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# DIFFERENT OEE APPROACHES' ANALYSIS OF APPLICABILITY IN PRINTING SECTOR

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**ABSTRACT**

Total Productive Maintenance is one of the application techniques, which is a widely accepted form of lean management system, at business and production management. OEE (Overall Equipment Effectiveness) technique is used in Total Productive Maintenance for assessing equipments' being used efficiently or not in any organizations and applications. In this study, testing the applicability of two different OEE approaches and comparing the obtained results in the daily newspaper printing having a unique working conditions are aimed. In the application part of the study, traditional OEE calculation method and OEE calculations with a new approach was made in a printing press which performs the publication of the largest circulation newspapers in Turkey. Datas were collected during six months and calculations were made with two mentioned methods for each day in which the datas were collected. The evaluation about the applicability of two OEE approaches in the printing sector was made according to the obtained results after the calculations being made.

**Key words:** *Lean Manufacturing, Total Productive Maintenance, Overall Equipment Effectiveness*

# FARKLI OEE YAKLAŞIMLARININ MATBAA SEKTÖRÜNDE UYGULANABİLİRLİĞİNİN ANALİZİ

**ÖZET**

Toplam verimli bakım, işletme ve üretim yönetiminde yalın yönetim sisteminin yaygın bir şekilde kabul görmüş olan uygulama tekniklerinden birisidir. Toplam Verimli Bakım uygulamalarında, bir organizasyonda ekipmanların etkin bir şekilde kullanılıp kullanılmadığının değerlendirilmesi için OEE (Overall Equipment Effectiveness) yöntemi kullanılır. Bu çalışmada kendine özgü çalışma şartlarına sahip olan günlük gazete basım matbaasında iki farklı OEE yaklaşımının uygulanabilirliğinin test edilmesi ve elde edilen sonuçların karşılaştırılması amaçlanmıştır. Çalışmanın uygulama bölümünde, Türkiye'deki en büyük tirajlı gazetelerin basımını gerçekleştiren bir matbaada geleneksel OEE hesaplama yöntemi ve yeni yaklaşımla OEE hesaplamaları yapılmıştır. Altı ay boyunca veri toplanmış ve söz konusu iki yöntemle veri toplanan her gün için hesaplamalar gerçekleşmiştir. Yapılan hesaplamalardan sonra elde edilen sonuçlara göre söz konusu iki OEE yaklaşımın sektörde uygulanabilirliğine ilişkin değerlendirme yapılmıştır..

**Anahtar Kelimeler:** *Yalın Üretim, Toplam Verimli Bakım, Toplam Ekipman Etkinliği*

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## 1. INTRODUCTION

Scientists working on measuring the production performance of businesses use different metrics to develop the best measurement method. Overall Equipment Effectiveness (OEE), which is firstly presented as a tool to measure the success of the total productive maintenance philosophy by Seiichi Nakajima in 1988, is one of the widely accepted metric in this field (Zandieh vd., 2013: 1). The disruptions causing the inefficient use of the equipment and increased costs are tried to be determined with OEE. OEE is also used as a starting point for determining the activities, which are included in the production process and which do not create any values, and improving the performance by increasing productivity and quality (Raja ve Kannan, 2007: 1).

Compared to the capacities of production equipment during specified operating time to what extent they revealed their performance is determined with OEE calculations. OEE allows a machine to be analyzed the expected performance and the measured performance of it and to be developed the current performance of it (Kumar vd. 2012: 1). OEE is used as an indicator not only as an operational measurement but also in terms of process development activities in the production area (Williamson, 2006: 1). OEE is also used for measuring the effectiveness of a machine, a production cell or a production line (Frost&Sullivan, 2005: 9). OEE is an indicator showing how a business is able to manage its most important values, its equipment with little loss and waste to produce value-added products. Being an important development in OEE calculation results shows that business manages its equipment well, improves its maintenance and repair operations and in the short term, reduces the equipment sourced six major loss (Maran vd., 2012: 1). Measurements related to OEE is an important element in the formulation and implementation of the development strategy of total productive maintenance. OEE is also considered as an important indicator for measuring the success of total productive maintenance and lean manufacturing applications (Hedge vd., 2009: 1).

## 2. LITERATURE

In Literature, there are a number of studies in which OEE is used with different approaches. Ivanic (1998) developed a very similar index with OEE named as Total Effective Equipment Performance (TEEP), in which planned downtime are taken into account with unplanned stances in activity calculation to show how the maintenance work is contributed to the activity of production facilities (Zandieh vd., 2012: 2). Jeong and Phillips (2001) defended the original OEE calculations', provided by Nakajima, not being appropriate for capital-intensive business and the need of regulation according to the industry for the scheme for losses. Nachiappan and Anantharaman (2006) developed a total production line activity - Overall Line Effectiveness (OLE) index measuring total production line activity. Muthiah and Haung (2007) developed total factory activity - Overall Factory Effectiveness (OFE) the concept to follow the performance of the factory level, to identify the occluded points and to remove the obstruction; and the total volume of business efficiency - Overall Throughput Effectiveness (OTE) concept to measure the effectiveness of the basis of sub-system (Andersson ve Bellgran, 2011: 2). Sarkar (2007) focused on the use of OEE results as a parameter while executing the process development studies with the six sigma methodology.

Raja and Kannan (2007) presented an OEE application example in a casting business producing pipe by stating that the factors used in vary according to the calculations OEM and the application method of the sectors and the production process. Hedge etc. (2009) presented an application example for increasing the coefficient of OEE by using total productive maintenance and 5S techniques in a CNC workshop. Wudhikarn (2010) stated that the factors of availability, performance and quality used in OEE calculation do not have the same effect of the production activity of businesses. He defended that these factors should be included in the calculations by weighting with AHP according to the cost that caused during the production process before OEE calculations and presented an OEE calculation method named as Total Weighted Equipment Activity. Andersson and Belgran (2011) analyzed data by measuring the effectiveness of line with OEE calculations under determined specific assumptions related to the production made in a semi-automatic assembly line and listed the situations encountered in OEE activities and the related factors about the management of the effective use of OEE production performance.

There are a number of reviews about criticized points about OEE in literature, the benefits provided by OEE to businesses, the causes of OEE applications' failed results and the points to be considered for a successful OEE application. Even though OEE is considered to be an effective technique in terms of measuring the production performance of the machines, there are some differences in practice how the measurements made on OEE and their results will affect the performance improvement, on topics such as how to do the calculations. Industry making measurement leads to be made changes in calculations in OEE according to facts such as production system, process and machine type (Raja ve Kannan, 2007: 2). Some researchers defends that because of each factors' not having the same weight in OEE calculations, weighting the ratio of availability, performance and quality before calculating OEE will give more accurate results (Wudhikarn, 2010: 3). In a production system, while calculating the efficiency of a machine the machines' coming before and after the target machine ignoring their relationship with each other is expressed as one of the weak points of OEE (Zandieh vd, 2012: 3). Moreover, taking into account the lack of entrance of raw material and interruptions caused from a lack of labor in OEE calculations provided by Nakajima are also expressed as one of the incomplete points (Ljungberg, 1998: 6).

## 3. OEE CALCULATION METHODS DEVELOPED BY GIBBONS AND BURGESS – NAKAJIMA

Nakajima identified six major losses related to equipment in his study presented in 1988 and made OEE calculations according to these losses. These losses are listed as breakdown resulting from equipment failure, installation / setting induced postures, time losses occuring due to machine's waiting empty / small postures, speed losses, the losses occuring during the equipment's being started for the first time and quality defects / losses occuring in reprogressing cases (Raja ve Kannan, 2007: 2). According to the definition made by Nakajima classic OEA is calculated as follows by multiplying availability, performance and quality parameters obtained by using these mentioned six losses.

**Availability** = Loading Time / Operation Time x 100
**Performance** = Net Operation Time / Loading Time x 100
**Quality** = Valuable Operation Time / Net Operation Time x 100
**OEE** = Availability x Performance x Quality (1)

OEE approach offered by Gibbons and Burgess (2010) has a similar formulation with the OEE approach presented by Nakajima. Calculation of parameters in terms of availability is made by the formula used in OEE approach provided by Nakajima. While using data related to the production time in OEE approach presented by Nakajima in the calculation of performance and quality parameters, calculations in OEE approach presented by Gibbons and Burgess are made according to the quantity produced. Accordingly, new OEE calculations developed by Gibbons and Burgess are made as follows (Gibbons and Burgess, 2010: 12).

**Availability** = Loading Time / Operation Time x 100
**Performance** = Total Throughput / (Cycle Time/Actual Run Time) x 100
**Quality** = **(**Total Good Production-Total Bad Production) / Total Good Production) x 100
**OEE** = Availability x Performance x Quality (2)

In above formulas;

Operation Time = Standart Minutes Available – (Electirical Interruption, Pressurized Air Interruption, Waiting for Raw Material…)

Loading Time = Operation Time – (Breakdown, Set Up and Tooling, Starting Losses…)

Net Operation Time = Loading Time – (Speed Losses, Monetary Slowdown Losses…)

Value Adding Time = Net Operation Time – (Scrap and Sample Collection, Quality Losses…)

## 4. APPLICATION

In 1440 as the invention of dynamic letter printing technique by Johann Gutenberg, a new industry's foundations are laid and a period may be described as a modern printing era began. This invention called the printing press spread rapidly and developed until today. While registered a total number of works was around 30,000 in the period until the invention of printing, pressing the 40,000 books in Europe in 50 years after the invention reveals the importance of invention and its contribution to history of mankind.

Printing industry, having become an important industry in the world, operates in different ways from other manufacturing industries. Printing industry is selected for the application especially because of the variability of the shift time and due to its unique operating system. Application is carried out with the data obtained from the printing plant publishing daily nationwide newspaper in Turkey. Data for 24 days was reached by randomly selecting one day each week for 6 months. Data was collected for use in this paper. OEE calculation was made by all machines in printing process. Packaging machines was not included these calculations.

Applications being subject to company activities started in 2009 and offset technique is made with printing. The company producing newspaper at printing press in four different cities pressed only its newspaper in first two years. In the year of 2011 an agreement was made for printing another newspaper distributed throughout the country and the number of products produced was doubled.

In today's modern facilities newspaper production are carried out using a series of highly automated machines. As shown in Figure 1, newspaper production process consists of three stages in examined printing. First stage is the preparation process of the molds including the images being attached to the printing machine and the pages to be printed. The second stage is the process of realization of the print job in the printing machine. The third stage is the process making ready to be shipped by packing the printed newspaper

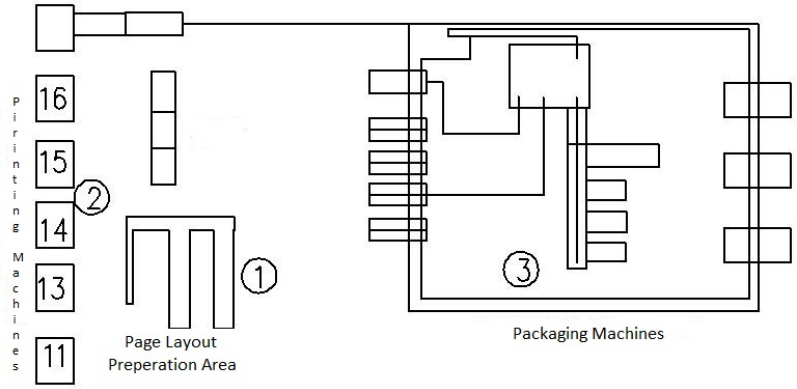


**Figure 1: Print Shop Process Diagram**

As daily production facilities are different from mass production industries in classical shifts and have a difficult structure to be analyzed, under investigation only the most important part of the newspaper printing process (2nd process) were analyzed. Some difficulties were faced while implementing OEE calculation method in examined printing facility. Printing process is a process progressing its case in stages. By discarding intertwined in the next process (packaging process) firstly newspapers' adds are printed and then the main newspapers' printing is pressed. Therefore, many times the print is finished in a production day and restarts for the new product. In this way, depending on the time of arrival of the page image between stages there becomes idle time. Moreover, the starting and ending times of a production day vary from day to day according to the advent of the page image. In Figure 2, an OEE table, which is prepared according to a typical production day (28.03.2015), is given. OEE calculation method application principles are mentioned only for the date of 28.03.2015 in newspaper production facility through Figure-2.

*TT: Total Throughput, TET: Theoretical Throughput (Maximum Machine Capacity)*

| 476,4 Min. | | | | |
|---|---|---|---|---|
| | 399,04 Min. | | | |
| 77,37 Min. | 0 Min. | 53,48 Min. | 109,04 Min. | 236,52 Min. |
| VALUABLE OPERATION TIME | QUALITY LOSSES | PERFORMANCE LOSSES | AVAILABILITY LOSSES | PLANNED DOWNTIME |
| 77,37 minutes value adding time in 476,4 standard minutes available | *Scrap and Sample Collection (0 min.)*<br><br>*Quality Losses: (0 pcs.)* | *Speed Losses and Momentary Slowdown Losses (53,48 min.)*<br><br>*(TT: 114884 pcs. TET: 194317 pcs)* | *Breakdown (39,72 min.)*<br><br>Set Up and Tooling *(58 min.)*<br><br>İnefficient Start-Up (Starting Losses) *(11,32 min.)* | *Electrical İnterruption*<br><br>Pressurized Air İnterruption<br><br>*Waiting for Raw Material*<br><br>*(236,52 min.)* |
| VALUE ADDING | NON VALUE ADDING | NON VALUE ADDING | NON VALUE ADDING | NECCESSARY BUT NON VALUE ADDING |

| | |
|---|---|
| VALUE ADDING TIME (77,37) | |
| NET OPERATION TIME | (77,37) |
| LOADING TIME | (130,85) |
| OPERATION TIME | (239,88) |
| STANDART MINUTES AVAILABLE | (476,4) |

**Figure 2: OEE Definitions (Prepared by Appendix 1 and 2)**

**Standard minutes available:** In this study, the analyzed printing process is defined as the period of time from outputting (producing) of the final molding to the finishing of the last pressing in the same day.Description of the title in Figure 2 is as follows.

**Downtime Losses:**

*Planned Maintenances:* In general, 24 hours of uninterrupted production is not performed in daily newspaper printing. There are certain times during the day when the machines do not work. Therefore, planned maintenances is carried out in times when the machines are empty. Thus, there won't be the concept of planned maintenance in this performed study's OEE calculations of daily newspaper publishing printing.

*Electrical / Pressurized Air İnterruption:* The electric's or air's being interrupt in this mentioned facility causes the pressing's stopping. Especially after electric interruption, there becomes problems such as paper's being broken and making new preparation and cleaning are required for producing in these stops.

*Waiting for Raw Material:* The critical raw materials are page images in daily newspaper printing. No activities can be done before page images are brought in. This situation is often faced during the day in between the pressings. 236.52 minutes of closing losses are removed from total time available and the load times are found.

**Availability Losses :**

*Set Up and Tooling:* In daily newspaper pressing, first of all the molds are changed and then the paper paths are set and the machines are getting ready for production by making the automatic washing process. In this study, the time passing from producing the final mold in analyzed printing process to the beginning of proofing printing is called preparation time.

*Cleaning before the process:* The machines are cleaned in daily newspaper printing at the beginning of the shifts (before molds are produced) and if necessary, during the printing processes (while waiting for the raw materials or in case of stops caused by breakdown) Therefore, the cleaning time during these periods are added to shutdown loss or breakdown loss depending on the situation.

*Inefficient Start (Starting Lossses):* The pressing machines give poor quality product for a certain period after they start running in daily newspaper printing. This period includes the period from the beginning of proof printing to producing the first good quality product. In this period of time, printing machine settings are trying to be set and the printing operators play a decisive role in this process

**Performance Losses:**

*Speed losses:* Speed loss occurs because of printing machines' not being use at the highest loop speed. The speed of the machine is increased up to the speed limit which is set gradually and is stopped by being slowed down gradually. Actual cycle time is found by multiplying the cycle time with a correction coefficient due to this acceleration and deceleration in the starting and stopping in the calculations. Correction factor is accepted as (%1).

*Momentary Slowdown Losses:* The speed of machines can be reduced for a short time in daily newspaper printing when there is a threat to continuity of production (e.g. while changing the paper bobbin). Thus, momentary slowdown loss occurs. After this slowdown machine speed is gradually increased until it reaches a predetermined speed and stopped by gradually being slowing down when the printing's being finished. Therefore, the loss of speed and momentary slowdown time will be calculated together.

**Quality Losses:**

*Scrap:* In the daily newspaper printing, scrap products being produced after the first good product are scrap and there is no chance of re-operation.

*Sample Collection:* Samples are taken from the production line in daily newspaper printing; however, these samples are given back to the production line after being checked. If these samples are not in a good position to give back, they are written on the scrap loss list. Therefore, there will not be a sample loss in this study.

A typical printing process time chart is given in Figure 3 in the light of this explanation. In a typical pressing day, first of all the page images of first production (1st press) of that day's pressing are brought from editorial department. Brought page images are sent to the mold maker machines by the relevant operator and the molds are prepared. The check out time of the last molds the beginning of the printing process. Molds are placed to the press machines by the pressing operators. The paper paths are either set or going to be set. Machines are switched (started) in control of print master after all molds are installed. Meanwhile, printing machine's detailed settings are made. After the detailed settings are completed, proof ing press is started again in control of print master. After producing bad quality products for a while, machine gives its first good quality product.

Thus, clear written press period starts. The pressing is terminated as reached the desired product number. If the next pressing's molds are ready, these molds are attached to the machine and the same process is operated in the same way for the 2'nd pressing.

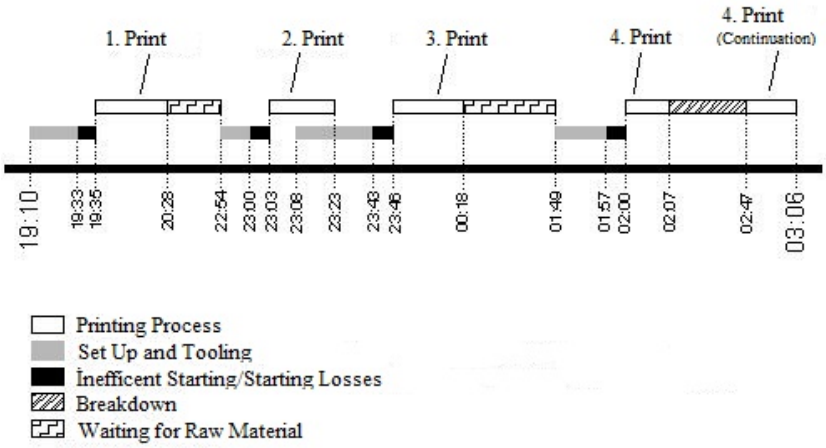


**Figure 3: Typical Printing Process İn The Printing House (28.03.2015)**

Table-1 contains classic and new OEE scores. As these OEE scores are compared, it is seen that most of the OEE values are the same and there are a small difference only in data that high loss in quality. However, all usability and performance efficiency are mutually same in classic and new OEE calculation.

**Table 1**: Classic and New OEE Scores

| DATES | CLASSIC OEE | NEW OEE | DATES | CLASSIC OEE | NEW OEE |
|---|---|---|---|---|---|
| 07/01/14 | 0,414 | 0,414 | 10/04/14 | 0,408 | 0,408 |
| 12/01/14 | 0,403 | 0,403 | 14/04/14 | 0,429 | 0,429 |
| 20/01/14 | 0,442 | 0,442 | 23/04/14 | 0,353 | 0,353 |
| 26/01/14 | 0,289 | 0,289 | 29/04/14 | 0,281 | 0,282 |
| 05/02/14 | 0,370 | 0,370 | 06/05/14 | 0,309 | 0,312 |
| 14/02/14 | 0,275 | 0,276 | 16/05/14 | 0,410 | 0,410 |
| 24/02/14 | 0,379 | 0,380 | 25/05/14 | 0,459 | 0,459 |
| 28/02/14 | 0,339 | 0,340 | 29/05/14 | 0,263 | 0,263 |
| 05/03/14 | 0,431 | 0,431 | 01/06/14 | 0,345 | 0,345 |
| 11/03/14 | 0,326 | 0,326 | 07/06/14 | 0,314 | 0,316 |
| 19/03/14 | 0,438 | 0,438 | 13/06/14 | 0,348 | 0,348 |
| 28/03/14 | 0,322 | 0,322 | 23/06/14 | 0,285 | 0,285 |

## 5. RESULT

In this study, availability and results of new OEE calculation method developed by Gibbons and Burgess with classical OEE method developed by Nakajima in newspaper printing press sector were examined. It was examined that how OEE calculations can be performed with these two approaches in the newspaper printing press sector having a different structure from production processes in the other sectors. It was tried to be determined whether

there is difference between OEE values obtained with these two approaches with the comparison of obtained results.

Since the availability loss was calculated with the same formula in both methods, they gave the same results. Although calculation methods of performance loss were different, the results were same. Even though formulas of two approaches examined in the study were calculated by the time or number, since two methods were based on cycle time, results of performance loss gave the same results in both methods. Average production rate in the printing press examined is about 900 piece/minute. Results were observed by increasing the cycle time of six days of data (4, 8, 12, 16, 20 and 24) selected randomly in order to see the effect of production rate. For this purpose, the highest production rate of machine was decreased from 1500 piece/minute to 1250 piece/minute. Thus, since amount produced in 1 minute was less, cycle time increased from 0,0404sn/piece to 0,0485 second/piece. Consequently, an increase of 20% in average was seen in both of new and classical OEE.

**Table 3: Comparison of Performance Ratios**

| **DATA NO** | **4** | **8** | **12** | **6** | **0** | **24** |
|---|---|---|---|---|---|---|
| **Cycle Time** | 0,0404 | 0,0404 | 0,0404 | 0,0404 | 0,0404 | 0,0404 |
| Classic OEE | 0,289 | 0,339 | 0,322 | 0,281 | 0,263 | 0,285 |
| New OEE | 0,289 | 0,340 | 0,322 | 0,282 | 0,263 | 0,285 |
| **İncreased Cycle Time** | 0,0485 | 0,0485 | 0,0485 | 0,0485 | 0,0485 | 0,0485 |
| Classic OEE | 0,346 | 0,407 | 0,387 | 0,338 | 0,316 | 0,342 |
| New OEE | 0,346 | 0,408 | 0,387 | 0,339 | 0,316 | 0,342 |
| Classic OEE İncreasement (%) | 19,72 | 20,06 | 20,19 | 20,28 | 20,15 | 20,00 |
| New OEE İncreasement (%) | 19,72 | 20,00 | 20,19 | 20,21 | 20,15 | 20,00 |

It was observed that whether there was difference between both methods in terms of quality losses by increasing the quality loss values of data whose quality loss number was zero (1, 3, 9, 15, 19 and 23), excessively. In the end, a small increase was seen in favor of the new OEE approach. Thus, classical OEE approach is affected from changes in quality loss number. This result reveals the reason of difference between two calculation methods in terms of printing press application.

**Table 4: Comparison of Quality Ratios**

| **DATA NO** | **1** | **3** | **9** | **15** | **19** | **23** |
|---|---|---|---|---|---|---|
| **Quality Losses** | 0 | 0 | 0 | 0 | 0 | 0 |
| Classic OEE | 0,414 | 0,442 | 0,431 | 0,353 | 0,459 | 0,348 |
| New OEE | 0,414 | 0,442 | 0,431 | 0,353 | 0,459 | 0,348 |
| **İncreased Qaulity Losses** | 20.000 | 20.000 | 20.000 | 20.000 | 20.000 | 20.000 |
| Classic OEE | 0,352 | 0,378 | 0,349 | 0,260 | 0,383 | 0,220 |
| New OEE | 0,375 | 0,400 | 0,383 | 0,293 | 0,410 | 0,273 |
| Classic OEE İncreasement (%) | 14,98 | 14,48 | 19,03 | 26,35 | 16,56 | 36,78 |
| New OEE İncreasement (%) | 9,42 | 9,50 | 11,14 | 17,00 | 10,68 | 21,55 |

According to data obtained from printing press where application was performed; very important part of the total available time is consisted of waiting period wasted for the arrival of image of next page in printing procedures and preparation of blocks (raw material waiting period). 236,52 minutes' part of the total available period of 476,4 minutes realized as partial image and block waiting period on 28.03.2015. Waiting period in which personnel and machinery are present is ignored since downtime losses are not included into OEE calculations. Non-inclusion of such high time losses into effectiveness measurement of production tools may reveal the question of whether production effectiveness can be properly measured or not.

Maximum 55.000 pieces are produced in an hour in the printing press as long as extraordinary situation does not exist. If production rate is increased, failure number and time wasted for eliminating the faults also increase. Also, time wasted for restarting the production after paper breaking in case of probable electricity cut-off is increasing in direct proportion to production rate. Besides, increasing the production rate has no return on the printing press. That is, it can be said that this production rate level is optimum production rate for the printing press and the said production rate was obtained as a result of studies conducted for four years. However, since theoretical capacity of machinery is suitable for making 90.000 productions in a hour, the difference within the framework of OEE calculations is considered as rate loss and it reduces the OEE index. Also, time earned by increasing the rate increase may be excluded from OEE calculations as closing loss. Thus, OEE indicators will improve but there will be too long gaps which are not included into the account.

According to results obtained, the question of how much proper taking the theoretical capacity of machinery as a basis directly is without taking conditions of product produced, production system and sector into account in OEE calculations, arises. Using the optimum production capacity to be determined with scientific methods in line with production conditions, instead of theoretical capacity of machinery in OEE calculations may give more accurate results in terms of sectors having specific conditions like newspaper printing press sector. In the light of explanations given above, developing a new OEE calculation method by taking specific conditions into account may provide more accurate results to be obtained in daily newspaper printing press sector. More general results will be reached and more definite results will reveal with application of OEE calculation methods in different firms operating at printing press sector, based on this study.

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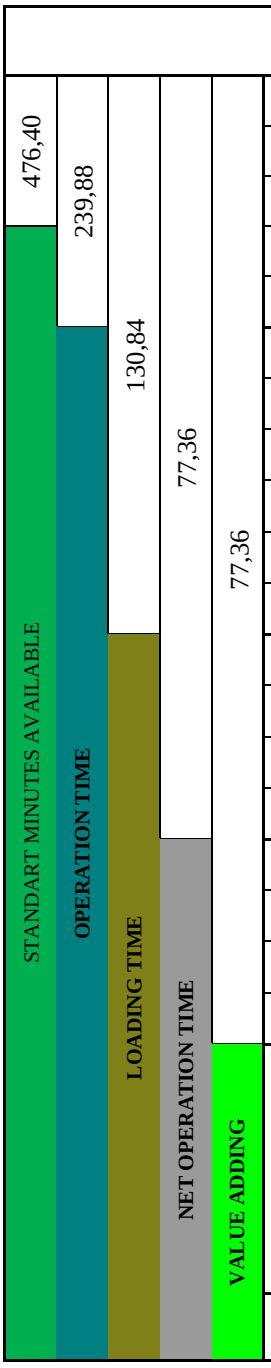
APPENDIX-1: Summary Classic OEE Calculation Table




| **28/03/14** | |
|---|---|
| **DOWNTIME LOSSES** | |
| Electrical Interruption | 0,00 |
| Pressurized Air Interruption | 0,00 |
| Waiting for Raw Material | 236,52 |
| **Total Downtime Losses** | **236,52** |
| **AVAILABILITY LOSSES** | |
| Breakdown | 39,72 |
| Set Up and Tooling | 58,00 |
| Inefficient Starting | 11,32 |
| **Total Availability Losses** | **109,04** |
| ***AVAILABILITY (%)*** | ***0,55*** |
| **PERFORMANCE LOSSES** | |
| Speed and Momentary Slowdown Losses | 53,48 |
| **Total Performance Losses** | **53,48** |
| ***PERFORMANCE (%)*** | ***0,59*** |
| **QUALITY LOSSES** | |
| Scrap | 0,00 |
| **Total Quality Losses** | **0,00** |
| ***QUALITY (%)*** | ***1,00*** |
| **VALUE ADDING TIME** | **77,36** |
| **CLASSİC OEE** | **0,322** |

APPENDIX-2: Summary New OEE Calculation Table

| **28/03/14** | | | | |
|---|---|---|---|---|
| STANDART MINUTES AVAILABLE 476,40 | OPERATION TIME 239,88 | LOADING TIME 130,84 | **DOWNTIME LOSSES** | |
| | | | Electrical Interruption | 0,00 |
| | | | Pressurized Air Interruption | 0,00 |
| | | | Waiting for Raw Material | 236,52 |
| | | | **Total Downtime Losses** | **236,52** |
| | | | **AVAILABILITY LOSSES** | |
| | | | Breakdown | 39,72 |
| | | | Set Up and Tooling | 58,00 |
| | | | Inefficient Starting | 11,32 |
| | | | **Total Availability Losses** | **109,04** |
| | | | ***AVAILABILITY (%)*** | ***0,55*** |
| | | | **PERFORMANCE LOSSES** | |
| | | | Cycle Time | 0,04 |
| | | | Total Throughput | 114884,00 |
| | | | Cycle Time/Actual Run Time | 194316,83 |
| | | | ***PERFORMANCE (%)*** | ***0,59*** |
| | | | **QUALİTY LOSSES** | |
| | | | Quality Losses | 0,00 |
| | | | ***QUALITY (%)*** | ***1,00*** |
| | | | **NEW OEE** | **0,322** |