INTERNATIONAL JOURNAL OF BUSINESS EDUCATION AND MANAGEMENT STUDIES (IJBEMS)
*A Peer Reviewed (Refereed) International Journal*
Impact Factor 4.308 | http://www.ijbems.com | ISSN:2941-9638
Vol.7. Issue 1. 2020 (July)

# Optimization of Target Calculation Method for Leather Skiving and Stamping: Case of Leather Footwear Industry

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**Abstract**
Time and motion study are subject of major concern for footwear especially on the production floor. It plays a remarkable role in calculation of target for various operations of leather upper cutting and stitching. Since, targets are associated with the cost so the non-value added time in the targets cannot be affordable. A little ignorance in targets can case the greater loss of resources (time and money). In the case footwear company, there has been the fight of workers and Industrial Engineering department since so long on the targets because of direct involvement of worker in the time study. Involvement of worker in the calculation of target cause decrease in targets because worker`s single micro motion (of few seconds) at the moment of time study can cause the loss of thousands to the company. In this regard, the method of calculation of target of leather skiving and stamping was formulated. Some pieces of leather were got issued from the leather store of the case company and cut into pieces for operations (stamping and skiving) to be performed on them. Both operations were split into the series of micro motions and 10 observations for each micro motions were collected from five workers individually (2 observations from each worker). The average time of micro motions was considered as standards and for the calculation of overall time of the operations was calculated by help of developed formulae. Data was entered and formulae were applied in the excel spreadsheet and charts were also plotted. For plotting the 3 dimensional chart, statistical package for social sciences was used. An excel spreadsheet was developed (containing the all formulae) for the purpose of target calculation for both operations. It was concluded that calculated targets as per suggested method for stamping and skiving were 4.4% and 4.74% greater respectively in the comparison of calculated targets as per old method.

**Keywords:** Leather skiving, stamping, time study, optimization

## INTRODUCTION AND LITERATURE

Shoe making industry is growing fast across the globe. Shoe making is a sensitive and costly work especially when the shoes are made of leather. Cutting leather, its stitching are quite critical stages in the shoe making in which the method of carrying out work by the worker should be designed in a way that it can be done in optimized way (without any wastage of time). To analyze the work and the determination of its completion time comes in the circle of work study. It is the general terminology of work measurement and methods study: It has been the base in the field of industrial engineering and was developed by Gilberth and F.W Taylor [1]. In work study, the way to carry out work is examined, the improvements are brought in method of operation by the eliminating the unnecessary/excess pieces of work and sets the time standard for the particular operation [1]. Time study and motion study are two major fields of work study. Time and motion study has been the challenge for industrial engineers in terms of accuracy of calculated per day targets in footwear industry. Time study has been defined by Meyers (2002), and cited by [2] "the time required to produce a product at a work station with the following three conditions: (1) a qualified, well-trained operator, (2) working at a normal pace, and (3) doing a specific task". In time study there are numerous ways for the determination of time needed to complete the task associated with man, machine or both[1], [3]. There are two types of activities in the operations carried out the manufacturing industries i.e. value added and non-value added activities:non value added activities are considered to be the waste[4], [5].When the labor is paid per day, every single minute of worker on cutting and stitching means a lot to the owner; on the same time if the work targets are not precise it would be the wastage of time, human resources and so the money. For the elimination of non-value added activities and work simplification in manufacturing operations, engineers are employed to look for the improvement of existing process so that processes can be simplified and standardized for greater good. It leads to the consistency and efficiency at the certain levels of the organizations. It`s all about the initiation of the way to achieve the most effective and consistent results [5]. Standardization is the very essential tool used to reduce the process variability so that chance of error can be reduced [5], [6].

In this regard, for the elimination of non-value added activities from operations i.e. stamping and skiving at the time of time study of mentioned operations. New method of target calculation was suggested in order to reduce the involvement of machine operator to aero during the calculation of targets for particular operations.

for particular operations.

## PROBLEM STATEMENT

Time and motion study is widely used in the footwear industry. It plays remarkable role in the calculation of daily targets for various operations (cutting, stitching and job work). Non value added single micro motion (of few seconds) of operator at the moment of recording time for calculation of target can affect the target with the greater magnitude. Thus it was needed to develop the framework/mechanism to calculate targets (for various operations) in which the involvement of worker can be minimized to 0. The mechanism by the help of

which time of value added micro motions in particular operation can be standardized; so that 100% accurate targets can be calculated.

## IMPORTANT DEFINITIONS

**Basket:** It is the packing usually contained of 5 pairs of cut upper leather.

**Stroke:** It defines the movement of stamping machine when one piece of upper is stamped.

**Stamping:** It is the process by which the leather is stamped in order to be identified and traced at the various stages of the production (skiving, splitting, inspection, Stitching, lasting etc.).

**Skiving:**It is the process used for reducing the thickness of leather in those areas which are to be folded and bent in the upcoming processes i.e. stitching and lasting.It is used when two leather sides/edges are joined so that the overlapping areas can be avoided to be bulky [7].

**Available Time:**The remaining time after the subtraction of break time and allowance time from the total shift time as can be seen in the below given equation.

Total Available Time = Total Shift Time (525 min)-(Lunch Break time (45 minutes) + Fatigue Allowance/day (30))

## RESEARCH METHODOLOGY

Research methodology is description of the various methods used in the research. Time study is the major technique used in this research. Data (time of various micro motions used on the particular operation) was collected by the help of stopwatch. Data collection of micro motion in overall skiving and stamping operations are presented under the heading of data collection.

### 4.1 Data Collection

In order to conduct the time study of skiving, leather pieces from the leather store of the company was issued and cut with the collaboration of cutting department. Motion and time study of both the operations are presented separately in the below given headings. Most of the operations were found to be same but the operations and performers were different; thus similar operations in both the operations were enlisted in different tables with different notations; so that the objection from the managerial side could be avoided.

#### 4.1.1 Data collection of stamping operation

The stamping operation was broken down into the small micro motions as listed in the table 1. Time study of listed micro motions was conducted as presented in table 1. 10 observations for each micro motion (two observations of each stamper) were taken and the average time of each micro motion was calculated as presented in the table 1.

##### 4.1.1.1 Time Study of Stamping Operation

The following notations are being used for deriving the equations for stamping operations:

a = Transport Basket to the table
b = Untie basket

c = Take out Bundles (Time/bundle)
d = Remove Rubber band (Time/Bundle)
e = Bundle Preparation Time
f = Transport Piece to the Stamping machine (Time/Piece)
g = Adjustment Time (Time/Basket)
h = Machine Adjustment Time (Time/Pair)
i = Stamp Stroke Time (Time/Stroke)
k = Put the piece down after the stamping (Time/Piece)
l = Tie rubber band on the bundles (Time/Bundle)
m = Put the bundles in the basket (Time/Bundle)
n = Knoting the basket
o = Transport the basket forward

**Table 1. Recorded time of operations performed by the stamper while stamping process**

| Operations | Obs.1 (sec) | Obs.2 (sec) | Obs.3 (sec) | Obs.4 (sec) | Obs.5 (sec) | Obs.6 (sec) | Obs.7 (sec) | Obs.8 (sec) | Obs.9 (sec) | Obs.10 (sec) | Mean (sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a | 2.4 | 3.11 | 4.79 | 3.82 | 4.57 | 4.79 | 4.98 | 3.62 | 3.76 | 4.99 | 4.1655 |
| b | 1.46 | 2 | 0.99 | 1.5 | 1.67 | 1.78 | 1.79 | 1.55 | 2 | 1.78 | 1.6636 |
| c | 5.71 | 5.42 | 5.15 | 4.98 | 4.79 | 5.23 | 5.15 | 5.27 | 5.25 | 4.23 | 5.0373 |
| d | 0.7 | 0.75 | 0.98 | 0.79 | 0.73 | 1.78 | 1.5 | 1.68 | 1.79 | 1.19 | 1.1891 |
| e | 4 | 4.51 | 5.1 | 4.9 | 3.8 | 2.79 | 2.65 | 3.13 | 2.69 | 3.13 | 3.6209 |
| f | 0.36 | 0.51 | 0.58 | 0.39 | 0.74 | 0.34 | 1 | 0.53 | 0.43 | 0.45 | 0.5255 |
| g | 12 | 10 | 8 | 10.5 | 10.7 | 13.17 | 15.11 | 12.71 | 13.15 | 14.68 | 12.245 |
| h | 0.5 | 0.78 | 0.73 | 0.69 | 0.75 | 0.98 | 0.67 | 0.42 | 0.54 | 0.78 | 0.6927 |
| i | 0.18 | 0.19 | 0.23 | 0.35 | 0.23 | 0.25 | 0.19 | 0.2 | 0.27 | 0.35 | 0.2536 |
| k | 0.36 | 0.71 | 0.4 | 0.45 | 0.7 | 0.5 | 0.2 | 0.41 | 0.53 | 0.39 | 0.4582 |
| l | 5 | 5.35 | 5 | 5.56 | 5.7 | 5.75 | 5.68 | 4.98 | 4.73 | 5.15 | 5.2773 |
| m | 4.78 | 5.5 | 4.33 | 4.65 | 4.93 | 3.78 | 3.61 | 3.67 | 4.05 | 3.99 | 4.2982 |
| n | 1.87 | 2.43 | 2.56 | 1.79 | 1.8 | 2 | 2.5 | 2.71 | 2.89 | 1.95 | 2.2227 |
| o | 2.08 | 2.1 | 1.99 | 2.5 | 3 | 2.89 | 2.76 | 2.83 | 2.75 | 3.05 | 2.6364 |

4.1.2 Data collection of skiving operation

For skiving operation, long strips of 53 cm each were skived from the available skivers at the cutting department and the time was recorded by the help of stopwatch as shown in the fig.1.The operations of skiving and stamping were performed by different operators on those pieces. After recording the time to skive the strip (length = 53 cm) skiving speed was calculated by the formula i.e. v = s/t = 54.45 cm/sec (s= 53 cm, mean skiving time = 1.03 sec). The observations of length, time and speed are presented in three dimensional scatter plot given in fig. 1.

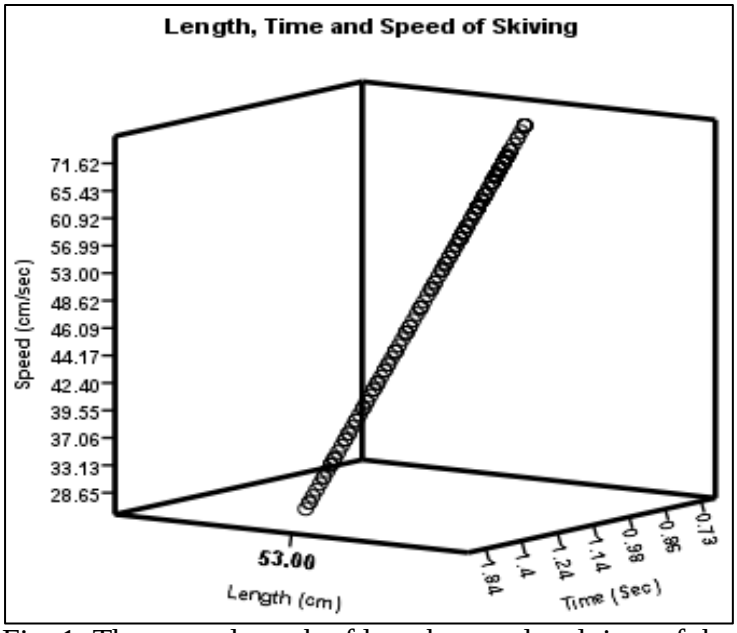

Fig. 1. The mutual graph of length, speed and time of the collected data

### *4.1.2.1 Time Study of Skiving Operation*

Skiving was broken down in the small micro motion same as stamping operation and the time study of those micro motions was conducted as presented in table 2. The time study was consisted on 10 observations for each micro motion (2 observations of each skiver). Average time (sec) for each of the micro motion was calculated as presented in the table 2.

The following notations are being used for deriving the equations for skiving operations:

p =Transport Basket to the table
q = Untie basket
r = Take out Bundles (Time/Bundle)
s = Remove Rubber band (Time/bundle)
t = Pieces Preparation Time (Time/Piece)
u = Transport Piece to the machine (Time/Piece)
v = Adjustment Time (Time/adjustment)
w = Put the piece down (Time/Piece)
x = Tie rubber band on the bundles (Time/bundle)
y = Put the bundles in the basket (Time/bundle)
z = Knoting the basket
aa = Transport the basket

**Table 2. Recorded Time of operations performed by the skiver while skiving**

| Operations | Obs.1 (sec) | Obs.2 (sec) | Obs.3 (sec) | Obs.4 (sec) | Obs.5 (sec) | Obs.6 (sec) | Obs.7 (sec) | Obs.8 (sec) | Obs.9 (sec) | Obs. 10 (sec) | Mean (sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| q | 1.05 | 2.07 | 3.5 | 1.25 | 1.22 | 1.98 | 1.79 | 1.89 | 2.75 | 1.63 | 1.913 |
| r | 1.46 | 1.27 | 0.97 | 1.17 | 0.98 | 1.25 | 0.99 | 1.33 | 1.19 | 1.18 | 1.179 |
| s | 7.58 | 7.5 | 6.05 | 5.73 | 6.28 | 6.75 | 7.43 | 7.1 | 8.01 | 8.05 | 7.048 |
| t | 3 | 3.05 | 2.71 | 2.68 | 2.86 | 3.11 | 2.95 | 2.98 | 2.3 | 3.3 | 2.894 |
| u | 1.16 | 1.85 | 0.56 | 0.71 | 0.95 | 1.2 | 1.5 | 1.67 | 2 | 1.75 | 1.335 |
| v | 1 | 0.51 | 1.25 | 1.58 | 1.5 | 0.98 | 0.71 | 0.68 | 1.62 | 1.55 | 1.138 |
| w | 5.72 | 6.33 | 6.28 | 5.73 | 6.19 | 5.44 | 5.47 | 6.37 | 6.7 | 6.39 | 6.062 |
| x | 0.51 | 0.75 | 0.48 | 0.27 | 0.8 | 0.52 | 0.67 | 0.41 | 0.29 | 0.32 | 0.502 |
| y | 2.09 | 3.78 | 2 | 4 | 3.79 | 3.69 | 2.75 | 2.8 | 3.95 | 3.5 | 3.235 |
| J | 6.4 | 5.2 | 4.8 | 3.28 | 2.5 | 3.53 | 2.58 | 3.26 | 3.78 | 4.5 | 3.983 |
| z | 1.86 | 2.47 | 2.17 | 1.98 | 1.95 | 2.55 | 2.58 | 3 | 3.01 | 2.89 | 2.446 |
| aa | 1.05 | 2.07 | 2.55 | 1.25 | 1.22 | 0.95 | 1.79 | 1.89 | 1.75 | 1.93 | 1.645 |

### 4.2 Tools Used for Data Presentation and Analysis

After the data collection, data entry was conducted in MS excel. The mean time was calculated and line charts were plotted in MS excel. One scatter plot was generated in statistical package for social sciences (SPSS) version 22. Furthermore, the two spreadsheets were made in MS excel for the purpose of target calculation of skiving and stamping as given in the appendix I and II.

## OLD AND SUGGESTED METHOD OF TARGET CALCULATION

5.1 Old method of target calculation of both stamping and skiving

Existing method was conventional in which the time study officer was supposed to go in cutting department whenever the production of new article used to start. Time study officer was supposed to start the watch before the stamper/skiver pick the basket and watch was used to be stopped on the transportation of basket after the completion of operations. Since the basket was contained of five pairs of shoe thus the basket time was used to be divided by 5. Target was calculated by using the formula given below.

Per day Target = available time (27000 sec)/standard allowed minutes (SAM) in sec

The major drawback of old method was the unnecessary movements during time study of the operation which used to affect the target with the greater magnitude; thus it was needed to bring such mechanism in which the involvement of operators could be minimized to zero.

5.2 Suggested method for target calculation of stamping
Since, the stamping operation was consisted of series of the micro motions as discussed earlier.The time study of all the micro motion is presented above table 1. The basic data was prepared by conducting the time study and the SAM for specific article was calculated by the help of developed formulae. In this regard one simple spreadsheet presented in appendix I was made in which the developed formulae were applied to calculate the SAM of stamping for the different articles.

### *5.2.1 Input Variable*

In the developed spreadsheet, the only three inputs i.e. pairs per basket, bundles per basket, number of pieces per basket (to be stamped) are put for the calculation of stamping target for specific article.

The following notations are being used for deriving the further equations:

P = Pairs per basket
B = Bundles per basket
$N_S$= Number of pieces per basket
$P_B$ = Time to take out all bundles from the basket
$R_T$ = Rubber band removing time from all bundles
$P_T$ = Bundle Preparation Time for all bundles
$T_T$ = Transportation time of pieces to the machine
$M_T$ = Machine adjustment time per Basket
$S_T$ = Time for all Strokes
$D_T$ = Time of putting all pieces down after stamp
$R_{BT}$ = Time to tie rubber band on the bundles
$B_{PT}$ = Time to put all bundles into the basket
$T_S$ = Total Stamping time/basket
$T_P$ = Total Stamping time/pair
$T_D$ = Target/Day
$A_T$ = Available Time in Seconds
Formulae and equations used in the calculation of target are presented below.

At the very first, worker pick up the basket and untie it. He takes out all the bundles (to be stamped). The time of taking out the bundles from the basket is calculated by eq. 1.

$$\mathbf{P_B} = cxB \qquad \textbf{Eq.1}$$

Then he removes the rubber band from the bundles so that he can prepare the pieces for the stamping; the time of which can be calculated by eq. 2.

$$\mathbf{R_T} = dxB \qquad \textbf{Eq.2}$$

The next step is to arrange the pieces (whole bundle) in order so that he can stamp them easily and quickly; the time of this operation can be calculated by eq. 3.

$$\mathbf{P_T} = exB \qquad \textbf{Eq.3}$$

The pieces are then transported to the machine for stamping; time of this micro motion can be calculated by eq. 4.

$$T_T = fxNs \qquad \textbf{Eq.4}$$

Before, the stamping of any component, machine stamp is needed to be reset to the required basket, pair and component number. Time of this micro motion, can be calculated by eq. 5.

$$\mathbf{M_T} = hxP \qquad \textbf{Eq.5}$$

Next micro motion is to put the stamp on leather component and the total time to put stamp on all the components present in the basket can be calculated by eq. 6.

$$\mathbf{S_T} = I\ xN_S \qquad \textbf{Eq.6}$$

After stamping the component, worker put that component down and total time to put all the components down after stamping can be calculated by the eq. 7.

$$\mathbf{D_T} = kxN_S \qquad \textbf{Eq.7}$$

When the whole bundle is stamped, the worker is supposed to tie that bundle; time taken by worker to tie all bundles can be calculated by eq. 8.

$$\mathbf{R_{BT}} = lxB \qquad \textbf{Eq.8}$$

The worker put the bundles back in the basket after the stamping is complete. The time of putting bundles back can be calculated by the help of eq. 9.

$$\mathbf{B_{PT}} = mxB \qquad \textbf{Eq.9}$$

In last, worker knot the basket and transport it to the next work station. The total time of stamping whole basket can be calculated by the help of equation of eq. 10.

$$\mathbf{T_S} = (a + b + P_B + R_T + P_T + g + T_T + M_T + S_T + D_T + R_{BT} + B_{PT} + n + o)$$

$$\mathbf{T_S} = (a + b + n + o + (c \times B) + (d \times B) + (e \times B) + (f \times Ns) + (h \times P) + (i \times N_S) + (k \times N_S) + (l \times B) + (m \times B)$$

$$\mathbf{T_S} = (a + b + n + o + B\,(c + d + e + l + m) + N_S\,(f + i + k) + (h \times P))$$

**Eq. 10**

Since, the value obtained from eq. 10 is the total stamping time of whole basket and target is supposed to be calculated per pair. Time to stamp a pair of shoe can be calculated by the help of eq. 11.

$$\mathbf{T_P} = T_B/P \qquad \textbf{Eq. 11}$$

Target of stamping per day can be calculated by the help of eq. 12. ($A_T$ = 27000 sec)

$$\mathbf{T_D} = A_T/T_P$$

$$\mathbf{T_D} = (A_T x\ P)/T_B \qquad \textbf{Eq. 12}$$

5.3 Comparison of old and suggested method of target calculation of stamping
After the development of new method, it was compared with the results of old method as presented in table 3.

Table 3.Comparison of the results obtained by existing and suggested method of target calculation for stamping

| **Article** | **Target by Suggested Method (Pairs/Day)** | **Existing Target (Pairs/Day)** | **Diff. (Pairs/Day)** | **Diff. (%)** |
|---|---|---|---|---|
| ND-ZE-001 | 490 | 460 | 30 | 6.5% |
| 760-07 | 1220 | 1176 | 44 | 3.7% |
| 4388 | 775 | 740 | 35 | 4.7% |
| 4755 | 820 | 780 | 40 | 5.1% |
| 4967 | 1320 | 1268 | 52 | 4.1% |
| 4763 | 863 | 820 | 43 | 5.2% |
| 4740 | 1315 | 1260 | 55 | 4.4% |
| 4814 | 1940 | 1892 | 48 | 2.5% |
| ND-RK-0026 | 1290 | 1240 | 50 | 4.0% |
| UM-9104 | 550 | 532 | 58 | 3.4% |
| **Average** | | | | 4.4% |

When the worker was involved in the process of target calculation, the reasonableness of the target was on question.The average difference in the old and suggested targets was calculated to be 4.4% as presented in the table 3 and fig. 2.

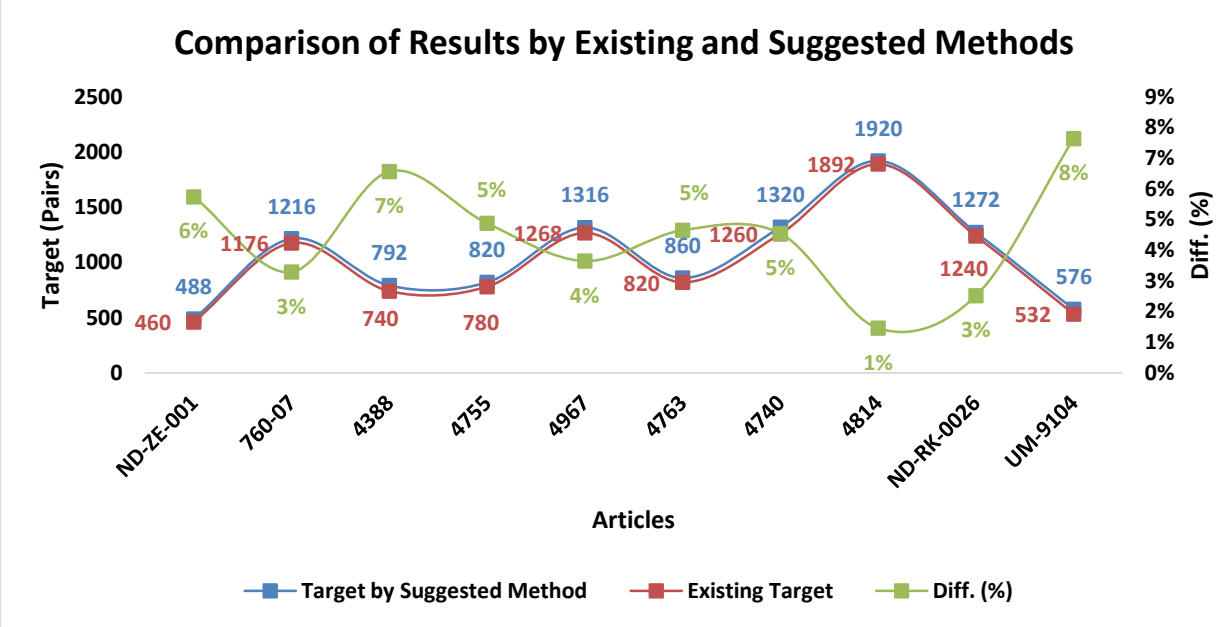


Fig. 2. Comparison of results calculated by using existing and suggested methods of target calculations

5.4 Suggested method of target calculation of skiving process

Since, the skiving operation was consisted of series of the micro motions as discussed earlier. The time study of all the micro motion is presented above table 2. The basic data was prepared by conducting the time study and the SAM for specific article was calculated by the help of developed formulae. In this regard one simple spreadsheet presented in appendix II was made in which the developed formulae were applied to calculate the SAM of skiving for the different articles.

***5.4.1 Input Variables***

In the developed excel spreadsheet, the inputs i.e. pairs per basket, bundles per basket, number of pieces per basket (to be skived), types of skiving used in the basket, number of skiving sides to be skived, number of re-prepared bundles, total skiving length (cm) are used to be taken in order to calculate the skiving target for an specific article.

The following notations are being used for deriving the further equations:

$S_T$ = Types of Skiving used in the basket
$S_S$ = Number of Skiving Sides to be skived
$R_N$ = Number of Re-Prepared Bundles
$V_S$ = Skiving Speed
$S_{KT}$ = Skiving Time
$L_T$ = Total Skiving Length (cm) of pair
$T_{SK}$= Total Time of Skiving per basket
Formulae and equation used in the calculation of skiving target.

At the very first, worker pick up the basket and untie it. Skiver takes out all the bundles (to be skived). The time of taking out the bundles from the basket can be calculated by eq. 14.

$$\mathbf{P_B} = r \times B \qquad \textbf{Eq. 14}$$

Then he removes the rubber band from the bundles so that he can prepare the pieces for the skiving; the time of which can be calculated by eq. 15

$$\mathbf{R_T} = s \times B \qquad \textbf{Eq. 15}.$$

The next step is to arrange the pieces (whole bundle) in order so that he can skive them easily and quickly; the time of this operation can be calculated by eq. 16.

$$\mathbf{P_T} = t\,(B+R_N) \qquad \textbf{Eq. 16}$$

The pieces are then transported to the machine for skiving; time of this micro motion can be calculated by eq. 17.

$$\mathbf{T_T} = (u \times N_S \times S_S) \qquad \textbf{Eq. 17}$$

Before, the skiving of any component, machine is needed to be reset as per skiving requirement of component. Time of this micro motion, can be calculated by eq. 18.

$$\mathbf{M_T} = v\,((S_T - 1) + R_N) \qquad \textbf{Eq. 18}$$

Next micro motion is to skive leather component and the total time to skive all the components present in the basket can be calculated by eq. 13.

$$\mathbf{S_{KT}} = ((L_T/V) \times P) \qquad \textbf{Eq. 13}$$

After skiving the component, worker put that component down and total time to put all the components down after skiving can be calculated by the eq. 19.

$$\mathbf{D_T} = (w \times N_S \times S_S) \qquad \textbf{Eq. 19}$$

When the whole bundle is skived, the worker is supposed to tie that bundle; time taken by worker to tie all bundles can be calculated by eq. 20.

$$\mathbf{R_{BT}} = (x*B) \qquad \textbf{Eq. 20}$$

The worker put the bundles back in the basket after the skiving is complete. The time of putting bundles back can be calculated by the help of eq. 21.

$$\mathbf{B_{PT}} = y \times B \qquad \textbf{Eq. 21}$$

In last, worker knot the basket and transport it to the next work station. The total time of skiving whole basket can be calculated by the help of equation of eq. 22.

$$\mathbf{T_{SK}} = (p + q + S_{KT} + P_B + R_T + P_T + T_T + M_T + D_T + R_{BT} + B_{PT} + z + aa)$$

$$\mathbf{T_{SK}} = (p + q + z + aa + ((L_T/V) \times P) + (r \times B) + (s \times B) + t(B+R_N) + (u \times N_S \times S_S) + (v((S_T - 1) + R_N)) + (w \times N_S \times S_S) + (x \times B) + (y \times B)$$

$$\mathbf{T_{SK}} = (p + q + z + aa + ((L_T/V) \times P) + B(r + s + t + (t \times R_N) + x + y) + (N_S \times S_S)(u + w) + (v((S_T - 1) + R_N)) \quad \textbf{Eq. 22}$$

Since, the value obtained from eq. 22 is the total skiving time of whole basket and target is supposed to be calculated per pair. Time to stamp a pair of shoe can be calculated by the help of eq. 23.

$$\mathbf{T_P} = T_{SK}/P \quad \textbf{Eq. 23}$$

Target of skiving per day can be calculated by the help of eq. 24.

$$\mathbf{T_D} = A_T/T_P$$

$$\mathbf{T_D} = (A_T \times T_{SK})/P \quad \textbf{Eq.24}$$

5.5 Comparison of old and suggested method of target calculation of skiving
After the development of new method, it was compared with the results of old method as presented in table 4.

**Table 4. Comparison of the results obtained by existing and suggested method of target calculation for skiving**

| Article | Target by Suggested Method | Existing Target | Diff. | Diff. (%) |
|---|---|---|---|---|
| ND-ZE-001 | 122 | 115 | 7 | 6.09% |
| 760-07 | 304 | 294 | 10 | 3.40% |
| 4388 | 198 | 185 | 13 | 7.03% |
| 4755 | 205 | 195 | 10 | 5.13% |
| 4967 | 329 | 317 | 12 | 3.79% |
| 4763 | 215 | 205 | 10 | 4.88% |
| 4740 | 330 | 315 | 15 | 4.76% |
| 4814 | 480 | 473 | 7 | 1.48% |
| ND-RK-0026 | 318 | 310 | 8 | 2.58% |
| UM-9104 | 144 | 133 | 11 | 8.27% |
| **Average** | | | | 4.74% |

When the worker was involved in the process of target calculation, the reasonableness of the targets was on question.The average difference in the old and suggested targets was calculated to be 4.74% as presented in the table 4 and fig. 3.

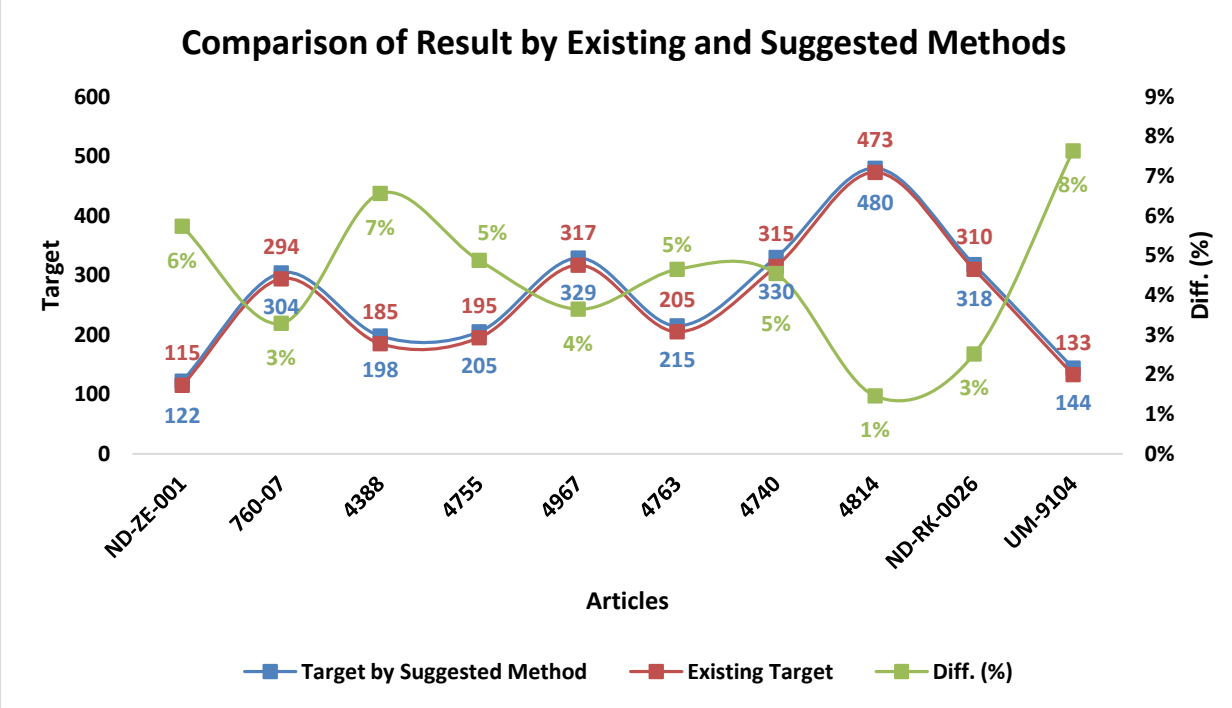


Fig. 3. Comparison of results calculated by using existing and suggested methods of target calculations

## CONCLUSION

It was concluded that new methods developed for the calculation of stamping and skiving targets are optimum i.e. free from non-value added time. The most important advantage of new methods is that the workers` involvement in the calculation of target for stamping and skiving operations as before because fight between time study officer and workers on the issue of per day targets was common case. The successful implementation of suggested method has somehow reduced the headache of the Industrial Engineering department.

## CONFLICT OF INTERESTS

There was no conflict of interest among the authors of this research paper.

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## APPENDIX I

**Spreadsheet made for the calculation of stamping target**

| **Stamping Time Calculation Sheet** | |
|---|---|
| **Article** | 4967 |
| Pairs/Basket | 5 |
| Bundles/Basket | 4 |
| Number of Pieces for Stamping | 40 |

| | |
|---|---|
| **Target/Day** | 1000 |
| **Time/Pair (Sec)** | 27 |
| **Total Time/Basket (Sec)** | 135 |

| **Standard Operations & Time** | |
|---|---|
| **Operations** | **Time (Sec)** |
| Transport Basket to the table | 3.99 |
| Untie basket | 1.73 |
| Take out Bundles (Time Per Bundle) | 1.25 |
| Remove Rubber band (Per Bundle) | 1.18 |
| Pieces Preparation Time | 3.74 |
| Transport Piece to the Stamping machine (Per Piece) | 0.53 |
| Adjustment Time (Per Basket) | 11.55 |
| Adjustment Time (Per Pair) | 0.34 |
| Stamp Stroke Time | 0.22 |
| Put the piece down | 0.56 |
| Tie rubber band on the bundles (Per Bundle) | 5.12 |
| Put the bundles in the basket (Per Bundle) | 1.07 |
| Knoting the basket | 2.20 |
| Transport the basket forward | 2.68 |

| **Calculated Time of Operations** | |
|---|---|
| **Operations** | **Time (Sec)** |
| Transport Basket to the table | 4.0 |
| Untie basket | 1.7 |
| Take out Bundles (Per Basket 4 Bundles) | 1.3 |
| Remove Rubber band (Per Bundle) | 4.7 |
| Pieces Preparation Time | 15.0 |
| Transport Piece to the Stamping machine (Per Piece) | 21.4 |
| Adjustment Time (Per Basket) | 11.5 |
| Adjustment Time (Per piece) | 13.6 |
| Stamp Stroke Time | 8.8 |
| Put the piece down | 22.3 |
| Tie rubber band on the bundles (Per Bundle) | 20.5 |
| Put the bundles in the basket (Per Bundle) | 5.3 |
| Knoting the basket | 2.2 |
| Transport the basket forward | 2.7 |

## APPENDIX II

**Spreadsheet made for the calculation of skiving target**

| **Skiving Time Calculation Sheet** | |
|---|---|
| **Article** | 760-07 |
| Pairs/Basket | 5 |
| Bundles/Basket | 5 |
| Total Pieces/Basket | 70 |
| Types of Skiving | 3 |
| Number of Skiving Sides | 3 |
| Number of Re-prepared Bundles | 3 |
| **Total Skiving Length (cm)** | 160 |

| | |
|---|---|
| Target/Day | 304 |
| Time/Pair (Sec) | 89 |
| Total Time/Basket (Sec) | 444 |

| **Standard Operations & Time** | |
|---|---|
| **Operations** | **Time (Sec)** |
| Transport Basket to the table | 1.90 |
| Untie basket | 1.18 |
| Take out Bundles | 1.40 |
| Remove Rubber band (Time Per Bundle) | 2.90 |
| Pieces Preparation Time | 1.29 |
| Transport Piece to the skiving machine (Time/Piece) | 1.14 |
| Skiving Speed (cm/s) | 54.10 |
| Adjustment Time (Time Per Adjustment) | 6.04 |
| Put the piece down (Time Per Piece) | 0.51 |
| Tie rubber band on the bundles (Time Per Bundle) | 3.23 |
| Put the bundles in the basket (Time Per Bundle) | 0.81 |
| Knot the basket | 1.68 |
| Transport the basket | 1.62 |

| **Calculated Time of Operations** | |
|---|---|
| **Operations** | **Time (Sec)** |
| Transport Basket to the table | 1.90 |
| Untie basket | 1.18 |
| Take out Bundles | 7.00 |
| Remove Rubber band | 14.50 |
| Pieces Preparation Time | 10.32 |
| Transport Piece to the skiving machine | 239.40 |
| Skiving Time | 2.96 |
| Adjustment Time | 36.24 |
| Put the piece down | 107.10 |
| Tie rubber band on the bundles | 16.15 |
| Put the bundles in the basket | 4.03 |
| Knot the basket | 1.68 |
| Transport the basket | 1.62 |

**Biographies**

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