Development of a Software about Calculating the Production Parameters in Knitted Garment Plants

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Abstract—Apparel product development is an important stage in the life cycle of a product. Shortening this stage will help to reduce the costs of a garment. The aim of this study is to examine the production parameters in knitwear apparel companies by defining the unit costs, and developing a software to calculate the unit costs of garments and make the cost estimates. In this study, with the help of a questionnaire, different companies' systems of unit cost estimating and cost calculating were tried to be analyzed. Within the scope of the questionnaire, the importance of cost estimating process for apparel companies and the expectations from a new cost estimating program were investigated. According to the results of the questionnaire, it was seen that the majority of companies which participated to the questionnaire use manual cost calculating methods or simple Microsoft Excel spreadsheets to make cost estimates. Furthermore, it was discovered that many companies meet with difficulties in archiving the cost data for future use and as a solution to that problem, it is thought that prior to making a cost estimate, sub units of garment costs which are fabric, accessory and the labor costs should be analyzed and added to the database of the programme beforehand. Another specification of the cost estimating unit prepared in this study is that the programme was designed to consist of two main units, one of which makes the product specification and the other makes the cost calculation. The programme is prepared as a web-based application in order that the supplier, the manufacturer and the customer can have the opportunity to communicate through the same platform.

Keywords—Apparel, cost estimating, design archive.

I. INTRODUCTION

APPAREL products are labor-intensive products and many well known apparel companies generally prefer to have their collections manufactured in global subcontractors where labor rates are much cheaper. As a result of this fact, apparel products have provided a perfect opportunity for developing countries to move towards industrialization. The organizational large apparel companies provide design, fabric and accessories and the contractor provides labor and

supplies. The contractor can also provide all necessary things such as, fabric, supplies and labor.

Turkey is one of the most important subcontractors of American and European apparel companies. Similar to the economic and industrial development stage of all developing countries, textile and apparel sector has also been a leading sector after the foundation of Turkish Republic. Apparel sector mainly showed a rise by manufacturing as a subcontractor, this has provided an opportunity for the Turkish apparel sector to move toward industrialization, and accordingly apparel sector has become one of the leading sectors for the economic development of the country. However, for today, Turkey has started to lose its competitive advantage of low labor rates when compared with rival countries where labor costs are much cheaper. As a result, apparel producing started to migrate to different regions such as China, Thailand, Malaysia, Philippines, Spain, the Middle East, and Central and South America, Pakistan, India and Indonesia. For today Turkey seems to be losing its advantage [1]. By evaluating the situation of apparel producers in Turkey, it is seen that many small and medium sized companies are starting to gain lower profit margins to be able to continue their business. However, this may not last long. The only alternative to compete in this sector now seems to produce collections, create a global brand, increase the quality and follow the technological developments all of which will add a value to the garment.

A. Costing in Apparel Companies and Product Development

Costing is the process of estimating and then determining the total cost of producing a garment, including the cost of materials, labor and general expenses of indirect costs [2].

The increased number of seasons or offerings per year has put tremendous pressure on product development and the costing process. Constant style changes require constant feedback and adjustments for whichever costing strategy a company chooses to adopt. This has resulted in a multilevel costing process, which includes:

- Quickie costing (cost estimating)
- Costing for sale (cost calculating)
- Production costing (cost monitoring)
- Accounting costing (cost reporting) [3].

Cost Estimating: Cost estimation is the forecast of costs made before the item is manufactured. The first step in the costing process can also be called as precosting. Precosting is a preliminary estimate or "best guess" of what it will cost to produce the garment, based on judgment and past experience. This quick cost is usually accurate within 10 to 15% of the actual cost and gives the manufacturer some idea of whether the style can be produced and sold at a profit. The quick cost helps the manufacturer decide whether to reject the style, accept it as a part of the line, or send it back to the designer or merchandiser for changes to reduce its cost [2].

For a proposed new style, summarized cost data, previous garments cost sheets and fabric requirement approximations are used to prepare cost estimates. Cost estimates are standing at an important step of product development. Product development process is shown at Fig. 1 [3].
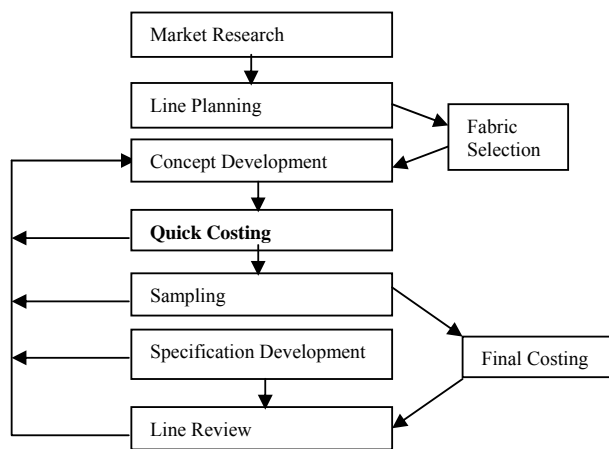

Fig. 1 Product development process

Cost Calculation: Cost calculation is the computation of the actual cost of manufacturing. This process is a detailed calculation of the costs required to manufacture a style based upon available data. A detailed analysis is made based upon prototypes. This level of costing is important in determining price values [3].

Production Costing: Production costing is related with the actual costs of production but does not take into consideration the overhead costs and profit margins [3].

Accounting Costing: accounting costing is used to make the final adjustments to all elements of costing and pricing processes [3].

B. Unit Cost of Goods

To provide a highly effective cost system, costs in companies should be categorized and be searched according to some categories. The main cost categories in apparel companies can be classified into these titles and sub categories [4]:
- Assignment to a cost object
    Direct costs / Indirect costs
- Behaviour pattern in relation to changes in the level of activity or volume

    Variable costs / Fixed costs
- Components (elements)
    Material costs / Labor costs / Overhead costs
- Business function
    Administration costs / Sales costs / Purchasing costs / Production costs
- Aggregate or average
    Total costs / Unit costs
- Assets or expenses
    Inventoriable costs / Period costs

To define the unit cost of goods each component (element) of a garment should be defined clearly. The unit cost of goods includes all expenses involved in the manufacture of an apparel product. The cost of goods is summarized under the categories of material cost, labor cost and overhead costs.

Material costs: Material costs include fabric and accessory costs. Fabric is the most costly material in most garment styles. Fabric accounts for %45 of a garment according to the statistical data [4]. Since fabric is the most significant factor in costing a garment, an accurate calculation for the required amount of fabric per garment is essential. There are two stages to determine fabric expenditure. First of all, unit fabric price is defined. Accordingly, the expenditure of fabric per unit garment is determined. To accurately determine the average amount of fabric needed for a garment style, marker plans are prepared by using the size scale and the fabric width. After determining the consumption of fabric required to produce a style, including a waste factor, total cost of the fabric is defined by multiplying the expenditure value by the price per square meter.

For all other direct materials such as trim, thread, buttons, zippers, labels, shoulder pads and poly bags, quantities per garment are measured in units, sets or meters. Waste factors are also calculated to accommodate materials that are dropped, broken or damaged during the manufacturing process [3].

Labor Costs: Labor costs include those costs that change the condition or physical appearance of raw materials [3]. Examples of direct labor functions are cutting, bundling, folding, sewing and finishing. Labor accounts for a large portion of the total cost of garments and sewing is the most costly process. Regarding this, each individual operation in the production of a garment should be defined and total time of sewing operations should be carefully calculated.

Overhead costs: Overhead costs include all the costs except material and labor costs. Manufacturing overhead, general and administrative expenses are all included in overhead costs. Marketing and selling expenses, merchandising, design or product development expenses and distribution expenses can be examples of this group. According to a research made by Istanbul Textile & Apparel Exporters' Associations, the allocation of cost components was tried to be analyzed. Within the scope of the research, approximately 50 companies that were chosen from different locations of Turkey were examined to make a statistical analysis. The results of the

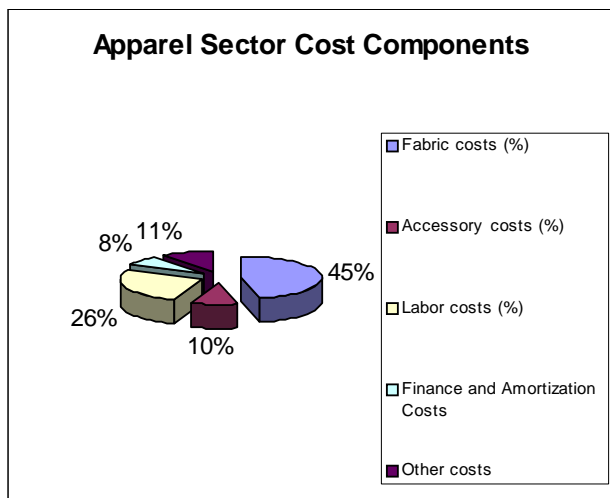research and the allocation of cost components are seen in Fig. 2 [5].

Fig. 2 Apparel sector cost components

II. RELATED WORK – COMPUTER APPLICATIONS

All the elements and methods to calculate cost of garments are the same no matter how they are calculated. However, the style of the forms and how the forms are completed, either manually or by computer, vary among companies.

- Some firms complete cost sheets manually.
- Some firms complete cost sheets using commercially sold spreadsheet programmes. Microsoft Excel is the most commonly used spreadsheet programme. By entering the formulas into the software programme, subtotals are found for materials, labor and overhead costs. The computer calculates the totals. By changing an item or trying another choice, the totals are instantly changed by the programme.
- Some firms complete cost sheets using industry-driven software programmes that have been developed by large apparel technology firms, such as Gerber Garment Technology or Lectra [6].

There are numerous computer software applications available to automate the maintenance of data and the calculations required to determine costs and selling prices. Some companies create their own software applications using interactive databases or standard spreadsheet programmes. A typical software application allows a company to create a number of cost-related reports that are linked together to generate cost analysis sheets as well as cost evaluation summaries [3].

PDM (Product Data Management) systems are fully integrated systems that offer sophisticated computer tools prepared by industry-designed software programmes such as Gerber, Lectra and Assyst.

Examples of software applications for apparel costing are:

- WebPDM Product Data Management System from Gerber Garment Technology [7],
- Gallery from Lectra Systems, (Mikalis for product specification) [8],
- Pdm.Assyst from Assyst Bullmer (Automation Software and Systems) [9],
- PM Web from Investronica Sistemas [10],
- Byte Software [11],
- ….

Since mentioned systems are fully integrated systems with a high capacity, apparel companies in Turkey found these systems too complex to adapt to their organizational structures. Some domestic companies preparing software for apparel organizations can be listed as follows:

- EDS (*Enformasyon Destek Sistemi*)- Apparel Planning and Management Systems [12] ,
- SentezXL Apparel Management Systems [13],
- WinTex Apparel Production Planning and Follow-up Systems [14].
- "Web based automation software for calculating production costs in apparel industry" [15].
- ...

III. AIMS OF THE STUDY

Cost estimating is an important stage of product development. For the companies which are working as subcontractors of organizational companies, cost estimations are also an agreement between the manufacturer and the customer. In this study production parameters in knitwear apparel companies were examined by defining unit costs and a software was developed to calculate the unit costs of garments. Keeping all data regarding the costs and production parameters will help future cost estimates. A model archive was prepared to keep the data and make ready for future use. The programme was prepared as a web-application with the aim of wide access to any necessary production information by manufacturers and customers. The web based programme helps to shorten product development process and order acceptance. The reason why the knitwear companies are chosen is the fact that trends are sliding through more elastic and comfortable clothes. Another reason is the low costs of knitting technologies and establishing knitted garment manufacturing plants comparing with woven garment technology.

IV. MATERIAL METHOD

A. Preparing the Questionnaire

In this study, with the help of a questionnaire, different companies' systems of unit cost estimating and cost calculating were tried to be analyzed. Within the scope of the questionnaire, the importance of cost estimating process for

apparel companies and the expectations from a new cost estimating programme were investigated. The questionnaire form included 14 questions. These forms were sent 61 companies by e-mail or fax that were selected randomly and 22 of them responded.

B. Sample Selection and Defining Model Details

Different knitwear companies' cost estimating systems were tried to be analyzed in order to create a basis for the computer programme. A virtual company was designed which manufactures both for its own brand and another company's brand as a sub contractor. 10 different models were chosen for the contracting business and three different models were chosen to represent the company's own collection. Model specifications including the fabric and accessory details, sewing details, color alternatives and size tables were defined for each model.

C. Model Drawings

Model drawings were prepared by using Gerber Micrografix Designer aiming to show a general view of the model and to explain the technical details of garments.

D. Calculating Unit Fabric Costs

Fabric consumptions for each model and each fabric type included in each model were calculated by preparing marker planning. By multiplying the fabric width, marker length, fabric weight per square meter and dividing with the number of the sizes at the marker plan, total consumption of fabric for that garment was specified. Waste factors were included according to the fabric type. This result gave the fabric consumption and multiplying this with the unit fabric price gave the cost of the garment. After adding the waste factor, and adding all these sub totals, the fabric cost of that garment was specified.

E. Calculating Unit Accessory Costs

The price of the accessories used in chosen models were defined and multiplied by the quantity of usage in each garment. The usage of accessories was calculated in two ways: either as unit quantities or as length units per garment.

F. Defining Sewing Operation Lists and Labor Costs

Operations such as cutting, printing, sewing, packaging and quality control were included in the search of labor costs. Since sewing is the most affective labor cost among mentioned units, sewing operation lists were prepared to determine total operation minutes. The unit labor price per hour is multiplied with this total operation time to find the sewing labor cost. For the other operations included in labor costs, fixed values were determined and added to the unit cost calculation of the garment if it is necessary. For instance, printing costs were added according to the number of colors included in print design.

G. Calculating Unit Garment Costs

The components and methodology of costing formulas vary by apparel manufacturers depending on what they are manufacturing and the size of their product runs. In this study, to be able to define a system of unit garment cost estimating, different companies' systems were analyzed and a similar system was prepared for unit cost calculating. Starting from the fabric cost calculation up to the price definitions, each step was defined by a specific method.

Unit garment costs were calculated by using following formulas (all calculations were done by considering just one single garment):

Unit fabric costs = Unit fabric price x Unit fabric usage x waste tolerance

Unit accessory cost = Unit accessory price x Unit quantity x waste tolerance

(This operation was repeated for each accessory type being used in the garment and a sum of these costs gave the total accessory cost.)

Unit labor cost = [Sewing labor costs x total sewing operations time] + [Cutting labor costs] + [Quality control labor costs] +[Print or embroidery costs] + …

Total finance costs = (Fabric costs + Accessory costs + Labor costs) x 0,03

2nd *quality costs* = [(Fabric costs + Accessory costs + Labor costs) +Finance costs] x 0,07

(To determine 2nd quality costs previous sum was multiplied by 0,1 for garment wash model types instead of 0,07.)

Overhead costs were added as fixed values which change according to the order quantity.

Unit Cost of Garments = (Fabric costs + Accessory costs + Labor costs) + Finance costs + 2nd Quality costs + Overhead costs.

To determine the price:

- Profit margin was added as a value of %15-25 of total cost of garment.
- For some models, %2 commission was also added to get the price of the garment.

H. Developing the Software

In this study the cost estimating programme was prepared by using PHP technology. The system uses MySQL for the database, and it calculates the unit costs by integrating the data entered by the user and the data stored in the database. PHP pages are prepared in ZEND platform.

V. STUDY RESULTS

A. Evaluation of the Questionnaire Results

At the end of this study, the results of the questionnaire were accumulated. Each questionnaire item was evaluated one by one by using Excel programming and accordingly, percentage deviations were computed. Frequent answers were

determined at items; the items which can not be evaluated as percentage deviations were analyzed by written expressions.

According to the results of the questionnaire, it was seen that the majority of companies which participated to the questionnaire use manual cost calculating methods or simple Microsoft Excel spreadsheets to make cost estimates. Furthermore, it was discovered that many companies meet with difficulties in archiving the cost data for future use. Nearly half of the companies claimed that they had to make their cost estimations within a day the latest and it was said that the most necessary innovation in a cost estimating programme would be the capability of the programme to adapt changes easily.

B. The Cost Estimating Programme

In this study, a software was developed to make cost estimations easier during the process of apparel product development or at the stage of taking orders from different companies while producing as a subcontractor. The programme consists of two main parts, one of which is necessary for product specification, and the other part is necessary for calculating the unit costs. By the integration of these two main parts, the programme is able to serve for the manufacturer as well as the customer who will give the orders. So there will be two main user groups, the supplier (the manufacturer) and the customer. In Figure 3, two main parts of the cost estimating programme are shown. As shown on the left row, the programme can be used for companies producing apparel for their own brand and the right row is explaining the sequence of the programme when used by contracting companies.
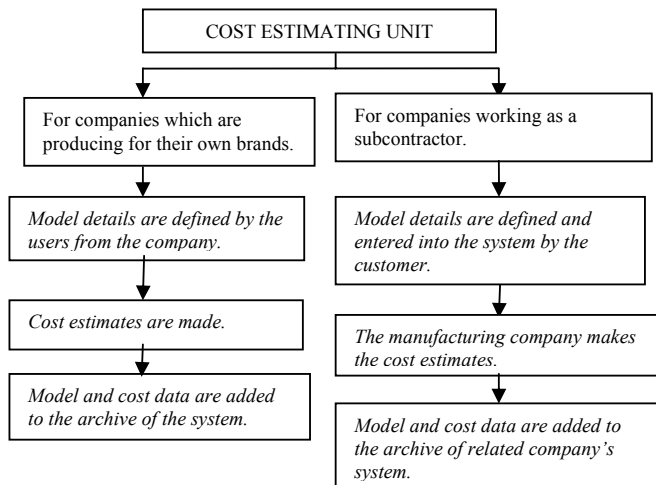

Fig. 3 Cost estimating unit

The programme can serve in several languages for international business relationships among companies.

The cost estimating programme is designed as a web-based application. There can be a link from the web site of the related company for easy access; therefore, the programme can also be an example for B2B e-commerce application since

two companies can make an agreement using the programme. Each user has to sign in with a password in order to reach the website of the cost estimating programme. Since cost data is a key value for companies, the security of the web site is important and therefore, only people with passwords can reach to the web site.

Since most of the apparel companies in Turkey work as a subcontractor of big European and American companies such as Adidas, Tommy Hilfiger, HM, Diesel, GAP,… and export their sewn products to be sold under the name of such brands, this programme is thought to be working as a link between customers and the manufacturers. The manufacturing company is the administrator of the programme and adds the customers to its list and adds the customers' passwords to be able to reach the web site of the cost estimating programme.

The customer may try to get a price for a new item to make a decision whether to choose this company to have the garment produced or to choose another one. So, the customer has the opportunity to make a garment specification over this unit and send an alert to the manufacturing company.

Creating a New Model and Calculating the Unit Costs: This part is the common section used by both the customer and the manufacturer. Customers use this section to define the models which they are planning to have manufactured and send an alert to the manufacturer to give a price for that specific garment. The manufacturer continues the process by calculating the unit cost of the model. A sample screen view to create a new model is shown in Fig. 4.

Fig. 4 Creating a new model – A screen view

To create a new model, first of all, all model details should be defined which will later help to access any model being stored in the archive of the system. In the first screen of new model creation, these definitions should be completed. Season, company name, model number, model name, product category, product type, size scale, estimated order quantity and the explanations of model details are added to the system. Model photos, drawings, sketches or any other visual specifications are uploaded to the system at this stage of the programme. After entering the necessary info, step by step, fabric details, accessory details, model details, color alternatives and size table data should be entered. For fabric

and accessory details, user can choose any fabric or accessory type from the database of the system. If the desired type is not included in the database, the user can create a new one and add this to the database for future use. To make the selection process easy for frequently used accessories, groups can be formed. Labels are an example of this; frequently used labels can be a group, and just selecting this group will be easier rather than selecting each of them one by one.

After defining fabric and accessory specifications, model details should be included in the system. Written or graphical expressions of model details should be defined by using model details screen. Accordingly, color alternatives for the model are defined to make clear expressions of the model.

After completing color alternatives info, cost calculation process can start. Step by step, fabric cost, accessory cost, labor cost values were calculated by using the info entered in the system at mentioned earlier stages. All formulas to calculate unit costs are written in the system; however, the administrator can make any necessary changes or updates according to the company demand. After calculating the unit cost of the garment, a pie chart is prepared to see the proportions of the sub units of the total cost which will enable a visual evaluation for the user.

Archiving the Model Data: While creating a new model, the user can choose any similar model from the model archive and can create a new one by making changes over this model. With this method, the user will save time by using the previous model data. Any model can be added to the archive of the system for future use and the access to desired models can be provided by sorting the models according to their model number, season, product type, company name and other model info.

VI. Conclusions and Future Work

In this study, a new software was prepared in order to help cost estimating process during product development. Another main aim of the programme is to help getting orders for the manufacturer companies which are working as subcontractors of big apparel companies. During the preparation of this paper, the results of the study for a M.Sc thesis is taken as a reference [16].

Before starting the software a questionnaire was prepared and sent to apparel companies to analyze the cost estimating systems. At the end of the questionnaire, it was seen that many of the companies which participated to the questionnaire use manual cost calculating systems or excel sheets for cost estimating purposes. It was also seen that companies would prefer a system with an archive for all models in order that they can make the estimating process quicker and much closer to real values by taking into consideration the earlier estimating data.

The software prepared in the study is a web-based application in order that the supplier, the manufacturer and the customer can have the opportunity to communicate through the same platform. The system has two main users, one of which is the administrator of the system, and the other is the customer who gives orders. The system is not a simple cost estimating programme; it also works for product specification. The programme makes cost calculations and every new data can be added to the system's archive if desired by the user. Each data stored in the system archive can be called for new cost estimates by sorting according to the model number, model name, product category, customer name, season and any other info of the model. Since all data are captured in a master database, comparisons and 'what if' scenarios can be evaluated quickly and accurately.

Apparel producers can store their production parameters and the managers can get any related information from any place, any time via Internet. This programme aims to provide higher production efficiency assuring better quality products in shorter production cycles. System can also be an example of B2B commerce since the manufacturer and the customer can make an agreement over the system.

This system is prepared for cost estimates which is an earlier stage of apparel production. The project can be extended by integrating this programme with systems which can be prepared for all production stages. Adding different properties to the system such as making technical drawings within the system or calculating fabric expenditures without using a marker plan can be thought for future work which will extend the content of the system.

With this system, the administrator company takes orders from its customers and many customers of this system can use this module to give orders to that specific customer. If we think about just the opposite version of this situation, a customer company can be the administrator of the system and prepares a package specifying all the characteristics needed in the garment. The manufacturer enters the garment specification data onto a preformatted screen on the computer and notes the desired price range. Then the package is electronically transmitted to a group of candidate suppliers in the system. Within a specified time period, interested suppliers send back any questions. The customer selects a contractor from the group of respondents and transmits a purchase agreement. When many apparel companies are linked via computer, the system can work quicker and easier by taking many many companies in contact.

References

[1] *Tekstil ve hazırgiyim endüstrisi için sürdürülebilir gelişme: MFA'dan ATC'ye 2005. (Research Report),* Competitive Advantage of Turkey, Istanbul, 2003.
[2] P. Brown and J. Rice, *Ready-to-wear apparel analysis (2nd ed.).* Upper Saddle River: Prentice Hall, 2001.
[3] J. A. Rosenau and D. Wilson, *Apparel merchandising.* New York: Fairchild, 2001.
[4] C.T. Horngren, S.M. Datar and G. Foster, *Cost accounting: a managerial emphasis (11th. Edition).* Upper Saddle River, NJ: Prentice Hall, 2003.
[5] *Tekstil ve konfeksiyon sektörü maliyet bileşenleri.(Research Report),* Istanbul Textile & Apparel Exporters' Associations, Istanbul, 2004.
[6] J.M. Johnson and E.C. Moore, *Apparel product development (2nd ed.)* Upper Saddle River: Prentice Hall, 2001.
[7] Gerber Garment Technology Catalogues, 2005, [Online] Available:

http://www.gerbertechnology.com/gtwww/03Prods/pdm/pdm.htm

[8] Lectra Catalogues, 2005, [Online] Available: http://www.lectra.com/en/retailing/products/mikalis_retailing.html

[9] Assyt Bullmer Catalogues, 2005, [Online] Available: http://www.assyst-intl.com/pdm/english/pdm.html

[10] Investronica Catalogues, [Online] Available: http://www.macphersons.co.uk/newcadcam.htm

[11] Byte Software Catalogues,[Online] Available: http://byte-software.com/

[12] Enfotek Catalogues, [Online] Available: http://www.enfotek.com.tr/

[13] Sentez Yazılım Catalogues, [Online] Available: http://www.sentezyazilim.com.tr/Default.aspx?tabId=5&linkId=373&PID=4

[14] Yage Yazılım Catalogues, [Online] Available: http://www.yage.com.tr/wintex.htm

[15] E. Bulgun, A. Kut, G. Başer and M. Kasap, "Web based automation software for calculating production costs in apparel industry". *Advance*s In Information Systems Proceedings, pp.223-231, 2002.

[16] A.Vuruskan, "Örme Konfeksiyon İşletmelerinde Üretim Parametrelerinin Hesaplanması Üzerine Bir Bilgisayar Programının Geliştirilmesi", M.Sc. thesis, Dept. Textile Eng., Dokuz Eylül Univ., İzmir, Turkey, 2005.