Productivity Improvement by Work Study Technique: A Case on Leather Products Industry of Bangladesh

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Abstract

In Bangladesh, leather and leather products sector plays a vital role for economy development. Productivity improvement can be helped to enrich profit of a leather products industry by minimizing excess work and developing new method for particular operation. Now a day, productivity improvement is a popular topic for any kinds of industry. So that improving productivity is one of the main concerns of leather products industries. Work study is most important tools that can help to increase productivity in leather products industry. Hence, this study helps to identify the bottleneck and suggest appropriate system to improve productivity. For this purpose, method study has been carried out by applying questioning techniques concept where recording and critical analysis of all related information has been performed in particular production line. As a result considerable amount of work content is reduced in the new improved method. Then time study has been taken by stopwatch and determined the basic time for all operation sequences and the capacity of each workstation per day has been calculated. By applying method study and work measurement in the industry at production line-Surma for ladies bag, productivity has been improved by 12.71%.

Keywords: Production; Productivity improvement; Work study; Method study; Work measurement; Leather products; Application in assembly line

Introduction

In Bangladesh, Leather and leather products sector plays a significant role for the economic development of the country. The industry has contributed to export earnings, foreign exchange earnings, employment creation, poverty alleviation and the empowerment of women. Bangladesh earned $1.16 billion from the leather sector in the year of 2015-16, which was the second highest contributor to national exports after RMG. To sustain the positive growth, it is necessary to ensure the proper utilization of resources. Financial growth of any industry largely depends on minimizing excess work and productivity improvement. To minimize excess work and improving productivity at first we should realize the production term. Production is any process or procedure developed to transfer a set of input into a specified set of output in proper quality and quantity thus achieving the objectives of an industry. Production helps to create products by the transformation of raw materials [1]. The production system of leather products industry can be shown by the following diagram (Figure 1).

Productivity is the ratio between output of wealth and the input of resources used in the process of production [2]. Productivity measurement turns a comparison of outputs to inputs normally by calculation of a productivity index [2,3].

\[
\text{Productivity} = \frac{\text{OUTPUT}}{\text{INPUT}} \quad (1)
\]

Productivity can be used to measure the extent to which a certain output can be extracted from a given input [4]. Productivity measurement is the important for any kinds of industry. Increasing productivity is one of the major issues for enhancing more profit from same kinds of resources. Productivity improvement helps to satisfy customer and reduce time and cost to develop, produce and deliver products [5]. Productivity includes effective relationship to performance measure for method utilization, method output, product prices, and work in process inventory levels and on time delivery [6]. Productivity is considered to be a growth of profit [7].

Productivity improvement can be done by sorting of elimination, repairing of ineffective process, simplifying the method, optimizing the system, reducing variation, maximizing turn up quality or responsiveness and reducing set-up time. Productivity can be also achieved by increasing the value-added content of products [8], or by decreasing the unit cost of production or decreasing the work content of the production, or line balancing of the production line or by a combination of all [3,9,10]. Productivity improvement is the continuous improvement process of any types of activities [3,11]. In this study, productivity improvement gained through reducing work content by implementing new methods in assembly line of a specific leather product (i.e. leather ladies Bag).

To the best of our knowledge there are no studies on how to apply work study technique in leather products industry for productivity improvement although one study fund in shoe manufacturing industry [12]. Productivity improvement through work study technique is necessary for increasing profit as well as proper utilization of labor of an industry [6]. Leather products industry is one of the most significant exports earning industry of Bangladesh. This paper helps to implementing work study technique in assembly line of leather products industry for increasing productivity. The novel contribution of this paper is to find out the method for improvement of productivity in leather products industry.

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Materials and Methods

**Literature review of work study**

Work study is the investigation process, by means of a consistent system of the work done in an industry, in order to attain the best possible use of the men, machines, materials, available in the building at present [13].

Method study [14] and Work Measurement is the two major segments of work study [1]. Figure 2 helps to understand the two basic parts of work study method. Work study then aims at examining the method associate activity is being disbursed, simplifying or modifying the tactic of operation to unnecessary work or the wasteful use of resources and fixing a time commonplace for plying the activity [15]. The relation between productivity and work study so evident. To appriciate how work study helps to reduce costs and reduce the time of certain activity, it is necessary to examine more closely what the time consists of [4,16]. It is used to systematically study and improve human working condition by considering all factors that affect the working efficiency and conditions. Work study helps to systematically reduce the work content in an assembly line.

This method is subdivided into two categories which are method study; used to modify method or develop new method and work measurement which is basically time study of each operation with the help of stopwatch [17].

The application of method study and work measurement is widely used tools in manufacturing industry as well as different fields [18-22]. Literature reveals that in different sector like health sector this method is also used [23,24] shows the improvement of the bottleneck process in a lamp assembly line by applying the work study method, ECLS, and line balancing. The result shows the improvement for both product and operator. The reduction in production time resulted in better productivity in system [25,26] studied the manufacturing process in the automobile industry both before and after the improvement had been made, by using an operation process chart. In this research, we use the work study method for productivity improvement in particular assembly line by selecting a products in leather products industry with the help of management personnel. We try to balancing line and reduction of work content by critical analysis and time study [27]. For research work, the particular assembly line is selected for observing each operation with time study for productivity improvement.

The basic steps of work study are exposed by Figure 3. We use this conceptual chart for analysis particular production line with selecting particular products. For this research purpose, we select a Leather ladies bag for critical analysis and time study. After collecting observes time of each operation, we compute the standard time for each operation including rating and two types of allowance.

**Research methodology**

Step by step procedure is the most important for improving productivity through work study method to reduce work content to particular products. Here is given key steps of this case study. We try to develop a conceptual framework for our work. This frame helped to accomplish our research work in systematic way.

In this study, at first we selected a leather products industry with specific products. After that we selected a specific production line for accomplishing our study. We observed all the particular operations with the help of stopwatch. After observing all the operations, identified the existing problem by critical questioning technique. After identifying problems, we developed new method or process [28] for particular products. When our proposed method applied to this particular assembly line, the productivity has been improved. Our contributed research objectives are:

1. Analyze the production system with the help of work study technique for productivity improvement.
Method study

- To improve methods of productions

Work Study

Work measurement

- To assess human effectiveness.

SELECT

Work to be select

RECORD

Present method to limit of detail economically justified using

Chart

- diagram & models
- other means

EXAMINE

The facts critically considering in turn purpose-place - sequence-person -means

DEVELOP

Best method under prevailing circumstance

SELECT

Work to be measured

DEFINE

Method to be used

BREAK DOWN JOB INTO ELEMENTS

MEASURE

Quantity of work involved in the method by

- Direct observation
- predetermination using time study synthesis analytical estimating

Apply relaxation allowances

OBTAIN

Work until value add other justifiable allowances

ESTABLISHED

Target time for defined method

INSTALL

MAINTAIN

Define & measured method

To achieve improved factory and work place lay-out

Improved design of equipment

Better working environment

Reduction of fatigue

Improved used of m/c, materials, man power and equipment.

To achieve a basis of comparison of alternative methods

Correct initial meaning

Continuously economy of man power

Effective planning of productions

Realistic labor costing

Figure 3: Co-ordination Procedure for Work Study for Higher Productivity (Jain and Aggarwal, [1]).
2. Identify the existing problem in a particular production line and develop new system with the help of critical analysis.

Solution Methodology

In this research, we used some terminology for research purpose. Here is given that terminology for analyzing data.

Observe time

The time taken to perform an operation or combination of operations obtained by means of direct measurement [29].

Selected time

The time chosen as being representative of a group of times for an operations or group of work by calculating mean, median or mode.

Rating

Rating is the assessment of the worker’s performance rate of working relative to the observer’s concept of the rate corresponding to standard pace. The commonly used rating scale in use is shown in Table 1 [16].

Basic time

Basic time is the irreducible minimum time theoretically required to produce one unit of output. The time for carrying out an element of work at standard rating [16].

\[
\text{Basic Time} = \frac{\text{Observed Time} \times \text{Observed Rating}}{\text{Standard Rating}} \quad (2)
\]

Standard time

Standard time is the total time in which a job should be completed at standard performance [16].

\[
\text{Standard Time} = \text{Basic Time} + \text{Allowances} \quad (3)
\]

For allowances, we consider 15% relaxation allowances and 3% contingency allowances.

Relaxation allowances

Relaxation allowance is an addition to the basic time intended to improve the worker with the opportunity to recover from the physiological and psychological effects of carrying out a specified operation and to allow attention to personal needs. The amount of allowance depends on the nature of the work. Generally Relaxation allowances is 15% of basic time, has been added to calculate standard time from basic time [30].

Contingency allowances

A contingency allowance is a very small amount of time that may be included in a standard time for time study. In this study, we consider 3% contingency allowance of basic time to calculate standard time [30].

\[
\text{Efficiency} = \frac{\text{Minutes Output}}{\text{Minutes Input}} \quad (4)
\]

\[
\text{Increasing efficiency} = \left( \frac{\text{The efficiency of proposed line} - \text{Present efficiency}}{\text{Present efficiency}} \right) \times 100 \quad (5)
\]

\[
\% \text{ of work content reduction per piece} = \left( \frac{\text{Present work content / piece} - \text{proposed content / piece}}{\text{Present work content / piece}} \right) \times 100 \quad (6)
\]

\[
\text{Increasing productivity (at 100% capacity)} = \left( \frac{\text{Proposed std output} - \text{Existing output}}{\text{Existing output}} \right) \times 100 \quad (7)
\]

A Real Case Study

Data collection and calculations

For practical implementation of our research framework, we select Picard Bangladesh Ltd for real life implementation. Picard Bangladesh Ltd. is a Bangladesh-Germany joint venture leather products industry which produces quality products. Picard Bangladesh Ltd. is a one of the big leather products industry of Bangladesh which produces lots of small and large leather goods like wallet, card case, ladies bag, ladies purse, travel bag, and varieties types of products. For this research work we select a ladies bag for observing each operation along with time study. After observing all the operations along with time study, we fund 60 operations for manufacturing of selected ladies bag. There are about 50 operations for our research products. We compute observe time for all of these existing operations. The existing sequential operations are shown in Table 2 and Picture 1.

We observe five times for each operation for taking time for particular operations. After taking observe time, it converted to basic time with particular rating for each worker by using equation (2). After that we transferred this basic time with adding allowance to standard time by using equation (3). We consider two types of allowance for calculating standard time which is relaxation allowances and contingency allowances. We consider the 8 h working time for each worker.

The graphical representation of capacity of each station is shown in Figures 3-5.

Proposed line

After studying all of those operations, we fund some problem which is improved during proposed method implication to our research work. We have done some critical operations for productivity improvement

| Rating scale | Description |
|--------------|-------------|
| 0            | No Activity |
| 50           | Very slow, clumsy, fumbling movements, operative appear half-asleep, with no interest in the job |
| 75           | Steady, deliberate, unhurried performance, as of a worker not on Piecework but under proper supervision, looks slow, but time not being intentionally wasted while under observation |
| 100          | Brisk, Business-like performance, as of an average qualified worker on piecework, necessary standard quality and accuracy standard rate achieved with confidence |
| 125          | Very fast,operative exhibits a high degree of assurance, dexterity and co-ordination of movement, well above that of an average works |
| 150          | Exceptionally fast, requires intense effort and concentration and is us-like to be kept up for long periods, a performance achieved only by a few outstanding workers |

Table 1: Rating scale (Kanawaty, [16]).
| Sl No. | Name of the operations                                                                 | Observed times in centiminutes | Selected Time | Rating | Basic Time | Standard Time | Manual or M/c | Man power | Capacity/Day@100% efficiency |
|-------|----------------------------------------------------------------------------------------|-------------------------------|---------------|--------|------------|---------------|---------------|-----------|-------------------------------|
| 1     | Cutting all leather                                                                    | 566                           | 560           | 490    | 545        | 550           | 542           | 50        | 80                            |
| 2     | Cutting all PVC, lining, Reinforcement                                                  | 273                           | 262           | 279    | 269        | 275           | 271           | 50        | 80                            |
| 3     | Imaging and Numbering                                                                   | 108                           | 118           | 120    | 111        | 115           | 114           | 50        | 80                            |
| 4     | Splitting leather                                                                      | 33                            | 37            | 34     | 29         | 35            | 34            | 50        | 80                            |
| 5     | Skiving leather, rabus and PVC                                                          | 240                           | 260           | 235    | 246        | 238           | 242           | 50        | 80                            |
| 6     | Sewing back part Face to face                                                           | 40                            | 37            | 32     | 42         | 35            | 37            | 50        | 80                            |
| 7     | Double way tap attaching to back joining and hammering                                  | 105                           | 110           | 100    | 120        | 118           | 111           | 50        | 80                            |
| 8     | Double stitching to back part                                                           | 22                            | 23            | 27     | 19         | 25            | 23            | 50        | 80                            |
| 9     | Gluing on back leather and foam and back top folding 8 mm from the edge by both way tape | 230                           | 223           | 225    | 235        | 218           | 225           | 50        | 80                            |
| 10    | Gluing on back trim part and back part rabus and folding top and below 8 mm from edge   | 208                           | 230           | 220    | 227        | 223           | 223           | 50        | 80                            |
| 11    | Setting back and back trim part by both way tape attach on back zipper#5 part leather and attach zipper | 188                           | 192           | 180    | 178        | 185           | 185           | 50        | 80                            |
| 12    | Back zipper #5 lining attach with back and back trim part by both way tape              | 45                            | 40            | 42     | 44         | 39            | 42            | 50        | 80                            |
| 13    | Back zipper #5 lining stitching by flat bed sewing M/c                                  | 112                           | 101           | 99     | 114        | 108           | 107           | 50        | 80                            |
| 14    | Marking Logo position and Logo fitting on Front leather and tape attach                  | 129                           | 126           | 123    | 139        | 138           | 131           | 50        | 80                            |
| 15    | Gluing on front Leather and rabus and foam and folding top 8 mm from edge               | 259                           | 275           | 250    | 265        | 269           | 263           | 50        | 80                            |
| 16    | Marking magnet position on inner front trimming part and fixing                         | 58                            | 65            | 60     | 67         | 60            | 62            | 50        | 80                            |
| 17    | Gluing on front inner trimming part and PVC and folding 8 mm from edge                  | 177                           | 170           | 167    | 178        | 185           | 185           | 50        | 80                            |
| 18    | Both way tape attach on front inner trimming part and lining attaching                   | 67                            | 52            | 57     | 64         | 61            | 60            | 50        | 80                            |
| 19    | Front inner trimming part and lining stitching                                          | 21                            | 18            | 23     | 26         | 20            | 22            | 50        | 80                            |
| 20    | Setting front and inner trimming part by both way tape                                   | 122                           | 115           | 120    | 117        | 119           | 119           | 50        | 80                            |
| 21    | Front and inner trimming part sewing 2.5 mm from top edge                               | 89                            | 93            | 97     | 85         | 95            | 92            | 50        | 80                            |
| 22    | Marking magnet position on inner Back trimming part and fixing                           | 65                            | 69            | 67     | 61         | 67            | 67            | 50        | 80                            |
| 23    | Gluing on back inner trim part and PVC and folding 8 mm from edge                       | 167                           | 156           | 163    | 160        | 159           | 161           | 50        | 80                            |
| 24    | Both way tape attach on Back inner trimming part and lining attaching                    | 73                            | 67            | 69     | 71         | 71            | 72            | 50        | 80                            |
| 25    | Back inner trimming part and lining sewing                                               | 18                            | 21            | 19     | 24         | 20            | 21            | 50        | 80                            |
| 26    | Setting back and inner trimming part by both way tape                                    | 132                           | 135           | 137    | 129        | 142           | 135           | 50        | 80                            |
| 27    | Back and inner trimming part sewing 2.5 mm from edge                                     | 76                            | 82            | 87     | 79         | 84            | 82            | 50        | 80                            |
| 28    | Gluing on gusset and EVA and top folding                                                | 211                           | 201           | 209    | 200        | 204           | 205           | 50        | 80                            |
| 29    | Gluing on loop and gusset and zipper with help of mark and attach loop and zipper on gusset and attach lining | 240                           | 257           | 249    | 253        | 263           | 252           | 50        | 80                            |
| 30    | Loop and gusset and zipper stitching                                                    | 45                            | 53            | 41     | 56         | 49            | 49            | 50        | 80                            |
| 31    | Preparation of piping                                                                   | 240                           | 244           | 256    | 252        | 260           | 250           | 50        | 80                            |
| 32    | Both way tape attach on middle-1 and lining attaching                                   | 89                            | 52            | 57     | 64         | 54            | 59            | 50        | 50                            |
| 33    | middle-1 and lining stitching                                                            | 23                            | 20            | 26     | 25         | 27            | 24            | 50        | 50                            |
| 34    | Marking magnet position on front middle-1 and fitting magnet                            | 95                            | 87            | 92     | 89         | 91            | 91            | 50        | 50                            |
| 35    | Both way tape attach on middle-2 leather and lining attaching                            | 76                            | 67            | 79     | 72         | 76            | 74            | 50        | 50                            |
| 36    | middle-2 leather and lining stitching                                                    | 24                            | 21            | 27     | 19         | 22            | 23            | 50        | 50                            |
| 37    | Marking magnet position and fitting magnet                                              | 100                           | 93            | 91     | 87         | 94            | 93            | 50        | 50                            |
| 38    | Piping sticking with front part with middle-1 and back part with middle-2               | 320                           | 322           | 329    | 334        | 337           | 329           | 50        | 50                            |
| 39    | Handy pocket attaching with middle-1 by adhesive with help of marking                   | 120                           | 112           | 109    | 117        | 125           | 117           | 50        | 50                            |
| 40    | Handy pocket sticking with middle-1                                                     | 89                            | 79            | 75     | 82         | 71            | 79            | 50        | 50                            |
Middle zipper attaching with middle with middle-2 lining  
257 247 243 251 254 250 80 200 236  
Manual 2 407

Middle zipper and middle-2 lining stitching  
105 98 108 112 102 105 75 79 93  
M/c 1 516

Middle-2 lining attaching with middle-2 leather by false stich  
93 91 87 86 83 88 80 70 83  
M/c 1 578

Middle-2 lining and middle-2 leather stitching  
78 71 82 74 79 77 85 65 77  
M/c 1 623

Gluing on bottom part and PVC and lining attaching on bottom part  
149 156 148 150 152 85 129 152  
manual 2 632

Piping stitching with bottom part leather  
107 113 99 114 100 107 75 80 94  
M/c 1 511

Gusset stitching with front and back part  
425 437 439 420 423 429 80 343 405  
M/c 1 119

Bottom stitching with upper  
200 192 188 194 199 195 80 156 184  
M/c 1 261

Belt joining by stitching  
90 87 82 86 89 87 85 74 87  
M/c 1 552

Adhesive apply on leather and hamaring  
128 123 131 139 129 130 85 111 131  
Manual 2 733

Gluing on full belt and stitching by die fixed sewing m/c  
211 199 204 212 209 207 85 176 208  
M/c 2 462

Belt attaching on bag by sewing  
80 84 77 83 79 81 80 85 77  
M/c 1 623

Binding on the leather joining edge by die fitting sewing m/c  
104 112 107 102 99 105 85 89 105  
M/c 1 457

Gluing on full pullar and stitching by cnc m/c and embossing  
110 119 124 115 120 118 85 100 118  
M/c 3 1220

Puller attaching on bag  
120 117 115 123 119 119 80 95 112  
Manual 1 429

Edge coloring  
59 54 51 49 57 54 75 41 48  
Manual 1 1000

Thread burning and cleaning and polishing  
389 361 379 357 385 374 80 299 353  
Manual 3 408

Staffing  
79 73 69 81 82 77 75 58 68  
Manual 1 706

Final checking  
120 127 118 131 128 125 80 100 118  
Manual 1 407

Price tag attaching and packaging  
233 227 220 229 240 230 80 184 217  
Manual 1 221

Total 6787 8004 97

Table 2: Existing operations for ladies bag in centiminutes.
**Figure 5:** This graphical representation is computed by using Table 2. From this graph we observe the capacity of each operation very easily.
| Step Description                                                                 | Station capacity@85% |
|---------------------------------------------------------------------------------|----------------------|
| Price tag attaching and packaging                                              |                      |
| Staffing                                                                        |                      |
| Thread burning and cleaning and final checking                                 |                      |
| Edge coloring                                                                   |                      |
| Puller attaching on bag                                                         |                      |
| Gluing on full puller and stitching by CNC m/c and embossing                    |                      |
| Binding on the leather joining edge by die fitting sewing m/c                  |                      |
| Belt attaching on bag by sewing                                                 |                      |
| Gluing on full belt and stitching by die fixed sewing m/c                       |                      |
| Adhesive apply on leather and joining and hammering                            |                      |
| Belt joining by stitching                                                       |                      |
| Gusset stitching with front and back part & Bottom stitching with upper         |                      |
| Piping stitching with bottom part leather & with front part with middle-1 & back part with middle-2 |                      |
| Gluing on bottom part and lining attaching on bottom part                       |                      |
| Middle-2 lining and middle-2 leather stitching                                  |                      |
| Middle-2 lining attaching with middle-2 leather by false stitch                 |                      |
| Middle zipper and middle-2 lining stitching                                      |                      |
| Middle zipper attaching with middle with middle-2 lining                       |                      |
| Handy pocket stitching with middle-1                                            |                      |
| Handy pocket attaching with middle-1 by adhesive with help of marking           |                      |
| Marking magnet position and fitting magnet                                      |                      |
| Middle-2 leather and lining stitching                                           |                      |
| Both way tape attach on middle-2 leather and lining attaching                   |                      |
| Marking magnet position and fitting magnet with middle-1 and lining stitching   |                      |
| Both way tape attach on middle-1 and lining attaching                           |                      |
| Preparation of piping                                                           |                      |
| Gluing on loop & gusset & zipper with help of mark & attach loop & zipper on gusset & attaching lining |                      |
| Gluing on gusset & eva & top folding                                            |                      |
| back & inner trimming part sewing 2.5mm from edge                              |                      |
| Setting back & inner trimming part by both way tape                            |                      |
| back inner trimming part & lining sewing                                        |                      |
| Both way tape attach on Back inner trimming part & lining attaching             |                      |
| Gluing on back inner trim part & pvc & folding 8mm from edge                   |                      |
| front & inner trimming part sewing 2.5mm from edge                             |                      |
| Setting front & inner trimming part by both way tape                           |                      |
| front inner trimming part & lining stitching                                     |                      |
| Both way tape attach on front inner trimming part & lining attaching           |                      |
| Gluing on front inner trimming part & pvc & folding 8mm from edge              |                      |
| Marking magnet position on inner front  trimming part and fixing & Marking magnet position on |                      |
| Gluing on Leather & rhabus & foam & folding 8mm from edge                     |                      |
| Marking Logo position & Logo fitting on Front leather & tape attach            |                      |
| Back zipper #5 lining stitching by flat bed sewing m/c                           |                      |
| Back zipper #5 lining attach with back & back trim part by both way tape        |                      |
| Setting back & back trim part by Both way tape attach on back zipper #5 leather and attach zipper |                      |
| Gluing on back trim part & back part rhabus & folding top & below 8mm from edge |                      |
| Gluing on back leather and foam & back top folding 8mm from the edge           |                      |
| Sewing back part Face to Face & Double stitching to back part                   |                      |
| Double way tap attaching to back joining & hammering                           |                      |
| Splitting & Skiving leather, rhabus and pvc                                    |                      |
| Cutting all pvc, lining, Reinforcement                                          |                      |
| Cutting all leather                                                             |                      |

Figure 6: Graphical representation of proposed balanced line. This graph is computed by using Table 4.
to these specific products. Table 3 shows the critical operations which is done during implementation our research framework.

After line balancing of this product, we get higher productivity [31,32]. The calculation of proposed line balancing is shown in Table 4.

The graphical representation of proposed balanced line is also shown in Figures 5 and 6.

Results and Discussion

The present production of existing production line is 240 pieces bag/day. The working hours for this company are 8hr. In this production line the total number of worker is 97. So, that according to equation (1) the average productivity of this production line is approximately 2.5 pieces of bag per day. In this production line, the available working time is 48000 cent minutes. So, that work content for per pieces of bag is 8004 cent minutes. Standard output at 100% efficiency is 582 pieces bag per day. After all, the efficiency calculation is computed by using equation (3) is 41.23%.

In this research, using proposed line that can increase productivity to 12.71% from previous existing line. In earlier the work content per piece was 80.04 minutes. After line balancing and critical analysis the work content was 71.03 minutes. So, that the work content reduced to 9.01 minutes after line balancing and critical method work. In this proposed line the standard output at 100% efficiency was 656 pieces bag per day. Input of this proposed line was 582 pieces bag per day. By using equation (6) the productivity improved to 12.71%.

Our proposed method helps to increase productivity to 12.71% with reduction of work content and line balancing.

Conclusions and Recommendation

Productivity improvement is an important issue in leather products industry. The profit earning of leather products industry largely depends on productivity improvement. This study shows the way of finding gap of production process and operations. By implementing work study and method study and established new effective process for particular operation, we have to able to increase productivity. Especially this study shows the improvement of productivity in assembly line [33] of leather products manufacturing industry. The line balancing is the key point to increase productivity to particular products. For the sake of limitation we could not apply this technique to all products. For reducing work content to improve productivity, Lean manufacturing concept [34,35] could be used for our work. This study shows the productivity improvement by reduction of work content and line balancing. Further research could be done by using combination of lean and work study technique.

| Name of the critical operation | Existing Line | Proposed Line |
|-------------------------------|---------------|---------------|
| Gluing on back leather and foam and back top folding 8 mm from the edge | Through gluing on leather is generally done by brush. The using brush to apply adhesive need more time. | 212 | Due to small component we could use water based adhesive by spraying m/c. By using this types of method of applying adhesive is more quicker than existing method |
| Inspection and Numbering | Inspection and numbering done in cutting. | 107 | Should be avoided in cutting section |
| Gluing on back trim part and back part nubus and folding top and below 8 mm from edge | Through gluing on leather is generally done by brush. The using brush to apply adhesive need more time. Due to curve of top need more time. | 210 | We could use spraying method to apply adhesive. For curve of top folding we could use quicker method to save time. |
| Gluing on front Leather and nubus and foam and folding top 8 mm from edge | Through gluing on leather is generally done by brush. The using brush to apply adhesive need more time. | 264 | Due to small parts we could use spraying method to apply adhesive and if we use this method save time. |
| Gluing On front inner trimming part and PVC and folding 8 mm from edge | To manufacture this article use brush to apply adhesive. This method need more time than spraying method. | 168 | To manufacture this article we could use spraying method to apply adhesive to save time. |
| Front and inner trimming part sewing 2.5 mm from top edge | To attach front and inner top part generally use cylinder bad sewing m/c. Due to curve of top need more skilled worker and more time. | 87 | If we could use CNC m/c to stitch top curve due to small component and it save time to improve productivity. |
| Gluing on back inner trim part and PVC and folding 8 mm from edge | To manufacture this article use brush to apply adhesive. This method need more time than spraying method. | 152 | To manufacture this article we could use spraying method to apply adhesive to save time. |
| Back and inner trimming part sewing 2.5 mm from edge | To attach front and inner top part generally use cylinder bad sewing m/c. Due to curve of top need more skilled worker and more time. | 77 | If we could use CNC m/c to stitch top curve due to small component and it save time to improve productivity. |
| Gluing on gusset and EVA and top folding | To manufacture this article use brush to apply adhesive. This method need more time than spraying method. | 182 | To manufacture this article we could use spraying method to apply adhesive to save time. |
| Gluing on bottom part and lining attaching on bottom part | To manufacture this article use brush to apply adhesive. This method need more time than spraying method. | 152 | To manufacture this article we could use spraying method to save time. |
| Edge Coloring | Here there is no raw edge but still the use edge coloring for manufacturing defect. | 48 | Most be avoided this for this article due to there is no raw edge present here. |
| Staffing | To save the article they use paper which need more time then use poly bag use. | 68 | If we could use poly bag to shape the article. This will be time saver method for this article. |

Table 3: Critical analysis of operation.
| Sl. No | Name of the Operation                                    | Slewed Time | Rating | Basic Time | Standard Time | M/c/Manual | Man Power | Capacity/Day @ 100% efficiency | Capacity/Day @ 85% efficiency |
|--------|----------------------------------------------------------|-------------|--------|------------|---------------|------------|-----------|--------------------------------|-------------------------------|
| 1      | Cutting all leather                                      | 542         | 80     | 434        | 513           | M/c        | 3         | 281                            | 239                           |
| 2      | Cutting all PVC, lining, reinforcement                   | 271         | 80     | 217        | 256           | M/c        | 3         | 563                            | 479                           |
| 3      | Splitting and Skiving leather, rabus and PVC             | 276         | 85     | 253        | 275           | M/c        | 4         | 698                            | 593                           |
| 4      | Double way tap attaching to back joining and hammering   | 111         | 85     | 94         | 110           | Manual     | 2         | 873                            | 742                           |
| 5      | Sewing back part Face to face and Double stitching to back part | 60          | 80     | 48         | 56            | M/C        | 1         | 857                            | 728                           |
| 6      | Gluing on back leather and foam and back top folding 8 mm from the edge | 180         | 80     | 144        | 170           | Manual     | 2         | 564                            | 480                           |
| 7      | Gluing on back trim part and back part rabus and folding top and below 8 mm from edge | 190         | 80     | 152        | 179           | Manual     | 2         | 536                            | 456                           |
| 8      | Setting back and back trim part by Both way tape attach on back zipper#5 part leather and attach zipper | 120         | 85     | 102        | 120           | Manual     | 2         | 800                            | 680                           |
| 9      | Back zipper #5 lining attach with back and back trim part by both way tape | 42          | 80     | 34         | 40            | Manual     | 1         | 1200                           | 1020                          |
| 10     | Back zipper #5 lining stitching by flat bed sewing m/c    | 107         | 85     | 91         | 107           | M/c        | 1         | 449                            | 362                           |
| 11     | Marking Logo position and Logo fitting on Front leather and tape attach | 67          | 85     | 57         | 67            | Manual     | 1         | 716                            | 609                           |
| 12     | Gluing on Leather and rabus and foam and folding top 8 mm from edge | 210         | 85     | 179        | 211           | Manual     | 4         | 910                            | 774                           |
| 13     | Marking magnet position on inner front trimming part and fixing and Marking magnet position on inner Back trimming part and fixing | 129         | 85     | 110        | 130           | Manual     | 2         | 738                            | 627                           |
| 14     | Gluing On front inner trimming part and PVC and folding 8 mm from edge | 130         | 80     | 104        | 123           | Manual     | 3         | 1171                           | 935                           |
| 15     | Both way tape attach on front inner trimming part and lining attaching | 60          | 85     | 51         | 60            | Manual     | 2         | 1600                           | 1882                          |
| 16     | front inner trimming part and lining stitching            | 22          | 85     | 19         | 22            | M/c        | 1         | 2182                           | 1855                          |
| 17     | Setting front and inner trimming part by both way tape   | 119         | 85     | 101        | 119           | Manual     | 3         | 1210                           | 1029                          |
| 18     | front and inner trimming part sewing 2.5 mm from edge    | 46          | 80     | 37         | 44            | M/c        | 1         | 1091                           | 927                           |
| 19     | Gluing on back inner trim part and PVC and folding 8 mm from edge | 120         | 80     | 96         | 113           | Manual     | 2         | 850                            | 723                           |
| 20     | Both way tape attach on Back inner trimming part and lining attaching | 72          | 85     | 61         | 72            | Manual     | 2         | 1333                           | 1133                          |
| 21     | back inner trimming part and lining sewing               | 21          | 80     | 17         | 20            | M/c        | 1         | 2400                           | 2040                          |
| 22     | Setting back and inner trimming part by both way tape    | 135         | 85     | 115        | 135           | Manual     | 2         | 711                            | 604                           |
| 23     | back and inner trimming part sewing 2.5 mm from edge     | 46          | 80     | 37         | 44            | M/c        | 1         | 1091                           | 927                           |
| 24     | Gluing on gusset and eva and top folding                 | 170         | 75     | 128        | 151           | Manual     | 2         | 636                            | 541                           |
| 25     | Gluing on loop and gusset and zipper with help of mark and attach loop and zipper on gusset and attaching lining | 200         | 80     | 160        | 189           | Manual     | 3         | 762                            | 648                           |
| 26     | loop and gusset and zipper stitching                      | 49          | 75     | 37         | 44            | M/c        | 1         | 1091                           | 927                           |
| 27     | Preparation of piping                                   | 240         | 80     | 192        | 227           | M/c        | 3         | 634                            | 539                           |
| 28     | Both way tape attach on middle-1 and lining attaching    | 59          | 85     | 50         | 59            | Manual     | 1         | 814                            | 692                           |
| 29     | middle-1 and lining stitching                            | 24          | 85     | 20         | 24            | M/c        | 1         | 2000                           | 1700                          |
| 30     | Marking magnet position and fitting magnet               | 67          | 85     | 57         | 67            | Manual     | 2         | 1433                           | 1218                          |
| 31     | Both way tape attach on middle-2 leather and lining attaching | 74          | 80     | 59         | 70            | Manual     | 1         | 686                            | 583                           |
| 32     | middle-2 leather and lining stitching                     | 23          | 85     | 20         | 24            | M/c        | 1         | 2000                           | 1700                          |
| 33     | Marking magnet position and fitting magnet               | 67          | 85     | 57         | 67            | Manual     | 2         | 1433                           | 1218                          |
| 34     | Handy pocket attaching with middle-1 by adhesive with help of marking | 117         | 75     | 88         | 104           | Manual     | 2         | 923                            | 785                           |
| 35     | Handy pocket attaching with middle-1                     | 79          | 80     | 63         | 74            | M/c        | 1         | 649                            | 552                           |
| 36     | Middle zipper attaching with middle with middle-2 lining | 210         | 80     | 168        | 196           | Manual     | 2         | 485                            | 412                           |
| 37     | Middle zipper and middle-2 lining stitching              | 105         | 75     | 79         | 93            | M/c        | 1         | 516                            | 439                           |
| 38     | Middle-2 lining attaching with middle-2 leather by false stitch | 88          | 80     | 70         | 83            | M/c        | 1         | 573                            | 491                           |
| 39     | Middle-2 lining and middle-2 leather stitching           | 77          | 85     | 65         | 77            | M/c        | 1         | 623                            | 530                           |
| 40     | Gluing on bottom part and lining attaching on bottom part | 121         | 85     | 103        | 122           | Manual     | 2         | 787                            | 669                           |
| 41     | Piping stitching with bottom part leather and with front part with middle-1 and back part with middle-2 | 427         | 75     | 321        | 378           | M/c        | 3         | 381                            | 324                           |
| 42     | Gusset stitching with front and back part and Bottom stitching with upper | 560         | 80     | 448        | 528           | M/c        | 3         | 273                            | 232                           |
| 43     | Belt joining by stitching                                | 87          | 85     | 74         | 87            | M/c        | 1         | 552                            | 469                           |
| 44     | Adhesive apply on leather and joining and hammering      | 130         | 85     | 111        | 131           | Manual     | 2         | 733                            | 623                           |
| 45     | Gluing on full belt and stitching by die fixed sewing m/c | 207         | 85     | 176        | 208           | M/c        | 2         | 462                            | 393                           |
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