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DEVELOPMENT OF AMHARIC COMPUTER PROGRAM FOR CUT ORDER PLANS TO UTILIZE FABRIC IN ETHIOPIAN SMALL TO MEDIUM ENTERPRISES

SELAM TSEGAYE

ETHIOPIAN INSTITUTE OF TEXTILE AND FASHION TECHNOLOGY

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BAHIR DAR, ETHIOPIA

2017

DEVELOPMENT OF AMHARIC COMPUTER PROGRAM FOR CUT ORDER PLANS TO UTILIZE FABRIC IN ETHIOPIAN SMALL TO MEDIUM ENTERPRISES

BY

SELAM TSEGAYE

A Thesis Submitted to the

Ethiopian Institute of Textile and Fashion Technology

In Partial Fulfillment of the Requirements for the Degree of

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In

Fashion Technology

Under the guidance of

Dr. Karan Khurana (PhD)

Ethiopian Institute of Textile and Fashion Technology

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ABSTRACT

Ethiopia has great potential for wide range of industrial development with availability of labor force and natural resources which can help as raw material. Due to these the growth of garment and textile sectors in Ethiopia become stronger in this recent decade. Number of large and small to medium enterprises (SMEs) in clothing sector has opened. All these clothing industries are time sensitive in nature. So, the aim of this study is primarily to develop Amharic computer program that performs cut order plans for Ethiopian small to medium scale garment manufacturers. The study focus on cutting section activity of cut scheduling.

To undertake this research, the method used to make the proposed Amharic computer program model was “Python 3.6” programming language which enable to writing clear programs. A standard Python interface module “Tkinter” used to prepare the user interface which help to run application and also “Pyinstaller” program that helps to freezes/packages Python programs are used to make the proposed computer program. In addition, to make necessary drawings like system design and flow diagram the software so called “Edraw” was used.

Findings of this research are computer program that can perform cut order plan both in Amharic and English as the user option. The program able to take necessary inputs like different buyer orders with different sizes and quantity from user through user interface and results the required number of lay and size combinations in each lay within seconds and able to save the final result as a

report. This research also results to change the conventional methods of cutting room activities which cause unnecessary fatigue for operators, reduce throughput time of cutting room, and improve the overall operation. Finally, the program tested and a number of recommendations are given for the garment companies. This research can be used as a lead for future research works in the field.

Key words: Cut order plan, small to medium enterprise, programming language, software, system design, fabric utilization

ADVISOR'S APPROVAL

This is to certify that the thesis entitled "Development of Amharic Computer Program for Cut Order Plans to Utilize Fabric in Ethiopian Small to Medium Enterprises" submitted in partial fulfillment of the requirements for the degree of Master's with specialization in Fashion Technology, the Graduate Program of the Ethiopian Institute of Textile and Fashion Technology, and has been carried out by Selam Tsegaye ID.No Mftech/08/08, under my supervision. Therefore I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the Institute.

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We, the undersigned, members of the Board of Examiners of the final open defense by have read and evaluated her thesis entitled **"**Development of Amharic Computer Program for Cut Order Plans to Utilize Fabric in Ethiopian Small to Medium Enterprises**",** and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of Master Science in Fashion Technology.

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As members of the Board of examiners of the final Master's degree open defense, we certify that we have read and evaluated the thesis prepared by Selam Tsegaye under the title **"**Development of Amharic Computer Program for Cut Order Plans to Utilize Fabric in Ethiopian Small to Medium Enterprises**"** and recommend that it be accepted as fulfilling the thesis requirement for the degree of Master's of science in Fashion Technology.

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled, “Development of Amharic Computer Program for Cut Order Plans to Utilize Fabric in Ethiopian Small to Medium Enterprises” is my own original work, has not been presented for a degree of any other university and all the resource of materials uses for this thesis have been properly acknowledged.

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With sincerity, I extend my warm and deep appreciation and gratitude to my advisor, Dr. Karan Khurana and my personal co-advisor Mr. Euael Tsegu for his unreserved guidance and support to come up with this research work. Above all, I praise the Almighty God who gave me his enabling grace and strength to successfully complete this research work through the difficult time. I would also like to thank the owner of Evolution garment Mr. Yonas Workneh and all company employees for their willingness and support throughout this research. Finally I thank my friends and family for their continuous support, ideas and love during my studies.

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LIST OF ACRONYMS

GTP II ……Growth and Transformation Plan II

COP ……Cut Order Planning

SLCD……Software Life Cycle Development

CGA……..…Canonical Genetic Algorithm

GA…….Genetic Algorithm

SME……. Small to Medium Enterprise

CWI ……..…… Centrum Wiskunde & Informatica

GUI …….……Graphical User Interface

AGOA …….……..…African Growth Opportunity Act

FTA ……..Free Trade Agreements

LDCs ……..…Least Developed Countries

COMESA …… Common Market for Eastern and Southern Africa

EiTEX……...Ethiopian Institution of Textile and Fashion Technology

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The textile and garment industry is one of the rising sectors in Ethiopia. It is one of the developmental sectors that are given a due attention by the government in the second Growth and Transformation Plan II (GTP II). Textile and apparel production and trade have been important elements of economic activity since the industrial revolution. This is because textiles and apparel products serve as basic human needs. Moreover, textile and apparel industry, particularly apparel is labor-intensive and offers huge employment opportunity for a mass of people. This industry requires relatively little capital for entrepreneurs to establish production facilities. Above all modest capital requirement makes textile and apparel industry preferable at the start of the industrial revolution(Gelb, 2007).

The industries considered as the stepping stone and have played a key role in several waves of industrializing economies of East Asia such as: Hong Kong, Singapore, Taiwan, South Korea, Malaysia and, more recently, China, Indonesia, Thailand and Vietnam. Similar efforts to develop textile and apparel industries were undertaken in South Asia, including India, Pakistan, Sri Lanka and Bangladesh (Herbert Jauch and Rudolf Traub-Merz, 2006).

Ethiopia can be placed in a comparative advantageous position in textile and apparel production. This is because of different reasons. First, Ethiopia has

suitable agro-climatic conditions for the production of cotton, which serves as the main raw material of the sector. Second, there is abundance and relatively lower cost of labor power. Third, the global textile and apparel production and consumption have shifted to least developed countries (LDCs). Fourth, the availability of the international good will to avail market privilege through Free Trade Agreements (FTA), manly African Growth Opportunity Act (AGOA) to US market and Common Market for Eastern and Southern Africa (COMESA) to regional market. Thus it is necessary to be quite confident about the role of textile and apparel industry as a catalyst for Ethiopian industrialization and as a major source of foreign currency if it gets untouched government policy backup, practical support and incentive.

The SME sector in Ethiopia is taken as an instrument in bringing about economic transition by effectively using the skill and talent of the people particularly women and youth without demanding high-level training and much capital. Small and Medium sized enterprises (SMEs) have usually been perceived as the dynamic force for sustained economic growth and job creation in developing countries. They play many-sided role such as enhancing competition, innovation, as well as development of human capital and creation of a financial system.

The development of the sector in Ethiopia is believed to be the major source of employment and income generation for a wider group of the society in general and urban youth in particular. The five-year Growth and Transformation Plan (GTP) of Ethiopia envisages creating a total of three million micro and small scale enterprises at the end of the plan period (NBE, 2010/2011).

The Government of Ethiopia five-year development plan emphasizes the key role of SMEs for the local economy and identifies support to SMEs as a key industrial policy direction for creating employment opportunities (Woodeneh, 2016).

One of SME which found in the capital city of Ethiopia in Addis Ababa is Evolution Garment private garment factory. Evolution Garment private garment factory was established by Ethio- Canadian entrepreneur Yonas Workneh in 1996 Ethiopian calendar. When he came to Ethiopia to establish a business he has seen the potential in garment and textile sectors as untouched and blooming business in the years to come, investing in this sector and controlling the local market was the idea and still is, and most of all to open the opportunity of a job to the working class of the country. The factory have around 140 employees and commonly produces different products like Uniform, Gown, Polo shirt, Shirt. The marketing strategy is push system, after producing these different products, by using their more than eight retailing shops throughout Addis Abeba, will distributed. The company is targeting full local market.

1.1.1 Garment SMEs' cutting section

The cutting section of SMEs' garment manufacturing firm has numbers of activities. Those activities are planning, spreading, cutting and preparing for sewing room. Cutting section can be called a heart of garment manufacturing firm because if any activity goes wrong it brings a huge fail both for manufacturer and operators due to cost and also if the activity goes in correct and expected manner the result will be tremendous. The cutting section of apparel manufacturing industry supplies the cut panels required in the sewing section for

the production modules. There are several functions in a cutting section like fabric spreading, cutting, numbering and bundling of cut panels (Upendra, RAS, P Kaluarrachchi, and VS Ratnavake, 2013). The section is the second section next to design and sample making section. After cutting section what came next is production section which helps to assemble the cut pieces that were cut in previous section. The final section is finishing section that the assembled product gets ready for sell in the way that customer can adore it. Let's see cutting section each activities one by one the first one is planning, unfortunately this activity may not implement in any garment manufacturing firm even though it's a very crucial activity. On this activity the next three activities will be determined. It helps to decides and give information through relating with the order that manufacturing firm received. It determines number of lay, marker combination and size ratio. Side by side it resolve how many times the spreading process takes time with what combination of sizes (marker), what to cut first and next and also what cut pieces could be prepared for further section which is production section. Most of all it utilizes the resource one manufacturing have like time, raw material and labor.

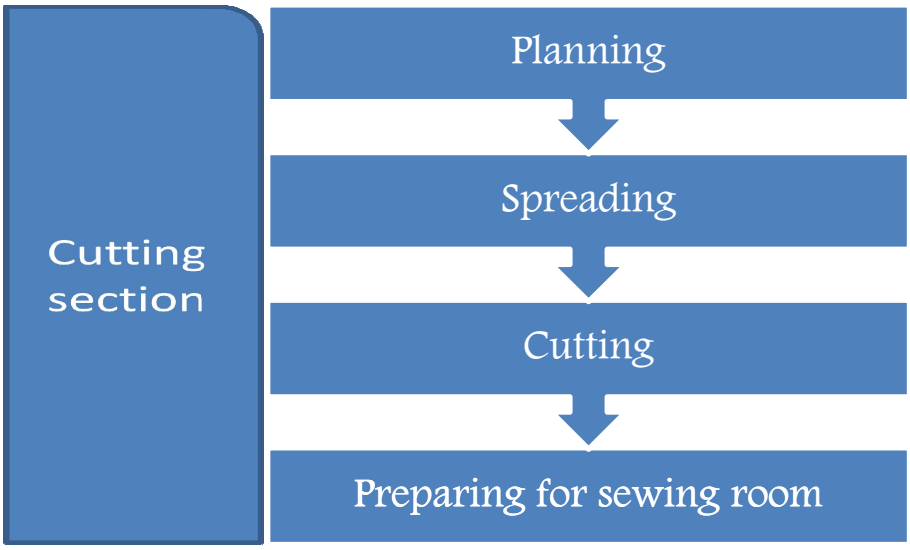

Figure1.2: Cutting room activities

Garment manufacturing firm whether it is large or small to medium enterprise (SME), the buyer will send/ bring an order. The next example will show that.

Example; An order may came with a total quantity of 260 shirts.

Table1.1: Sample buyers cut order

Size	10	12	14	16	18
Quantity	40	90	80	25	25

So the order looks like the above figure. After this it important to start the process of planning in order to determine the number of lay, marker combination and size ratio as discussed on previous paragraphs.

1.1.1.1 Advantages of Cut order plan in garment manufacturing firms

During the last decade, the clothing manufacturing companies have being exposed to high competition from the compotators and to constant increasing of production costs. This in turn, for the manufacturing companies aiming to

increase competitiveness and profitability, imposes the issue of better utilization of the existing resources. The focus of efficiency in the apparel industry is to reduce the cost of raw materials (material costs), which often reach up to 75% of total production costs. In the recent years we witness continuous increasing of the price of textile materials, so any higher percentage of utilization of materials achieved directly affects the overall production costs (Hands C,Hergeth H H A,Hudson P., 1997).

The technique of processing cutting orders and planning economic cutting lays are of utmost importance for better utilization of materials and for increasing the efficiency of cutting process.Lay planning is task that has direct relationship with fabric utilization (Jacobs Blacha C.Ammons J. C. and Smith T, 1998). Once the patterns are ready the cutting room management must calculate the possible cut quantity from the received fabric.

The garment factory can capitalize less cost and more savings by responding faster cutting. To find out the non-valuated activities, it is important for cutting, planning accurately and thereby to reduce lead time and cost involved in the cutting process (A. T. M Mohibullah, Umme Magreba takebira, Zinia Anjuman Aral, Md Maksudur Rahman, 2017).

Cut order planning (COP) plays a significant role in managing the cost of materials (Jacobs Blacha C.Ammons J. C. and Smith T, 1998). COP seeks to minimize the total manufacturing costs by developing feasible cutting order plans with respect to material, machine and labors. Cut order planning software determines what markers should be made; how fabrics should be spread and

cut; the most cost-effective number of plies, colors and size mixes. It provides ongoing status report, stores data and nested marker files, calculates quantity of order bundles and marker definitions, creates nesting markers for production, reduces material consumption, maximizes marker efficiency, and provides detailed spreading information for multi-color plies. Such software saves time when managing multi-color orders and calculates production costs accurately for better management, while minimizing time-to-market by dramatically reducing development cycle. Cut-Order Plan is a tool used in garment industry for making cut plan (T Peric and Z Babic, 2008).

1.1.1.2 Cutting room fabric utilization and its importance

In garment manufacturing firm there are different raw materials are used. The main raw materials are fabric and different of accessories which cost the manufacturer. But the main raw material that cost manufacturer a lot is fabric. For instance, let's take shirt, the material that it made from is always from fabric (the type of fabric can be synthetic or natural), fusible interlining, sewing thread again the material of this thread can still vary and finally different type of buttons or zipper. From all this material that made this specific shirt that cost the manufacturer most is always the fabric whatever material it make from. Usually, fabric constitutes more than half of the total garment cost. So this tells that the manufacturer always needs to pay attention on the fabric while the manufacturing process in order to save the cost due to the loss of fabric unconditionally.

Fabric utilization means how much fabric is being utilized in cutting for garment patterns out of total fabric laid for cutting. Usually, fabric constitutes more than

half of the total garment cost. So, through effective fabric utilization factory can save lot of money from fabric. Fabric is the main raw material for the production of garments. The minimization of fabric wastage is crucial to the reduction of production costs (Haque, 2016). Fabric is the biggest element of cost in the clothing industry (50-80%), so a small saving on fabric with 2% can significantly affect the pockets of clothing manufacturers (Mausmi, 2013). Any reduction in the amount of the cloth used per garment leads to increased profit (Lakshmanakanth, 2012). The minimization of fabric wastage is crucial to the reduction of production costs (Wong. W and Leung. S.Y. S., 2009).

1.2 Statement of the problem

Ethiopian garment small to medium enterprises are expanding more than ever a due attention by the government in the second Growth and Transformation Plan II (GTP II). This newly grown SMEs' are becoming source for entrepreneurs and hope for unemployed. Even though, they lack technologies in every aspects of production. So a lot can be done to support those SMEs". The concern of this research is only cut order planning in cutting section of the production. In my observation except the largest garment company almost all Ethiopian small to medium garment manufacturers plan this process manually or did not plan it all. In most cases solutions of COP problems are derived subjectively, based on the experience of production managers. Once managers realize any inefficacy in their plan, they tend to adjust their plan in a trial-and-error approach.

The conventional process of planning cut order is very time taking and difficult to come up with similar result while doing it the same inputs again and again.

Because of this, numbers of garment manufacturers are forced to waste materials like fabrics, lack of utilizing cutting room resources (both equipment and manpower), waste of time, lack of frequent supply for sewing room and it's also one of the reasons for late delivery of the product for customer.

The main reasons for this Ethiopian small to medium scale garment manufacturers for the present current scenario is it's difficult to afford the full package systems which are commercially available in other countries, lack of awareness about the existence of the system and its advantages and lack of skilled manpower to operate.

1.3 **Research Objective**

1.3.1 General objective

The main objective of this research is to developing Amharic computer program that perform cut order plans to utilize fabric for Ethiopian SME garment manufacturers.

1.3.2 Specific objectives

- ✓ To modify the routine lay planning method of small scale garment manufacturers
- ✓ To provide accessible and affordable system COP.
- ✓ To simplify the process of lay planning
- ✓ To reduce throughput time in cutting section
- ✓ To minimize the number of operators incur due additional operation
- ✓ To enhance productivity of cutting room

- ✓ To increase production capacity
- ✓ To improve the overall operations

1.4 Significance of the study

Ethiopian small to medium garment enterprises may need in-depth studies to improve implementation of technology advancements in the overall working environment. Unfortunately, only limited numbers of researches have been done at national level on implementation of technology advancements in Ethiopian garment manufacturers. This research aims to understand the current situation of Ethiopian SMEs' and develop appropriate Amharic computer program for COP. The research has a great benefit to overcome the conventional method of COP so, that the sector can be competitive and expand the business. When the research result is applied accurately it's expected to play an important role in the productivity of cutting room, reduces the time it takes for planning, and utilizes fabrics as well as resources. The application of the result will introduce new system for cut order planning in for Ethiopian small to medium scale garment manufacturers. It is hopefully believed that the Ethiopian garment SMEs' will implement the developed Amharic computer program for COP and have a remarkable improvement in cutting room activity.

1.5 Benefit and beneficiaries of the research

If the proposed research is done and applied in those targeted Ethiopian small scale garment manufacturing factories, they can get benefits like;

- Financial benefit
- Resource conservation
- Community building/ use technology
- Satisfaction / simplification
- Working Environment
- Generate income for developers
- Technological – Introduce and implement new system
- The report can be used as a reference for students

And beneficiaries from this project are;

- Ethiopian small scale garment manufacturing factories
- Operators - operators are beneficiaries from this research because their job will be faster and organized.
- The project owners
- The EiTEX (Ethiopian institution of textile and fashion technology)
- Country

1.6 **Scope of the research**

There are different large scale garment manufacturing industries in Ethiopia. However, this research does not focus on those industries. The study mainly devotes itself on the developing Amharic computer program for cut order plan in Ethiopian garment small to medium enterprises. Cut order planning software is developed so that the overall activities of the SMEs' cutting section can be improved and other related advantage could be gain.

CHAPTER TWO

REVIEW OF LITERATURE

By observing the frequent problems which take place in lay planning on different part of the world different literature and studies has been done to solve this significant problem. In addition, it discusses the previous researches that had been done before using these techniques. From those relevant studies;

2.1. Cut order planning

Cut order planning (COP) is one of the most crucial activities that take place in cutting room which decide the combination of markers, and lays for a particular order. The cut order plan (COP) is a significant task in apparel production which arranges cut templates to execute the fabric cutting operation (W Wong and S Leung, 2004). Cut order planning is also the activity of planning the order for cutting, as input into the marker making stage so that the cutting room receives complete spreading and cutting instructions. The cut order planning activity is also termed as “lay plan”, “cut plan”, “lay lot plan”. It is the process that coordinates customer orders with all the variables of marker making, spreading, and cutting to minimize total production costs and meet customer demand for timely products. The requirements of production planning in cutting room will be to supply the sewing room with an adequate amount of cut garments at sufficiently frequent intervals, consistent with availability of fabric and the best utilization of cutting room resources.

A major activity of the cut - plan is marker making that is the process of determining the most efficient layout of the pattern pieces for a specific style, fabric, and the distribution of sizes (Dumishllari, E. and Guxho, G., 2015). Marker making is a critical step in the manufacturing process. Fabric loss in cutting room is mainly caused by two operations- marker making and fabric spreading (Ho, 1999). Traditional manufacturers manage the process of marker making in house. By retaining strict control over this critical step, they keep the fabric consumption as low as possible. Controlling this step also permits them to ensure that the issues that affect quality will be given proper attention. Depending on the relative efficiency of each marker produced, the company may save or waste money. The methods chosen for these steps have a direct effect on the quality and cost of the finished garment (Elmira Dumishllari and Genti Guxho, 2015).

Cut Order Planning is deciding the combination of markers, and lays for a particular order (Haque, 2016). There are many features of Cut Order Planning, and reducing fabric consumption is just one of them. Cut Order Plan is one of the tools which, if properly used, can result in major cost saving. Fabric is the core of apparel manufacturing. A cut operation plan consists of several lays, and for each lay is done a marker the combination of them will be decides by the cut order plan. Scheduling of fabric spreading and cutting demands labor cost minimization, faster throughput, greater accuracy, higher fabric utilization and correct cut-piece fulfillment.

In 1976, Howard S. Coff, Cut scheduling for optimum fabric utilization in apparel production. The constraints concerning the quantities of the garments required and the fabrics available are also linear functions of the marker parameters. Consequently, the optimum cut schedule can be obtained by using linear programming.

- ✓ $x_1, x_2, \ldots, x_n$ are the decision variables
- ✓ Optimize (Maximize or Minimize)

  $Z = c_1 x_1 + c_2 x_2 + \ldots + c_n x_n$
- ✓ Subject to:

  $a_{11} x_1 + a_{12} x_2 + \ldots + a_{1n} x_n \ (\leq, =, \geq)\ b_1$

  $a_{21} x_1 + a_{22} x_2 + \ldots + a_{2n} x_n \ (\leq, =, \geq)\ b_2$

  . . . . . .

  $a_{m1} x_1 + a_{m2} x_2 + \ldots + a_{mn} x_n \ (\leq, =, \geq)\ b_m$
- ✓ $x_1, x_2, \ldots x_n \geq 0$

Where:

n = number of decision variables

m = number of constraints

$a_{ij=}$ resource utilization for products

i =resource, varies from 1 - m

j = product, varies from 1 to n

In 1995, Degraeve & Vanderbroek,A Mixed Integer Programming Model for Solving a Cutting Stock Problem in the Fashion Clothing Industry have used linear integer programming solver to work out the objective function to determine the cutting setup cost with constrains such as cutting knife height, cutting table length.

In 1998, Jacobs - Blecha C., Ammons J. C., Schutte A., Smith T., Cut order planning for apparel manufacturing. Proposed heuristic approaches to solve COP problem with some assumptions and the problem were modeled to minimize the costs incurred; specifically, fabric cost, spreading cost, cutting cost and the marker making cost, in cutting process.

In 2012, R. P.Abeysooriya & T G I Fernando, Canonical Genetic Algorithm to Optimize Cut Order Plan Solutions in Apparel Manufacturing. The study was conducted by two lecturers in the Department of Textile and Clothing Technology, University of Moratuwa, Sri Lanka under the topic “Canonical Genetic Algorithm to Optimize Cut Order Plan Solutions in Apparel Manufacturing”. This study presents a canonical genetic algorithm (CGA) approach to the problems of cut order planning with the objective of finding the optimum size ratios for each cut template used to fulfill the cut order requirement. And finally compare performance of proposed algorithm with the commercial COP software available.

The results show that proposed GA has more economical performance than the existing methodologies in the Sri Lankan apparel industry, in solving COP problems.

The objective function is to optimize the number of garments included for each marker *k* in the cut-order and thereby minimize the cost.

$$f(Y^{(k)}) = max(\sum_{i=1}^{m} y_i^{(k)} \sum_{j=1}^{n} b_j^{(k)})$$

where

$$Y^{(k)} = [y_1^{(k)} \quad \dots \quad y_m^{(k)}]$$

$$c_i^{(k)} = \begin{cases} 0 & if\ Size_i\ is\ not\ used \\ 1 & if\ Size_i\ is\ used \end{cases} \qquad \forall\ i, k$$

subjected to

$$g_{min} \leq \sum_{i=1}^{m} c_i^{(k)} y_i^{(k)} \leq g_{max}$$

$$y_i^{(k)} \leq \min_j a_{ij}^{(k)} i = 1, 2, \dots, m. \quad \forall\ j$$

The main objective of COP problem is to find $Y^{(k)} = (y_1^{(k)} \quad \dots \quad y_m^{(k)})$ for all k values while maximizing the $f(Y^{(k)})$ under the given constrains.

The corresponding size-ratio $y_i^{(k)}$ $\forall\ i$, was used to calculate the corresponding ply numbers of the fabric layer.

$$b_{max\ ,j}^{(k)} = min_j \left(\left[\frac{a_{ij}^{(k)}}{y_i^{(k)}} \right] \right) \qquad i = 1, 2, \dots, m.$$

where $j = 1, 2, \dots, n \qquad k = 1, 2, \dots$

2012, R. P. Abeysooriya & T G I Fernando, Hybrid Approach to Optimize Cut Order Plan Solutions in Apparel Manufacturing. This study was conducted by the same authors' months later after the first work. Their second study support first work on a topic "Hybrid Approach to Optimize Cut Order Plan Solutions in Apparel Manufacturing". This hybrid approach combined conventional heuristic

and genetic algorithm to find better solutions for COP, short execution time and performing under large population size.

This study presents a hybrid type of solution search algorithm to reduce the long execution time of GA based algorithm implemented for COP problem.

In 2015, Elmira Dumishllari, Genti Guxho, Influence of lay plan solution in fabric efficiency and consume in cutting section. The study was conducted in Department of Textile and Fashion, Polytechnic University of Tirana, Albania under the topic “Influence of lay plan solution in fabric efficiency and consume in cutting section”. The main purpose of this paper is to determine the best solution of lay plan and its influence, in the cutting room, starting from the analysis of the lay indicators calculations.

By understanding the concept of other scholars through their related works, my study will take some important methods and customize in the way that Ethiopian’s small to medium garment company needs to achieve. Commercial software for cut order planning has been developed, but effective application requires extensive customization and the necessary hardware for implementation. (Hands C.Hergeth H. H. A.,Hudson P, 1997).

2.2. Literature Gap

The major literature gap that is observed from the above literature is lack of customizing the cut order planning process in to different customers and being not available in different country at affordable price for all level of manufacturers.

.

CHAPTER THREE

MATERIALS AND METHODOLOGY

3.1. Materials and Instruments

- Programming language tools

Python is the programming language tool used. It is was conceived in the late 1980s, and its implementation began in December 1989 by Guido van Rossum at Centrum Wiskunde & Informatica (CWI) in the Netherlands as a successor to the ABC language. Python is regarded as being a great hobbyist language, yet it is also an extremely powerful language. It has bindings for C/C++ and Java so it can be used to tie large projects together or for rapid prototyping. It has a built-in GUI (graphical user interface) library via Tkinter, which lets the programmer make simple graphical interfaces with little effort (Jackson, 2009).

The tool used to make the proposed Amharic computer program model was developed by using “Python 3.6” programming language which enable to writing clear programs. A standard Python interface module “Tkinter” used to prepare the user interface which help to run application and also “Pyinstaller” program that helps to freezes/packages Python programs are used to make the proposed computer program. In addition, to make necessary drawings like system design and flow diagram of the system “Edraw” software was used.

- Personal and desktop Computer
- Hard disks
- Notebook and pen

3.2. Methods

3.2.1. Sampling Method

To undertake this research, out of many garment factories in Ethiopia, Evolution Garment private legal factory was selected out of many garment industries which found in Ethiopia. The sample factory was decided according to the expected response rate, requirements for performing statistical analysis, available time, survey cost and orders product variety. To obtain necessary additional information related organizations are contacted.

The sample method that is used to select one garment factory to record data, study the existing working system and for testing the developed computer program purposive sampling method was used. Purposive sampling (also known as judgment, selective or subjective sampling) is a sampling technique in which researcher relies on his or her own judgment when choosing members of population to participate in the study.(Palys, 2008). Researchers often believe that they can obtain a representative sample by using a sound judgment, which will result in saving time and money.

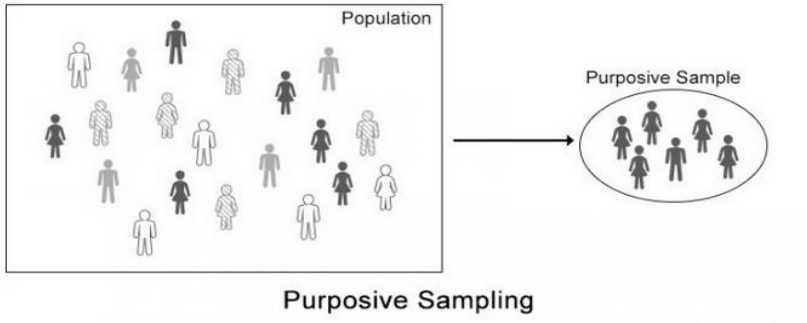

Figure3.1: Purposive sampling (Source: Palys, 2008)

In the case of this study out of many Ethiopian garment industries only one garment manufacturing factory was selected based on purposive sampling method. For choosing this garment manufacturing factory the judgment points that were relies on the orders product type flexibility, method that the factory implement for cut order planning process in cutting department, and willingness of the garment manufacturing factory to allow implementing the system, record the existing system and to use the factory as a sample throughout the study.

Different activities like necessary data collecting, recording data, programming tools selection, developing the program, analyzing data, collecting result and implementation are engaged to carry out the research. The following figure shows the general work flow of activities throughout the research.

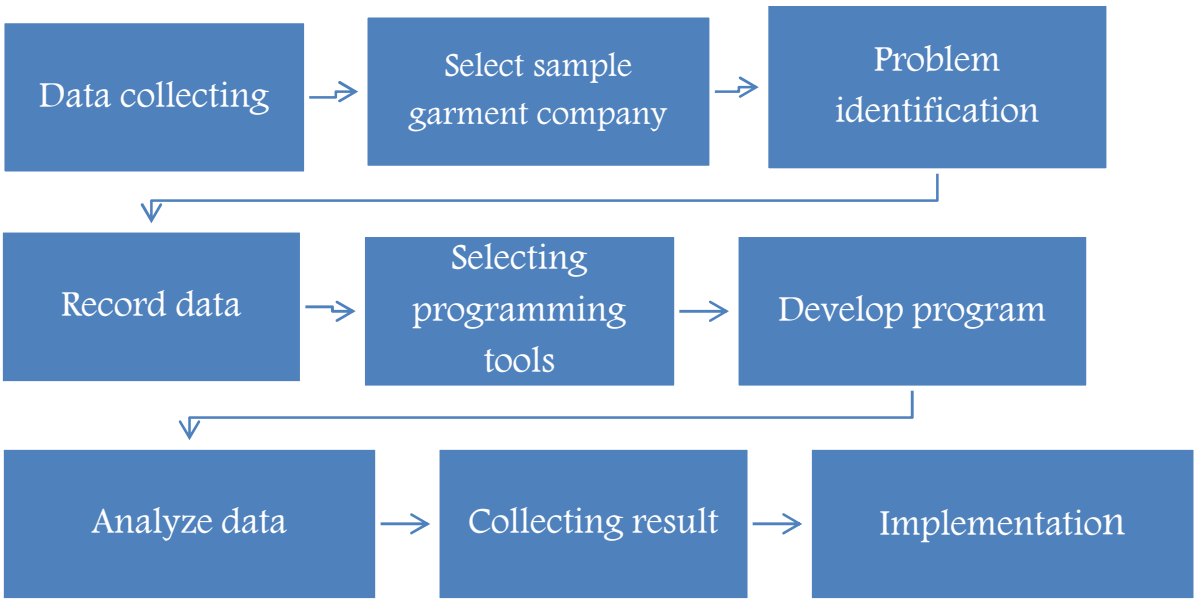

Figure3.2: General work flow of thesis

3.2.2. Data collection and analysis

As a means of finding the techniques used in cut order plan, the existing facilities and to get information about cut order plan processes in Ethiopian garment SMEs cutting section primary and secondary data were collected using well-structured interviews, personal observations and review of previous related research works. The study was intended to confine the current status of all the system of cutting room management where we will find out the potential method of cut plan.

3.2.2.1. Structured Interviews

The design of the interviews was based on the research objectives. Interviews were conducted with top management of the garment industries and different information technology professionals whenever necessary. The interviews were used to cross check the reliability of the actual environment of the process with observation. It is also used to gather additional information which is not able to get from direct observation.

3.2.2.2. Direct Observation

In this research direct observation is used as a means to assess the techniques used in documentation and production processes as well as the existing facilities inside the selected garment SME. Important documents of the respective garment small to medium enterprise such as annual reports, company profile brochure, and inspection data have been also used to understand the existing system.

3.3. Computer program development life cycle

For the development of the software the normal software life cycle development (SLCD) procedures are followed and the major steps involved are:

- ✓ Analysis Phase
- ✓ Design Phase
- ✓ Construction Phase
- ✓ Implementation & Testing phase

Stage I – Analysis Phase

- ✓ Gather information and analyze the project goals to define business rules and application requirements.
- ✓ Define the scope of the project.
- ✓ Analyze the problem, define the problem, analyze the solution and define the project goals and success criteria.
- ✓ An initial Requirements Analysis document will be formulated at the end of this phase.

Stage II – Design Phase

- ✓ Perform preliminary Use Case Analysis and create preliminary Use Case diagrams.
- ✓ Improve and finalize the Use Case Diagrams.
- ✓ Finalize the screens and user interfaces.

- ✓ Create the database design.
- ✓ Develop the Data Flow diagrams.
- ✓ Create project documentation that incorporates the following:
  - Problem definition.
  - Analysis and Design Method.
  - User interface specification.
  - Data validation and error checking.
  - Testing.
  - Source code control.
  - Data fields, types, field lengths and constraints

Step III – Construction Phase

- Create development environment.
- Build the database.
- Create computer program in python Soft ware
- Update project design document.
- Create maintenance plan.
- Formulate test strategies.
- Create implementation plan

Step IV – Implementation & Testing phase

- Deploying the program on the selected area
- Test the application
- Create a maintenance plan

CHAPTER FOUR

RESULT AND DISCUSSION

The proposed program for cut order plan has been done as planned in order to solve the problem faced by Ethiopian small to medium garment manufacturers. The new computer program is named “Selam COP”. The program was developed by using basically “Python 3.6” programming language which enable to writing clear programs. A standard Python interface module “Tkinter” used to prepare the user interface which help to run application and also “Pyinstaller” program that helps to freezes/packages Python programs are used to make the proposed computer program. In addition for to make necessary drawings and diagrams “Edraw” software was used.

Even though the proposed solution is planned to develop program with Amharic interface language but the study go further with additional English language as an option. The program able to take necessary inputs like different buyer orders with different of sizes and quantity from user through user interface and results the required number of lay and size combinations in each lay within seconds and able to save the final result as a report. This research also results to change the conventional methods of cutting room activities which cause unnecessary fatigue for operators, reduce throughput time of cutting room, and improve the overall operation.

4.1. Design of the System

This program is designed with three components user, system, and storage.

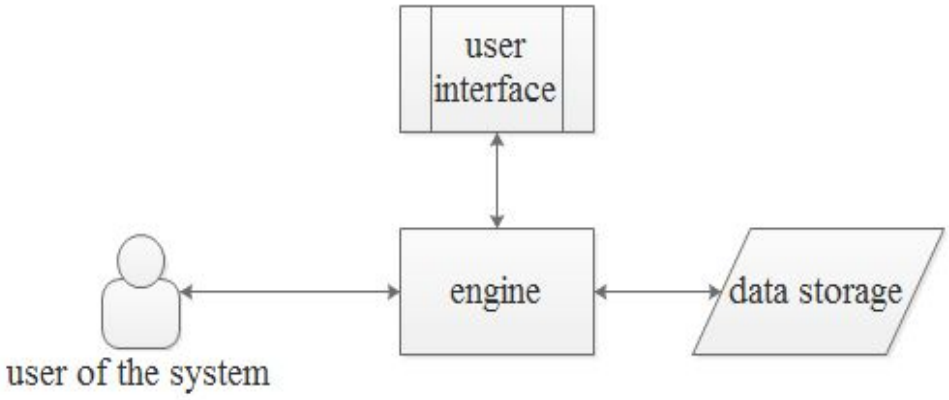

Table4.2: Design of the System

A. User of the system

The user of the system is the one that needs to operate a system for obtains the result which is expected from the system. In this case the user can be any person who is responsible for the process of cut order plan (COP) in cutting department for the required amount of order from buyer.

B. User interface

The user interface is a connection between the user of the system and computer. It helps users to accept essential inputs and also display and show expected outputs (results). In this cut order plan system the essential inputs and expected outputs are as follow:

- ✓ Inputs: Maximum plies per lay, maximum garment per ply, number of size, and Quantity of each size

- ✓ Expected outputs: number of lays, size combination on each lay, number of plies, extra piece and total garment pieces of size which are cut

C. Engine

The engine processes the inputs which are feed by the user of the system through user interface and gives expected outputs or results. Processes will be expressed using mathematical formulas, pseudo code (algorithms), and experimental flowcharts.

D. Data storage

The data storage will store necessary constant values and outputs to the system throughout the processing process of engine in the system.

4.2. User interface of the system

The inputs and expected results are display here on the user interface which the user immediately gets when the system opens. The newly introduced computer program' final user interface is as follow;

Figure4.15: The Amharic graphic user interface of the system

As an option the final English user interface of the program is as follow;

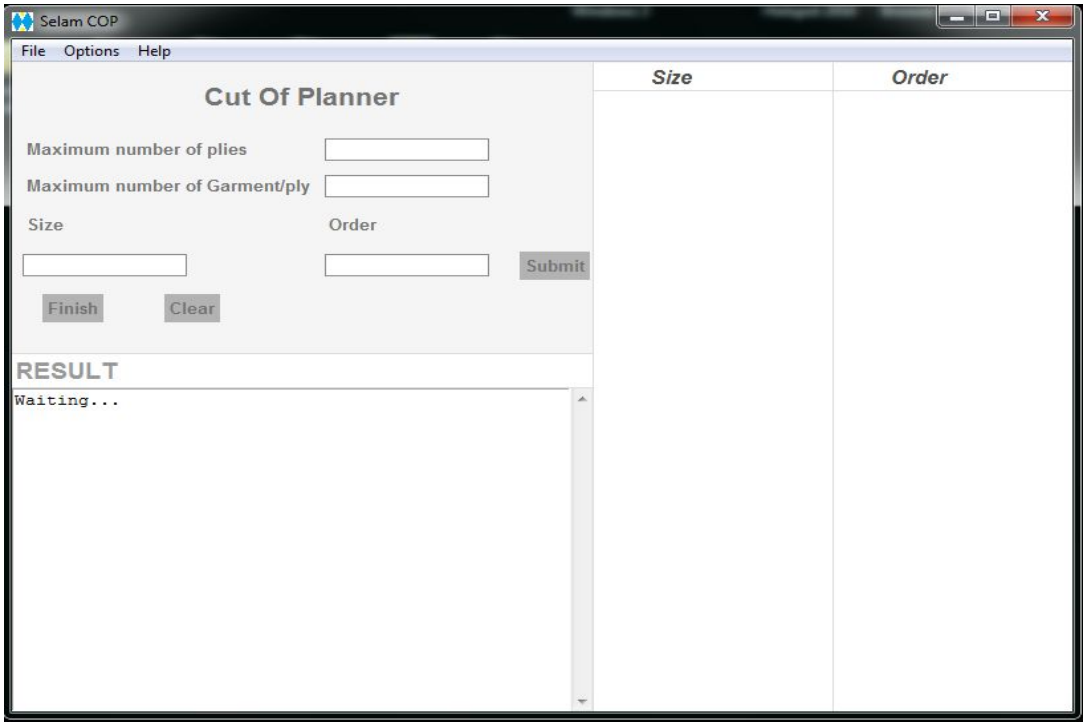

Figure4.16: The English graphic user interface of the system

4.2.1. Tabs / page headers in the system interface

So the graphic user interface has three different tabs at a top which helps to one for search files, save what is already done and to exit. The other tab is for language selection for Amharic language or English language and other option for default settings and that last tab is for help;

Figure4.17: Tabs of the Amharic graphic user interface

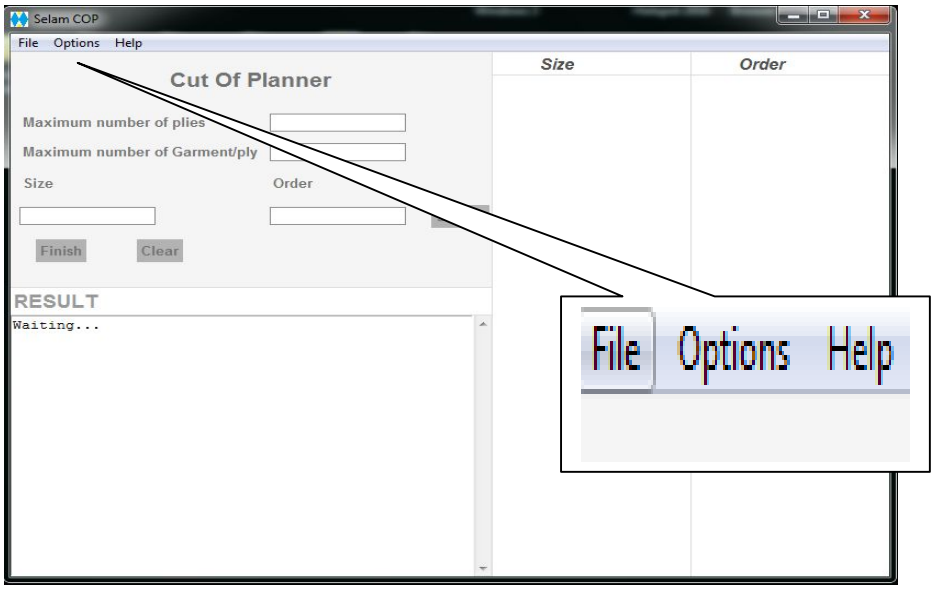

Figure4.18: Tabs of the English graphic user interface

Under the tab named “File” there are three options that able to perform different tasks. When file tab get clicked “Open”, “Save” and “Exit” option automatically drop dawn. “Open” option is for bringing data from existing computer files in “.csv” file formats. “Save” option is for keeping the result as report. Finally the “exit” option is for depart or go way from the tab itself.

Figure4.19: The drop downs under the file tab of Amharic user interface

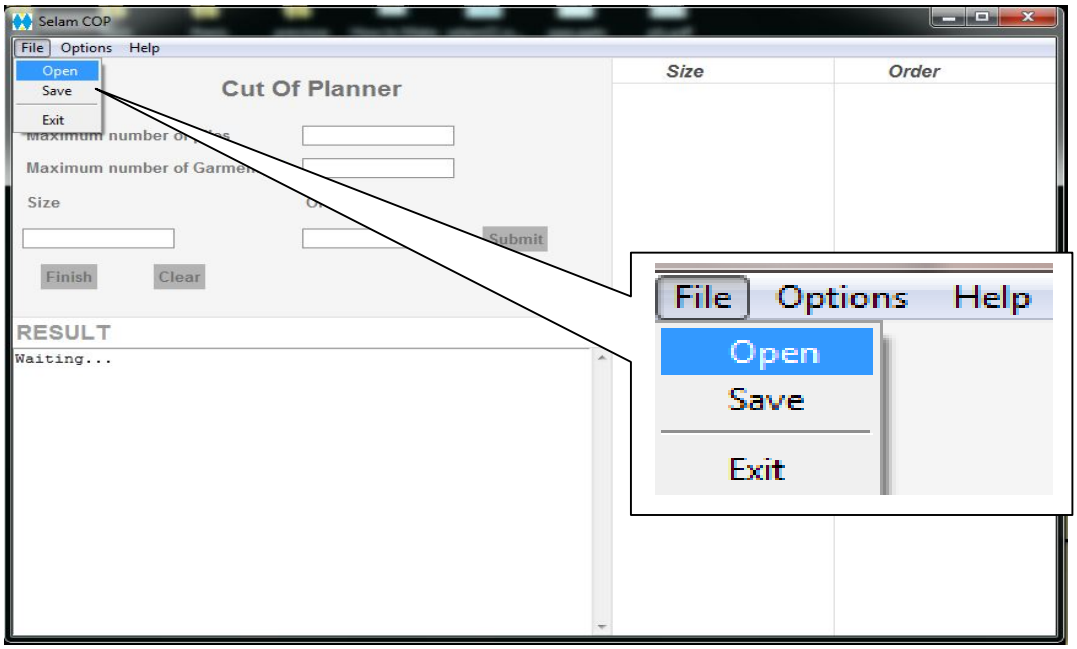

Figure4.20: The drop downs under the file tab of English user interface

The second tab is “Options”. Under “Options” tab there are two options that will drop dawn “Language” option and “Option”. In “Language” option there are “Amharic” and “English” language alternatives. And in the “option” label default settings for input are presented.

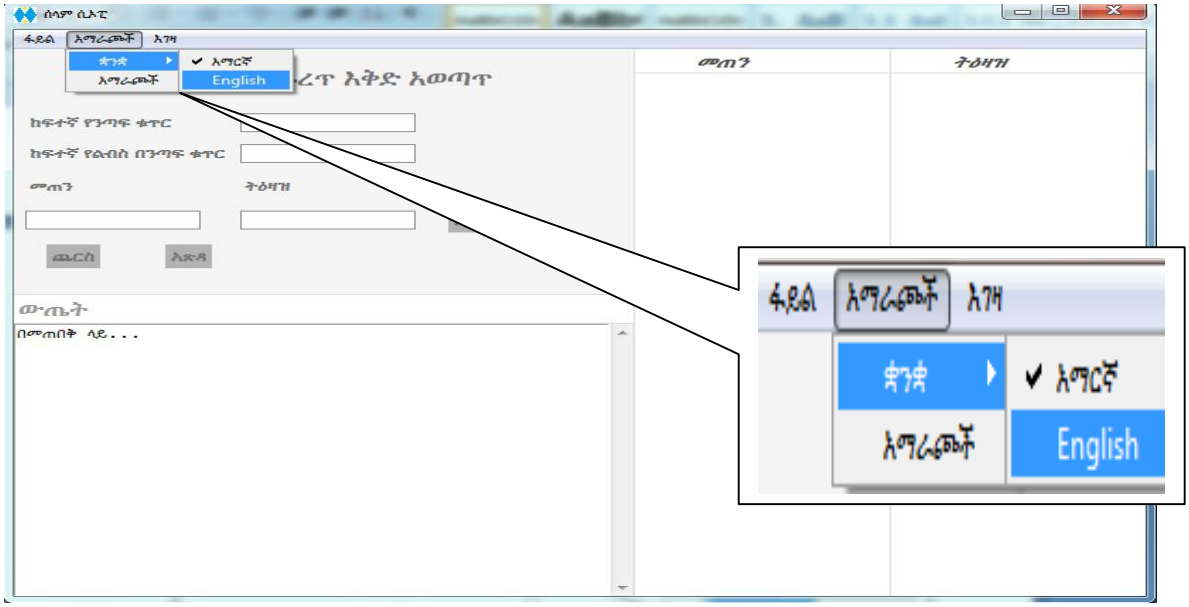

Figure4.21: The drop downs under the options tab of Amharic user interface

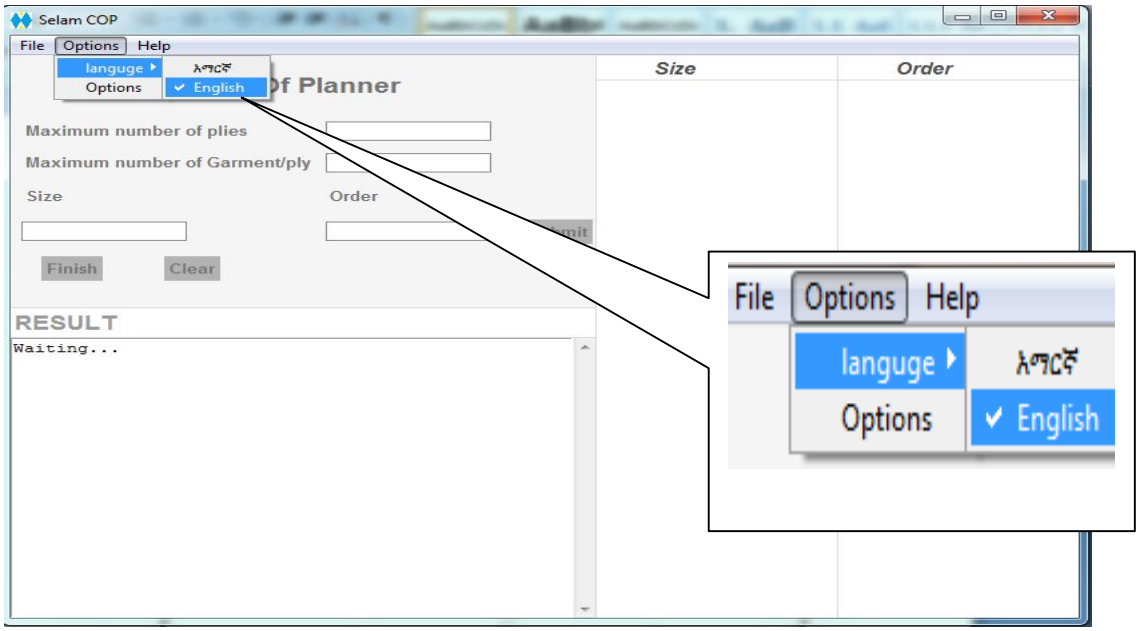

Figure4.22: The drop downs under the Options tab of English user interface

The final tab is “Help”. Under this tab required and necessary help to operate the computer program will drop dawn if any help is needed.

Figure4.23: The drop downs under the help tab of Amharic user interface

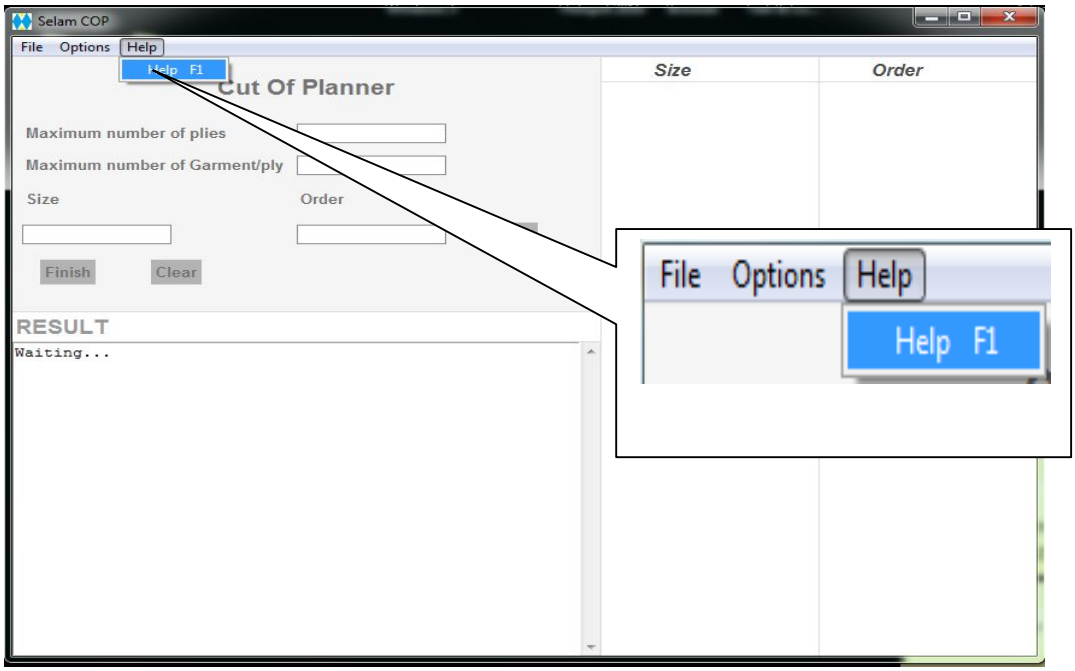

Figure4.24: The drop downs under the help tab of English user interface

4.3. Operation of the system

To operate this developed computer program the essential inputs are on user interface which are maximum plies per lay, maximum garment per ply, number of size, and quantity of each size. Next to each topic there is an interactive blank space that the inputs numbers / order size and maximum possible numbers of height and width are going to feed. After the order get insert and press finish the result drop down in the result section of the interface within seconds.

Let see a sample: maximum lay height 50 plies and maximum lay length 4 garments.

Table4.3: Sample buyers order

Size	10	12	14	16	18
Quantity	40	90	80	25	25

STEP 1- Insert the inputs in to fields which are ready to take inputs. These inputs are maximum plies per lay, maximum number of garments per lay, size and order quantity. After ever size and order quantity insertion it's important to press submit to precede to the next size and order quantity as a result inputs will be verified. But if maximum plies per lay and maximum number of garments per lay are constant it is possible to set by default. And for size and order quantity it is possible to import from excel in ".cvs" file format.

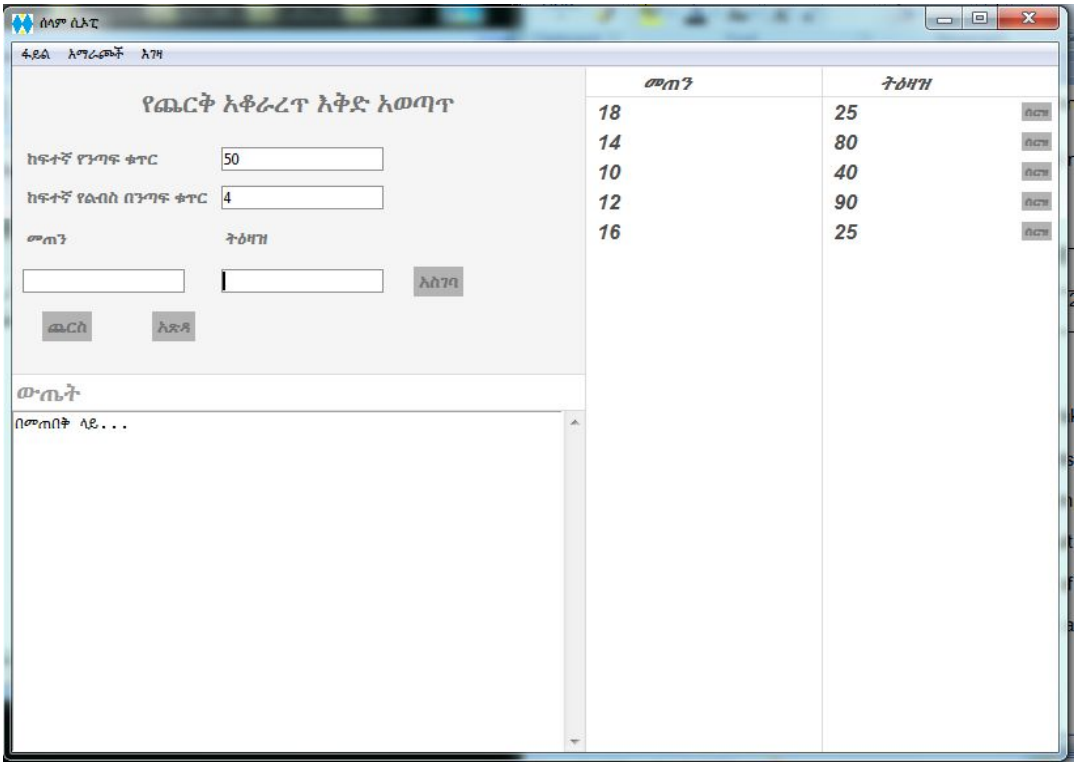

Figure4.25 : The Amharic graphic user interface with insert input order

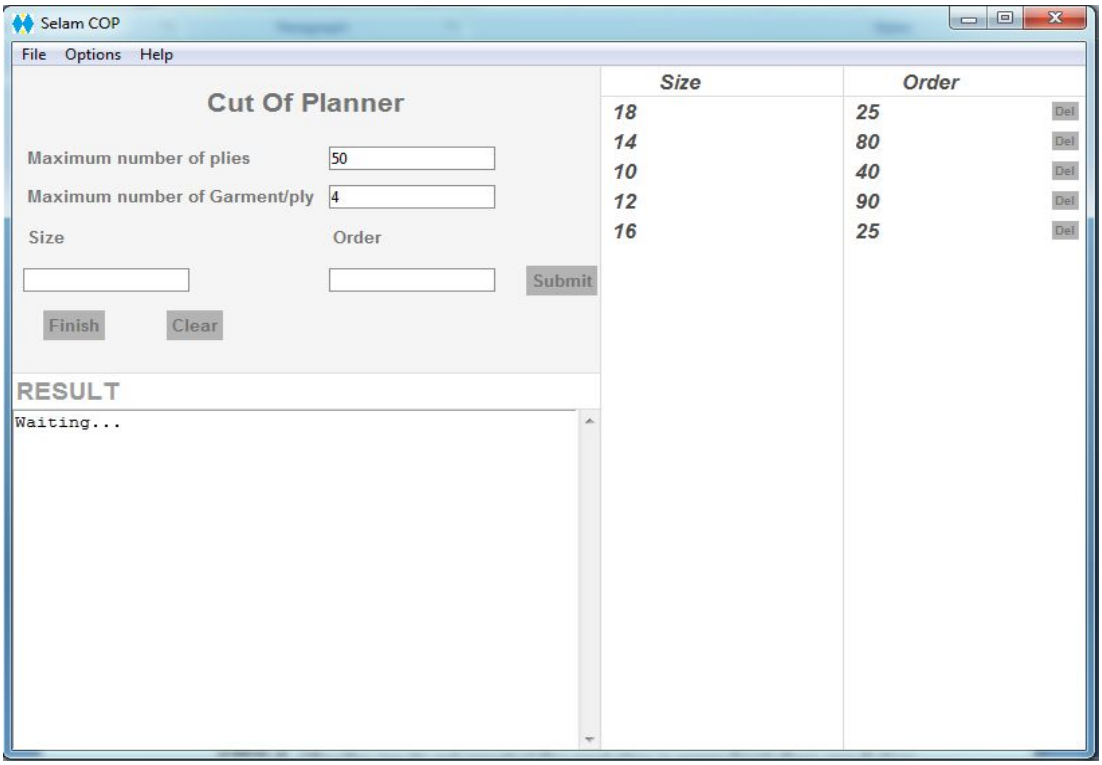

Figure4.26: The English graphic user interface with insert input order

STEP 2- After the inputs get inserted the next step is press finish then result drop down in the result section of the interface within seconds. With results of possible answer, number of lays, size combination for each marker, number of plies, number of size already cut and extra garment of size.

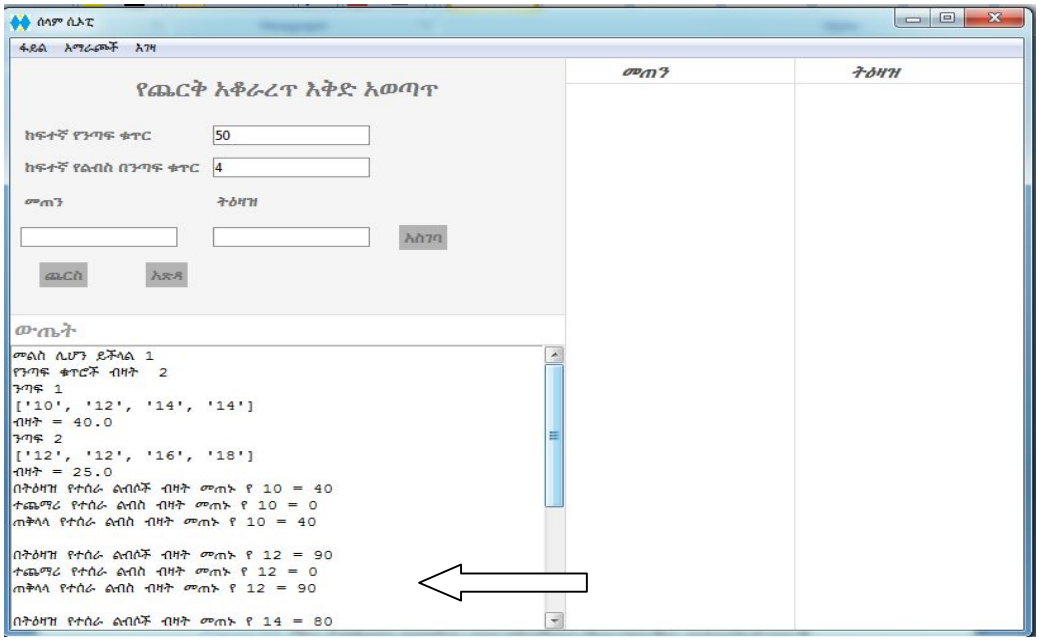

Figure4.27: The Amharic graphic user interface showing the expected result

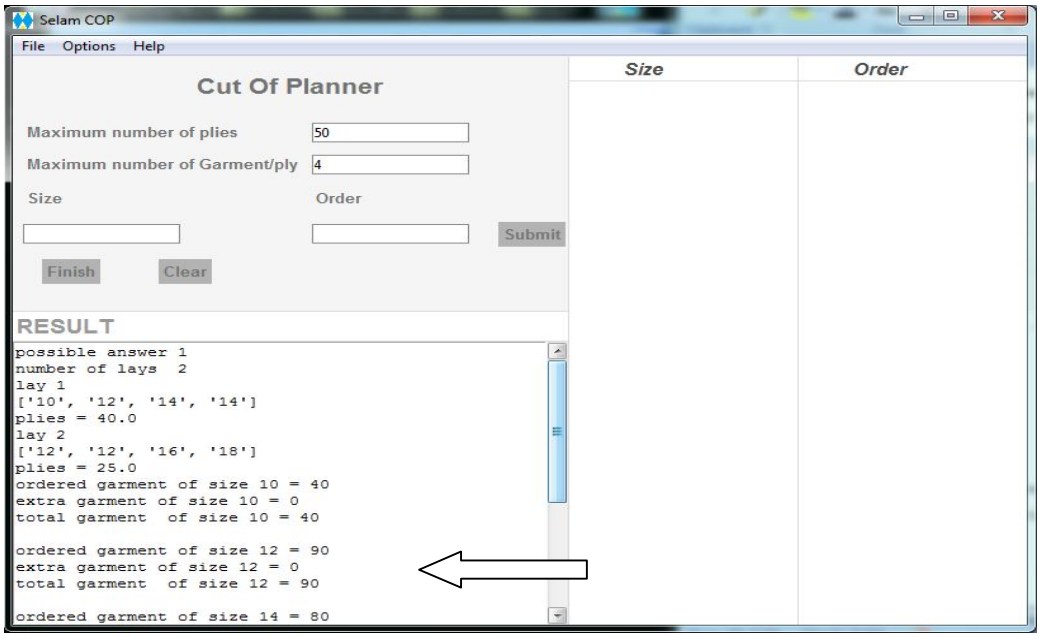

Figure4.28: The English graphic user interface showing the expected result

The constraints on lay dimensions are: Maximum lay height =50 plies and Maximum lay length = 4 garments marked. It is useful to determine the theoretical minimum number of lays required to cut the contract:

- The maximum number of garments per lay is 4*50=200 garments
- The number of garments required = 40+90+80+25+25= 260 garments
- Therefore the theoretical minimum number of lays = 260/200= 1.3
- This gives a practical minimum of two lay to cut the contract- the best that is possible. However, it may be in some cases that the number required do not permit a simple solution, so additional lays may be needed.
- Three important principles which can be used to determine the cut plan:

1) Aim to minimize total costs (giving priority to material cost).
2) Start with the lowest figures in the contract (fewer options)

   Lay 2 with 40 plies and size combination of 10,14,14,12
3) Exploit simple multiples between contacted quantities.

   Lay 1 with 25 plies and size combination of 16,18,12,12

4.3.1. Flow diagram of the system

Figure4.17: Flow diagram of the system

STEP 3- Finally after the result came out save the result under file tab and prepare the report. The report is automatically saved in note pad text document ".txt" file format.

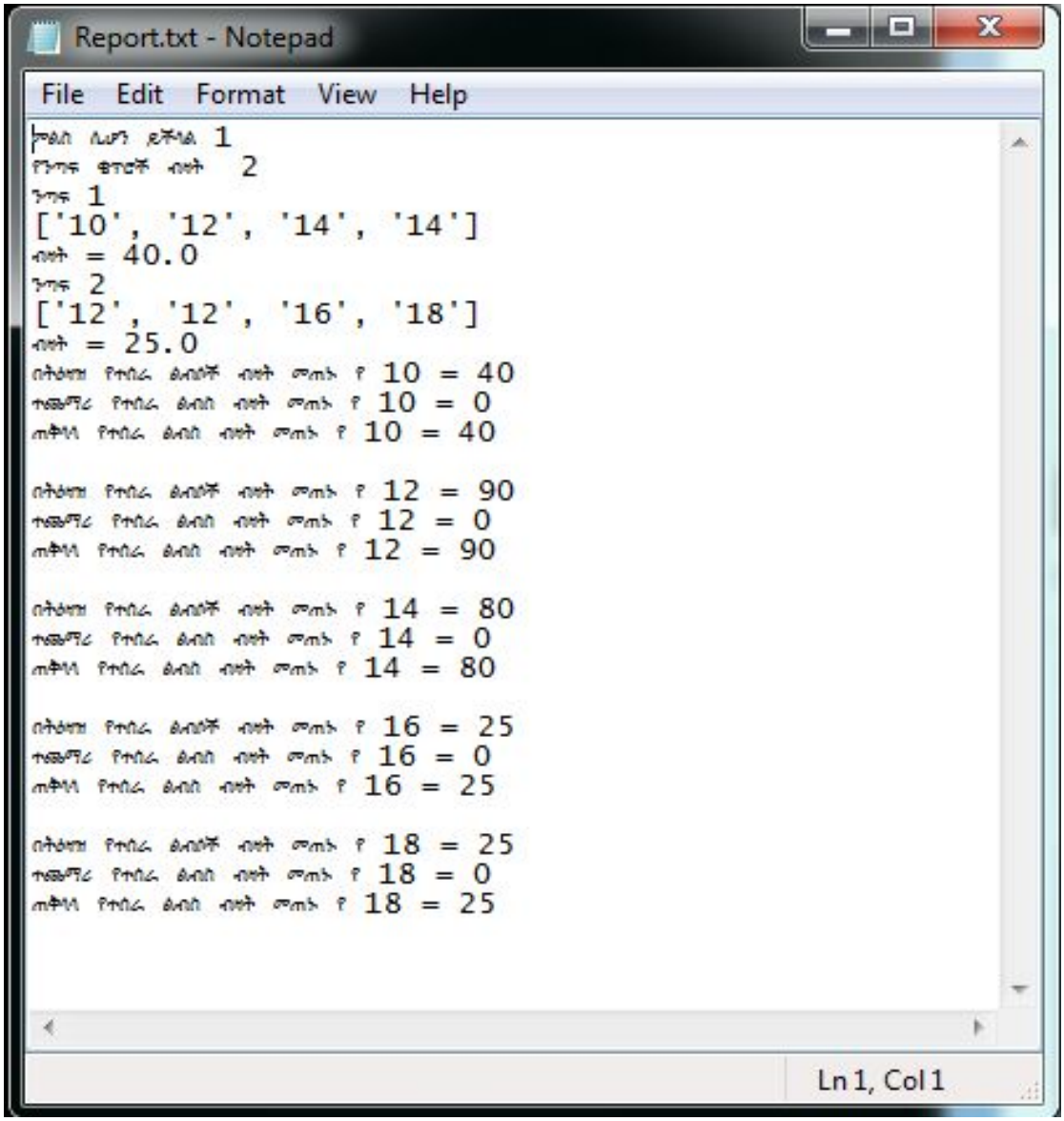

Figure4.17: The Amharic result report

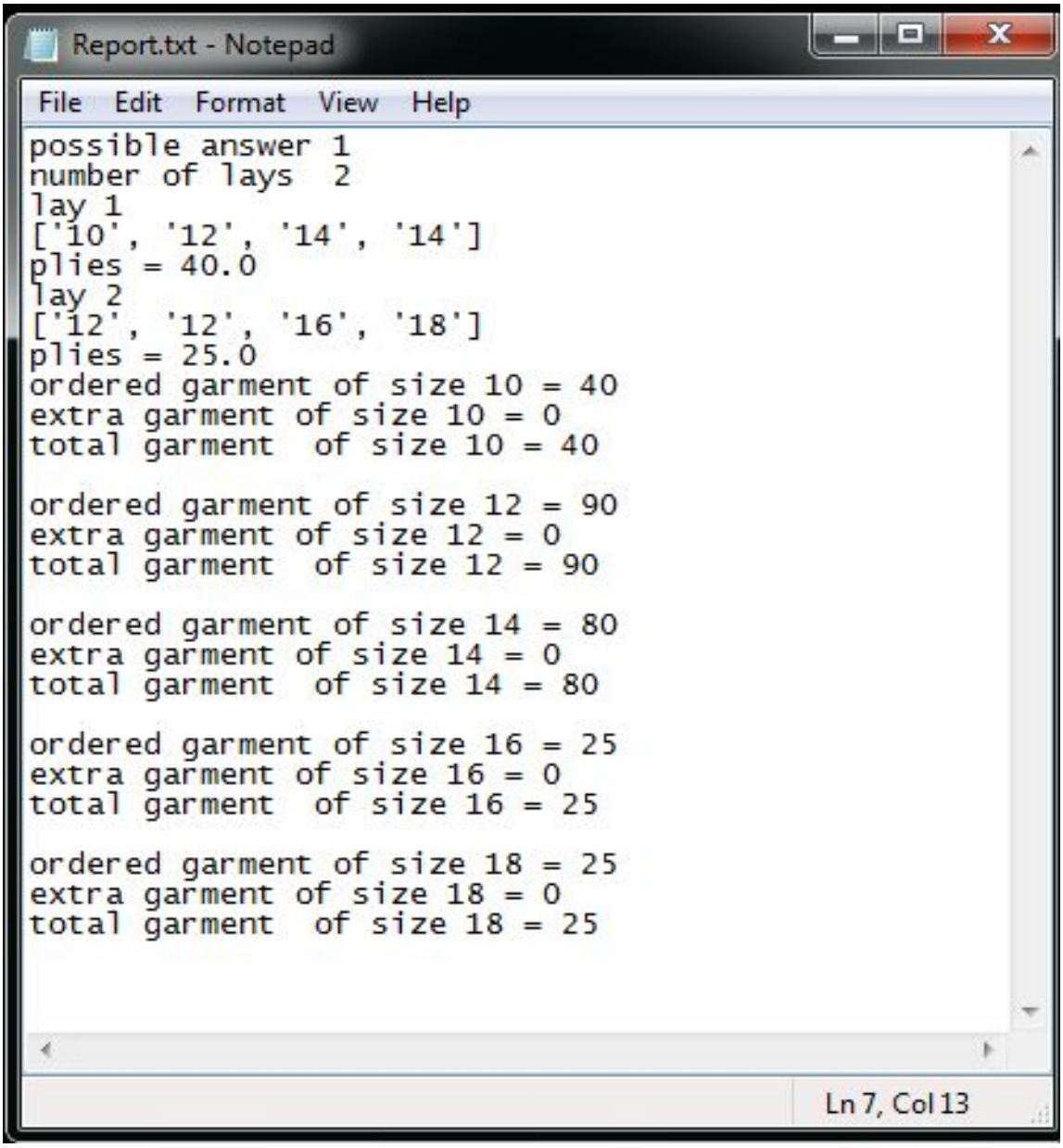

Figure4.18: The English result report

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

It is generally believed that technology adoption could have the greatest impact on factory environments and will make the process much quicker and more cost-effective, benefiting both the manufacturer and the customer. A new technological advance in manufacturing is relevant and has helped to better meet consumer demand. It is logical to assume that, with the implementation of computerized production system, the garment manufacturing sector became incredibly more efficient.

The research clearly indicates that by developing Amharic computer program which perform cut order planning in cutting section able to meet the expected result and objectives. This developed Amharic computer program will get rid of the routine conventional practice of COP in small scale garment manufacturers, make the cut order plan process very simple and accessible, and reduce throughput time in cutting section. Indirectly this program able to minimize the number of operator incurs due additional operation, enhance productivity of cutting room, increase production capacity and improve operations. As different literatures consent the planned cutting operation which means knowing the number of lay and size combination before has better fabric and other resources utilization than unplanned operation. So if the cut order planning activity done correctly fabric which cost more than 50% raw material cost will be utilized. The developed Amharic computer program capable of generating the possible

alternative expected result within seconds. Due to this time and cost are saved which have an important impact on overall factory financial system. Even though the initial plan of the research was to develop computer program in Amharic to make the operating process easy and accessible but lastly to operate the system language can be optional with both Amharic and English depending on the user.

5.2. Recommendation

The developed computer program is easy to access and interact because of its program works both in Amharic and English language; any assigned operator at any educational level could operate the program. So, any small to medium enterprises (SMEs) that manufacturer's garments in Ethiopia are recommended to implement this computer program for the cut order plan activity in their cutting section. Even though the developed program perform the cut order as expected there are some modifications required for future work. The recommendations for future work are able to generate report in table form, develop keys for program in order to get authorization ever time the program is on other hand, add other language as an option, add another feature that able to measure the efficiency of the fabric and improve the processing speeds for numbers of sizes to make this program implementable in large firms.

BIBLIOGRAPHY

A. T. M Mohibullah, Umme Magreba takebira, Zinia Anjuman Aral, Md Maksudur Rahman. (2017). Cost and time savings of apparel industry through elimination of non-valeate process in cutting section. *International journal of textile science* , 49-56.

B Filipic, I Fister, and M Mernik. (2006). *Evolutionary search for optimal combinations of markers in clothing manufacturing.* Washington: GECCO.

Cooklin G., Hayes S. G., McLoughlin J. (2006). Introduction to clothing manufacture. Blackwell publishing Ltd.

David J. Tyler Carr and Lathams. (2008). *technology of clothing manufacturing .*

David J. Tyler. (n.d.). Carr and Latham's Technology of clothing manufacture. In *Technology of clothing manufacture* (pp. 19-64). Australia: blackwell publisher Ltd.

Dumishllari, E. and Guxho, G. (2015). Impact of marker on cut plan in garment . *International journal of innovative research in science*, 77-81.

Elmira Dumishllari and Genti Guxho. (2015). Influence of lay plan solution in fabric efficiency and consume in cutting section.*AUTEX Research Journal*, 01-05.

Elmira Dumishllari and Genti Guxho. (2015). Infuence of lay plan solutionin fabric efficiency and consume in cutting section. *AUTEX Research Journal*, 01-05.

Gelb, B. A. (2007). *Textile and Apparel Trade Issues.* Washington DC: congressional research service (CSR).

Gradiar M, Jesenko J, Resinov G. (1997). Optimization of roll cutting in clothing industry. *computers and operations research*, 945-953.

Halterman, R. L. (2011). *Learning to program with Python.*

Hands C,Hergeth H H A,Hudson P. (1997). Marker making in small clothing companies. *international journal of clothing science and technology*, 154-165.

Haque, M. N. (2016). Impact of differnt sorts of Marker efficiency in fabric consumption. *International journal of textile science* , 96-109.

Herbert Jauch and Rudolf Traub-Merz. (2006). *The future of the textile and clothing industry in Sub-Saharan Africa.* Cape Town: Friedrich-Ebert-Stiftung.

Ho, C. S. (1999). *A study of fabric loss during spreading.*

Iztok Palcicl, Marc Pons Andrea Bikfalvi, Josep Llach, Borut Buchmeister. (2013). Analyzing energy and material saving technologies adoption and adopters. *journal of mechanical Engoneering*, 409-417.

Jackson, C. (2009). *Learning to Program Using Python.* California: Mountain View.

Jacobs Blacha C.Ammons J. C. and Smith T. (1998). Cut order planning for apparel manufacturing. *IIE trensactions*, 79-90.

Lakshmanakanth, P. (2012). *Spreading and cutting of apparel products .*

Lectra. (2010). Retrieved from Optiplan - Cut-order Planning and optimazation http://www.lectra.com/en/fashion_apparel/options/o

Mausmi, A. (2013). Fabric Utilization,cut order planning. Stitch world.

NBE. (2010/2011). *National Bank of Ethiopian annual report.* Addis Ababa, Ethiopia: NBE.

P., J. (2008, July). *Cut Order Planning.* The Dot Com Way. Stitch World,.

Palys, T. (2008). *Purposive sampling. In L.M. Given (Ed.) .* Los Angeles: The Sage Encyclopedia of Qualitative Research Methods.

Puri, A. (2013). *Efficacy of Pattern Making Software in Product Development.*

R P Abeysooriya and T G I Fernando. (2012). Canonical Genetic Algorithm to optimize cut order plan solutions in apparel manufacturing. *journal of emerging trends in computing and information science*.

Ruth E. Glock. Grance I, and Kunz. (2005). Apparel Manufacturing Sewn Product Analysis. New Jersey.: PEARSON Prentice Hall.

Silvana Zhezhova, Goran Demboski and Vlatko Panov. (2000). Optimization of technological process of cutting by use of software applications for cut order planning. *Faculty of Technology, Goce Delčev University*, (pp. 01-07). Macedonia.

Stjepenovic,Z.(1995). Computer-aided processes in garment production:Features of CAD/CAM hardware . *International journal of clothing science and technology*, 81-88.

T Peric and Z Babic. (2008). Determining optimal plan of fabric ctting with the multiple criteria programing methods. *The international multi-conference of Engineers and computer scientists*, (pp. 19-21). Hong Kong.

Tincher W. C.,Daley W., Holcomb W. (1993). Detection and removal of fabric defects in apparel production. *international journal of clothing science and technology* , 54-65.

Upendra, RAS, P Kaluarrachchi, and VS Ratnavake. (2013). Developing a system to calculate cutting process time of garments. *National engineering conference 2013, 19th eru symposium,faculty of engineering, university of moratuwa*, (pp. 26-32). Sri Lanka.

W Wong and S Leung. (2004). Real time GA based rescheduling approach for the pre sewing stage of an apparel manufaxturing process. *advanced manufacturing technology*, 180-188.

Wallace T. F., Stahl R. A. (2003). Master scheduling in the 21st century: for simplicity, speed, and success. USA: T. F. Wallace & Company.

Wallace T.F. and Stahl R A. (2003). *Master scheduling in the 21 st century: for simplicity, speed, and success.* USA: T.F. Wallace company.

Wong. W and Leung. S.Y. S. (2009). *A hibrid planning for improving fabric utilization .*

Woodeneh, G. (2016, May 17). *World bank support.* Retrieved September 9, 2017, from The world bank: http://www.worldbank.org/en/news/press-release/2016/05/17/world-bank-supports-ethiopias-small-and-medium-enterprises-to-boost-job-creation

Z Degraeve and M Vanderbroek. (1995). A mixed integer programming model for solving a cutting stock problem in the fashion clothing industry.