REST Journal on Emerging trends in Modelling and Manufacturing
Vol:2(1),2016
REST Publisher
ISSN: 2455-4537

Website: www.restpublisher.com/journals/jemm

Case Study on Profit Planning of Textile Industry Using Linear Programming Approach

Eshetie Kassegn[1], Dr. Ashish Thakur[1], Niguss Haregot[2], Aregawi Gebreyesus[3]

School of Mechanical and Industrial Engineering, Mekelle University, Mekelle, Ethiopia

keshetie61@yahoo.com, thakurashish1@gmail.com

Abstract

This study deals about the development of linear programming model for Almeda Private Limited, Ethiopian Textile Industry as a case study. Loose of profit of a company, that is expected to gain, is the result of poor profit planning way or limitation of modern profit planning tools which subjects the company to promote more expenses rather than revenue. Linear Programming (LP) is a linear programming model in which there a particular function to be maximized is or minimized subject to several constraints, and in this case it is to maximize profit. So, in pursuit of maximizing profit or minimizing production cost, the linear programming model was developed. The model was developed by taking considerations on market segmentation, interest of workers, utilization of machines and other resources, demand of products by forecasting, and production capacity of the company. To develop the model, data were collected from primary and secondary sources. This study was supported through accessing available and related literatures, company survey and software, and analyzed the information collected using main principles of linear programming technique. All major products and constraints with their values were identified and used for developing the model. The main objective of this study is to increase profit by using linear programming technique and reduce production cost. As a result, the linear programming model was developed which maximizes profit from around 44.46 million ETB to 53.77 million ETB. This was achieved by applying proper product mix strategy as production of 0.25 unit of yarn, 0.25 unit of fabric, 0.76 unit of CM, 8.5 units of knit garment, and 0.25 unit of woven garment product. Increasing profitability and decreasing cost of production is the main challenges of many industries in our country Ethiopia, particularly this affects textile industry. The main cause of these problems is lack of a quantitative technique which enables them to minimize cost of production within the production system.

Key Words: Linear programming; profit maximization; model development; textile products.

1. Introduction

The textile industries in Ethiopia are considered as weak in either research or development and lack the school of thoughts regarding innovation. This sector as a modern textile started in Ethiopia in 1939, established by foreign capital under the name of Dire Dawa Textile Mills [7]. Accordingly, Ethiopia has 2.6 million hectares of land suitable for cotton production, which is equivalent to that of Pakistan, the fourth largest producer of cotton in the world. The success of textile and garment companies in their competition for the global market rests in large part on their focus on more effective and efficient manufacturing processes. The necessity to reduce the cost of production has also caused manufacturers to focus on waste minimization [2]. According to [2], Ethiopia has the potential to develop cotton farms for domestic use and export; recently its apparel and textile exports have been continuously increasing. This study aims to put forth the benefits of linear programming technique, which is one of the quantitative decision-making techniques, for the most efficient use of established business capacities. In order to achieve this aim, capacity planning is carried out in a textile enterprise in Ethiopia. The theme of this study is identification of wastes in textile and garment factories which then forwards their economic cost-benefit analyses intuitively. Cost is one of the crucial criteria which are considered in the implementation phase. Time is another important criterion which is normally considered in the implementation phase of the strategic planning [10]. In this research, it is attempted to make a capacity planning [10] as well as cost benefit through linear programming technique by using an Almeda Textile enterprise's data of the last four years. According to the model, it is determined that the cutting, ironing and packaging units of the enterprise operate with idle capacity and provide a low profitability. In this regard, a new linear programming model has been developed and analysed in order to ensure that the enterprise manufactures its own products, which are mainly sewed by contract manufacturing. According to the proposed model, it is seen that the enterprise has doubled its profitability. Moreover, the local and foreign researches about linear programming are reviewed and evaluated in this research [2]. The model was developed by taking considerations on market segmentation, interest of workers, utilization of machines and other resources, demand of products by forecasting, and production capacity of the company. The linear programming techniques have universal applicability and they are of great help in making rational decisions on different aspects of business. The multinational companies (MNC), public sector undertakings (PSUs) of strategic importance and private corporate sector units might have applied and realized the importance of the resource management techniques. But when it comes to textile industries in Ethiopia, these techniques are seldom used to aid decision making.

2. Literature Review

According to [2], as a result of the governmental export incentives and opportunity of international trading environment, in the past few years, the export of textile product has shown significant increase. The four major production stages in textile industry are yarn formation, fabric formation, wet processing and fabrication [6]. (Fig.1)

2.1.1 Yarn Formation

Textile fibers are converted into yarn by grouping and twisting operations used to bind them together. Natural fibers must go through a series of preparation steps before they can be spun into yarn, including opening, blending, carding, combing, and drafting [15]. Manmade fibers are processed into filament yarn or staple-length fibers (similar in length to natural fibers) so that they can be spun.

2.1.2 Fabric Formation

Fabric formation includes processes for flat fabrics such as sheets and apparel. Weaving or interlacing yarn is the most common process used to create fabrics. Knitting is the second most frequently used method of fabric construction.

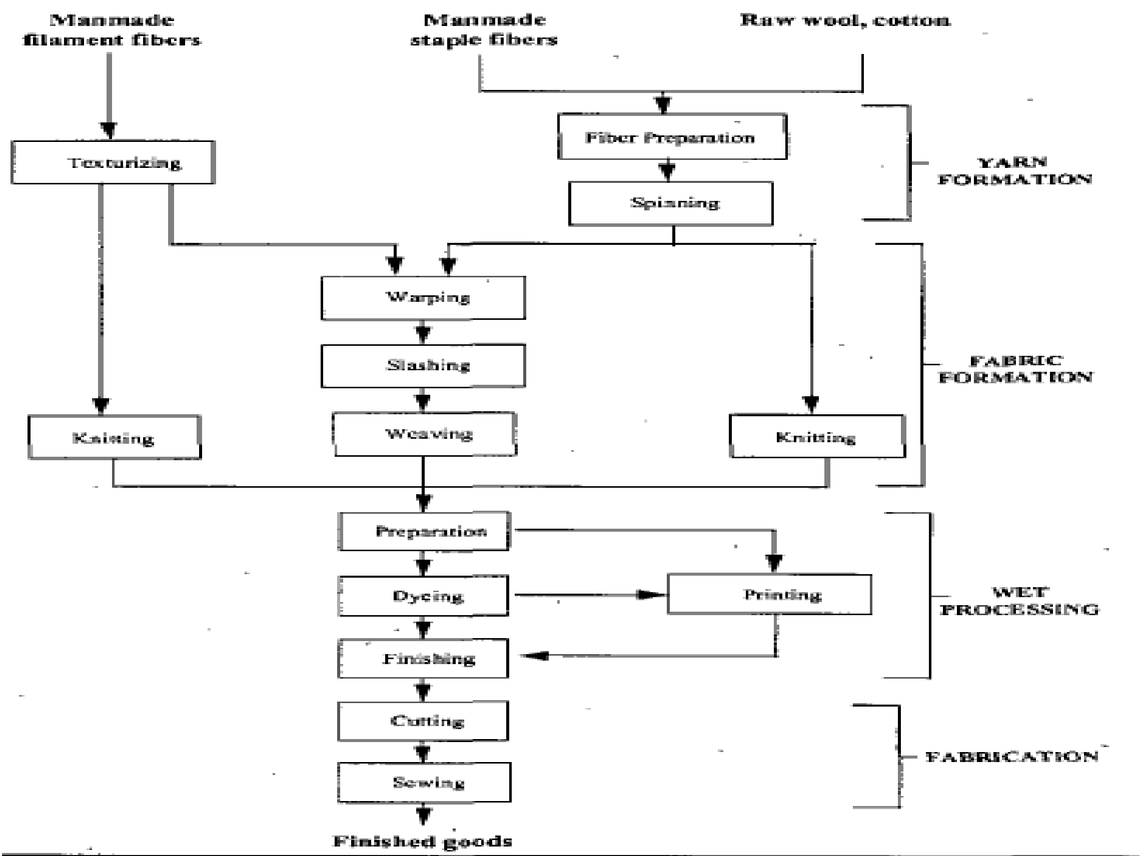

Figure 2.1: Typical Textile Processing Flow Chart

2.1.3. Wet Processing

Woven and knit fabrics cannot be processed into apparel and other finished goods until the fabrics have passed through several water-intensive wet processing stages.

2.1.4 Fabrication

Finished cloth is fabricated into a variety of apparel and household and industrial products. Apparel and more complex house wares are usually fabricated by the cutting trades. Before cutting, fabrics must be carefully laid out.

2.2 Application of Linear Programming for Textile Production Planning

Many engineering optimization problems can also be considered as linear programming problems where all or some of the parameters involved are linguistic in nature [5]. As the discussion made by [3], the application of linear programming models are blending and mix determination problems, planning and scheduling problems, distribution cost problems, plant location decisions, resources allocation to activities problems, and analysis of a multi-plant production system to determine whether or not certain plants should be shut down as a result of high cost of production [16].

2.3 Profit Planning Tools

Among the modern profit planning techniques, programming models are the most important and frequently applied once because of their simplicity to use and applicability to wider areas. [4] States that linear programming is one of the best known tools to management science.

2.4 Profit Planning by Linear Programming

Linear Programming (LP) is a linear programming model in which there a particular function to be maximized is or minimized subject to several constraints [1]. There are five essential conditions used in a problem situation for linear programming to pertain. According to [3], refers to linear programming as a uni-objective constrained optimization technique. [8] Argue that linear programming deals with linear optimization of a function of variables known as objective function subject to set of linear equations and /or inequalities known as constraints.

2.4.1 Requirements of Linear Programming

According to the study by [9], linear programming can be applied to only those problems, which satisfy the following conditions.

1. Objective: In business problems the objective is usually the maximization of profits or minimization of costs.
2. Constraints: All constraints relating to resources should be fully spelt out.
3. Linearity: Under linear relationship, every increment in one variable results in proportionate change in another variable.
4. Non- negativity: This suits the production decisions, as negative values of physical quantities are never possible.
5. Finiteness: The number of inputs, outputs and activities need to be finite, as otherwise computation of an optimal solution is not possible.

3. Methodology

3.1.1 Research Methodology

Some manufacturing companies like Almeda Textile Factory have started implementing lean production system with some extent following the principle of kaizen (continuous improvement) and 5S. The reason behind this is the existence of constant pressure on costs, quality and delivery time. These driving forces pressurize the organizations to improve their business processes continuously and stay in market. As per the results shown by [3], Linear Programming, an operations research technique is widely used in finding solutions to complex managerial decision problems, but firms make more use of the trial-and-error method. Data were gathered from the case company to identify the method (s) of decision making for profit determination and develop the model that maximizes profit. Then, the collected data were used to develop the linear programming model with an appropriate products mix or ratio. Data were collected on the types of textile and non-textile products produced at the case company, unit production costs of each product, unit prices of each product to know the profit of products, each raw material costs, quantities of raw materials used for each products, constraints, labor costs for each products, and production capacity. Doing this, the model was developed and analyzed, and then the products ratio or mixture was determined which enhances productivity. Quantitative method was used in conducting the research because the issues inbounded in this research were related to quantitative aspects. Numerical or quantitative related values have been collected and analyzed. The survey strategy was usually associated with the deductive approach. Using this method allowed the collection of a large amount of data, which afterwards was analyzed. Different literatures such as journals, articles and books were reviewed which are related to linear programming technique on textile industries as a major target, and operation research and optimization. The application of operation research, particularly linear programming technique in achieving proper profit determination (planning) of the factory was identified from the literatures. The research discussed on the development of a linear programming model that maximizes profit and customer satisfaction by reducing unnecessary costs during production process at Almeda Textile Factory context. This comprises all the issues of main products produced at the case industry, constraints affecting the ongoing processes, and opportunities that could be taken as an advantage to maximize the overall profit.

3.2 Data Collection Techniques

To conduct the research, the following data collection and analysis methods were applied.

Primary Data Collection

a. Visual observation: This method has been used to visualize the overall performance of the textile company's activities, and to come up with some concrete ideas. It also gave general understanding of what will be done to solve the problems.
b. Questionnaire: It was used for this study to dig out the feeling of employees of the company about the study to be conducted. It was also used to gather the relevant data about the optimization of resources, production costs, prices, raw materials, types of products, and so forth.
c. Interview: It was conducted to collect data from the company related to the study from the managers' side/perspective. Even if this method was challenging to collect data, it was very important to obtain more relevant primary data about the overall activities and strategies of the company in terms of profitability, and to get adequate clarification of other variables influencing the development of a model.
d. Focused group discussion: This method was applied to gather raw data related to the study based on the facts and suggestions from the experts' side.

Secondary Data Collection

a. Company background: Secondary data were accessed using company background. It was used to know the company from its initial up to the current of its status. This was applicable to understand the level of improvements of the process for manufacturing of the product from the establishment time to the current time.
b. Documents from the company: Relevant data were directly collected from the documents of the company such as reports, records of financial statements for the fiscal year of 2005 E.C, and standards; then these data were used for the study. This method was also important as the other methods in collecting available data for conducting effective and reality based research.

c. Related books and papers: Facts related to the study have been collected through accessing books related to the research. Websites were also used to access papers or journals related to the study. This was very important to understand and apply the scientific facts and implications of the study. It has also provided similar findings or researches done before and these findings were used as literatures.

Data Analysis

After relevant data have been collected, data analysis was conducted using linear programming approaches.

Data Analysis Tools

A linear programming problem could be solved either by graphical method or simplex method. The graphical method involves use of graphs. The software called Linear Interactive and Discrete Optimizer (LINDO) could be used to get the solution for the decision problems, and it was proposed to apply in profit planning under this research. However, it couldn't be found from the market around Mekelle. Hence, Microsoft Excel Solver, which is easily available at Microsoft office without any cost, was used to get the solution of profit planning problem.

3.3. Sampling Technique and Source

A survey based research was conducted using samples from the population. To conduct this research, random sampling method was used. From the selected five textile industries inland, fifteen respondents from each industry were selected randomly. The respondents are working from the marketing department, human resource department, finance department, production department and purchasing & procurement department. A sample taken out of this sampling frame was representative for the whole population because these respondents were selected from all concerned departments of the industries.

3.3.1. Data Collection Process

Participants were invited to take part in the survey on April 20th, 2013. One day later on April 21th, 2013 the questionnaires were collected. Some of the participants didn't return the questionnaire because of unknown reasons. The quantities of questionnaires distributed were 15 for each of the five selected textile industries, and then out of those questionnaires 65 were returned. Among 65 questionnaires returned, 5 were not fully filled in. As a result, 60 questionnaires were analyzed which were answered a minimum of 80% of the total questions, which means more than half of the questionnaires distributed were analyzed. The response rate was almost 80% (60/75). Consequently, the participation was run well enough to extract the required data. Majority of the respondents jumped some parts of the questions like amount of each raw material for each product and others from the questionnaire, which could indicate that they might not have awareness or enough knowledge about the questions rose. The result of literature survey and data survey were integrated to develop the linear programming model that would maximize the benefit of the case industry through the best combination of product mixtures without denying customer demands.

4. Result and Discussion

4.1 Data Presentation

As already stated before, the research is focused on profit planning of textile and non-textile products of the case company. Data related to cost and profit have been collected from the company. One category of cost parameter is raw materials expenses. As can be seen from Table 4.1, there are five basic processes under production of textile and non-textile products. The table clearly shows the raw materials requirement plan at each process for the last fiscal year (2005 E.C). The requirement plan of raw materials was scheduled on quarter basis.

Table 4.1: Quarterly materials requirement plan for 2005 E.C or 2011/2012 G.C (Value in Birr)

Material Type	**Quarters**				**Total**
	1st	**2nd**	**3rd**	**4th**	
Spinning					
Cotton	35,741,868	35,741,868	35,741,868	35,741,868	142,967,474
Polyester	8,511,186	8,511,186	8,511,186	8,511,186	34,044,744
Weaving					
Sizing chemicals	3,423,490	3,423,490	3,423,490	3,423,490	13,693,959
Processing					
Chemicals	8,917,840	8,917,840	8,917,840	8,917,840	35,671,361
Dyestuffs	4,688,344	4,688,344	4,688,344	4,688,344	18,753,374
Knit Dyeing					
Chemicals	2,125,788	2,125,788	2,125,788	2,125,788	8,503,153
Dyes	4,148,228	4,148,228	4,148,228	4,148,228	16,592,913
Garment					
Accessories	9,273,773	9,273,773	9,273,773	9,273,773	37,095,090
Chemicals	612,639	612,639	612,639	612,639	2,450,555
Engineering					
Water treatment chemicals	443,040	443,040	443,040	443,040	1,772,160
Total	**77,886,196**	**77,886,196**	**77,886,196**	**77,886,196**	**311,544,783**

Assumption:

Costs incurred for products under the processes of engineering, selling & distribution, and administrative & general is assumed to be the same for all processes of manufacturing textile and non-textile products. The basis for this assumption is because these processes have same value and application to all processes. The total costs incurred at each process to produce the corresponding products for the last year were calculated. The Table 4.3 shows the types of products and their costs at the corresponding processes. The costs of processes would be costs of the products under the respective processes if all constraints were consumed at processes to produce the respective products. For example, 181,988,211.03 birr would be cost of yarn as if no further process beyond yarn with the resource already considered.

Table 4.2: Cost parameters and their annual respective values in birr at each process for 2005 E.C or 2011/2012 G.C

Process	**Cost Parameters**							**Total**
	Direct Material	**Indirect Material**	**Direct Labor Cost**	**Indirect Labor Cost**		**Production Overhead Cost**		
	Material Types	**Costs**	**Material Types**	**Costs**				
Spinning	Cotton Polyester Chemical	101,675,675.75 25,058,866.88 1,865.80	None	0.00	4,367,232.89	2,641,223.34	18,421,051.02	152,165,915.68
Weaving	Sizing Agent	6,339,958.3	P/Material Accessories	40,782.57 377.62	3,723,617.73	2,456,181.92	10,478,860.79	23,039,778.94
Finishing	Chemical Dyestuff Sizing Agent	11,629,870.55 7,778,496.12 968.88	P/Material	849,981.60	1,882,369.80	1,470,827.95	6,839,586.03	30,452,100.93
Knit Wear	Chemical Dyestuff	3,603,072.17 3,638,880.02	P/Material Accessories	2,156,931.86 3,975,846.91	4,594,899.56	2,299,513.37	7,630,923.74	27,900,067.63
Woven Garment	Chemical	601,180.29	P/Material Accessories	1,552,748.86 9,312,262.13	21,325,691.38	3,634,978.80	46,526,191.31	82,953,052.59
Engineering	None	0.00	None	0.00	0.00	3,362,430.08	72,744,564.23	76,106,994.31
Selling & Distribution	None	0.00	None	0.00	0.00	2,623,068.82	2,408,461.05	5,031,529.87
Administrative & General	None	0.00	None	0.00	0.00	12,337,110.92	55,635,841.66	67,972,952.58
465,622,392.71 Birr/Year								

Note: P/Material= Packing Material

Table 4.3: Types of products and costs at each process for 2005 E.C or 2011/2012 G.C

S.N	**Types of product**	**Process**	**Total Costs incurred at each process (in birr)**	**Remark**
1	Yarn	Spinning	181,988,211.03	Annual value
2	Fabric	Weaving	202,386,766.60	Annual value
3	CM	Finishing	230,341,525.45	Annual value
4	Knit Garment	Knit Garment	255,920,783.53	Annual value
5	Woven Garment	Woven Garment	330,441,544.16	Annual value

From Table 4.2, the costs of constraints (material, labor and overheads) were found. Then, the percentages of share of each constraint with respect to the total value of the three constraints of each product were determined exclusively. This is illustrated by Table 4.4 as shown below. The total material cost is the summation of direct and indirect materials costs. In the same manner, the total labor cost is also the summation of direct and indirect labors costs. Specifically, engineering costs, selling and distribution costs, and genera administrative costs are included in labor and production overhead costs of each process since they are part of labor and overhead costs but not part of material costs. Each product’s cost is expressed in terms of the three constraints; namely, raw material costs, labor costs and overhead costs. These constraints are very important to develop the linear programming model which enhances maximum profit with proper product mix. As a result, the company would earn better profit compared to the existing one. Each product’s cost is expressed in terms of the three constraints; namely, raw material costs, labor costs and overhead costs. These constraints are very important to develop the linear programming model which enhances maximum profit with proper product mix. As a result, the company would earn better profit compared to the existing one. It is common for matrices in industrial applications of linear programming to have a large proportion of zero coefficients. While every item (raw material, intermediate material, end item, equipment item) in, say, a petroleum refinery may be indirectly related to every other, any particular process uses few of these. Thus the matrix describing petroleum technology has a small percentage of non-zeros. Main types of products produced and sold by Almeda Textile Factory for 2005 E.C (2011/12) are listed here below in the Table 4.5.

Table 4.4: Summary of cost parameters (constraints) and their respective annual values for 2005 E.C or 2011/2012 G.C

S/N	**Type of Product**	**The Cost Parameter**	**Unit Measurement**	**Annual Value (in Birr)**	**Percent of Share**
1	Yarn	Material	Kilogram	126,736,408.43	0.70
		Labor	Number	10,672,978.19	0.06
		Overhead	Number	44,578,824.41	0.24
2	Fabric	Material	Kilogram	133,117,526.93	0.66
		Labor	Number	14,211,554.50	0.07
		Overhead	Number	55,057,685.20	0.27
3	CM	Material	Kilogram	153,335,683.89	0.67
		Labor	Number	15,108,570.33	0.06
		Overhead	Number	61,897,271.23	0.27
4	Knit Garment	Material	Kilogram	165,860,433.25	0.65
		Labor	Number	20,532,155.31	0.08
		Overhead	Number	69,528,194.97	0.27
5	Woven Garment	Material	Kilogram	171,193,845.76	0.52
		Labor	Number	43,193,312.12	0.13
		Overhead	Number	116,054,386.28	0.35

Table 4.5: Annual sales volumes, costs and prices of major products for 2005 E.C

S.N	**Product Name**	**Unit Measurement**	**Annual Sales**	**Unit Cost**	**Unit Price**	**Unit profit**	**Market Location**
1	Yarn	Kilogram	20,850	72.77	83.69	10.92	Local
2	Fabric	Meter	2,389,478	30.58	35.17	4.59	Local & Export
3	CM	Pieces	94,478	23.82	27.39	3.57	Export
4	Knit Garment	Pieces	3,071,706	22.99	26.44	3.45	Local & Export
5	Woven Garment	Pieces/set	1,052,850	141.4	162.64	21.21	Local & Export

The unit prices are an average unit prices calculated by dividing the total annual sales value in birr of the product to the annual sales quantity or volume. According to the standard of the company, the profit of each product is 15% of the overall cost of the product. Therefore, as can be seen in Table 4.5, the formula used to determine the costs was:

Profit=15% of product cost
Price= overall cost + 15% of overall cost
Price= overall cost (1+15%) = overall cost (1+0.15)
Price= overall cost (1.15)

$$cost = \frac{price}{1.15}$$

In this manner, costs as well as profits of each product were determined. Why we were forced to go through this way was due to the absence of required cost data of each product. Simply, the data related to the sales volumes and sales values in terms of birr were available from the company. After determining the costs of products using the above formula as shown in table 4.6, the unit cost of each constraint were also determined using the percentage of share of each constraint with respect to the others. And, values are provided in Table 4.6.

Table 4.6: Detail costs of each constraint and total profits of the products

S	**Product Name**	**Unit Measurement**	**Annual Sales Value**	**Unit Cost**	**Unit Price**	**Unit Profit**	**Total Profit**	**Unit Cost of Each Constraint**		
								Constraint	**% of Share**	**Unit Cost**
1	Yarn	Kilogram	20,850	72.7	83.6	10.92	227,682.00	Raw Material	0.70	50.9
								Labor	0.06	4.37
								Overhead	0.24	17.4
2	Fabric	Meter	2,389,478	30.5	35.1	4.59	10,967,704.0	Raw Material	0.66	20.1
								Labor	0.07	2.14
								Overhead	0.27	8.26
3	CM	Pieces	94,478	23.8	27.3	3.57	337,286.46	Raw Material	0.67	15.9
								Labor	0.06	1.43
								Overhead	0.27	6.43
4	Knit Garment	Pieces	3,071,706	22.9	26.4	3.45	10,597,385.7	Raw Material	0.65	14.9
								Labor	0.08	1.84
								Overhead	0.27	6.21
5	Woven Garment	Pieces/Set	1,052,850	141	162.	21.21	22,330,948.5	Raw Material	0.52	73.5
								Labor	0.13	18.3
								Overhead	0.35	49.5

4.2 Model Development

To develop a mathematical model that optimizes anything, there should be a comprehensive study on the components, namely decision variables, the objective function and the constraints. Formulation of linear programming model involves three basic steps.

a. Specifying the decision variable
b. Specifying the objective function
c. Specifying the constraints

Decision variables are major products to be produced and sold. These products are yarn, fabric, CM, knit garment, and woven garment. **Objective function** is the objective to be achieved. In this case, the objective function is to maximize the profit gain of the company via developing a linear programming model which results better product mix. **Constraints** are all related to resources which mainly affects the performance of the organization. In this case, the major constraints are raw material, labor and overheads. The relationship that exists among the components should be analyzed to ensure that the model is complete in all respects. This must be done before running the model developed. The model is a linear programming model. It is well known that in finance, linear programming has been applied in decision making situations such as capital budgeting, profit planning, product portfolio selection, resource allocation, inventory control, make or buy decisions, assets allocation, and financial planning. And, the aim of this research is profit planning through linear programming technique which maximizes it [11].

4.2.1Formulation of LP Model for the Selected Products

Textile and non-textile products

a) Decision variables: for the textile products of Almeda textile factory

• Let X1 be the number of units of yarn to be produced. Where 1 Unit = ETB 83.69 worth of product.
• Let X2 be the number of units of fabric to be produced. Where 1 unit = ETB 35.17worth of product.
• Let X3 be the number of units of CM to be produced. Where1 Unit = ETB 27.39 worth of product.
Let X4 be the number of units of knit garment to be produced. Where1 Unit = ETB 26.44 worth of product.
Let X5 be the number of units of woven garment to be produced. Where1 Unit = ETB 162.64 worth of product.

b) Objective Function

The decision is to determine the most viable and profitable textile and non-textile products, and the optimum volume of production of each item of the textile and non-textile products. Let X1, X2, X3, X4 and X5 represent the number of units of yarn, fabric, CM, knit garment and woven garment manufactured during the given period. The feasible alternatives are set of values of X1, X2, X3, X4 and X5, Where X 1, X2, X3, X4 and X5≥ 0. The profit per unit of X1, X2, X3, X4 and X5 is ETB 10.92, ETB 4.59, ETB 3.57, ETB 3.45, and ETB 21.21 respectively. The **objective is to maximize** the total profit of the Almeda textile factory through manufacturing and sale of textile and non-textile products. That is, **Maximize** $Z = 10.92 X1 + 4.59 X2 + 3.57 X3 + 3.45 X4 + 21.21 X5$

Subject to the input constraints,

$50.94 X1 + 20.18 X2 + 15.96 X3 + 14.94 X4 + 73.54 X5 \leq 175.56$ (Raw material cost)

$4.37 X1 + 2.14 X2 + 1.43 X3 + 1.84 X4 + 18.39 X5 \leq 28.17$ (Labor cost)

$17.46 X1 + 8.26 X2 + 6.43 X3 + 6.21 X4 + 49.50 X5 \leq 87.86$ (Overhead cost)

Where X1, X2, X3, X4 and X5 ≥ 0

c) Constraints

The main problem in the process of manufacturing is the shortage of resources like raw materials, labor, and overheads. Therefore, the management imposes restrictions on the use of these resources. The restrictions are due to the availability of resources. The restrictions in the usage of materials and resources is expressed as follows, the inputs required for manufacturing is less than or equal to maximum availability of inputs. Inputs are normally categorized as materials, labor and overhead expenses. Hence they form the resource constraints in the model. They are discussed as follows:

(i) Raw Materials Cost Constraint

The raw material cost constraint of the five products of Almeda textile factory are expressed as follows. The raw material cost of producing one unit of products X1, X2, X3, X4 and X5 are 50.94 ETB, 20.18 ETB, 15.96 ETB, 14.94 ETB, and 73.54 ETB respectively, and indicated mathematically as: $50.94 X1 + 20.18 X2 + 15.96 X3 + 14.94 X4 + 73.54 X5 \leq 175.56$

(ii) Labor Cost Constraint

The labor cost of producing one unit of products X1, X2, X3, X4 and X5 are 4.37 ETB, 2.14 ETB, 1.43 ETB, 1.84 ETB, and 18.39 ETB respectively, and expressed as follows:

$4.37 X1 + 2.14 X2 + 1.43 X3 + 1.84 X4 + 18.39 X5 \leq 28.17$

(iii) Overhead Cost Constraint

The overhead cost of producing one unit of products X1, X2, X3, X4 and X5 are 17.46 ETB, 8.26 ETB, 6.43 ETB, 6.21 ETB, and 49.50 ETB respectively and it is described mathematically as follows:

$17.46 X1 + 8.26 X2 + 6.43 X3 + 6.21 X4 + 49.50 X5 \leq 87.86$

4.3 Analysis of Optimization Models of Products

The profit earned by the company from production and sale of textile and no-textile products for 2005 E.C, viz., yarn, fabric, CM, knit garment and woven garment was 44,461,006.68 ETB annually. The linear programming model suggests different feasible solutions for maximizing the profit from the present level taking into consideration all possible constraints faced by the company in terms of raw materials, labor availability and other material and labor overheads. The first model by Microsoft excel solver has been developed without forecasting demand for textile products and based on the assumption that whatever the products produced will be sold in the market. It is understood from the model that producing knit garment alone is economically viable and profitable. As of the result, it is advisable to concentrate more on knit garment and it is better to drop other four product items. But this is not feasible due to the following reasons or factors such as movement of products in the market, opportunity to provide employment to the existing workforce and optimum utilization of fixed resources (machines and equipment). As a result, it is advisable to reconsider the other models which increase profit when compared with the existing one, but also consider the factors mentioned above. Hence, other three best alternatives of models were developed by considering different product mix solutions as shown in Table 4.7 below.

Table 4.7: Results of feasible optimization models of textile and non-textile products

Model 1				Model 2			
Demand	Solution	Present production (million)	Demand in production (million)	Demand	Solution	Present production (million)	Demand in production (million)
$X1 \geq 0$	X1 = 0	1.745	0	$X1 \geq 1$	X1 = 1	1.745	1.745
$X2 \geq 0$	X2 = 0	84.038	0	$X2 \geq 0$	X2 = 0	84.038	0
$X3 \geq 0$	X3 = 0	2.588	0	$X3 \geq 0$	X3 = 0	2.588	0
$X4 \geq 0$	X4 = 11.751	81.216	954.369	$X4 \geq 8.3$	X4 = 8.3	81.216	674.093
$X5 \geq 0$	X5 = 0	171.236	0	$X5 \geq 0$	X5 = 0	171.236	0
Z = 55.511 Million ETB				Z = 53.060 Million ETB			
Model 3				Model 4			
Demand	Solution	Present productio n (million)	Demand in production (million)	Demand	Solution	Present production (million)	Demand in production (million)
$X1 \geq 0.25$	X1 = 0.25	1.745	0.436	$X1 \geq 0.5$	X1 = 0.5	1.745	0.873
$X2 \geq 0.25$	X2 = 0.25	84.038	21.006	$X2 \geq 0.5$	X2 = 0.5	84.038	42.019
$X3 \geq 0.76$	X3 = 0.76	2.588	1.967	$X3 \geq 0.5$	X3 = 0.5	2.588	1.294
$X4 \geq 8.5$	X4 = 8.5	81.216	690.336	$X4 \geq 5.0$	X4 = 5.0	81.216	406.08
$X5 \geq 0.25$	X5 = 0.25	171.236	42.809	$X5 \geq 0.75$	X5 = 0.75	171.236	128.427
Z = 53.770 Million ETB				Z = 51.010 Million ETB			

The first model (model 1) suggests production of knit garment only to maximize profit up to 55.511 million ETB regardless producing of other products. This profit is more than 10 million ETB greater than the existing profit level. As of Model 1, this maximum profit is found by producing 11.751 units of knit garment only. If this model is implemented, the following problems will face the company:

- It is always impossible to sell all units of knit garment products.
- Workers employed for producing other products may become jobless.
- The resources like machineries and raw materials used in the production of others products cannot be effectively utilized or they may remain underutilized.
- Customer needs may be denied or ignored so that customer satisfaction won't be the issue. Thus, the company will fail to keep or maintain its reliability by customers.

Due to these and others cases, the first model (model 1) is not the best of the others even if the profit is better than other models. Model 3 was developed with the assumption of earning maximum profit via producing 8.5 units of knit garment, 0.76 unit of CM, 0.25 unit of yarn, 0.25 unit of fabric, and 0.25 unit of woven garment product which provide a maximum profit. As a result of this product mix, the maximum profit is around 53.77 million ETB which is marginally higher than the current profit level by more than 9 million ETB. Model 2 was also developed based on the assumption of maximizing the profit by producing 8.3 units of knit garment and one unit of yarn, but keeping other products as unproduced. According to the model, the profit is around 53.06 million ETB which is higher than the current profit level by more than 8 million ETB. At last but not the least, Model 4 was developed by assuming that maximum profit could be earned through producing 0.5 unit of yarn, 0.5 unit of fabric, 0.5 unit of CM, 0.5 unit of knit garment, and 0.75 unit of woven garment products. As a result of this model, the maximum profit is around 51.01 million ETB which is greater than the current profit level by more than 6 million ETB. From the above discussions, it is possible to conclude as Model 1 is the best of others. But, it has some serious drawbacks like it was developed without considering the demand of knit garment and other factors, it recommended the production of knit garment without considering its marketability, it ignored the customer needs of other products, underutilization of machines and other resources appointed for production of other products, and it also made workers employed for producing other products jobless. As a result of these limitations, Model 1 is not recommended for implementation. Thus, the other the best model that tries to consider the above issues and provide better profit to the company is Model 3. This Model provides better product mix solution, protects the interest of workers, provides maximum profit to the company, and maintains better use of production capacity in terms of producing all products mentioned before (five major products). In view of these, Model 3 is recommended for implementation as it suggests better product mix with maximum profit, while giving due care to other factors like catering the needs of different market segments, providing employment to the workers to the extent possible, keeping customer needs for better satisfaction, and maintaining machines and resources on better utilization. As aforementioned, a research gap has been detected for this study, and the development of framework of mass customization model for customers' needs is focused. The conceptual from mass customization systems will facilitate the management in terms of the production designing in factories, aiming at clustering which is complex to the creation of Platform from common parts, leading to the development of a variety of goods by the process of product Family [12]. Besides print and pattern, consumers demand for basic characteristics in textiles. These must resist to the agents that cause colours to fade (washing, light, perspiration, etc.). To guarantee these properties, dyes conferring colour to fibres must present high-affinity properties with the latter, allowing for a greater colour fastness and uniformity. They must, simultaneously, allow for a great range of colour shades and be cost effective [13, 14].

5. Conclusion and Recommendation

Ethiopian textile factories are engaged in production of different textile and non-textile products; however, there are limitations in earning the maximum possible profits to the companies as well as the country in general. Almeda Textile Factory, one of those textile factories faces such problems because of lack of good profit planning techniques. This research addressed a solution for the problem mentioned using development of linear programming model for major products of the company (Almeda Textile Factory). As a result of the model developed, the maximum profit of the company would be 53.77 million ETB with product mix of 0.25 unit of yarn, 0.25 unit of fabric, 0.76 unit of CM, 8.5 units of knit garment, and 0.25 unit of woven garment product. And, the profit according to the new model is highly greater than the current profit level by more than 9 million ETB annually. After accomplishing the research, the following recommendations are forwarded towards to the company and researchers. Almeda textile factory is recommended to implement the Model developed so far to earn better profit from production of textile and non-textile products. Operation research is tried to find out an optimum value of profit of products. Therefore, this tool should also be applied for the optimization of other products which are going to be produced by the company for better profitability. This research is the corner stone of applying different profit planning techniques for being more profitable. So, other researches should be done on optimization of resources under production of textile and non-textile products.

References

1. A. John Rajan, K. G. (January 9-10, 2010). Application of Integer Linear Programming Model for Vendor Selection in a Two Stage Supply Chain. Proceedings of the 2010 International Conference on Industrial Engineering and Operations Management (pp. 1-6). Dhaka, Bangladesh: Sathyabama University, Chennai, India.
2. Berihu A. (2008), Tsegay Tesfay Mezgebe, International Journal of Academic Research in Business and Social Sciences, August 2013, Vol. 3, No. 8
3. Benedict, U. A. (2012). Optimizing Profit with the Linear Programming Model: A Focus on Golden Plastic Industry Limited, Enugu, Nigeria. Interdisciplinary Journal of Research in Business , pp. 1-13.
4. Dwivedi, D. (2008). Managerial Economics. New Delhi: VIKAS Publishing House PVT Limited.
5. Elamvazuthi, T. G. (2009). Application of a Fuzzy Programming Technique to Production Planning in the Textile Industry. (IJCSIS) International Journal of Computer Science and Information Security, 6, pp. 1-6.
6. EPA Office of compliance Sector Notebook Project: Profile of textile Industry. (1997). Washington, DC: U.S. Environmental Protection Agency.
7. Feyera, A. (2012). Productivity in footwear and garment sector in Addis Ababa. Addis ababa: Addis Ababa University.
8. Hira, P. G. (2009). Operation Research. New Delhi: S. Chand Company Limited.
9. Murugan, N and S. Manivel, 2009, "Profit Planning of an NGO run Enterprises using Linear Programming Approach", International Research Journal of Finance and Economics,Issue 23, 443-454
10. Ayhan YALÇINSOY, Mustafa ZİNCİRKIRAN, Hidayet TİFTİK (2014). Approach of Capacity Planning Through Linear Programming Technique: A Practice in Textile Enterprise
11. Kornthip Watcharapanyawong, Sompong Sirisoponsilp, Peraphon Sophatsathit. "A Model of Mass Customization for Engineering Production System Development in Textile and Apparel Industries in Thailand" systems Engineering Procedia 2 (2011) 382 – 397
12. Clarke, E.A. & Steinle, D.1995. J.Soc. Dyes Color, 25
13. Vandevivere, P.C. Bianchi, R. Verstraete, W. 1998. Treatment and reuse of wastewater from the textile wet processing industry: Emerging Technologies, Journal Chemistry Technology Biotechnology, 72 (4): 289-302.
14. Markowitz.H.M. "The Elimination form of the Inverse and its Application to Linear Programming", Management Science, 3(2), 255-269(1957).
15. M. Ramachandran, Application of Natural Fibres in Terry Towel Manufacturing, International Journal on Textile Engineering and Processes, ISSN: 2395-3578, Vol 1, Issue 1, Jan2015, pp. 87-91.
16. Pramod Raichurkar, M.Ramachandran, Recent Trends and Developments in Textile Industry in India, International Journal on Textile Engineering and Processes, 1(4), 2015, 47-50.