Pantolon	KASAR	3

Machine-Production Capacity

Code	MacCode	Speed
Carsaf	BASKI	4800,00
Carsaf	BUHAR	3000,00
Carsaf	KALANDIR	2400,00
Carsaf	KASAR	7200,00
Carsaf	RAMOZ	3000,00
Carsaf	SG6300CA	10,10
Carsaf	YAKMA	9000,00
Divitin	BASKI	4800,00
Divitin	BUHAR	3000,00
Divitin	KASAR	6000,00
Divitin	MERSERIZE	4800,00
Divitin	RAMOZ	3000,00
Divitin	SARDON	1800,00
Divitin	SG6100DIV	15,90
Divitin	YIKAMA	2400,00
Doseme	BASKI	3600,00
Doseme	BUHAR	3000,00
Doseme	KALANDIR	2400,00
Doseme	KASAR	6000,00
Doseme	MERSERIZE	4800,00
Doseme	PO6R190DOS	30,40
Doseme	RAMOZ	2400,00
Doseme	YAKMA	9000,00
Doseme	YIKAMA	2400,00
Elbise	BASKI	3600,00
Elbise	BUHAR	3000,00
Elbise	KASAR	7200,00
Elbise	MERSERIZE	6000,00
Elbise	RAMOZ	3000,00
Elbise	SANFOR	4800,00
Elbise	SP7150EL	23,50
Elbise	YAKMA	9000,00
Elbise	YIKAMA	3600,00
InGomlek	BUHAR	3000,00
InGomlek	DBOYA	2100,00
InGomlek	KASAR	9000,00
InGomlek	MERSERIZE	6000,00
InGomlek	RAMOZ	3000,00
InGomlek	SANFOR	3600,00
InGomlek	SP7150IG	15,40
InGomlek	YAKMA	9000,00
InGomlek	YIKAMA	3600,00
K1	BOBIN	102,06
K1	CER1KAR	198,49
K1	CER2KAR	198,49
K1	FITIL	104,76
K1	HARHAL	475,00

Code	MacCode	Speed
K1	YARN2	43,44
K1	YARN3	43,44
K1	TARKAR	52,43
K2	BOBIN	102,06
K2	CER1KAR	198,49
K2	CER2KAR	198,49
K2	FITIL	104,76
K2	HARHAL	475,00
K2	YARN2	35,88
K2	YARN3	35,88
K2	TARKAR	52,43
K3	BOBIN	68,04
K3	CER1KAR	198,49
K3	CER2KAR	198,49
K3	COZGU	6800,00
K3	FITIL	104,76
K3	HARHAL	475,00
K3	HASIL	20400,00
K3	YARN2	26,87
K3	YARN3	26,87
K3	TARKAR	52,43
K4	BOBIN	102,06
K4	CER1KAR	198,49
K4	CER2KAR	198,49
K4	FITIL	174,60
K4	HARHAL	475,00
K4	YARN4	125,00
K4	TARKAR	52,43
K5	BOBIN	102,06
K5	CER1KAR	198,49
K5	CER2KAR	198,49
K5	FITIL	174,60

Code	MacCode	Speed
K5	HARHAL	475,00
K5	YARN4	90,48
K5	TARKAR	52,43
K6	BOBIN	68,06
K6	CER1KAR	198,49
K6	CER2KAR	198,49
K6	COZGU	8640,00
K6	FITIL	104,76
K6	HARHAL	475,00
K6	HASIL	20400,00
K6	YARN2	35,88
K6	YARN3	35,88
K6	TARKAR	52,43
K7	BOBIN	102,06
K7	CER1KAR	198,49
K7	CER2KAR	198,49
K7	FITIL	174,60
K7	HARHAL	475,00
K7	YARN4	90,48
K7	TARKAR	52,43
K8	BOBIN	68,06
K8	CER1KAR	198,49
K8	CER2KAR	198,49
K8	COZGU	6171,00
K8	FITIL	104,76
K8	HARHAL	475,00
K8	HASIL	20400,00
K8	YARN2	35,88
K8	YARN3	35,88
K8	TARKAR	52,43
K9	BOBIN	68,06
K9	CER1KAR	198,49

Code	MacCode	Speed
K9	CER2KAR	198,49
K9	COZGU	4533,00
K9	FITIL	104,76
K9	HARHAL	475,00
K9	HASIL	20400,00
K9	YARN2	35,88
K9	YARN3	35,88
K9	TARKAR	52,43
KalGomlek	BASKI	3600,00
KalGomlek	BUHAR	3000,00
KalGomlek	KASAR	6000,00
KalGomlek	MERSERIZE	4800,00
KalGomlek	RAMOZ	2400,00
KalGomlek	SANFOR	3600,00
KalGomlek	SARDON	1800,00
KalGomlek	SP7150KG	16,70
KalGomlek	YIKAMA	2400,00
P1	BOBIN	68,06
P1	BUKUM	17,25
P1	CER1PEN	157,69
P1	CER2PEN	121,30
P1	COZGU	8160,00
P1	FITIL	103,30
P1	HARHAL	475,00
P1	HASIL	20400,00
P1	YARN1	25,20
P1	YARN2	25,20
P1	YARN3	25,20
P1	PENYE	47,32
P1	TARPEN	43,57
P1	VATKA	291,60
P2	BOBIN	102,06

Code	MacCode	Speed
P2	BUKUM	19,25
P2	CER1PEN	157,69
P2	CER2PEN	121,30
P2	FITIL	103,30
P2	HARHAL	475,00
P2	YARN1	14,88
P2	YARN3	14,88
P2	PENYE	47,32
P2	TARPEN	43,57
P2	VATKA	291,60
P3	BOBIN	68,06
P3	BUKUM	17,25
P3	CER1PEN	157,69
P3	CER2PEN	121,30
P3	COZGU	4800,00
P3	FITIL	70,08
P3	HARHAL	475,00
P3	HASIL	20400,00
P3	YARN1	11,52
P3	YARN3	11,52
P3	PENYE	47,32
P3	TARPEN	43,57
P3	VATKA	291,60
P4	BOBIN	102,06
P4	CER1PEN	157,69
P4	CER2PEN	121,30
P4	FITIL	103,30
P4	HARHAL	475,00
P4	YARN2	26,87
P4	YARN3	26,87
P4	PENYE	47,32
P4	TARPEN	43,57

Code	MacCode	Speed
P4	VATKA	291,60
P5	BOBIN	68,04
P5	CER1PEN	157,69
P5	CER2PEN	121,30
P5	COZGU	5486,00
P5	FITIL	103,30
P5	HARHAL	475,00
P5	HASIL	20400,00
P5	YARN1	14,88
P5	YARN3	14,88
P5	PENYE	47,32

Code	MacCode	Speed
P5	TARPEN	43,57
P5	VATKA	291,60
Pantolon	BUHAR	3000,00
Pantolon	DBOYA	2100,00
Pantolon	KASAR	7200,00
Pantolon	MERSERIZE	6000,00
Pantolon	RAMOZ	3000,00
Pantolon	SANFOR	4800,00
Pantolon	SP7150PAN	12,50
Pantolon	YAKMA	7200,00
Pantolon	YIKAMA	3600,00

Yarn Specifications

Code	TypeName	RovingNo	YarnNo
K1	KarÇar	0,8	18/1
K2	KarKalGöm	0,8	20/1
K3	KarKalGöm	0,8	30/1
K4	KarDöş	0,6	8/1
K5	KarDiv	0,6	10/1
K6	KarDiv	0,8	20/1
K7	KarPamElb	0,6	10/1
K8	KarDös	0,8	20/1
K9	KarÇar	0,8	20/1
P1	PenElb	0,9	32/2
P2	PenPan	0,9	40/2
P3	PenPan	1,2	50/2
P4	PenInceGöm	1,2	30/1
P5	PenInceGöm	1,2	40/1

Queue

Code	MacCode	Quant	Sm
K4	bitti	96,8281326293945	7,00
K6	bitti	790,3916015625	9,00
K8	bitti	422,053802490234	9,00
K9	bitti	478,32763671875	9,00
K1	bitti	98,2875747680664	7,00
K2	bitti	104,666236877441	7,00
K7	bitti	165,840194702148	7,00
K3	bitti	1220,11926269531	9,00
K5	bitti	102,492393493652	7,00
P4	bitti	156,595077514648	9,00
P5	bitti	1935,17517089844	11,00
P1	bitti	1058,10168457031	12,00
P3	bitti	1014,65313720703	12,00
P2	bitti	149,089782714844	10,00
Pantolon	bitti	987,529724121094	3,00
Carsaf	bitti	465,923583984375	7,00
Doseme	bitti	411,109039306641	9,00
Elbise	bitti	1029,81677246094	9,00
InGomlek	bitti	1883,86669921875	9,00
Divitin	bitti	769,894958496094	9,00
KalGomlek	bitti	1188,47924804688	10,00

Fabric Production

WeavingCode	Quantity (X1000 m)	SimQuant	YarnCode1	Quant1(gr)	YarnCode2	Quant2(gr)
Carsaf	525,00	467,50	K9	176,00	K1	206,00
Divitin	830,00	772,50	K6	88,00	K5	130,00
Doseme	470,00	412,50	K8	187,00	K4	230,00
Elbise	690,00	1035,00	P1	119,00	K7	157,00
InGomlek	1950,00	1892,50	P5	73,00	P4	81,00
KalGomlek	1250,00	1192,50	K3	84,00	K2	86,00
Pantolon	1050,00	992,50	P3	123,00	P2	147,00

Worker

MacCode	Code	StdLabor	Current
BASKI		2,00	2,10
BOBIN	K9	0,50	0,52
BOBIN	K1	0,50	0,52
BOBIN	K8	0,50	0,52
BOBIN	K4	0,50	0,52
BOBIN	P3	1,00	1,05
BOBIN	P2	1,00	1,05
BOBIN	K3	1,00	1,05
BOBIN	K2	0,50	0,52
BOBIN	P5	1,00	1,05
BOBIN	P4	1,00	1,05
BOBIN	P1	1,00	1,05
BOBIN	K7	0,50	0,52
BOBIN	K6	0,50	0,52
BOBIN	K5	0,50	0,52
BUHAR		1,00	1,05
BUKUM		2,00	2,10
CER1KAR		0,33	0,35
CER1PEN		0,33	0,35
CER2KAR		0,33	0,35
CER2PEN		0,33	0,35
COZGU		2,00	2,10
DBOYA		1,00	1,05
FITIL		1,00	1,05
HARHAL		2,00	2,10
HASIL		2,00	2,10
YARN1	P3	1,00	1,05
YARN1	P2	1,00	1,05
YARN1	P5	1,00	1,05
YARN2	K3	0,50	0,52
YARN2	P4	0,50	0,52

MacCode	Code	StdLabor	Current
YARN2	P1	0,50	0,52
YARN3	K9	0,33	0,35
YARN3	K1	0,33	0,35
YARN3	K8	0,33	0,35
YARN3	K2	0,33	0,35
YARN3	K6	0,33	0,35
YARN4	K4	0,25	0,26
YARN4	K7	0,25	0,26
YARN4	K5	0,25	0,26
KALANDIR		1,00	1,05
KASAR		1,00	1,05
MERSERIZE		1,00	1,05
PENYE		0,25	0,26
PO6R190DOS	Doseme	0,14	0,15
RAMOZ		1,00	1,05
SANFOR		1,00	1,05
SARDON		1,00	1,05
SG6100DIV	Divitin	0,13	0,13
SG6300CA	Carsaf	0,08	0,09
SP7150EL	Elbise	0,17	0,18
SP7150IG	InGomlek	0,17	0,18
SP7150KG	KalGomlek	0,13	0,13
SP7150PAN	Pantolon	0,17	0,18
TARKAR		1,00	1,05
TARPEN		1,00	1,05
VATKA		0,50	0,52
YAKMA		1,00	1,05
YIKAMA		1,00	1,05

Shrinkage / Weight in Loss

MacCode	Quant	Length
Finishing	0,04	0,03
Spinning	0,005	0
Weaving	0,01	0,04

Finished Processes (only a part)

Section	Code	MacCode	Sm	Quant	ProdTime	OrderNo	ProdOrdNo
Spinning	P2	CER2PEN	6,00	151	0,4376723	5	121
Spinning	P2	FITIL	7,00	150	0,1922404	5	122
Spinning	P2	YARN1	8,00	150	0,5898734	5	123
Spinning	P2	BOBIN	9,00	150	0,1470331	5	124
Spinning	P2	BUKUM	10,00	150	0,6558382	5	125
Weaving	Carsaf	SG6300CA	1,00	228,5	1	6	126
Weaving	Carsaf	SG6300CA	1,00	228,5	1	6	127
Weaving	Carsaf	SG6300CA	1,00	22,7	0,0995676	6	128
Weaving	Elbise	SP7150EL	1,00	297,1	1	6	129
Weaving	Elbise	SP7150EL	1,00	297,1	1	6	130
Weaving	Elbise	SP7150EL	1,00	297,1	1	6	131
Weaving	Elbise	SP7150EL	1,00	169,2	0,5697013	6	132
Weaving	InGomlek	SP7150IG	1,00	828,5	1	6	133
Weaving	InGomlek	SP7150IG	1,00	828,5	1	6	134
Weaving	InGomlek	SP7150IG	1,00	283,3	0,3419415	6	135
Weaving	KalGomlek	SP7150KG	1,00	557,7	1	6	136
Weaving	KalGomlek	SP7150KG	1,00	557,7	1	6	137
Weaving	KalGomlek	SP7150KG	1,00	108,7	0,1949621	6	138
Weaving	Divitin	SG6100DIV	1,00	365,7	1	6	139
Weaving	Divitin	SG6100DIV	1,00	365,7	1	6	140
Weaving	Divitin	SG6100DIV	1,00	61,5	0,1683368	6	141
Weaving	Pantolon	SP7150PAN	1,00	441,8	1	6	142
Weaving	Pantolon	SP7150PAN	1,00	441,8	1	6	143

APPENDIX 4 AN ILLUSTRATION TO CAPACITY USAGE RATES AFTER AND BEFORE CORRECTION

BEFORE CORRECTION

Section Finishing

MacCode	Process Time (Hours)	Process Time %
YIKAMA	1.320,98	58,58
SARDON	1.165,82	51,70
SANFOR	1.124,95	49,89
MERSERIZE	1.050,29	46,58
RAMOZ	1.031,14	45,73
BASKI	1.003,70	44,51
KASAR	970,90	43,06
BUHAR	970,13	43,02
DBOYA	911,93	40,44
YAKMA	600,45	26,63
KALANDIR	385,16	17,08

Summary for 'Section' = Finishing (11 machine groups)

Threshold Machine **YIKAMA** **1.320,98**

Section Spinning

MacCode	**Process Time (Hours)**	**Process Time %**
TARKAR	2.078,07	92.15
CER2PEN	2.049,60	90.89
YARN4	1.988,68	88.19
PENYE	1.984,28	87.99
BOBIN	1.939,08	85.99
FITIL	1.935,98	85.85
BUKUM	1.894,03	83.99
HARHAL	1.821,89	80.79
YARN1	1.769,03	78.45
YARN3	1.766,28	78,33
YARN2	1.641,93	72,81
CER1KAR	1.630,94	72,33
CER2KAR	1.624,63	72,05
CER1PEN	1.582,66	70,19
TARPEN	1.554,50	68,94
VATKA	1.281,13	56,81

Summary for 'Section' = Spinning (16 machine groups)

Threshold Machine TARKAR 2.078,07

Section Warping

MacCode	**Process Time (Hours)**	**Process Time %**
COZGU	1.201,97	53,30
HASIL	357,14	15,84

Summary for 'Section' = Warping (2 machine groups)

Threshold Machine **COZGU** **1.201,97**

Section Weaving

MacCode	**Process Time (Hours)**	**Process Time %**
SP7150EL	3.569,70	158,30
SP7150IG	2.341,94	103,86
SP7150PAN	2.301,81	102,08
SP7150KG	2.194,96	97,34
SG6100DIV	2.168,34	96,16
PO6R190DOS	2.117,21	93,89
SG6300CA	2.099,57	93,11

Summary for 'Section' = Weaving (7 machine groups)

Threshold Machine **SP7150EL** **3.569,70**

AFTER CORRECTION

Section Finishing

MacCode	Process Time (Hours)	Process Time %
YIKAMA	1.257,98	55,79
SARDON	1.165,82	51,70
SANFOR	1.021,24	45,29
MERSERIZE	970,12	43,02
RAMOZ	955,78	42,39
KASAR	906,05	40,18
BASKI	896,61	39,76
BUHAR	894,27	39,66
DBOYA	878,08	38,94
YAKMA	543,81	24,12
KALANDIR	385,16	17,08

Summary for 'Section' = Finishing (11 machine groups)

Threshold Machine YIKAMA 1.257,98

Section Spinning

MacCode	Process Time (Hours)	Process Time %
TARKAR	1.937,52	85,92
CER2PEN	1.864,30	82,67
FITIL	1.806,62	80,12
PENYE	1.804,93	80,04
BOBIN	1.789,82	79,37
YARN3	1.766,28	78,33
YARN1	1.723,66	76,44
HARHAL	1.680,64	74,53
BUKUM	1.639,14	72,69
YARN4	1.629,37	72,26
CER1KAR	1.520,67	67,44
CER2KAR	1.514,82	67,18
CER1PEN	1.439,85	63,85
TARPEN	1.414,08	62,71
YARN2	1.409,18	62,49
VATKA	1.165,36	51,68

Summary for 'Section' = Spinning (16 machine groups)

Threshold Machine TARKAR 1.937,52

Section Warping

MacCode	Process Time (Hours)	Process Time %
COZGU	1.133,22	50,25
HASIL	332,26	14,73

Summary for 'Section' = Warping (2 machine groups)

Threshold Machine COZGU 1.133,22

Section Weaving

MacCode	Process Time (Hours)	Process Time %
SP7150IG	2.255,00	100,00
SP7150EL	2.255,00	100,00
SP7150PAN	2.255,00	100,00
SP7150KG	2.194,96	97,34
SG6100DIV	2.168,34	96,16
PO6R190DOS	2.117,21	93,89
SG6300CA	2.099,57	93,11

Summary for 'Section' = Weaving (7 machine groups)

Threshold Machine SP7150IG 2.255,00