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# Analyzing Effects of Obeya – A Productivity Enhancement Philosophy & Tool Using SPC

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**Abstract:** Production assembly line is a very critical and important area of an industry as every product is unique and has distinctive manufacturing processes after the minor changes of difference in raw materials, work order machining, on floor bottleneck issues and others limitations. There are different production practices carried out by small and medium enterprises based on different production factors like Quality, Raw material shortage, Work order monitoring, Production time, and less revenue. Similarly, OBEYA is a lean engineering production practice pioneered by Toyota Production System (TPS) and later adopted in range of automotive industries. OBEYA focuses on enhancement of production performance and tools along with feedback from the departments. In this research, an empirical study was conducted implementing process control tool on an industry to study and analyse results before and after OBEYA implementation. The analysis in production process improvement was carried out using Statistical Process Control (SPC) methodology. SPC is used to bind the variation between the permissible tolerances, as it is inevitable part of any process. This paper discusses planning and implementation of SPC with lean technique (OBEYA) to study the effects on production system and eliminate the perception of OBEYA to be purely on automotive industry technique. The results of the approach supports the methodology developed and its implementation in a case industry producing ceiling fan.

**Key Words**: Fan, Obeya, Lean production, SPC

## Introduction

Production processes are very critical and important area of an industry. Most of production problems regarding lean management such as Production time, Raw material shortage, Cost of end product due to high inventories level, and less productivity are faced by the manufacturing Industries (Shah & Ward, 2003). This research reports development and identification of a method that can be employed for efficient production practice in SMEs like fan industry. Lean production activity is optimising the product development, value chain analysis and shop floor management under controlled circumstances (Warnecke & Hiiser, 1995). Development of lean manufacturing systems is compulsory due to energy crises and high cost of industrial stuffs, machinery and manpower involved (Begam, Swamynathan, & Sekkizhar, 2013) with the benefits of reduced wastage, improved lead times, reduced rework and work in process utilizations and increased financial savings (Melton, 2005). From last four decades in the developed countries, the lean production management has a vital role in manufacturing and process industries (Shah & Ward, 2007). Lean manufacturing was implemented in different manufacturing industries and developed relative approaches that incorporate different techniques like, Obeya, Value Stream Mapping, Kaizen, Total Productive Maintenance, Kanban, etc. to focus on wastages and produce cost-effective products due to deteriorating financial situation along with strong market competition (Sullivan, McDonald, & Aken, 2002).

Lean techniques of production processes can be achieved by introducing OBEYA (Morgan & Liker, 2006). Obeya (Lean production technique) was developed by Toyota. Its literal meaning is 'Big Room' which is an information centre in practical terms. In late 90's, Obeya concept was familiarized during the development of Toyota Prius car and later it has become a typical tool for the process of product development in Toyota ( Liker, 2004). Obeya is implemented through the use of charts, participation of responsible persons from various departments involved in the decision making along with using colour thumb pins and threads (Morgan & Liker, 2006; Man et al. 2012). This leads to higher level of cross-functionality in the department (Alfredson, 2009). Participants are Cross-functional team, and would typically include all main support function of an organization represented such as Production, Product planning and control, Quality, Procurement, Marketing, Finance etc. In order to require production practice solution, we studied thoroughly what is Obeya, how is it used, what characteristics must be covered, and how Obeya is mapped. Exhibit 1 represents an Obeya meeting room for management authorities in the industry used as case industry.

Insert Exhibit 1 here

Experimental study using statistical process technique was done before and after implementing Obeya in case industry. Statistical process control (SPC) is a widely used method to control manufacturing processes. SPC is defined as the application of statistical tools to control a process. In all manufacturing processes, we need to know that up to which level the production meet the required specifications. The divergences and variability from targeted production are main specifications to diminish from the production assembly line by using SPC. Two types of control charts are typically used in SPC; X-bar (average) charts and R (range) charts. These are used to confirm that if a process is stable and in control. The research carried out by academic and industry linkage, focusing on production practice (OBEYA), could optimize the production assembly line of the Industry producing ceiling fan by using statistical process control. On completion of the project, the case study factory had a much higher production capability with high efficiency and reduced deflection rate. Increased efficiency reduced unit cost. Industry was able to identify problem areas and apply remedial measures ensuring future success.

**Methodology**

The research methodology consists of six stages. At first stage, a detailed review of the similar industry processes and literature was done. It helped to identify the current state of production technology, issues and research trends in the field because existing theories and methods is highly relevant for discussions related to improving complex processes. In worker productivity, task identification has core importance (Drucker, 1999). Most importantly, this study highlighted knowledge gaps using production flowchart and industrial department's layout. The resulting flowchart of the case industry of this first step has been presented in the next section.

The second and third stage of the methodology involves the transformation of the identified knowledge gaps into clearly defined research objectives. There are two main research objectives identified, namely:

- Collection of data and discretization of production departments.
- Track Statistical Process Control & Formulation of departments charts.
- Obeya lean technique optimization and analysis with the help of SPC results.

At this step the assumptions and limitations that govern the developments of this study are clearly defined. Also, it was decided to focus the research efforts on Lean principle Obeya. As a result, the proposed lean technique described in this research is expected to be more beneficial to such structures which will be supported using statistical analysis. The third stage of the research methodology involves the execution of the necessary activities towards achieving the core research objectives like flow chart and Obeya charts for the departments. These developing activities and implementing Obeya forms in case industry lead to the achievement of the research objectives also described in the next two sections.

The fifth and sixth stages of the methodology involve the validation of the models and methods developed. To achieve this combination of analytical and experimental approaches will be utilized. As part of this step of the methodology a fully-active Obeya system is proposed supported by Statistical analysis. Furthermore, a prototype run, which is based on this concept, is developed, serving as the platform for all experimental validation processes. The fifth and sixth stages are elaborated in results and conclusion sections.

The first three steps of the methodology occur sequentially. However, the third and the fourth step of the research methodology were executed concurrently as one affects the other. Presenting the particulars of the fourth step before the developments within the third step, shall facilitate and enhance the reader's understanding of fully-active lean production technique, tools and methods proposed through in study. For this reason, the concept of a fully-active (Obeya) lean technique, designed for the needs of this work. The research implementation methodology is briefly explained in Exhibit 2.

Insert Exhibit 2 here

**Collection of Data and Production Flow Chart of The Case Industry**

The manufacturing layout is an integral part of an industry. The performance of the industry is highly dependent on the design of process flow chart of the production and departmental layout. The process flow chart represents the analyses of current scenario, and also to understand the functional dynamics of the industry. The sample fan industry flow chart is illustrated in Exhibit 3.

Insert Exhibit 3 here

The sample Fan industry is manufacturing a wide range of durable, unique, and first class fans, expendable in domestic usage. In 1987, the sample manufacturing industry was appeared on the horizon of fan industry. The products are exported to Middle East, African and Asian countries. The sample industry fan are certified by the Pakistan Standards and Quality Control Authority (PSQCA) and also by international authorities like European Conformity (CE Certification) and ISO 9001:2008. It believes in consolidating the lifelong affiliation with all shareholders by giving the very standard fans, keeping in view a strong influence towards the success of the country.

We collected the targeted and actual production data of 5 different models (fan brands) in the case industry for implementing SPC. The data is in percentage and the fan brands denotes as A,B,C,D and E in Exhibit 4.

Insert Exhibit 4 here

By using the SPC formulation and experimental data, we have concluded the results as shown in Exhibit 5.

Insert Exhibit 5 here

The average chart represents actual production parts and its variation with respect to time. Average chart is representing experimental data of the case industry before implementation of Obeya, in average line, mean, upper and lower specification limits i.e. USL=50 % and LSL=45 % fans , Upper and lower control limit as illustrated in Exhibit 6.

Insert Exhibit 6 here

Range chart shows the range of samples and its variation. Range chart consists of upper control range limit and data line. Range chart has only one limit i.e. Upper Control limit because range cannot be negative.

$$UCLr = D_4 \times \overline{R}$$

Where $D_4$ is the constant value of control chart that depends on the subgroup size (where $D_4$=2.114 for 5 subgroups). The difference between the smallest and largest value in a set of data is called R (range) and average of these values is known as $\overline{R}$.

$$R = Max(A) - Min(A)$$

$$\overline{R} = \frac{1}{n}\sum_{i=1}^{n} R_i$$

By using the above formula the average and range values shown in Exhibit 7 and illustrate in range chart.

Insert Exhibit 7 here

**Developing and Implementing Obeya Forms In Case Industry**

Set a room for OBEYA. Green board, coloured pins, threads but no chairs and Exhibits required. All Supervisors / Managers of different departments meet once every week at a fixed time in the OBEYA room. To understand Obeya chart, we developed a sample chart for machining department presented in Exhibit 8.

Insert Exhibit 8 here

In Obeya charts, form were characterised in three main fields; time, Production targets and deficiencies. Production targets were categorised in proposed, actual and pending/defective parts. Deficiencies must be represented according to the issues which may occur or faced by the departments as illustrated in Exhibit 9.

Insert Exhibit 9 here

All Supervisors / Managers display their targets on the green board. Targets are discussed and problems are solved in front of everyone. Decisions are made within minutes rather than days as Obeya is an innovation support tool for production system development in this research. The key objective of Obeya is immediate judgment in making, direct conclusion implementation, striking off the deceased subjects, decreasing the revision and reassessments issues, and drop the redundant negotiations due to this activity (Blankenburg et al. 2013). Targets and problem solutions are discussed among themselves and all have access to the incumbents indication at the same time (Aasland, & Blankenburg, 2012).

Insert Exhibit 10 here

For the sample ceiling fan industry, we developed the OBEYA chart presented in Exhibit 4 according to their different departments like, Finance, Sales Production Planning and Control, Die Casting, Winding, Armature and Rotor, Fitting, Painting, Packaging Section and machining section. One of the departments' deficiencies were highlighted in Exhibit 10. After implementation of Obeya in the sample industry, findings and targets are presented in Exhibit 11.

Insert Exhibit 11 here

**Results Analysis and Feed Back**

After one month of Obeya implementation, data collection, departmental deficiencies and bottlenecks points were visible and an obvious production difference is shown in Exhibit 12.

Insert Exhibit 12 here

Production Percentage increased from 45-46 to around 77-78 as shown in Exhibit 13. Exhibit 14 shows SPC results with mean value of the production after implementing Obeya. It has noticeable progressive change i.e. 77.5 percent which means production increase is 30 percent (47.3-77.5).

Insert Exhibit 13 here

Insert Exhibit 14 here

Results were checked before and after implementation of Obeya with the help of Statistical process control (See Exhibit 15 & 16). It shows 28 to 30 percent of production increases as illustrate in SPC charts after implementing Obeya. Departments have an advantage of increasing production efficiency through identification and elimination of departmental deficiencies by using the methodology.

Insert Exhibit 15 here

Insert Exhibit 16 here

The first week production targets are going to pending phase due to machining workshop. The extended problematic areas are shown in red circles and intermediate problems defined as yellow circles. Machining workshop has less production because it faced twice manpower issues and once maintenance problem. Fitting section faced extended problems 8 times; painting section 7 times, machining section 5 times, motor inspection section 4 times and packaging section faced least extensive problems i.e. 3 times, which can be seen in Exhibit 12.

First day proposed production target was 400 parts, out of which 324 were actually produced while 76 were pending and accumulated in the production plan for the next day. The first day Production efficiency was, therefore, 81%. Actual Production efficiency steadily increased over the month and pending production targets gradually decreased. On the last day of the month, proposed production target was set for 465 fans, out of which 421 were produced, leaving only 44 fans pending for the next working day at an efficiency of 90%. Previously low production efficiency i.e. 81% was recorded mainly due to high rejection rates, bottleneck points and lack of storage utilization in work process. Work in process storage utilization have controlled efficiently in the manufacturing industry by using the Lean management technique (Demeter & Matyusz, 2011). After one month of Obeya implementation the production efficiency increased to 90% through rectification of aforementioned problems; illustrated in Exhibit 17. The chart below highlights changes in various criteria for measuring production efficiency through implementation of Obeya.

Insert Exhibit 17 here

## How Obeya Helps Practicing Engineering Managers

Obeya helps industrial managers to track production issues more efficiently and accurately. All different departmental supervisors/ managers meet every week at fixed time at the Obeya room. They display their targets and issues on the board with the help of colored pins i.e., red pin : dangerous zone, Yellow: issues zone and White : No problem zone. when all departmental supervisors display their pins according to level of severity of their issues . Industrial manger easily observe the production work order, progress of production schedule, consecutively red zone departments, maintenance and labour issues and raw material shortage etc. He inquire first of all red zone portion issues and then yellow zone. No one can bluff the practicing engineering manger because at that specific time all concerning departmental head are present. Decision and issues resolved in front of everyone within minutes rather than days. The few benefits of Obeya for Practicing managers are:

- Obeya facilitate the practicing managers to decrease the management load
- Problems will be resolved much faster
- Efficient Monitoring and solving of problem areas
- Identification problem areas and key players that cause delay
- Higher efficiency and improved productivity

## Conclusion

OBEYA is a very simple tool with considerable benefits for SMEs. Industrial growth leads to a stage where micro-management of production processes directly becomes impossible for managers. This is mostly due to time spent on coordination between growing departments on inter-dependent projects or processes. OBEYA offers a simple solution to detailed departmental meetings on daily bases. Production process management is simplified by quick identification of problem areas on the production floor and rapid decision making to address the issues. The implementation of OBEYA in the case study organization and SPC analysis has resulted in excellent results. The practice can be adopted across small and medium industries with slight modifications offering similar outcomes. Production costs in the case study organization were brought down by 9% after one month of OBEYA implementation supported by SPC. The improvement was a result of bottleneck processes management and reduction in waiting times.

**Future Research**

OBEYA has been implemented in some industries in a digitalized manner hence increasing its capabilities even further. PSA Peugeot Citron has implemented iOBEYA to some of its operations with excellent results. Further studies can be conducted on customizing the techniques for implementation in SMEs. Smart iOBEYA would enable enhanced flexibility and visualization of production floor activities hence further simplifying decision making process with focus on problem identification. iOBEYA may be merged with statistical analysis technique to monitor the improvement on production floor and in other departments of organization.

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**Exhibits**

**Exhibit 1: Obeya Room**

**Exhibit 2: Research Implementation Methodology**

**Exhibit 3: Process Flow Chart**

**Exhibit 4: SPC Data Collection Chart Before Implementing Obeya**
**Exhibit 5: SPC Results Before Implementing Obeya**
**Exhibit 6: Average Chart Before Obeya Implementation**

**Exhibit 7: Range Chart Before Obeya Implementation**

**Exhibit 8: Sample chart for Machining Section**
**Exhibit 9: Departmental Chart**

**Exhibit 10: Departmental deficiencies Chart**

**Exhibit 11: Findings and Targets**
**Exhibit 12: Comparison Result Chart**

**Exhibit 13: SPC Data Collection Chart After Implementing Obeya**

**Exhibit 14: SPC Results Chart After Implementing Obeya**
**Exhibit 15: Average Chart After Implementation**

**Exhibit 16: Range Chart After Obeya Implementation**
**Exhibit 17: Comparison Result Chart**

**Exhibit 3: Obeya Room**

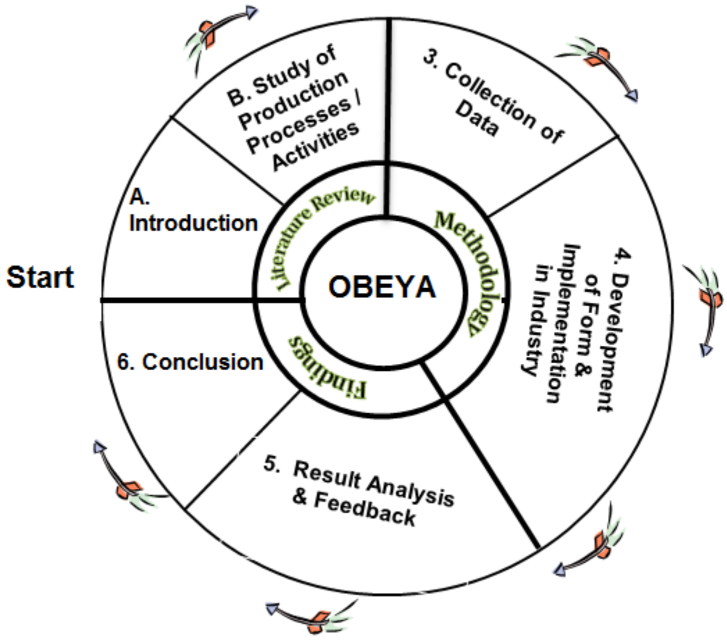


**Exhibit 4: Research Implementation Methodology**

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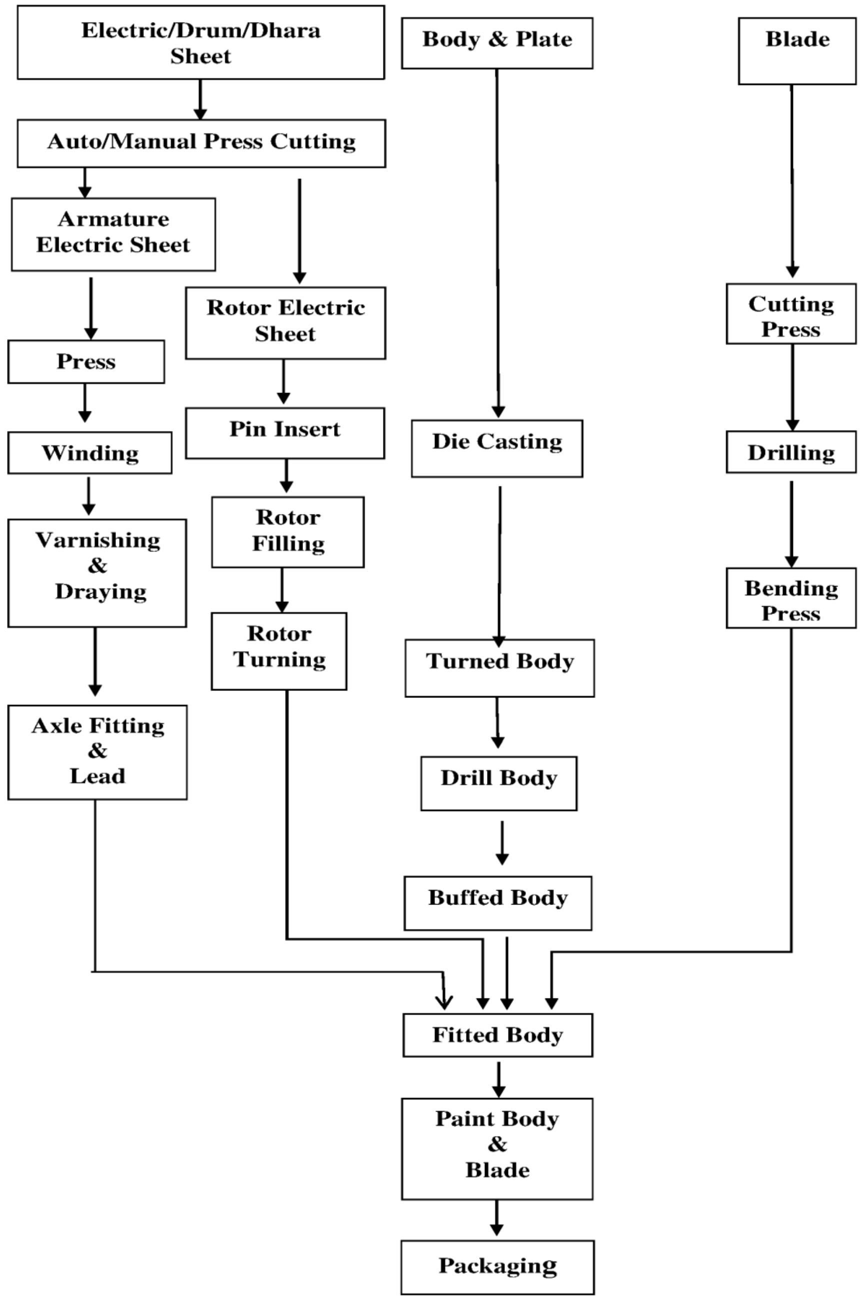



**Exhibit 3: Process Flow Chart**

| Days | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Models | A | 47 | 46 | 48 | 45 | 48 | 45 | 47 | 48 |
| | B | 49 | 48 | 46 | 46 | 48 | 47 | 49 | 48 |
| | C | 48 | 47 | 48 | 47 | 47 | 46 | 48 | 48 |
| | D | 49 | 50 | 46 | 48 | 46 | 48 | 49 | 47 |
| | E | 48 | 47 | 47 | 47 | 48 | 46 | 47 | 47 |
| SUM | | 241 | 238 | 235 | 233 | 237 | 232 | 240 | 238 |
| AVG | | 48.2 | 47.6 | 47 | 46.6 | 47.4 | 46.4 | 48 | 47.6 |
| RANGE | | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 1 |

**Exhibit 4: SPC Data Collection Chart Before Implementing Obeya**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MEAN | 47.35 | $\bar{R}$ | 2.375 | Sigma bar= | 0.639195923 | UCLr | 5.02075 |
| USL | 50 | LSL | 45 | UCL | 48.72038 | LCL | 45.97963 |

**Exhibit 5: SPC Results Before Implementing Obeya**

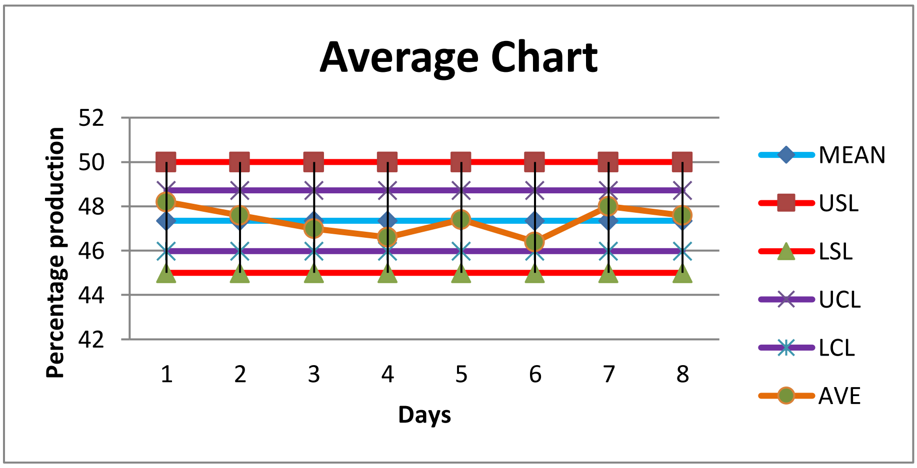



**Exhibit 6: Average Chart Before Obeya Implementation**

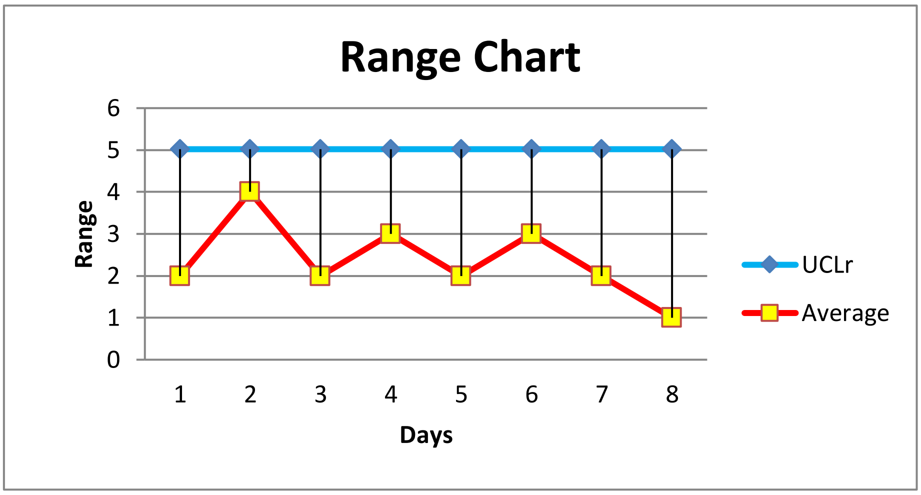



**Exhibit 7: Range Chart Before Obeya Implementation**

| Four Week Action Plan (OBEYA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Machining Workshop | | | | | | | | | | |
| WEEKS | DAYS | | Production Targets | | | Deficiencies | | | | |
| | | | Proposed | Actual | Pending/Defective | Men Power | Raw Material | | Maintenance | |
| | | | | | | | Quality | Inventory | | |
| Week 1 | Saturday | Line 1<br>Line 2 | | | | | | | | |
| | Monday | Line 1<br>Line 2 | | | | | | | | |
| | Wednesday | Line 1<br>Line 2 | | | | | | | | |
| Week 2 | Saturday | Line 1<br>Line 2 | | | | | | | | |
| | Monday | Line 1<br>Line 2 | | | | | | | | |
| | Wednesday | Line 1<br>Line 2 | | | | | | | | |
| Week 3 | Saturday | Line 1<br>Line 2 | | | | | | | | |
| | Monday | Line 1<br>Line 2 | | | | | | | | |
| | Wednesday | Line 1<br>Line 2 | | | | | | | | |
| Week 4 | Saturday | Line 1<br>Line 2 | | | | | | | | |
| | Monday | Line 1<br>Line 2 | | | | | | | | |
| | Wednesday | Line 1<br>Line 2 | | | | | | | | |

**Exhibit 8: Sample chart for Machining Section**


**Exhibit 9: Departmental Chart**

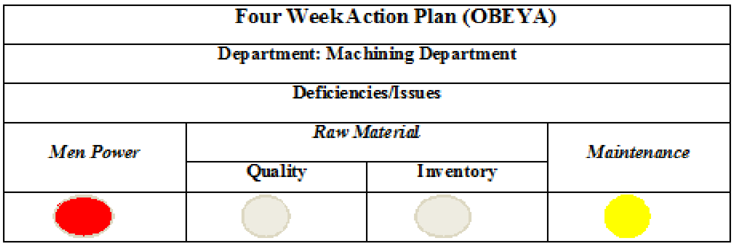
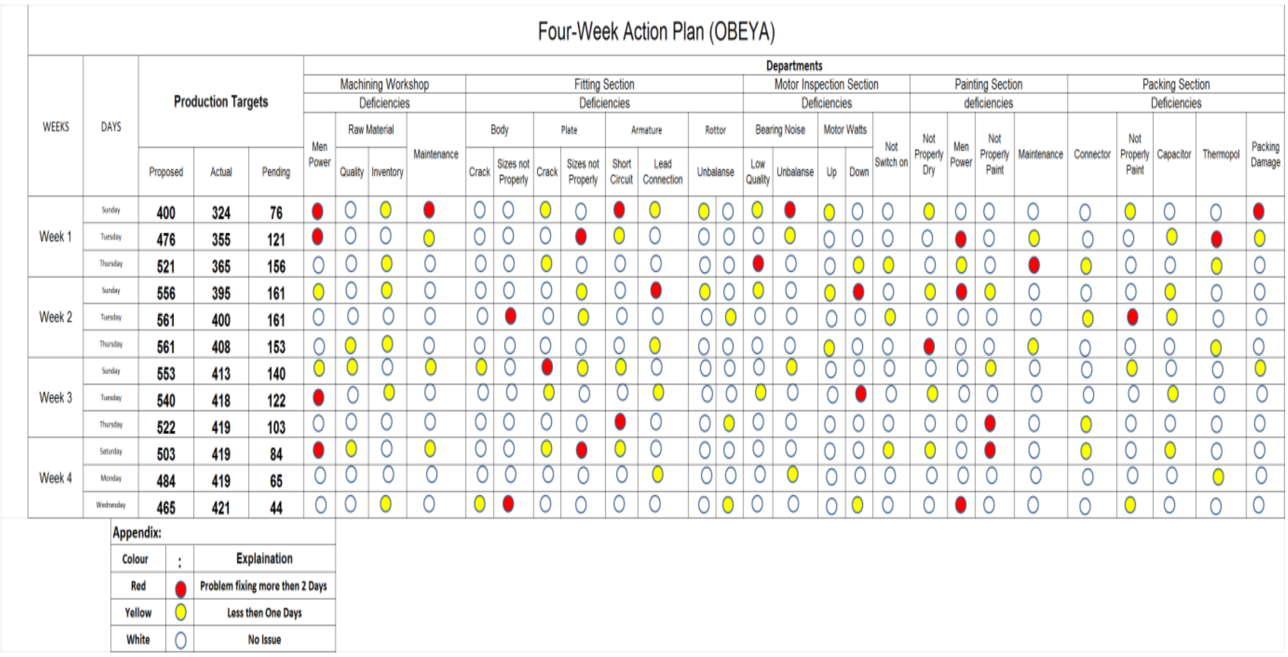



**Exhibit 10: Departmental deficiencies Chart**



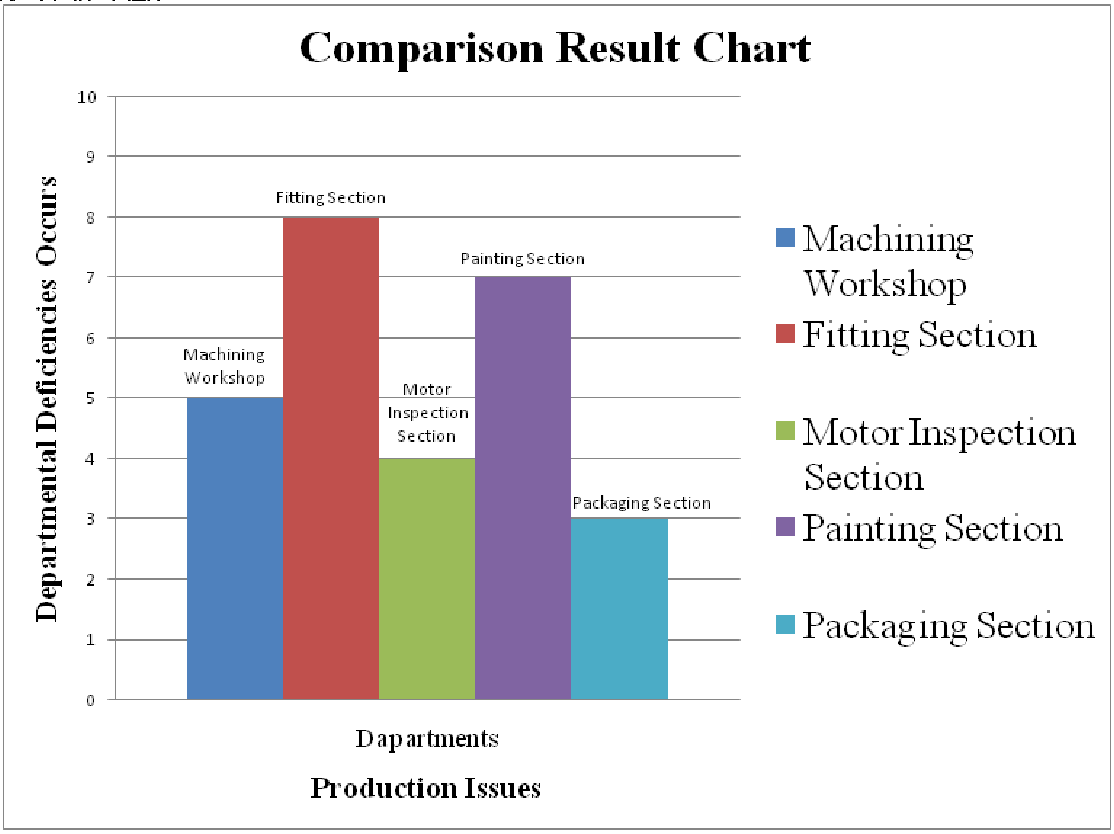



**Exhibit 12: Comparison Result Chart**

| Days | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Models | A | 77 | 78 | 77 | 76 | 78 | 76 | 78 | 77 |
| | B | 77 | 77 | 77 | 77 | 78 | 77 | 77 | 78 |
| | C | 78 | 76 | 77 | 77 | 78 | 76 | 77 | 79 |
| | D | 78 | 78 | 78 | 77 | 78 | 77 | 78 | 79 |
| | E | 77 | 79 | 79 | 78 | 78 | 78 | 78 | 77 |
| SUM | | 387 | 388 | 388 | 385 | 390 | 384 | 388 | 390 |
| AVG | | 77.4 | 77.6 | 77.6 | 77 | 78 | 76.8 | 77.6 | 78 |
| RANGE | | 1 | 3 | 2 | 2 | 0 | 2 | 1 | 2 |

**Exhibit 13: SPC Data Collection Chart After Implementing Obeya**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MEAN | 77.5 | $\bar{\bar{R}}$ | 1.625 | USL | 80 | LSL | 75 |
| Sigma bar= | 0.42761 | UCL | 78.4376 | LCL | 76.5623 | UCLr | 3.43525 |

**Exhibit 14: SPC Results Chart After Implementing Obeya**

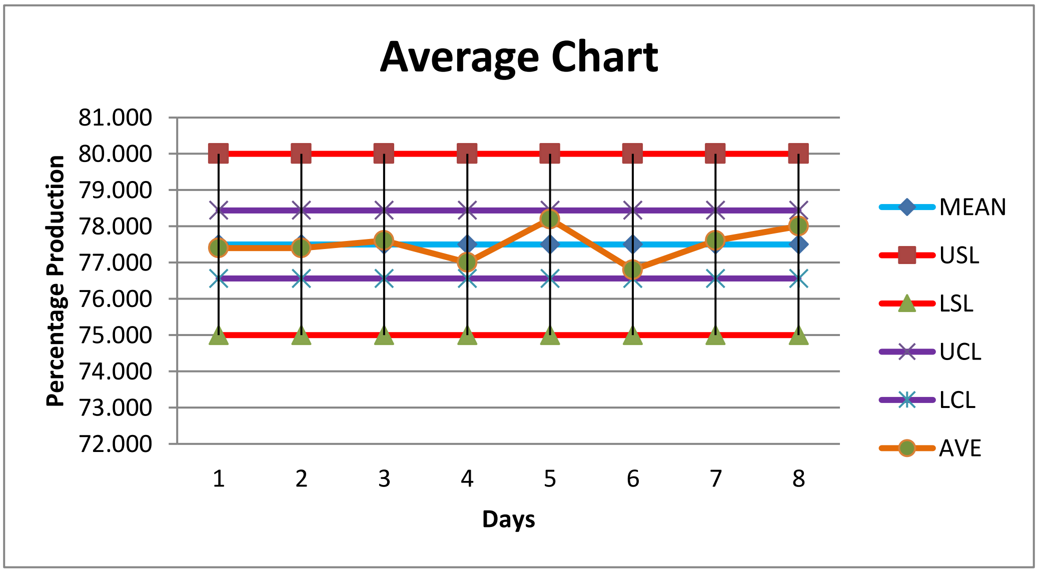



**Exhibit 15: Average Chart After Implementation**

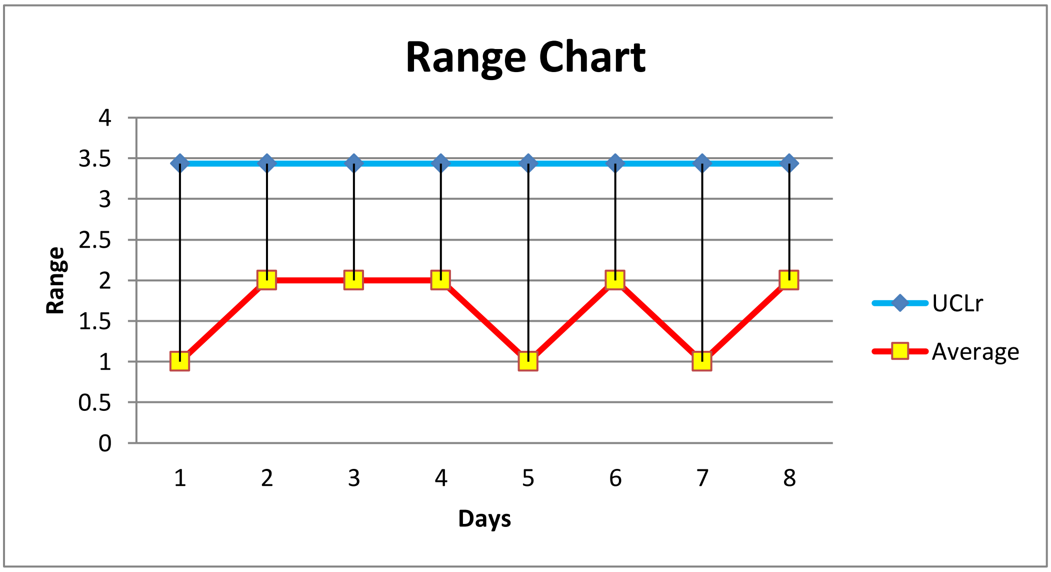



**Exhibit 16: Range Chart After Obeya Implementation**

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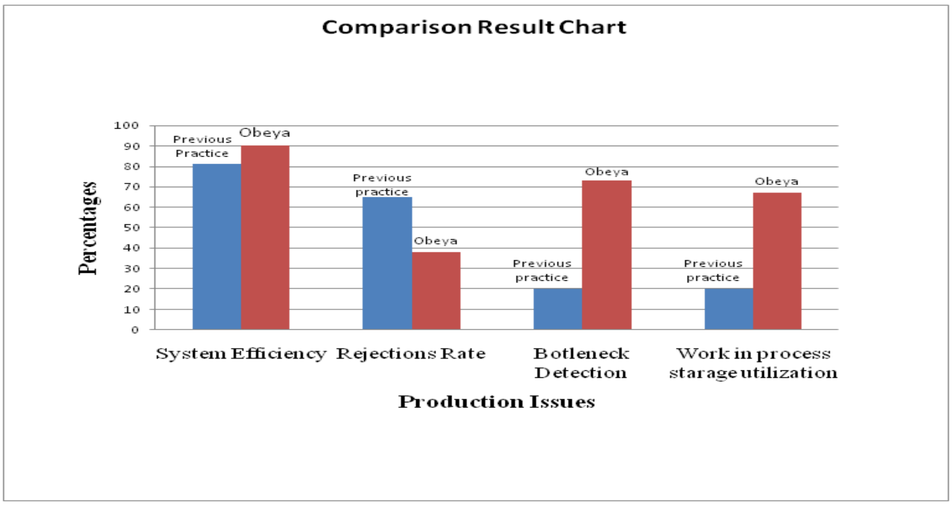


**Exhibit 17: Comparison Result Chart**