# Classical Model Garment Cost Analysis using a simplified Mathematical model

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**Abstract**

*Ever growing needs of the market and dynamics of the business increases the desire to add more features in the ERP solution used in the apparel industry. In order to achieve operational excellence and get the best on Return on Investment it is mandatory for an apparel manufacturing company to change the features of the ERP application. Moreover, majority of the ERP packages that are adopted in the apparel industries are not satisfied with the functions for Calculation of Manufacturing cost, Cost Analysis Report, Warehouse Management and Stock Management. In this work, a working model on the calculation of manufacturing cost and Cost Analysis has been developed in such a way that these can be incorporated in the existing ERP packages as a plug and play or adds on module in the apparel industry.*

Keywords: *Apparel Industry, Cost Analysis, ERP, Manufacturing cost*



## I. Introduction

The ERP users always looked up to an additional feature as an add on solutions to function that does not disturb the existing ERP solution. Majority of the apparel industry is of the opinion that it is essential to have modification on garment cost analysis. Therefore in this work, modifications on to the existing ERP software in terms of cost analysis as a plug in model is incorporated to cater specific requirements of the apparel industry. These specific requirements could be addressed by providing a solution to calculate accurate costing solution. In traditional cost analysis model, cost of manufacturing each style is not mapped. Rather overall manufacturing cost of the factory is measured with Standard Average Minute (SAM) value, expertise in assuming consumption and other over heads. A classical model could be developed to identify the exact cost incurred in manufacturing a particular style by identifying exact cost raw material, cost of production per unit, overheads, actual rejection, margin, and cost on board. Developing such Add on solution could take up to 60 days, that is again determined by the scope, complexity and various other factors.

## II. Review of Literature

Actual Cost of manufactured Goods are not always the same as projected at the sample level due to Various factors that influence cost of manufacturing a product which is dynamic in nature (Gandhi M.K. and Sarukesi .K. 2015 [1] ). Implementing ERP with or without Business Process Re-engineering (BPR) has been surveyed and analyzed (Bernroider and Koch (1999[2])). Despite this increased experience and capability, changes required by ERP have often proved to be over-whelming in many organizations by resulting in ERP project failures (Maguire etal.,2010[3]). The overall implementation failures and difficulties involved in ERP projects attracted much research interest (Liu and Seddon, 2009[4]). This has resulted in substantial studies conducted on Critical Success Factors (CSF's) for ERP implementation and overall project success.

Quality check in day-to-day operations and significantly lowered the operational costs (Gupta et al.,2004 [5]). Improved performance on a variety of financial metrics, and higher market valuation (as measured by Tobin's. q) (Hitt et al., 2002[6]). Reduced inventory cost and a related reduction in the cost of capital (Rikhardsson and Krcmmergaard,2006[7]). Operational performance and continuous learning leads to continuous improvements in performance (Cotteleer and Bendoly, 2006[8]). Enhancement in firm competency of supply chain management through operational process integration and customer relationship interaction (Su and Yang,2010[9]). Efficient use of information leading to profitability (Bendoly et al., 2009[10]).



## III. Garment Cost Analysis Model

Garment cost plays pivotal role in determining an organizations existence. Calculating the Total investment made on manufacturing a Garment is called Garment manufacturing cost. Cost of garment is projected at the time of sample development with numbers which is arrived at based on general manufacturing parameters such as Raw Material cost, Manufacturing over heads, administrative over heads, cost of shipping and the profit margin. Proposed cost is generally arrived at based on a prevailing market price of raw material and other overheads. The product cost arrived at the time of sample development is projected to a potential buyer and negotiated with the buyer for placement of orders.

### *A. Factors Influence the cost of Manufacturing*

There are more factors that influence Garment Manufacturing cost which include cotton price, Yarn price, Knitting or weaving cost, cost of dyeing, finishing cost, cutting sew and Trim (CMT) cost, printing cost, direct and indirect labour cost, factory over heads, Sales over heads, shipping and transport, profit etc.

### *B. Process Flow Diagram for Garment Cost analysis*

Process flow diagram for Add-on module for cost analysis for ERP software is shown in Fig 1. The Add on model on Garment cost analysis has 3 options primarily master data capturing option, Process and reports generated out of it. Information related to Style is captured in master and in the process the manufacturing information is captured along with product costing. Reports are generated to prepare a cost analysis and to find out exact profit made out of each style. Process flow diagrams for Add-on solution for cost Analysis is given in Fig 1. Estimated Cost in Traditional Model is presented in Table 1.

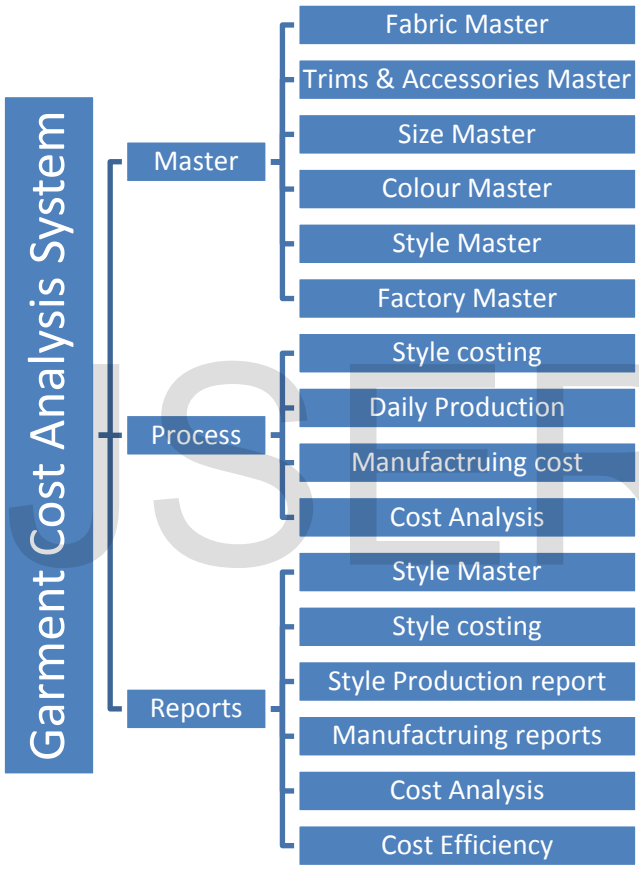


Fig1. Process flow diagrams for Add-on solution for cost Analysis

### *C. Traditional Costing Model*

In a traditional model Estimated cost is arrived at based on the Raw material cost which include Fabric price & consumption, Trims & Accessories used , Standard CMT charges, other overheads, rejections and Margin. The traditional model of arriving at the estimated cost is shown in table 1.

Table 1 Estimated Cost in Traditional Model

| C=0 | Estimated Cost |
|---|---|
| $C_F(0) = P_F(0) \,.\, A(0)$ | Cost of Fabric = Price per Meter / Unit *Amount of Consumption |
| $C_T(0) = P_T(0) \,.\, A(0)$ | Cost of Trims = Price per Unit *Amount of Consumption |
| $C_P(0) = \sum(S_{TI}(0)+C_{UT}(0)+ F_{IN}(0)+P_{ACK}(0)+E_{MBL}(0))$ | Cost of Production = Stitching + Cutting + Finishing + Packing + Embellishment |
| $C_M(0) = \alpha.\ (C_F(0) + C_T(0) + C_P(0))$ | Margin = % * (Cost of Fabric + Trims + Production) |
| $C_{OH}(0) = \beta.\ (C_F(0) + C_T(0) + C_P(0))$ | Overheads = % * (Cost of Fabric + Trims + Production) |
| $C_R(0) = \Upsilon.\ (C_F(0) + C_T(0) + C_P(0))$ | Rejection = % * (Cost of Fabric + Trims + Production) |
| $C_{OB}(0) = O(0)$ | Onboard = X Value |
| $C = C_F(0) + C_T(0) + C_P(0) + C_M(0) + C_{OH}(0) + C_R(0) + C_{OB}(0)$ | Cost = Cost of Fabric + Cost of Trims + Cost of Production + Margin + Overheads + Rejection + Onboard |



### *C. Cost variance analysis– Classical Model*

Cost variance analysis is prepared by comparing the costing sheet prepared at the time of developing the style or order confirmation with the actual cost incurred in manufacturing a particular style. Here actual manufacturing cost is calculated for each style. On selection of a Style the estimated cost used for costing appears on the screen of Fabric and Trims, which are primary raw material in manufacturing a garment. Once the actual consumption is entered along with the actual rate at which the raw material was procured the cost of raw material is derived automatically. Application displays Fabric cost, trims cost, total number of pieces manufactured and cost of manufacturing each piece once the calculate profit option is selected. In case of any change in the percentage of Over heads, Cost on Board, Margin and rejection that

can be updated in the application. Application instantly shows variance in each component. The application enables the organisation to find out whether they are able to make profit in manufacturing a style, whether there is any variation in the prices Estimated and actually incurred. Classical approach for traditional costing model is shown in Table 2

Table 2 Classical approach for traditional costing model - Actual Cost Analysis

| t=0 | Product Cost (Unit) |
|---|---|
| $C_F(t) = P_F(t) \,.\, A(t)$ | Cost of Fabric = Price per Meter / Unit *Amount of Consumption |
| $C_T(t) = P_T(t) \,.\, A(t)$ | Cost of Trims = Price per Unit *Amount of Consumption |
| $C_P(t) = e(t) / N_0(t)$ | Cost of Production = Total Expenditure / Number of Units Produced |
| $C_M(t) = \alpha.\ (C_F + C_T + C_P)$ | Margin = % * (Cost of Fabric + Trims + Production) |
| $C_{OH}(t) = \beta.\ (C_F + C_T + C_P)$ | Overheads = % * (Cost of Fabric + Trims + Production) |
| $C_R(t) = \Upsilon.\ (C_F + C_T + C_P)$ | Rejection = % * (Cost of Fabric + Trims + Production) |
| $C_{OB}(t) = O(t)$ | Onboard = X Value |
| $C_{ost} = \sum C(t) = [C_F + C_T] + \sum C_P(t) + [\alpha.\ (C_F + C_T) + \alpha.\ \sum C_P(t)] + [\beta.\ (C_F + C_T) + \beta.\ \sum C_P(t)] + [\Upsilon.\ (C_F + C_T) + \Upsilon.\ \sum C_P(t)] + O_B(t)$ | Style Cost per unit = Cost of Fabric used + Cost of Trims Used + Cost of Production per unit + Margin (% on COF+COT+COP) + Over heads + Rejection + Cost on Board per unit |

### *III. Cost Analysis Report*

Cost analysis report is generated for a particular period. This report can provide details of individual or various styles manufactured during the period in all the factories. This report can be seen for all styles or a selective style. This report also provides details of Style Estimated cost per unit, actual cost, and number of units produced along with the total estimated price and total cost of manufacturing. The report also indicates whether the organisation has made profit out of that particular style or not. Particulars of cost analysis report are shown in Fig 2.

| Style No | Description | Estimated Cost (per unit) | Actual Cost (per unit) | Quantity Produced | Estimated Price | Actual Price | Profit / Loss |
|---|---|---|---|---|---|---|---|
| KID001 | Kids Casual | 437.06 | 373.09 | 3150 | 1376739.00 | 1175233.50 | Profit |
| QS010101 | Quick Silver | 678.10 | 594.09 | 2610 | 1769841.00 | 1550574.90 | Profit |
| KID003 | kids casuals | 396.09 | 319.35 | 1000 | 396090.00 | 319350.00 | Profit |
| A00010101 | Spring summer 2017 | 342.13 | 315.12 | 560 | 191592.80 | 176467.20 | Profit |
| RD LBS 024 | SHORT SLEEVE SHIRT | 564.14 | 376.32 | 1175 | 662864.50 | 442176.00 | Profit |
| KID001 | Kids Casual | 437.06 | 373.09 | 3150 | 1376739.00 | 1175233.50 | Profit |
| QS010101 | Quick Silver | 678.10 | 594.09 | 2610 | 1769841.00 | 1550574.90 | Profit |
| KID003 | kids casuals | 396.09 | 319.35 | 1000 | 396090.00 | 319350.00 | Profit |
| A00010101 | Spring summer 2017 | 342.13 | 315.12 | 560 | 191592.80 | 176467.20 | Profit |

Fig 2. Actual Cost Analysis

### *A. Cost Analysis and Profit*

Cost Analysis report option facilitated in identifying exact profit made from a particular style. Here the estimated cost of the garment is updated first which include, Cost of fabric used, Trims and accessories used, CMTP charges (Manufacturing cost), Over heads, Margin, Rejection and Cost on Board. Actual cost of manufacturing a garment in a style is derived from actual cost of fabric used, trims used, Cost of production is taken from the daily production information, actual rejection is obtained from production line, margin and actual Cost on board is obtained. Cost of each component is compared between estimated cost and actual cost is compared and variation in each component is analysed to enhance profitability. Details of cost comparative analysis is shown in Table 3



**Table 3 Cost comparative analysis**

| Stye Master | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Style Number | QS010101 | | | | Date | 15-05-2015 | |
| Season | Spring Summer | | | | | | |
| Country | Norway | | | | Colour | BL-GR-NB-WH-OR | |
| Classification | Menswear | | | | Size | 36-38-40-42-44 | |
| Type | Casual | | | | | | |
| Fabric Type | Fabric | Estimated Cost | | | Actual | | |
| | | Rate | Consumption | Total | Rate | Consumption | Total |
| Woven | FAB0117 | 240 | 1.60 | 384.00 | 240.00 | 1.50 | 360 |
| Denim | Den 001 | 230 | 0.10 | 23.00 | 220.00 | 0.10 | 22 |
| | | | | | | | |
| **Total Fabric Cost** | | | | 407.00 | | | 382.00 |
| | | | | | | | |
| Trims Type | Trim | Estimated Cost | | | Actual | | |
| | | Rate | Consumption | Total | Rate | Consumption | Total |
| BUTTON | BUT004 | 15.00 | 1 | 15.00 | 13.00 | 1 | 13.00 |
| Wash Care Label | LBL002 | 1.50 | 1 | 1.50 | 1.50 | 1 | 1.50 |
| Size Label | SIZLBL001 | 1.50 | 1 | 1.50 | 1.50 | 1 | 1.50 |
| Label Set | ML002 | 13.00 | 1 | 13.00 | 13.00 | 1 | 13.00 |
| **Total Trims Cost** | | | | 31.00 | | | 29.00 |
| | | | | | | | |
| Sub Total | | | Estimated Cost | | Actual Cost | | Variation |
| | | | | | | | |
| Production Cost | Per Garment | | 499.00 | | 458.00 | | 41.00 |
| Overhead cost | | | 74.85 | | 68.70 | | 6.15 |
| Margin | | | 143.46 | | 137.40 | | 6.06 |
| Rejection | | | 24.95 | | 9.160 | | 15.79 |
| Charges for On Board | | | 12 | | 17 | | -5.00 |
| Profit | | | 0 | | 64.00 | | -64.00 |
| Total Cost of the Garment | | | 754.26 | | 754.26 | | 64.00 |

## IV. Performance Evaluation

This section deals with the statistical analysis (ANOVA and Regression Statistics) for analysing the Impact of fabric cost with respect to margin in a particular style. The Hypothesis set is framed in Fig 3 for various parameters and different models (actual vs proposed) are used to statistically verify the performance of these parameters and models in terms of optimality of results.

***Hypothesis with respect to the margin***

***Null Hypothesis H0*** : Actual model = Proposed model
(There is no significant difference between actual model and proposed model in terms of margin in predicting the manufacturing cost of a garment through regression)

***Alternate Hypothesis H1 :*** Actual Model ≠ Proposed model
(There is significant difference between actual model and proposed model in terms of margin in predicting the manufacturing cost of a garment through regression)

Fig 3: Hypothesis of Statistical Analysis for Garment Industry



For this study, manufacturing cost incurred through the proposed model in 10 different factories for manufacturing a particular style is analysed. Simple linear regression is performed to predict the relationship with one independent variable like Fabric cost with margin. Multiple regression is used to predict the value of the dependent variable based on the value of two or more independent variables. In addition multiple regression determines the overall fit of the proposed model and the relative contribution of each of the predictors (Independent variables). In the proposed model manufacturing cost for 9 different styles were computed. For Analysis purpose manufacturing cost incurred in producing Style A across 10 different factories are taken and it is given in Table 4.

Table 4 Manufacturing cost of Style A across 10 different factories of a proposed Model

| | Y | X1 | X2 | X3 | X4 | X5 | X6 |
|---|---|---|---|---|---|---|---|
| Factory | Margin | Fabric Cost | Trims | Manufacturing Cost | Over Heads | Rejection | Cost on Board |
| 1 | 120.76 | 427.50 | 45 | 18 | 48.95 | 9.79 | 10 |
| 2 | 118.71 | 413.25 | 45 | 17 | 47.525 | 28.515 | 10 |
| 3 | 146.81 | 399.00 | 45 | 19 | 46.3 | 13.89 | 10 |
| 4 | 78.34 | 456.00 | 45 | 18 | 51.9 | 20.76 | 10 |
| 5 | 94.36 | 427.50 | 47 | 17.5 | 49.2 | 34.44 | 10 |
| 6 | 136.23 | 396.15 | 46 | 18 | 46.015 | 27.609 | 10 |
| 7 | 88.39 | 441.75 | 45 | 19 | 50.575 | 25.2875 | 10 |
| 8 | 113.46 | 418.95 | 45 | 20 | 48.395 | 24.1975 | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | 87.93 | 427.50 | 48 | 22 | 49.75 | 34.825 | 10 |
| 10 | 85.62 | 436.05 | 45 | 21 | 50.205 | 30.123 | 12 |

In the proposed model 6 parameters namely Fabric cost, Trims cost, Manufacturing cost, Margin. Over heads, Rejection and cost on board have been considered for predicting the cost incurred for manufacturing a garment through correspondence analysis. The fabric cost has high impact in predicting the margin. Therefore simple linear regression analysis is done on the fabric cost with the margin for the data given in table 4. This regression analysis shows the relationship between the dependent variable margin and independent variable fabric cost in the garment industry and it is projected in Fig. 8. The Multiple correlation coefficient "R" value is given in Table 5

## I. *Statistical Analysis for Proposed Model*

*Simple Linear regression analysis for Proposed Model*

Simple linear regression analysis is done on the fabric cost with the margin

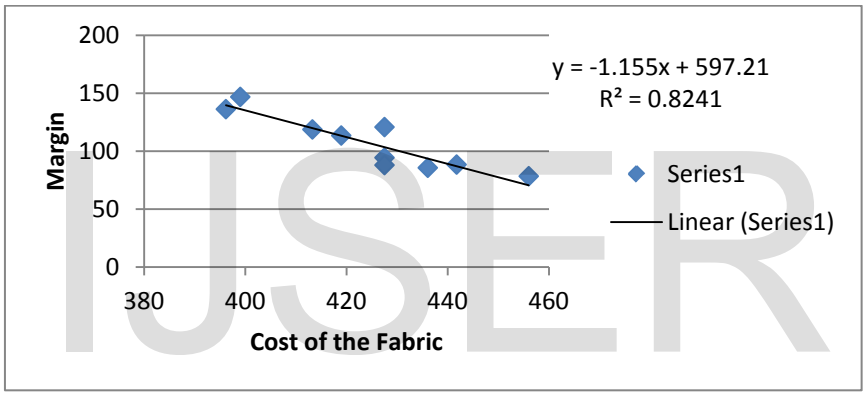


Fig 8. Relationship between Fabric cost and Margin

Table 5 : Regression statistics of Fabric cost Vs Margin of proposed model

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.9078121 |
| R Square | 0.8241228 |
| Adjusted R Square | 0.8021382 |
| Standard Error | 10.437827 |
| Observations | 10 |

The R Square column represents the R Value (also called the coefficient of determination) which is the proportion of variable in the dependent variables that can be explained by the independent variables. The regression model explains 82.41% of variation in the total cost observations which is pretty good.

Table 6 ANOVA for proposed model in terms of Margin as dependent variable Fabric cost

| | | | | | |
|---|---|---|---|---|---|
| ANOVA | | | | | |

| | *Df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 4084.1 | 4084.066 | 37.48629 | 0.000282 |
| Residual | 8 | 871.59 | 108.9482 | | |
| Total | 9 | 4955.7 | | | |

Table 7 provides F-test in order to determine whether the overall regression model is a good fit for the data. According to this P-value (0.000282) which is less than 5 % significance implies that the independent variable fabric cost has a significant difference in the margin for the proposed model.

Table 7 F-Test

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 597.20985 | 80.124 | 7.453605 | 7.24E-05 | 412.4445 | 781.9753 | 412.4445 | 781.9753 |
| X Variable 1 | -1.1550172 | 0.1886 | -6.12261 | 0.000282 | -1.59004 | -0.71999 | -1.59004 | -0.71999 |

Since P value of both the intercept and the X variable1 (fabric cost) is less than .05 (<5%) it is statistically significant which implies more than 95% confidence that the true coefficient is non Zero. Therefore the total cost can be estimated based on the intercept and the X variable.

$$Y = \alpha + \beta X \qquad (1)$$

Where Y is a dependent variable, X is an independent variable, α and β are the slope coefficients. Using this equation (1), the total cost of the proposed model through linear regression is computed as:

$$Predicted\ Garment\ Cost = 597.20985 + (-1.1550172) * \#\ \text{X Variable 1}$$

Since the Slope coefficient of X Variable is negative the predicted garment cost of the single garment through regression yields Rs. 597 which can be computed using Intercept alone. A comparison made based on the Simple linear regression analysis carried-out between the traditional model and classical model proposed is shown in Table 6.17 reveal that P value to x variable is less than 5% (0.000282 and 0.000281 respectively) which is very significant. Similarly, the comparative analysis between traditional model and classical model proposed on the fabric cost, trims cost, manufacturing cost, Overheads, rejection and cost on board as (X Values) with the margin (Y value) is shown in Table 6.18. P-value of X1 and X6 are less than 5% significance implies that the independent variable fabric cost has a significant difference in the margin for the classical model proposed.

**Conclusion**

A Classical Cost Analysis model proposed for calculating the actual profit made in a style by using a mathematical model. Further a comparative analysis was made between the proposed model and the traditional model, which reveals a significant cost difference of Rs. 64.00 per piece. Profit of Rs. 64000 for every 1000 piece manufactured in a particular style. The Factory with a capacity of 50000 pieces can make a direct profit of Rs. 3250000 every month by using a classical model.

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